and the remaining three reactors over the succeeding 12 months. A much larger staff was required than the constructing firm uses for conventional stations of equivalent capacity. A large part of the work was of the same sort as arises on conventional power stations, however, so that most of the staff could be drawn from those experienced in constructing such stations.

The manner in which difficulties experienced with a reactor experiment can provide a basis for design improvements in a large-scale reactor of the same type was described in a paper by R. Beeley and J. Mahlmeister (USA). The reactor involved was the Sodium Reactor Experiment in California which suffered fuel damage and other difficulties. Features to prevent such occurrences have now been installed in the SRE and incorporated in the design of the large-scale Hallam Nuclear Power Facility being built in Nebraska, for which the authors predict a high reliability and long plant life.

Technical Evaluations

Another feature of the Conference was the presentation of papers discussing the technical features and prospective economics of a variety of reactor types being developed in leading industrial nations and considered suitable for construction in small and medium sizes. Among the reactor types described were boiling water, with and without nuclear superheat; heavy water moderated; pressurized water; organic-cooled; and gas-cooled.

Conclusion

In bringing the Conference to a close, IAEA's Director General Sterling Cole stated that the review of the technical and economic status of nuclear power presented at the Conference had given "a realistic appraisal of the situation". Based on this appraisal, he found the outlook bright and encouraging, in spite of the fact that at present nuclear power generally costs more than conventional power. Deputy Director General de Laboulaye, in his concluding remarks, emphasized the usefulness of the discussions on reactor construction and operational experience and on reactor safety which indicated that power reactors had become technically very reliable. At a press conference held on the last afternoon of the Conference, Mr. de Laboulaye commented that the nuclear power cost picture, although not yet confirmed by experience, appears definitely brighter than the picture presented at the 1958 Geneva Conference on the Peaceful Uses of Atomic Energy. "This", he said, "indicates that we are on the right track."

The proceedings of the Conference will be published by the IAEA early in 1961.

REPORT ON VINCA DOSIMETRY MEASUREMENTS

The report by the scientific team from Oak Ridge National Laboratory, USA, on the dosimetry measurements carried out at Vinca, Yugoslavia, earlier this year has now been received by the Director General of the International Atomic Energy Agency.

The findings of the Oak Ridge team were discussed at a meeting on the Diagnosis and Treatment of Acute Radiation Injury organized by WHO and IAEA in Geneva, 17 - 22 October 1960. Some thirty of the world's leading specialists from France, India, Netherlands, Soviet Union, United Kingdom, United States and Yugoslavia and staff experts from the organizing agencies participated.

The Oak Ridge team, under the direction of Dr. K. Z. Morgan, was one of the main partners in the IAEA joint dosimetry project at Vinca which aimed at throwing light on the relationship between the exact doses received and the clinical effects observed immediately after the uncontrolled run of the Vinca reactor in October 1958 and in the period of treatment in Belgrade and at the Curie hospital in Paris of the six persons exposed to radiation.

Precise data on the relationship between levels of radiation and their effects on man are rare and the Vinca experiment was therefore unique in many respects. The results are considered to be of great value both for the scientific study of radiation effects and the development of methods of therapy.

The report from the Oak Ridge team reached the conclusion that the six exposed persons received total doses (gamma and neutron) varying from the low point of 207 rad units to the highest of 436 rad units (see

Table). A rad unit is the unit of absorbed dose, that is the amount of energy imparted to matter by ionizing particles. One rad equals one hundred ergs of absorbed energy per gram of absorbing matter.

For biological and medical purposes radiation exposure is usually expressed in rems. The rem is the absorbed dose of ionizing radiation having the same biological effect as one roentgen of high voltage X-radiation.

There is no simple automatic conversion factor between the physical measurement (rad) and the biological measurement (rem).

