by the International Nuclear Data Scientific Working Group – a committee designed to advise and to help in establishing links with centres and laboratories in various countries. It meets once or twice a year on IAEA invitation and the Government nominated participants are usually the same people. The third of these meetings was held in Warsaw in late 1964, the fourth in Tokyo in 1965.

Head of the IAEA Nuclear Data Unit is Carl H. Westcott (Canada), and other physicist members are Piotr Otatavnov (USSR), Kim Ekberg (Sweden), Hans-Dietrich Lemmel (Germany) and Miss Ursula Schulze (Germany). Mrs. Pamela Attree (Canada) is the programmer, Mrs. Françoise Hirschbichler (France) is the staff member for technical work and preparation of punched cards, and Miss Eva Kiovsky (Austria) is the secretary of the Unit.

NUCLEAR MATERIALS MANAGEMENT FOR SAFETY AND EFFICIENCY

The use of nuclear materials in industrial processes presents management with some special problems which are peculiar to the atomic energy industry. The value of the materials is much greater than is normal in a full-scale industrial operation; for example, a 500 MW nuclear reactor may use 50 to 75 tons of uranium fuel at a degree of enrichment which costs $254 per kilogramme. This calls for close control to ensure that fuel is not delivered from the manufacturer before it is needed. No "dead" stocks must be allowed to accumulate in plants in which these materials are used or processed. If reactor fuel costs are to be kept low, too, each fuel element must yield the maximum economic "burn-up" before it is withdrawn from service, and this calls for reliable non-destructive methods of measurement of "burn-up" and appropriate records and fuel-changing schedules.

The special hazards of radioactive materials call for special precautions and appropriate systems of handling and storage. A further danger unique to atomic energy is that of criticality – the possibility that an excessive concentration of fissile material may result in a chain reaction. Every part of the processing plant must be surveyed and checked to ensure that there is no build-up of fissile residues; in storage or transit there must be no aggregation of small lots.

In the nuclear energy industry, too, the standards of purity required are much higher than in most other large-scale operation, so that stringent quality checks are needed.

These problems were discussed at a symposium on Nuclear Materials Management, held by IAEA in Vienna from 30 August to 3 September 1965. The Agency had its own special interest in the Symposium because of the significance of the subject in the administration of Agency safeguards, which depend on book-keeping records, and on physical checks and analyses performed by inspectors from IAEA.

The topics discussed at the meeting included material control systems, recording and reporting techniques, sampling, analysis and physical measurements, determination of production and consumption of fissile material in a reactor, safety aspects, standard practices and materials, and economic considerations in nuclear materials management.

The discussions showed that routine industrial methods of material control and verification are largely used to ensure safe and economical operation in nuclear power stations, fuel fabrication and chemical treatment plants. Some special refinements are needed, but many of the papers emphasized that records, checks, measurements and handling precautions, intended primarily for safety and for materials accounting, can also provide a vital aid to efficient operation. The system should be devised with the different possibilities in mind.

SOME SPECIAL PROBLEMS

The problems of centralizing auditing data arising from mines, factories, reactors, research centres and storage depots were discussed by F. Ronteix (France). He gave a brief account of the French system of management, described steps taken to cope with the necessity for monthly closing of accounts for all the installations, and their centralization, and went into detail on the use of office machinery, preparation of balances and the publication of periodical documents. This included conditions in which use of office machinery was advantageous, coding systems, document circulation, time cycles and modifications imposed on auditing systems by office machinery, as well as the costs. S. Kops (USA) contrasted standard audits with the specialized needs and characteristics of an internal audit peculiar to an organization handling source or special fissionable material, and the necessity of a special audit because of the high monetary and strategic values. He demonstrated the necessity for physical testing of nuclear inventories.

An example of the type of complications which can be involved was given by G.K. Whitham, T.R. Saplding and M.J. Feldman (USA) on problems relating to management and inventory of fuel being solved in the operation of Experimental Breeder Reactor II (EBR-II) at the National Reactor Testing Station in Idaho, USA. Here there is a plant for pyro-metallurgical reprocessing of spent fuel. Fuel removed from the reactor, and also fuel which has been reprocessed, is highly radioactive, requiring remote handling at every step of the procedure used in removing, processing and returning to the reactor. In addition the fuel handling mechanism, as well as the reactor, pumps and heat exchanger, operate submerged in a large tank containing

86 000 gallons of sodium at 700°F. Transfers here are controlled by a digital computer, as are all processes in the reactor and fuel cycle facility.

The Centre de Bouchet, France, has a uranothorianite processing unit which supplies thorium and uranium salts of nuclear purity. They are obtained from ore concentrates by grinding, dissolving in nitric acid, successive solvent purification with uranyl nitrate and thorium nitrate concentration by evaporation and crystallization of the thorium nitrate and decontamination of the effluents. C. Lorrain (France) described the progress made in systematically reducing uncertainties in determining some of the uranium and thorium-bearing products, leading to a control system which had proved particularly satisfactory for uranium.

ACCURARY VERSUS EXPENSE

Comparisons of conditions in a research establishment with those in a production plant were made by W.J. Wright and D.R. Hocking (Australia). They suggested that large sums of money can be wasted in seeking unnecessary accuracy in material records and outlined an inspection system providing the maximum insurance against error for the least expenditure. Introduction of electronic data processing techniques had improved efficiency without increasing staff – a finding endorsed by G.W. Fletcher, H.B. Reid and W.G. Jenkinson (Canada) in reporting on accounting systems for heavy water and fissionable materials.

An optical examination system including a periscope, a telescope and a camera to overcome optical distortion caused by shielding media such as water and lead glass was described by E.M. Kinderman and J.S. Mills (USA). The telescope, camera and mountings weighed in total less than 22 lbs (10 Kg) and had maximum dimensions of 29 inches (73.2 cm); photographic observations of test resolution charts in air 20 ft (6 m) from the object lens of the telescope demonstrated that the system could resolve markings 22 microns in width, corresponding to 0.8 seconds of arc. Preliminary tests on the water system gave a resolution better than 125 microns at the same distance, or about 4 seconds of arc.

The necessity of balancing the values of materials involved against the costs of repeating measurements was discussed in several papers. H.H.P. Bokelund (Belgium) said that normally the shipper and the receiver of a batch of valuable material each established a value, but in the case of irradiated fuel it was impossible for obvious reasons for it to be sampled before shipment to a reprocessing plant. This had led to an arrangement giving the reactor operator the right to be present during sampling and to have access to all data to establish monetary value. This required an agreement about the number of measurements acceptable to both parties.

A detailed study of the parameters affecting the precision of an isotopic analysis made by the US National Bureau of Standards was reported by W.R. Shields (USA). He traced an evolution of accuracy of isotopic analysis from 2 per cent to 0.02 per cent after giving some surprising instances of errors arising because of insufficient knowledge in mass spectrometry use.