Useful knowledge about various aspects of fission product behaviour in the biosphere has already been obtained, but many important questions remain unanswered.

Considering the large increase in the construction of reactors planned for the near future, which will lead to a corresponding increase in the amount of fission products to be handled, it is necessary to intensify the efforts in this direction. In May 1958 a research project on "the factors controlling the distribution of fission products in the biosphere" was started at the First Chemical Institute of the University of Vienna under a contract with the International Atomic Energy Agency. The First Chemical Institute is headed by Professor Hans Nowotny. The project is carried out within the Department of Radiochemistry headed by Professor Engelbert Broda.

Methods of Investigation

The project will contribute to one of the objectives of the IAEA - the establishment of standards of safety for protection of health and minimization of danger to life and property. Various methods of investigation are already being applied or are in preparation as part of this research project. The distribution of some fission products, present throughout the biosphere from nuclear test explosions, is being determined to elucidate the factors governing this transport and enrichment. Further data on the uptake of fission products by certain organisms or mineral substances may later be obtained by experiments on a laboratory scale or by release of small amounts of fission products into a certain ecological environment under controlled conditions.

Detection methods of high sensitivity are required for determining the fission products in the biosphere. At the First Chemical Institute in Vienna gamma-spectrometry has been employed since the beginning of the investigation and a low-level beta-counter will soon be completed. With a gamma-spectrometer (supplied by IAEA) samples from the biosphere, such as plant ashes or residues from the evaporation of river water are measured directly. Since gamma-rays of different energies are registered separately with this instrument, gamma-emitting radioisotopes are detected individually through the characteristic energies of their radiations.

Features of beta-counter

The essential feature of a low-level beta-counter is that the background count due to cosmic rays and to the radioactivity of the surroundings is a low one. This is achieved by heavy shielding against radiation coming from the outside and by cosmic ray counters arranged around the beta-counting tube itself. With the help of these counters and a so-called "anti-coincidence" circuit, some counts in the beta-counter are automatically recognized as due to cosmic rays and are not registered. The low background value obtained in this manner permits the detection of very small activities in the material under investigation. The sensitivity of such a counter surpasses that of a gamma-spectrometer considerably. However, measurements are more difficult, since each radio-element to be determined must first be isolated by chemical techniques. Radiochemical separation methods suitable for the samples to be investigated by the research project are now being selected and checked.

In the project under way at the First Chemical Institute in Vienna particular attention is being paid to fission products with half-lives of several months. These have so far been investigated much less thoroughly than the long-lived isotopes caesium 137 and strontium 90. First results about the distribution of some of these fission products - zirconium, ruthenium and rare earths - in rivers and lakes and in vegetation have been obtained.

SAFETY WITH ISOTOPES

The world is warned at regular intervals of the possible dangers in all work connected with radioactive materials. Atomic radiation is indeed a double-edged sword. The benefits of its controlled use are enormous, and the possibilities of use apparently limitless. But every scientist knows - some of the pioneers learnt it from tragic experience - that handled with insufficient care and knowledge, radioactive substances can be a source of great harm.

Recent research has, however, made it possible to determine, with a fair measure of certainty, the effects of ionizing radiation in given conditions and decide on measures to minimize, if not altogether to eliminate, the risk of accidental or excessive exposure. But much of this knowledge belongs to specialized branches of study, and all of those handling radioisotopes in medicine, industry, agriculture and diverse other fields cannot be expected to go through the relevant specialized disciplines. The need thus arises for a brief and simple code of practice or at least a general guide for the safe handling of radioactive substances. And such a code - if it were to be thorough and dependable - could be evolved only from a pooling of knowledge and experience acquired in different fields of work and in different countries.

A panel is set up

It is with this awareness that IAEA set up a panel of thirteen scientists from ten countries to go into the question and formulate an agreed set of do's and dont's for radiation workers and others concerned. Their recommendations were recently published in the form of a handy manual called "Safe Handling of Radioisotopes". Considerable study and the widest possible consultation went into the preparation of this manual, and its possible future revisions will take into account all further expert comments and any new data that may be available.

The recommendations relate not only to the technical and medical but also to the organizational aspects of the problem. "Experience shows", says the manual, "that even the most competent worker cannot be relied upon to keep in mind all health and safety requirements while preoccupied with the successful prosecution of his work". The authority in charge of installations in which radioactive substances are stored or in any way handled are therefore called upon to make appropriate organizational arrangements for the application of safety standards. A major recommendation is that all such installations should have special officers technically qualified to advise on all points of radiation safety.

Medical care and supervision was naturally one of the principal subjects that engaged the attention of the IAEA experts. Among the general recommendations in this regard are that young persons should not be occupationally exposed to radiation, that women of reproductive age should be given special protection and that X-ray examinations, if necessary, should involve a minimum of exposure. For radiation workers in general, the essential aim is obviously to ensure that the amount of radiation to which they may be exposed in the course of their work is not excessive.

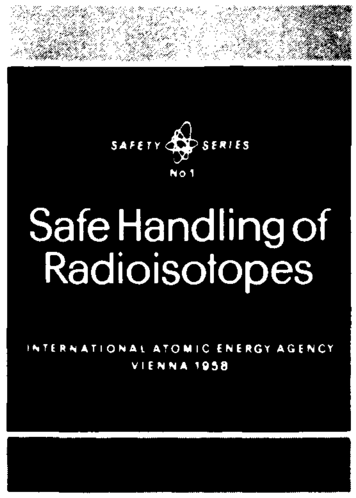
Problem of Safe Dose

There are various accepted methods to measure individual radiation exposure as well as to determine the levels of radiation in areas of work. For personal monitoring, the preferred device is a film dosimeter to be worn by each worker which would measure the dose of radiation received over a period.