The methods of dosimetry used by the Oak Ridge Team were essentially the same as had been used in connection with the accident at Oak Ridge in June 1958, the so-called Y-12 accident. The method is based on the fact that on entering the human body some neutrons are captured by sodium 23 giving rise to sodium 24, which omits high energy gamma rays and can thus be easily detected. As sodium 23 is uniformly distributed in the body this method makes it possible to normalize the neutron exposure of an individual. Through knowledge of the neutron spectrum, of which the neutrons affecting the sodium only form a part, it is then possible to determine the total neutron dose. This method is considered much more reliable than the theoretical calculations based on the known number of fissions and the stated location of the individual. The unreliability of this theoretical method was shown during the calculations of the Y-12 accident.

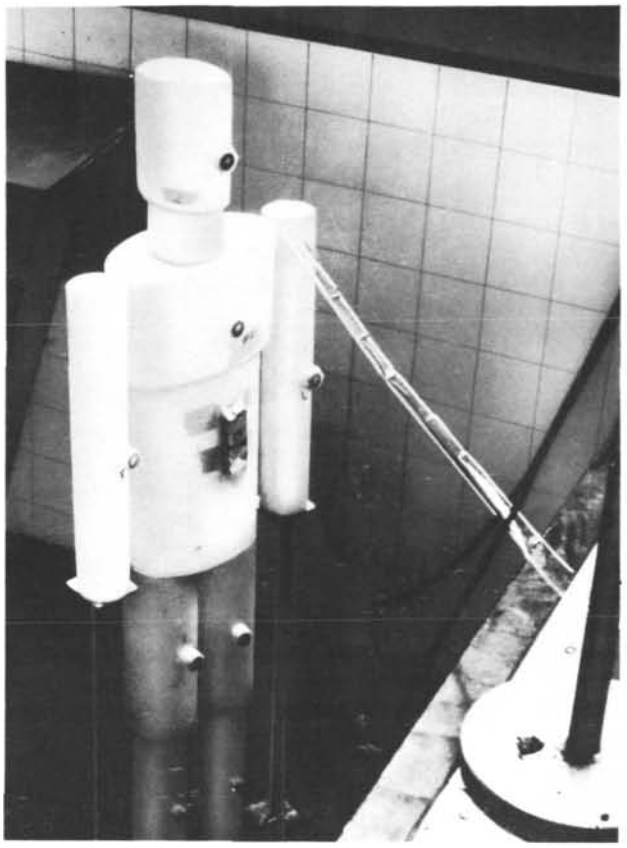
The sodium activation data were obtained through measuring the neutron dose required to produce a given amount of activation in plastic man-shaped phantoms, filled with salt water solution and located in many different positions round the reactor. The neutron spectrum was determined by calculation and by using a series of threshold detectors specially developed for this purpose. These consisted of plutonium, neptunium, gold, uranium and sulphur.

Another important aspect of the dosimetry project was to ascertain the ratio of the neutron to the gamma dose; this was done with neutron and gamma dosimeters. It was found that the gamma to neutron dose ratio varied according to positions between 3.5 to 1 and 4.2 to 1.

For these measurements the reactor was operated at three different levels of power, 5,1 000 and 5 000 watts.

IAEA officials point out that the Oak Ridge measurements of the sodium activation are in agreement with the slightly different type of measurements made in connection with the experiment by French scientists at Saclay.

It is also pointed out that the contribution of neutrons to the total exposure dose appears greater than was initially estimated and that it is generally known that a physical neutron dose (expressed in rads) produces a larger biological effect than a corresponding gamma dose. As it has been shown that the neutron



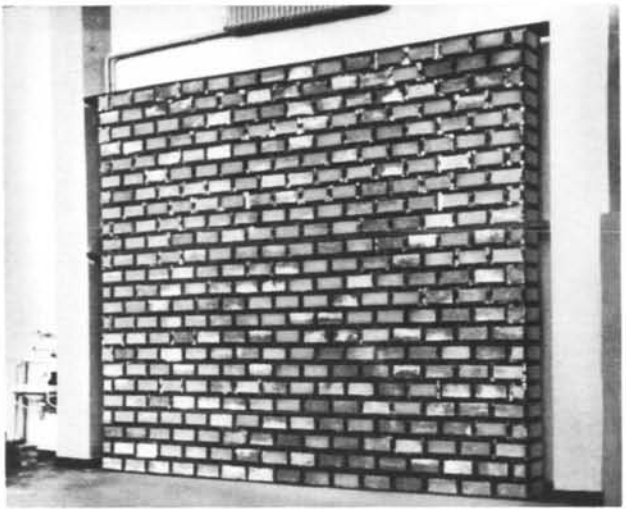
One of the four phantoms used in IAEA's dosimetry project at the Boris Kidric Institue, Vinca, Yugoslavia

