The level of those capital requirements is formidable and can very well be one of the limits to the growth of nuclear power in these countries. The outlook for funding may not be very encouraging and concessionary terms which have been given on some nuclear reactors in the past are less likely to be available.

In the context of these financing difficulties it does not seem too likely that larger-than-needed commercially available units will be purchased and operated at low capacity as an alternative to small units. This approach can be economical over the long term and is an immediate way to purchase a commercially available reactor. It does not seem likely, however, since it would exacerbate the problems of initial capital requirements. In addition, once a large nuclear unit is connected to a grid there would be a tendency to operate it at full capacity because of its low operating costs. If the nuclear unit's capacity is a significant fraction of the total grid, the system's reliability can be severely reduced.

IAEA's Future Plans

Evolving from the recommendations of the November 1974 Panel, the Agency is convening a technical group from reactor manufacturing countries on June 30, 1975 to prepare a catalogue of small and medium power reactor design characteristics. This catalogue will contain up-to-date technical data, and to the extent possible, realistic cost estimates.

This catalogue could be used as an input for further discussions by Member States as they plan their electrical power programmes. During the General Conference (September, 1975) there will be the opportunity also to discuss the possibility suggested by the Panel regarding future concerted action by several potential buyers interested in SMPRs.

The possibility of an interest by buyers in six to ten essentially identical units could help to make more designs available. Such co-operation by the potential buyers would probably also help to assure that capital costs could be held within a reasonable range.

INTERNATIONAL SYMPOSIUM ON
ADVANCES IN BIOMEDICAL DOSIMETRY, VIENNA, 10-14 MARCH
Thirty-one countries and 5 international organizations were represented by 139 participants and 15 observers at the symposium, during which 49 papers were presented in 10 sessions.

Dosimetry in Life Sciences

The uses of radiation in medicine and biology have grown in scope and diversity to make the Radiological Sciences a significant factor in both research and medical practice. Of critical importance in the applications and development of biomedical and radiological techniques is the precision with which the dose may be determined at all points of interest in the absorbing medium. This has developed as a result of efficacy of investigations in clinical radiation therapy, concern for patient safety and diagnostic accuracy in diagnostic radiology and the advent of clinical trials and research into the use of heavily ionizing radiations in biology and medicine.

Since the last IAEA Symposium on Dosimetry Techniques applied to Agriculture, Industry, Biology and Medicine, held in Vienna in 1972, it has become increasingly clear that advances in the techniques and hardware of biomedical dosimetry have been rapid. It is for these reasons that this symposium was organized in a concerted effort to focus on the problems, developments and areas of further research in dosimetry in the Life Sciences.

NEUTRON SOURCES AND MIXED-FIELD DOSIMETRY

The meeting first disussed neutron dosimetry since the greatest number of profferred papers were devoted to this subject. This is a clear reflection of the increasing practical importance which neutron sources are assuming in experimental clinical radiotherapy studies. In a review of the dosimetry of mixed radiation fields, the concepts of radiation dosimetry were examined to try to define those parameters which would be adequate in describing the field. For some fields, specifically those for which the neutron and gamma components of dose are approximately equal, a variety of techniques are available which will provide adequate accuracy. However, in the case of most accelerator-produced fields where the gamma component of dose is only a small fraction of the neutron dose, the 2 parameter field description may not provide sufficient accuracy.

Despite inherent difficulties, a number of presentations made it clear that the dosimetry system of choice remains paired ionization chambers.

The development of silicon diodes for fast neutron dosimetry and post-irradiation thermally stimulated conductivity following irradiation by neutrons in polyethylene detectors are techniques which will obviously be of value in the future.

An extensive session was devoted to a review of the status of neutron capture therapy — a subject which has excited renewed interest in the USSR, Japan and the United States. At present, the technique concentrates on the treatment of patients suffering from brain tumours (notably glioblastoma) where compounds carrying ^{10}B are introduced into the lesions, the skull is surgically retracted and the operating field exposed to thermal neutrons for extended periods. The complex orchestration of pharmacological techniques for localizing the boron compounds in the tumor, surgical procedures accompanying the treatment and the dosimetric calculations requisite to complete the prescription, requires the services of a varied and sophisticated team of experts.

