EFFECTS OF ATOMIC RADIATION

WORK OF THE UN SCIENTIFIC COMMITTEE

BY RAYMOND K. APPLEYARD

(Dr. Appleyard, who is the Secretary of the United Nations Scientific Committee on the Effects of Atomic Radiation, has written this article for the IAEA Bulletin in his individual capacity)

By 1955 the United Nations was engaged in three approaches to problems raised by the advent of nuclear energy. In September was held the first Geneva Conference on the peaceful uses of atomic energy. In the General Assembly, the first steps toward the creation of an international Agency to promote these uses were being planned. And in December, the First Committee of the Assembly, at the initiative of India and the United States, discussed the biological effects of ionizing radiation. Out of this discussion came a unanimous resolution establishing the United Nations Scientific Committee on the Effects of Atomic Radiation - a committee of the General Assembly consisting of fifteen Member States, including the principal nuclear powers. Although the members were thus political entities, each was represented by a distinguished scientist and by this device the Committee was enabled to function as an active scientific body. The permanent United Nations missions were always available to advise the scientists on how to keep the discussions on a scientific as distinct from a political level.

Scope of the Committee's Work

The principal task of the Radiation Committee, as it soon came to be called at United Nations Headquarters, was to collect information, study and analyze it, make certain evaluations, indicate research projects of interest in its field, report progress annually to the General Assembly and submit a comprehensive report within two and a half years. It was left free from all operational or executive responsibilities - a relief of considerable benefit to the Committee's scientific deliberations.

That the Committee had to have a reasonably limited task is apparent when one examines the scientific scope of its assignment, covering levels of ionizing radiation and their effects upon man and his environment. Such a broad field of enquiry, although centred in biology, pokes fingers into almost all branches of natural science as well as much agricultural and medical science and nuclear technology, both military and peaceful. It is, indeed, a subject admirably suited to Committee treatment, since comprehensive expert knowledge of all aspects of this field is probably beyond the compass of any single mind. Even a pathologist trained in nuclear physics, widely read in geophysics, statistical genetics, animal metabolism and meteorology would be rare: yet he might suffer from deficiencies in his knowledge of grain crops, soils, diets, cytology, cellular physiology, fundamental radiobiology and physical chemistry, to name only a few obvious aspects.

Between its formation and the submission of its comprehensive report in July 1958, the Radiation Committee held five sessions, roughly at the rate of two per year. Successively, in these, it considered the scope and organization of its work, discussed certain technical subjects of immediate importance, outlined the form and content of its comprehensive report, drafted the report, and adopted it. After the General Assembly at its thirteenth session asked the Committee to continue its useful work, the Committee again began to plan its future activities at its sixth session, held last March.

Method and Organization of Work

The Committee received over 200 special reports from governments in the two years during which it was actively preparing its comprehensive report, all of which had to be studied and related to the prodigious normal output of scientific literature in its field. It consequently felt that its work during Committee sessions needed to be supplemented by a continuing activity. Accordingly, a small staff of scientists, maintained at United Nations headquarters since the middle of 1956, has carried out preparative work for the Committee. The willingness of top-level experts, often members of national delegations and busy at home with their own research, to give up a year of their time to review material for the United Nations remains a remarkable tribute both to the public spirit of the scientific community and to the prestige of the organization - notwithstanding the sad truth that it is good for most of us to take a year off and review our own speciality in a wider and perhaps more human context.

The Committee's own methods of work were deliberately chosen to be as relaxed, flexible and informal as possible, as might have been expected of a group of men of great experience in international technical discussions. Plenary sessions with formal records have been few and more or less confined to such business as the adoption of previously agreed resolutions or documents, election of officers, discussions of the time and place of meetings and other such necessary arrangements.