dose formed a substantial part of the total physical or rad dose, it would be necessary to increase the rad-value by some factor to get an expression of the biological or rem dose. The exact value of this factor can only be obtained by comparison with other data and with reference to the specific biological responses shown in the present cases. No direct comparison of the magnitude of the rad dose calculated by the Oak Ridge Team should therefore be made with earlier (rem) measurements of the Vinca or other cases. In the methods used for the Vinca project some refinements had been introduced as compared with earlier measurements which again makes direct comparison with other results difficult.

The dosimetry project at Vinca was a fully international effort organized by the International Atomic Energy Agency and forms part of a world-wide effort to determine the deleterious effects of radiation on man.

The Yugoslav authorities and the Boris Kidric Institute in Vinca placed the complete reactor, necessary laboratory facilities, services and personnel at the Agency's disposal.

The French Atomic Energy Authority constructed comprehensive additions to the control system of the reactor, restarted and operated the reactor for the experiment.



A wall of the reactor room at Vinca where the IAEA's dosimetry project was conducted. The wall is shielded by concrete bricks

The United Kingdom Atomic Energy Authority supplied on loan the $6\frac{1}{2}$ tons of heavy water needed to restart the reactor and a scientist from the Authority performed his own measurements with the experiment.

The United States arranged for the expert team from Oak Ridge to perform the actual measurements with its own specialized equipment and make the necessary calculations. The team was under the direction of Dr. K. Z. Morgan and consisted among others of Dr. G. S. Hurst, Dr. R. H. Ritchie and Dr. A. D. Callihan.

The experiment and measurements were carried out at the end of April 1960.

Individual Doses (All Values are in Rad Units)

Individual	Charged Particle Dose	H(n, γ)D Gamma Dose *	External Gamma Dose	Total
H	66	99	158	323
V	89	133	214	436
G	90	135	189	414
M	87	130	209	426
D	91	136	192	419
B	45	67	95	207

* *Gamma dose resulting from the capture of neutrons by hydrogen in the body.*

ATOMIC SAFEGUARDS

Consideration by General Conference

At its fourth regular session in September of this year, the General Conference of IAEA considered a set of safeguards principles and procedures which had been provisionally approved by the Board of Governors and referred to the Conference "for appropriate action."

After detailed discussion, in which a large number of delegates took part, the Conference adopted by a vote of 43 in favor, 19 against and 2 abstentions, a resolution sponsored by 15 Member States. *

The sponsors had accepted in Committee an amendment moved by Austria, Sweden and Switzerland.

The resolution notes that the Board of Governors had "provisionally approved principles and procedures to provide information and appropriate guidance for Member States as well as for the guidance of the Board itself in the administration of safeguards by the Agency" and that the proposed procedure should guide the Board in negotiating agreements with Member States, "having regard to the principle of non-discrimination between them". The Board was invited, before giving effect to the safeguards principles and procedures, to take into account the views expressed in the General Conference and to report on the application of the safeguards annually to the Conference. A review of the principles and procedures should be presented to the sixth regular session of the General Conference (1962).

The following countries voted for the resolution: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Denmark, El Salvador, Finland, France, Federal Republic of Germany, Greece, Guatemala, Holy See, Honduras, Iceland, Iran, Israel, Italy, Japan, Korea, Mexico, Monaco, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Peru, Philippines, Portugal, Spain, Sweden, Switzerland, Thailand, Turkey, Union of South Africa, United Kingdom, United States of America, Venezuela, Viet-Nam.

* *Australia, Brazil, Canada, Greece, Italy, Japan, Netherlands, Nicaragua, Peru, Philippines, Portugal, Thailand, Turkey, United Kingdom, and United States of America.*