DEVELOPMENT IN DOSIMETRY

Developmental investigations have been pursued for several years in an effort to derive solid-state and chemical dosimeters which would provide accurate and precise dosimetry routinely. In order to accomplish this without intervening requirements for sophisticated analysis, complex instrumentation or troublesome fragility, dosimeters which are homogeneous with the irradiated material have received particular attention. A variety of chemical and dye systems which would not anomalously perturb the radiation fluence in a phantom were described. The advent of new radiochromic dyed plastic dosimeters with χ- and gamma-ray and electron energy absorption cross sections and radiation responses corresponding approximately to those for human muscle and bone, promises wide application in therapy studies. The availability of thin detectors greatly facilitates measurements at the interface between tissue and bone, although the low sensitivity still bars the use of such detectors for routine patient monitoring.

A report on the status of thermocurrent dosimetry in UV-grade alumina was presented with the evidence pointing to sufficient sensitivity, stability and fading characteristics for the system to be useful for personnel and environmental monitoring.

RADIATION THERAPY

It was shown that radiation therapy dosimetry and treatment planning methods have been steadily refined in order to better define the dose to the treatment volume, and some insight was given into the diffusion and transport of therapy gamma and electron fields in a scattering medium. Approaches which rely on transport and Monte Carlo codes are useful for a variety of irradiation problems involving gamma-rays, electrons and neutrons which could generate data for less sophisticated treatment planning programs.

The trend to automated treatment planning facilities coupled with data acquisition systems was further illustrated in the description of an integrated ultrasound-computer dosimetry system for radiation therapy.

The rather severe difficulties inherent in the determination of patient dose and treatment planning associated with the prescription of a large area field in electron therapy was discussed, as well as problems pertaining to combining dosimetry determinations with the dose fractionation schedule in order to optimise the treatment plan.

