International Atomic Energy Agency

General Conference

GC(XIV)/INF/124
11 September 1970
GENERAL Distr.
Original: ENGLISH

Fourteenth regular session

PROGRESS IN PEACEFUL APPLICATIONS OF NUCLEAR ENERGY DURING THE YEAR 1969/70

Statements by Member States

Note by the Director General

By 1 September 1970 three Governments had furnished statements for the information of the General Conference on the progress made in their respective countries during the year 1969/70 in peaceful applications of nuclear energy[1]. The statements in question are reproduced below.

1/ Corresponding statements in respect of the year 1968/69 were reproduced in the booklet GC(XIII)/113/Rev.1.

GERMANY, FEDERAL REPUBLIC OF

INTRODUCTION

1. In the Federal Republic of Germany research and technological development in the nuclear field proceed along the lines set forth in the Third German Nuclear Programme (1968-1972). Priority is given to the development of advanced reactor systems, i.e. sodium-cooled fast breeder reactors and high-temperature helium cooled reactors. As light-water reactors (LWR) of both the boiling and pressurized water cooling type designed by domestic manufacturers have now become firmly established on the German electrical power market, the joint endeavours of the nuclear research centres and industry since 1969 have been concentrated on the development of the advanced reactor systems and the corresponding fuel cycles.

2. Public funds allocated to peaceful nuclear research and development by the Federal and State Governments (80% and 20% of the total respectively) amounted to more than DM 1000 million in 1969 and again in 1970. About 40% of the total budget is allocated to the nuclear research centres, while another 20% is spent on scientific co-operation within international organizations.

3. At present about 25 000 people, including about 20% academic personnel, are working in the nuclear field in the Federal Republic. Nuclear industry and the research centres each employ about 10 000 people; the remaining 5000 employees do nuclear research and development work at the universities and Max Planck institutes. Nuclear industrial production accounts for about one third of the total employment in the field.

NUCLEAR POWER PLANTS

4. The first generation of nuclear power plants in the Federal Republic has been based on LWR. Following the successful operation of the experimental station at Kahl on the Main and of the three demonstration plants at Gundremmingen on the Danube, Lingen on the Ems and Obrigheim on the Neckar, construction of the first two large commercial nuclear power plants at Würgassen on the Weser and Stadersand on the Elbe, each with a capacity of more than 600 MW(e) is going on apace.

5. Site work for two new LWR power stations at Biblis/Middle Rhine (a pressurized light-water reactor of 1150 MW(e)) and at Brunsbüttel on the Elbe (a boiling light-water reactor of 800 MW(e)) was started in 1969; the plants are to be completed in 1974. In addition the Kraftwerk Union (Power Plant Combine) began the construction of a 440-MW(e) pressurized light-water reactor station at Borssele in the Netherlands. Construction of the 320 MW(e) pressurized heavy-water reactor station at Atucha in Argentina is making progress. The 25-MW(e) "HDR" station at Grosswelzheim, which has nuclear super-heated steam generation, went into operation at the end of 1969.

6. At that time a total nuclear **capacity** of 905 MW(e) was installed in the Federal Republic, which until then had produced more than 3 million kWh of electrical energy. In addition a capacity of about 4400 MW(e) plus 760 MW(e) for export is ordered or under construction. Of about 5000 MW(e) of nuclear power to be installed by 1974, about 90% will still be provided by LWR and the remaining 10% by other reactor types.

NUCLEAR SHIP PROPULSION

7. The 10 000 shaft horse-power nuclear cargo ship "Otto Hahn", in operation since 1968, demonstrated her performance on extensive voyages under various kinds of maritime conditions in the North and South Atlantic during the last year. The "Otto Hahn" visited Bandar Abas in Iran recently. The ship makes regular cargo trips to Casablanca in Morocco.

INDUSTRIAL ORGANIZATION

8. Industrial re-arrangements - as indicated last year by the foundation of the Kraftwerk Union (Power Plant Combine) by Siemens and AEG-Telefunken[1/] - are currently under way between the groups BBC-Krupp and GHE-MAN, envisaging the foundation of a joint high-temperature reactor company.

