(d) The Brookhaven National Laboratory is active in the intermediate reactor field.

Dr. Spinrad also said that General Electric Company was working on a fast oxide breeder program which included work on fuel, irradiation experiments, safety and conceptual work. Atomics International and the United Nuclear Corporation were working on fast reactor fuels and various aspects of safety.

According to a planning schedule, construction of an advanced power plant should start in 1964 and an economic fast reactor should operate in 1971. Dr. Spinrad, however, pointed out that this was not a firm decision.

MEASURING RADIOACTIVITY IN THE BODY

Techniques of measuring the total amount of radioactivity in the body of a living person as well as the principal applications of such measurements were reviewed at a Symposium on Whole Body Counting held in Vienna from 12 to 16 June 1961. Organized by IAEA, the meeting was attended by over 120 scientists from 27 countries and three international organizations. Thirty-three papers were presented and discussed.

The growing importance of whole body measurements was emphasized by the IAEA Director General, Mr. Sterling Cole, in his opening remarks at the symposium. He pointed out that historically the need for these measurements first arose in connection with studies to determine the degree of radioactive contamination of persons occupationally exposed to radioactive substances. With the development of atomic energy applications, this need has immensely grown and accurate measurements are now an integral part of health and safety measures in this field. A second important need for these measurements arises from the medical applications of radioactive tracers; when a radioisotope is administered to the body as a tracer it is often useful to determine how long the isotope is retained by the body.

Accordingly, whole body counters can be divided into two broad groups: (a) counters for the radiation protection surveillance of the general public and radiation workers, capable of detecting extremely low levels of radioactivity in the human body, and (b) counters for medical research and diagnosis, designed to check the retention and excretion of radioactive substances administered to patients for metabolic and pathological studies. In both cases, the primary requirement is that the counter must be able to measure the total activity in the body. To ensure this, the detector is so placed in relation to the subject that the measurements are not affected by variations in the distribution of the radioactive deposits in the body.

In recent years, there has been a remarkable development of the instruments and techniques for such measurements. One of the main purposes of the symposium in Vienna was to discuss how best to use these highly sophisticated instruments. It was hoped, as Mr. Cole said, the meeting would "produce, for the benefit of medical scientists and radiation protection workers throughout the world, an up-to-date survey of these instruments themselves and of the whole body counting applications to which they have been and will be effectively put".

Improvement in Methods

An indication of the progress in counting techniques was given by Professor F. W. Spiers, of the University of Leeds, UK, in an introductory review at the first scientific session of the symposium. He pointed out that the first attempts to measure total body burdens of radioactivity were made in 1929 with the object of determining the amounts of radium taken up by workers handling the substance. Accurate quantitative measurements, however, were not achieved until 1937, when Geiger-Mueller counters were applied and due consideration given to subject-detector geometry, i.e. their relative positions. The lowest body burden of radium that could be measured at that time was 0.1 microgram, which incidentally is just the maximum permissible burden of radium in occupationally exposed workers according to the recommendations of the International Commission on Radiological Protection. During the past two decades, the techniques have so improved that it is now possible to detect one-hundredth of this maximum permissible burden. Modern counters can also detect natural radioactive deposits in the body, such as potassium 40, and any additional intake from radioactive fallout due to nuclear weapon tests.

This improvement in the sensitivity of counting devices has been achieved mostly through the use of

heavy shielding against natural background radiation and the use of more sensitive radiation detectors. Construction, calibration and the properties of various types of whole body counters were discussed during the first part of the symposium in Vienna. This involved a comparison of the various radiation detectors used (e.g. G. M. counters, crystal detectors, large scintillation counters using a liquid as the scintillating material, and plastic scintillation counters), of the various shields against background radiation (e.g. iron, lead or water), and of the various types of subject-detector geometry. So far as the detectors are concerned, it was pointed out that each type had certain distinctive features. For example, crystal detectors are most suitable for the analysis of unidentified radiation sources, while G. M. counters are particularly useful in medical measurements when the administered radioactivity is known and its level relatively high. (The administration of a high level of radioactivity can be undertaken for such medical studies only when the radioisotope used has a short radioactive life.) For the measurement of extremely low amounts of radioactivity large liquid scintillators are most effective, for they offer the greatest sensitivity. Plastic scintillators are also highly sensitive and they have the additional advantage of being economical.

The symposium provided an opportunity for an exchange of information on results obtained from whole body counting. The scientists stressed the usefulness of whole body counters in nuclear establishments where hazards of internal contamination of radiation workers may be present. It was pointed out that these devices had enabled the detection of much smaller body burdens of gamma ray-emitting substances than those recommended as maximum permissible levels. The effectiveness of protective measures could thus be checked and serious internal contamination avoided.

Whole body counting techniques have been used for measuring the intake by the general public of radioactive cesium (Cs-137) from the fallout caused by nuclear tests. It was reported at the Vienna meeting that the mean Cs-137 burdens, after a steady increase since 1955 (when these measurements were first made), were now decreasing.

Medical Applications

Measurement of the total body burden of radioactive potassium (K-40), a substance which is naturally present in the body and emits beta and gamma rays, has been found very useful for the diagnosis of muscle diseases because potassium is mainly deposited in muscle cells. Among the chief medical uses of whole body counting are measurements of the retention and excretion of radioisotopes administered to the body. The discussions at the symposium indicated the variety of metabolic and pathological studies carried out by this method. For example, it was shown how it had been employed for studying the absorption of iron and vitamin B 12 from the gastro-intestinal tract or the turnover rates of protein, calcium, strontium and iodine. The information obtained from these studies has thrown much light on the nature and causes of various diseases, and in some cases this has helped in devising new lines of treatment.

A session of the symposium on whole body counting

The symposium also discussed techniques for the processing of data obtained from whole body counting. Since a single measurement may yield many items of data, the processing of the data to extract the maximum amount of information can be very tedious if done "by hand". It was reported that magnetic tape recorders and electronic computers had greatly increased the speed and effectiveness of data processing.

The different sessions of the symposium were presided over by nine eminent scientists: P. Burch (United Kingdom), A. Lansiart (France), K.V.H. Lidén (Sweden), B. Malamos (Greece), K. G. McNeill (Canada), G. R. Meneely (USA), H. Muth (Germany), J. Rundo (United Kingdom), and F. W. Spiers (United Kingdom).

In addition to the papers presented and discussed at the symposium, a survey paper on whole body counters in the Agency's Member States was prepared by the Agency's scientific staff and distributed to all participants. The material presented in the review, which was of a preliminary nature, had been obtained mostly in response to a questionnaire sent out by the Agency. Work is going ahead to make this review as comprehensive as possible, and the complete survey will eventually be published by the Agency so that the information may be available to scientific workers all over the world.