By contrast, the substantive work of the Committee has invariably been carried out without formal record in informal working groups, whose proceedings may or may not be summarized for the main Committee by rapporteurs. Unrecorded meetings of such

working groups in closed sessions have the great advantage of freeing the necessary bluntness and give-and-take of scientific discussion from political overtones. Perhaps for this reason, there have always turned out in the Radiation Committee to be more differences between biologists and physicists studying different aspects of the same problem than between the scientific representatives of different countries. There has been no pressure for all the national delegations to be represented in any one group: indeed, the composition of a working group can fluctuate from day to day with the precise angle under discussion, since just those most actively interested and able to contribute will normally attend each session. In fact, countless trials have shown that all one needs for a thoroughly successful technical working group is a tough problem, a good Chairman and a blackboard and plenty of chalk. The Radiation Committee was blessed from the start with an ample supply of the first two of these commodities: it has never been difficult for the United Nations to supply the others.

Nature of Investigations

The Committee was originally asked by the General Assembly to report progress annually, and to submit a comprehensive report by July 1958, two and a half years after its formation. At that time, it felt strongly that one of its first tasks was to fit different parts of the vast technical complex of radiation levels and their effects into perspective and in relation to each other. For that reason, its annual progress reports did not, up to 1958, contain substantive conclusions, all of which were held back for the comprehensive analysis presented to the thirteenth session of the General Assembly. Moreover, all the measurements of radiation levels with which this Committee was concerned are, in fact, of interest solely as measures of the causative agent of some biological effects. For example, it is necessary to study the biology of leukaemia or genetic mutation before one can decide just what tissue doses to calculate, and, having calculated these, one must go back and apply biological considerations appropriate to the doses and dose rates concerned, so as to estimate the end-effects. Thus all the separate physical and biological aspects of this field are more intimately interwoven than is sometimes realized.

Early in its work the Radiation Committee made two other decisions which were to influence the outcome of its deliberations. First, in line with the principles of scientific enquiry, it agreed to include in its report all minority views in extenso. This relieved the membership of any possible burden of seeking an artificial unanimity. When the report was completed, however, only a single paragraph lacked unanimity and needed to be accompanied by statements of dissenting minority views. Secondly, although the Committee's mandate covered the whole radiation field, it was born in an atmosphere of anxiety about radioactive fallout, and it decided to centre attention in its first comprehensive report upon one concrete technical problem: calculation of the hazards to the population

The Radiation Committee in session at UN headquarters. Left to right, around table, front row: Professor R.M. Sievert (Sweden), Chairman; Dr. R.K. Appleyard, Secretary; Dr. G. Failla, of the ICRP/ICRU; Dr. Shields Warren (USA); Dr. E.E. Pochin (UK); Dr. M.E.A. El-Kharadly (UAR); Professor A.M. Kuzin (USSR); Professor T.O. Caspersson (Sweden); and Dr. Manuel Martinez Beaz (Mexico)

of the world from that origin. Perhaps too much has been made of the results of the Radiation Committee's attempt at this analysis - for which indeed it explicitly set very wide margins of uncertainty - to the extent that the importance of such an attempt being made at all has been overlooked.

In view of the public and scientific controversy in this area, it should not be difficult to realize that the decision to make such a calculation, however cautious, and to publish actual numbers in black and white, was itself an act of courage on the part of the representatives: it had not previously been done in the public report of an official body, even in the reports of the national groups submitted to the Committee, and perhaps could not have been done except by a body secure in its inter-governmental authority and its consequent ability to marshal the collective expertise of fifteen Member States in the scrutiny of its conclusions.

In the outcome, this serious attempt at a full and extraordinarily complex calculation certainly proved to be the best method by which the factors entering into the estimates could be correctly identified and the uncertain and unknown ones pinpointed. A particularly clear and original analysis of this kind was given in a working paper of the Committee attached to its report to the General Assembly. This paper considered at great length the steps which need to be gone through in making a calculation of the possible incidence of leukaemia resulting from the fallout of radioactive strontium. A minor example of the sort of thing that can come out of such an analysis may be given here. Many people had not realized before this calculation was made that the peak in the distribution of strontium-90 as a function of latitude coincides in a remarkable way with the peak in the distribution of the human population as a function of latitude. This coincidence may have an underlying meteorological causation, but independently of that, it certainly contributes an unexpected factor of 2 to any estimate of global fallout hazards.