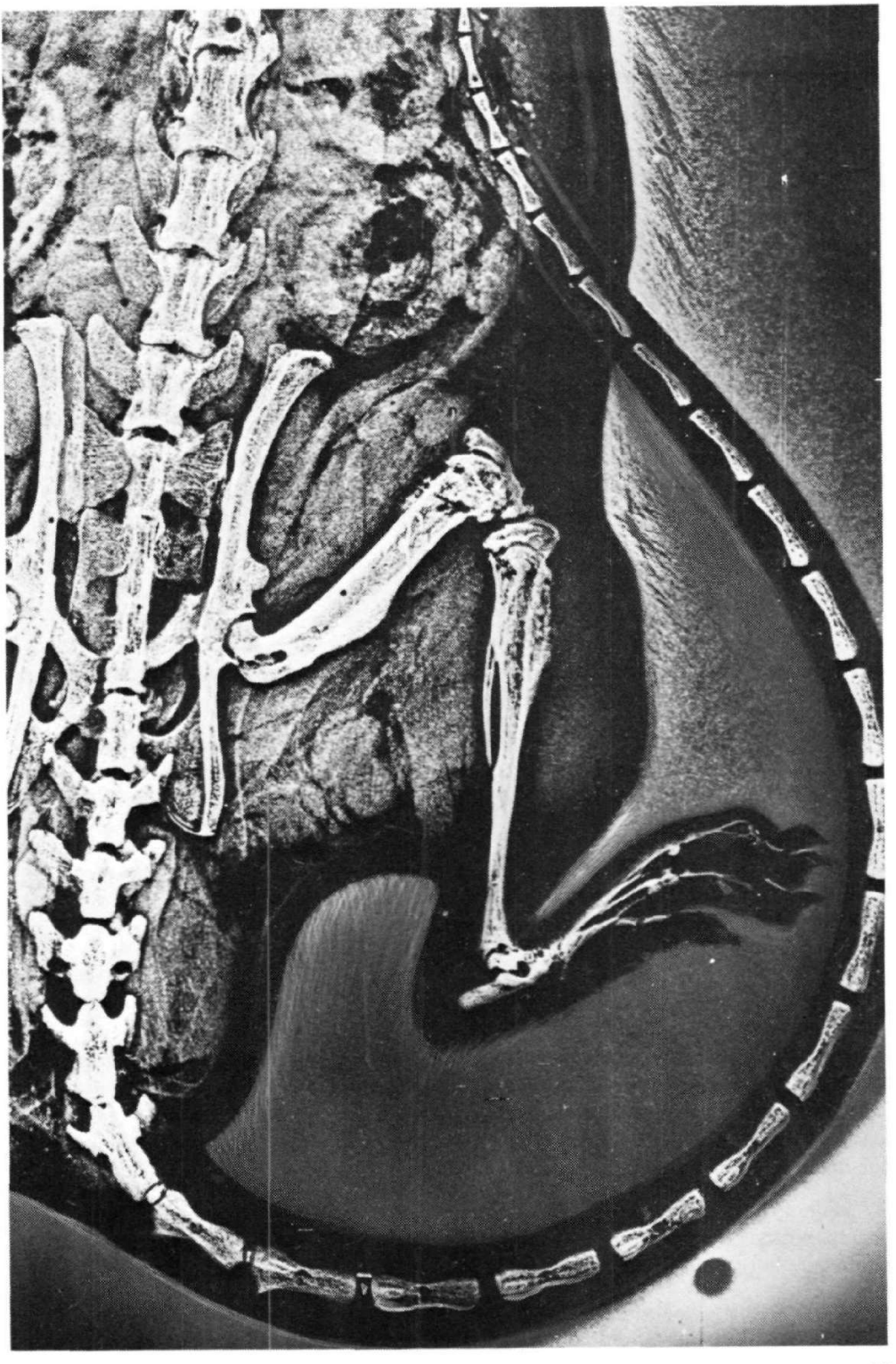
METROLOGY

There is a developing structure extending from the Meter Convention by means of the International Bureau of Weights and Measurements and the primary standards laboratories to regional and national secondary standards dosimetry laboratories.

National metrology programmes at the C.E.N. in Grenoble, at the O.H.M. in Budapest and at the B.A.R.C. in Bombay were discussed. Most important was the identification and reduction of the systematic errors accompanying the establishment of a primary exposure standard and the methods used to calibrate secondary standard dosimeters.

Professor Lidén (Sweden – representing ICRU) announced the long-awaited decision of the ICRU concerning the implementation of SI units in biomedical dosimetry. The ICRU prepared a Statement on Units in July 1974 which was forwarded to the Comité Consultatif des Unités (CCU) for consideration. Subsequently, the Comité International des Poids et Mesures (CIPM) proposed that the 15th Conférence Générale des Poids et Mesures (CGPM) adopt the becquerel (Bq) as the unit of activity of radionuclides equal to the reciprocal second, s^{-1}, and the gray (Gy) for the unit of absorbed dose equal to the joule per kilogram. If this proposal is accepted, a 10 year transitional period is envisaged for the exclusive adoption of the new units.

A technique of interest to diagnostic radiologists is illustrated by this Xeroradiograph of a rat metastases ▶ in a rat femur. Photo: J.W. Boag, Institute of Cancer Research, Surrey, UK



DIAGNOSIS

Radiological physics and dosimetry have been increasingly applied to improve on diagnostic instrumentation and imaging systems in order to reduce the hazard to the patient without sacrificing image fidelity. The problem was discussed from a number of different perspectives, such as source engineering, advances in imaging systems and techniques, imaging beam monitoring and patient dosimetry.

A review of xeroradiography and ionography – techniques of considerable interest to diagnostic radiologists because of the great detail which can be obtained often without contrast media – was given. The increase in edge contrast responsible for the peculiar quality of electrostatic images was examined along with the advances which have been made to obtain clinically useful radiographs.

A new fluorescence χ-ray source which may have useful applications in both dosimetry and diagnostic applications was presented, based on an χ-ray tube with a well type anode.

In the past, analysis of imaging systems in the spatial frequency domain has provided insight into the improvement of image quality. The power of this approach is demonstrated by the fact that reductions of patient exposure can be achieved without the sacrifice of diagnostic information.

The advent of high energy electron and gamma-ray therapy was attended by numerous problems of both a theoretical and practical nature which seriously affected the accuracy of clinical dosimetry, since comparison of the theoretical and experimental determinations of the conversion factor C_E which is proportional to the average water/air stopping-power ratio gave agreement to within one percent.

The application of the stopping power ratios in clinical dosimetry does not relieve the dosimetrist of the need to consider factors such as the errors introduced by the finite size of the ionization chamber in an absorbing medium, especially in a region of high dose gradient.

Other factors relating to clinical dosimetry were examined, such as departures from Bragg-Gray conditions, calorimetric calibration of chemical dosimeters, the use of silicon detectors, and the role of the fundamental constants.

DOSE DETERMINATION

In both radiation protection and nuclear medicine, it has become increasingly important to assess the dose to tissues accurately, and this objective suffers from gross theoretical and experimental difficulties. A calculational model was presented which examined the specific energies in cell nuclei from ^{239}Pu. This problem is of importance in estimating population hazards as a result of reactor emissions.

A survey of the radiation absorbed dose from the most frequently administered radio-pharmaceuticals was presented, and the genetically and somatically significant dose was estimated for 1975.

A major experimental effort designed to examine assumptions used in lung dosimetry for relatively insoluble lung burdens of energetic beta-gamma emitters was reported.