9. In 1969 Siemens took over the shares of the INTERATOM Company at Bensberg near Cologne. The enterprise is particularly involved in the development of fast breeder reactors.

1/ See document GC(XIII)/INF/113/Rev.1, section 4, para. 15.

REACTOR DEVELOPMENT

Fast breeder reactors

10. The basic programme for the development of fast breeder reactors is being promoted by the Karlsruhe Nuclear Research Centre. Late in 1969 sodium-cooling experiments were begun with the compact sodium-cooled reactor KNK at Karlsruhe.

11. At the beginning of this year the industries of Belgium, the Federal Republic, Luxembourg and the Netherlands prepared and submitted the final construction plans for the 300-MW(e) prototype plant "SNR" with a sodium-cooled fast breeder reactor. Belgian, Dutch and German utilities founded a joint Fast Breeder Project Company in November 1969 which is expected to order the prototype plant and operate it after completion. In addition, the basic research programme is being carried out in close co-operation between the four partner countries.

12. The need for a fast test reactor with a high flux of 1.5×10^{16} n/cm^2 is being studied. Limited studies are being carried out at Karlsruhe and Jülich for a gas-cooled breeder reactor.

High-temperature gas-cooled reactors

13. A second line of advanced reactors - high-temperature gas-cooled reactors - is being developed in close co-operation between the Jülich Nuclear Research Centre and industry. After submission by the BBC-Krupp consortium in 1969 of the design documents for the 300 MW(e) "THTR" prototype plant with a pebble bed reactor and secondary steam circuit, the final decision for the construction of this plant at Schmehausen in Westphalia was taken in July 1970. The interested utilities have founded a joint enterprize for this purpose, the Hochtemperatur-Kernkraftwerk-Gesellschaft (High-temperature Nuclear Power Plant Company).

14. The German high-temperature gas-cooled reactor programme aims at the construction of a 600 MW(e) power station with a helium turbine connected directly to the primary cooling circuit of the reactor. Extensive irradiation studies on the fuel for such reactors are continuing in many Eurepean facilities.

NUCLEAR FUEL CYCLE

Natural uranium supply

15. Efforts have been intensified to develop a complete nuclear fuel cycle for the estimated 20 000-25 000 MW(e) of nuclear power to be installed in the Federal Republic by 1980. This nuclear capacity corresponds to a cumulative need for about 30 000-40 000 metric tons of natural uranium. Present needs amount already to about 420 metric tons of natural uranium for initial reactor loadings and 100 metric tons a year for refuelling.

16. Estimates of uranium deposits in the territory of the Federal Republic amount to about 10 000 tons only. It is intended to procure 80% of the long-term supply by participation in prospecting and mining enterprises abroad and about 20% by buying on the international market. The Urangesellschaft (Uranium Company) and the Uranerzbergbaugesellschaft (Uranium Ore Mining Company) are already engaged in joint prospecting and mining enterprises with foreign partners in Australia, Austria, Canada, Ghana, the Niger, Somalia, Togo and the United States of America.

Uranium enrichment

17. In March 1970 an agreement was signed between the Federal Republic, the Netherlands and the United Kingdom of Great Britain and Northern Ireland for the joint development, construction and operation of uranium enrichment plants employing the gas-ultracentrifuge process. The joint enterprise shall be operated on an industrial scale and for peaceful applications of nuclear energy only.

18. Two tripartite industrial organizations are going to be set up - the Prime Contractor Company for the manufacture of centrifuges and the construction of plants, and the Enrichment Company for their operation. As the respective German partners in these two companies the Gesellschaft für nukleare Verfahrenstechnik (Nuclear Process Engineering Company) and the Uranisotopen-Trennungs-Gesellschaft (Uranium Isotope Separation Company) have been founded by industrial firms.