A further feature of this Committee's comprehensive report was the attempt to document every statement with detailed arguments and full references to the original material in the scientific literature or record. Again the Committee thereby adhered closely to the best traditions of science by giving full opportunity to those experts not associated with its work to see, examine, and, if they wished, to disagree with its sources, arguments and conclusions. In consequence, the Committee's report is backed by several massive annexes which by themselves constitute reviews that have been of value both for teaching and advanced study.

It was a matter of considerable interest to many of those concerned with it to see how the committee's comprehensive report of 1958 would be received, both by the scientific community and by the world at large. If the reviews of this report in serious scientific journals are any guide, the document has been read with great attention and in great detail by very many experts, and has provoked them to a good deal of thought, some of which has found expression in constructive criticism or commentary supplementing general agreement. Such criticism is, of course, welcome, and indeed avowedly sought by the Committee.

At governmental level, the General Assembly at its thirteenth session not only congratulated the Committee upon its labours, but showed its confidence by calling upon it "to continue its useful work and report to the General Assembly as appropriate", thereby freeing the Committee further to act upon its own initiative rather than upon detailed instructions.

Role in UN Family

It may indeed be asked why the central body making scientific evaluations of the radiation problem within the UN group of organizations should be located within the UN itself. Partly, of course, this is historical, but there are other good reasons for it. Radiation as a biological hazard to man is, in the first instance, a problem of public health, but it and its regulation have, of course, tremendous overtones for any atomic energy programme, or any agency involved in the promotion of such programmes. The existence and magnitude of the hazard are also of great concern to any organization concerned with the health of workers or with food and agriculture. But radiation is something more than any of these. It is a potentially noxious agent which may well, as the result of activities within one country, come to be applied to the inhabitants of another - as, for instance, if a faulty disposal of radioactive waste were to be made in international waters. As long as this remains true, the hazard retains the potential of becoming a source of political dispute, which must take an overriding priority. Thus, not only is it far from obvious just where else in the UN family these evaluations could best be made; it is well to have them made within the framework of the political parent organization, and reported directly to the General Assembly as the senior political body. Only so, as potential political disputes concerned with radiation arise, can we hope to separate them from the equally vehement but highly confusing and sometimes irrelevant scientific controversies and polemics which are the joy of the specialist, but a burden for those who must decide public affairs.

The Committee itself has kept its deliberations completely separate from political considerations or policy judgments. It has, for example, consistently avoided having anything to do with the setting of maximum permissible radiation doses. Indeed, in its long comprehensive report such levels are only mentioned incidentally on one or two occasions, reflecting a widespread feeling that scientific evaluation is one thing and is a job for scientific experts, but decisions about maximum permissible levels of radiation are matters of policy and often of grave public policy in UN Member States, which require social, economic and political considerations beyond the scope of any purely scientific body. Throughout its activities, the Radiation Committee and its scientific staff have worked very closely with the various specialized agencies of the United Nations, several of which have important interests in the field, and particularly with the FAO, UNESCO, WMO and WHO, all of which contributed reports and a wealth of expert knowledge to the discussion. It expects in the future to work just as closely with the new IAEA, with which it has a number of interests in common.

Future of the Committee

The SCEAR has established itself as a competent, serious and enthusiastic group, well able to continue its task of making surveys and reports upon radiation problems devoid of political or promotional pressures or limitations. Within the UN family it expects to work ever more closely with the other organizations of the United Nations - including IAEA - which have operational, executive and other wide responsibilities, but for which radiation questions have serious implications. It will doubtless seek their help in acquiring needed information, and in return can provide them with a deep technical source of judgment and scientific conclusion as well as a central forum where these problems may be discussed and, in the words of the Economic and Social Council, "provide a framework within which specialized agencies, the IAEA and non-governmental scientific institutions can co-operate on specific matters of common interest in the radiation field, and through which the relevant research programmes can be stimulated and co-ordinated and results evaluated".

In the wider sphere of radiation regulation and evaluation, the Committee's comprehensive report represents a pioneering attempt by an international group to publish, in full, serious calculations and computations of hazards based upon explicit assumptions. Such evaluation, although it does not constitute regulation, underlies all regulatory activity. If we are to safeguard the health and welfare of man and his environment as we penetrate deeper into the nuclear age,

one of our urgent tasks will surely be to base all regulation and policy decision in this field upon progressively more solid and more widely agreed scientific assessments of this kind. In this area, the Radiation Committee has developed a close and fruitful co-operation and has become a well balanced scientific instrument at the disposal of the General Assembly of the United Nations.