Most natural objects contain some radioactive material, and one cannot be shielded against all these objects. But in most things the radioactivity is of such a low order as to be negligible. The recommendations in the IAEA manual, therefore, apply to substances whose radioactivity exceeds a certain limit. The unit of activity is the curie, and the limit is fixed at .002 microcurie per gram of material.

A related, and perhaps a more significant question, is how much radiation is safe for a human being. The IAEA experts have not presented any new conclusion on this question because this is a matter that should call for separate detailed investigation. For the time being, the recommendations of the International Commission for Radiological Protection - included in an appendix to the manual - may be accepted as a common basis for relevant measures.

A considerable portion of the IAEA manual relates to technical arrangements, operations and practices. Separate recommendations have been made



Cover of the Manual which is printed in yellow, grey and red

about sealed and unsealed radiation sources. These relate, among other things, to the design of sealed sources, shielding, methods of use, choice of the material when unsealed, design of work areas, protective clothing and control of air contamination. Storage and transportation of radioactive material are dealt with in two separate sections, while a third is devoted to steps to prevent accidents or control accident effects. Decontamination is discussed in detail in yet another section, while the final section discusses the control and disposal of radioactive waste - a subject which has already aroused widespread interest.

The IAEA experts have sought to make their recommendations as comprehensive and precise as is possible at the present time. One of the chief virtues of these recommendations is that they are framed in exact and straightforward terms so that they may be easily intelligible even to the non-expert. The importance of such direct treatment of a complex subject will be apparent when one considers the rapidly growing fields of work in which radioisotopes are being used.

The Manual received considerable attention in the technical and daily press. Some of the comments are of particular interest. "Nuclear Power" (London) writes in its February issue:

> "As yet it is difficult to decide how far the cross currents of international politics will circumscribe the efforts of the International Atomic Energy Agency. Certainly it is clear that the original vague, but ambitious, objectives are unlikely to be reached. Up to now their greatest success has attended their preparations for educational developments and the study of public health questions related to nuclear science."

After a technical review, in which attention is drawn to certain omissions in the Manual, the article concludes:

> ". . . the document marks a valuable step towards an accepted international code of practice for the handling of radioactive substances."

Under the heading "Let's get organised", "Atomic World" (London) writes:

> "Only recently Euratom issued health protection

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(a) By sending to the UAR 2 to 3 sufficiently qualified technicians (dressing engineers and hydrometallurgists) to organize the research work (for a period of six months);

(b) By having the scientific research work on preliminary samples of ores carried out by one or more Member States with sufficient experience in that field, it being understood that 3 to 4 technicians from the UAR could take part in the work (for a period of at least six months).

The better procedure, it is felt, would be the former, since it would make it easier for the UAR to carry out further work in this field. The Agency could later offer to assist the UAR in designing, equipping and setting in motion, first the experimental, and then the industrial plants for the processing of uranium and phosphorus ores.

EXCHANGE AND FELLOWSHIP PROGRAMME

By February this year, IAEA had received and considered nearly 300 nominations from 31 countries for nuclear science fellowships. More than 200 of the candidates - from 29 countries - had been selected for placement in centres of training in 21 countries. Over a hundred fellowships had actually been awarded, and more than forty of the fellows were already receiving training.

This wide scheme of training in the science and technology of nuclear energy stems from IAEA's statutory obligation to "encourage the exchange and training of scientists and experts in the field of peaceful uses of atomic energy".

The obligation is fulfilled through the Agency's exchange and fellowship programme. The programme covers three types of training:

1. General techniques training: to develop skills in the use of some fundamental techniques in the field of nuclear energy;

2. Specialist training: to prepare specialists in the theoretical and experimental aspects of the science and technology of nuclear energy;

3. Research training: to provide advanced training, including active participation in research work; this is for persons potentially qualified to develop and carry out research programmes in the basic sciences and engineering.

The duration of training varies from some weeks to five or six years. The long-duration training is given at universities or educational establishments of university level, and is of special interest to Member States lacking personnel with the requisite university education.

Programme for 1959

Under its 1959 exchange and fellowship programme, the Agency will be in a position to award over 400 fellowships. Some of these will be paid out of the Agency's operating fund, while 130 fellowships have been offered directly to IAEA by Member States for training at their universities or institutes.

There are two new features in the Agency's 1959 programme. One provides for fellowships for scientific research work. These fellowships will be awarded only to persons with special experience and knowledge in this type of work; such fellowships will enable candidates to carry out their own research work in leading scientific centres, using technical equipment not available in their own countries. It is intended that these fellowships should be of two years' duration.

The other feature is exchange of specialists. Under this arrangement, visiting professors will hold special courses in the theoretical and experimental aspects of nuclear physics, radiochemistry, etc., and visiting scientists, engineers and other specialists will give courses in special techniques applieo definite research problems. Besides, at the request of Member States, experts and consultants will be sent to advise on problems related to the development of technical and scientific personnel in universities and other institutes.

Safety with Isotopes (Continued from page 12)

rules for workers exposed to radiation, and now the International Atomic Energy Agency has published the English version of its Draft Manual for the Safe Handling of Radioisotopes. Why should we have both, especially when a lot of careful thinking and a great deal of time has gone into the correlation of these manuals?

"This is the first important example of one organization duplicating the work of another but it is the sort of thing that always happens. We should make up our minds which organization is the most important, then give it the work of co-ordinating all the international nuclear work and approving the programme of the other groups.

"If this does not happen there will be two or three sets of standards in existence and we will find ourselves creating the very conditions we are trying to resolve in other fields ......

"Really the organization that should be given the supreme job of co-ordination should be the International Atomic Energy Agency for that is the only body which is truly international."