HIGH ENERGY RADIATION IN CANCER TREATMENT

Certain basic recommendations on the use of supervoltage radiation and radioisotope teletherapy in the treatment of malignant growths have been made by an expert study group which met in Vienna in August this year. The group, convened jointly by the International Atomic Energy Agency and the World Health Organization, was composed of 20 radiotherapists and radiation physicists from 12 countries, under the Chairmanship of Professor B. W. Windeyer of the Meyerstein Institute of Radiotherapy, Middlesex Hospital, London.

High energy radiation, used in the treatment of malignant tumours, can be either in the form of gamma- or x-rays or in the form of beams of accelerated electrons. The source of radiation is kept at a certain distance from the patient.

The study group was agreed on the value of supervoltage radiotherapy, including gamma-ray and high voltage x-ray therapy as well as electron beam therapy. The required gamma radiation can be obtained from large sources of radioactive materials like cobalt 60 or caesium 137, while electron beams are produced by high voltage accelerators.

Four Categories

The experts felt that while it would be somewhat arbitrary to divide the various sources of supervoltage radiation into rigid categories, certain broad divisions might be useful. They considered the sources in four broad categories: large supervoltage units, intermediate units, small isotope units and units of electron beams or very high energy x-rays.

The first group includes supervoltage x-ray units in the range of 2-6 MeV (million electron volts) and radiocobalt units in which the radioactivity is of the order of 1 000 curies or more. These sources are kept at a minimum distance of 75 cm from the tumour to be attacked. The group agreed that such apparatus was essential for all institutions undertaking the treatment of cancer by ionizing radiations.

Intermediate units were defined as smaller cobalt units working at source/tumour distance in the range of 35-50 cm. It was felt that on purely scientific grounds, such units were not as good as the large units and should not be encouraged; the only reason for their adoption would be one of economy.

As regards small isotope units working at a distance of 25 cm or less, it was agreed that these were of value for the treatment of certain selected sites in the body (e.g. head and neck) and they should be made available either in addition to, or in the absence of, large units. Such units may be specifically designed to hold either cobalt 60 or caesium 137.

The experts were of the view that electron beam therapy or very high energy x-ray therapy (for example, from betatrons and other accelerators) were of great interest and had a valuable part to play in the treatment of cancer by ionizing radiations. While they did not consider such facilities essential for all radiotherapy centres at the present stage, they thought it advisable to install such facilities at the larger and better equipped centres so that more experience could be gained of their use.

The experts made it clear that while supervoltage radiation should be a part of an organized radiotherapy department, the radiation facilities at any particular establishment should not be of the supervoltage type alone. The high energy facilities could be fruitfully used only when there was a background of general radiotherapy.

Need for Training

The group emphasized that supervoltage radiotherapy, in common with other forms of radiotherapy, should be conducted only by adequately trained and qualified personnel, including radiation physicists, and specified the training and qualifications required of such personnel. It was felt that specialized training was one of the main requirements at the present stage and the training programmes of IAEA and WHO should be utilized extensively for this purpose. It was further suggested that post-graduate training of radiotherapists and radiation physicists should be arranged by means of fellowships, visits of experts should be organized to give instruction and advice in different countries, and composite groups of workers should be enabled to study new techniques in other countries.

The experts recommended that further study groups should be convened to discuss such subjects as the determination of radiation doses in clinical practice and standardization of radiotherapy methods for their clinical evaluation. Another suggestion was that IAEA and WHO should promote, support and undertake research on problems of radiation medicine as related to atomic energy in those fields in which international co-operation was most desirable.

It is pointed out that the recommendations have been drawn up with a view to giving practical guidance and should be considered for that purpose rather than as a contribution to fundamental knowledge on the subject. In particular, it is felt the recommendations may be of special value in those countries where radiotherapy is not yet firmly established.