19. In addition to this participation in the development and industrial exploitation of the gas-ultracentrifuge process for uranium enrichment, an alternative enrichment technique, the nozzle method, is under development in the Karlsruhe Nuclear Research Centre. The possible advantages of this new approach in enrichment technology cannot be judged definitely at the present stage of pre-industrial

development. However, a contract has been signed lately between the Gesellschaft für Kernforschung (Nuclear Research Company) at Karlsruhe and the STEAG Company at Essen for the preparation of design documents for an enrichment plant with a capacity of 600 tons of separative work a year using the nozzle method.

Fuel element fabrication and reprocessing

20. The production capacity of nuclear fuel elements in the Federal Republic already exceed domestic needs considerably. Export and a continuously growing domestic market have caused the industry to extend production facilities for all kinds of nuclear fuel elements during the last years.

21. There are two major companies producing fuel elements for both light-water and heavy-water reactors: the Kernreaktorteile GmbH (Nuclear Reactor Component Company) founded in 1965 by AEG and General Electric, and the Reaktorbrennelemente GmbH (Reactor Fuel Company) founded in 1969 by Siemens and NUKEM. At present these two companies have a capacity of 85 and 180 tons of UO_2 per year respectively; this capacity will be approximately doubled by 1971/72.

22. NUKEM concentrates on the management of fuel cycle services and on the handling of highly enriched uranium fuel in different chemical forms, especially for the development and fabrication of fuel elements for high-temperature gas-cooled reactors. ALKEM, a subsidiary of NUKEM, is engaged in plutonium technology for fast breeder fuel elements.

23. In the later part of 1969 the first German reprocessing plant "WAK" with a capacity of 40 tons of enriched uranium fuel a year went into operation at Karlsruhe according to schedule.

24. Special methods for the reprocessing of high temperature fuel elements with coated particles are being developed at the Jülich Nuclear Research Centre in collaboration with industry.

Safeguards for fissile materials

25. Research and development on a safeguards system based on the principle of safeguarding the flow of fissile material at key points in the nuclear fuel cycle has been pursued with success by the Karlsruhe Nuclear Research Centre in collaboration with international institutions. The results of practical experiments at the EUROCHEMIC reprocessing plant and the ALKEM plutonium fuel fabrication plant

have turned out to be encouraging. Research and development on instrumented safeguards systems is progressing. The Agency, the European Atomic Energy Community (EURATOM) and national safeguard authorities have confirmed their interest in the work done at Karlsruhe.

NUCLEAR RESEARCH CENTRE

General

26. At present about 10 000 people, 20% of whom hold academic degrees, are employed in the seven national research centres, mainly in the nuclear field. In addition to these centres, a new Institute for Heavy Ion Research was founded near Darmstadt in 1969.

27. Efforts have been intensified during 1969 to reorganize and adapt the internal structure of the research centres according to the requirements of future developments.

28. Out of the broad scope of basic nuclear research, increasing activities and progress can be reported in the following disciplines:

High-energy elementary particle physics

29. A new injection linear accelerator was installed at the German Electron Synchrotron "DESY" at Hamburg, increasing the final energy of the machine from 6.5 to 7.5 GeV. Construction of the 3 GeV electron-positron storage rings at DESY is going on apace. By 1974 these devices will allow the study of elementary particle reactions at extremely high energies.

30. There are still three other high-energy electron accelerators in operation: two at the University of Bonn with final energies of 2.3 GeV and 500 MeV, and one of 300 MeV at the University of Mainz.

31. A large number of high-energy physics teams from the universities, Max Planck institutes and nuclear research centres took part in the research programme with the 28 GeV proton-synchrotron of the European Organization for Nuclear Research (CERN) at Geneva.

Low and medium energy nuclear physics

32. Nuclear spectroscopy and the study of nuclear reactions at higher energies are the highlights of activities in low and medium-energy nuclear physics. Four tandem Van de Graaff accelerators for light and medium ions with energies exceeding 10 MeV, three isochronous cyclotrons for protons, deuterons and alpha particles up to 100 MeV, and twenty research reactors are being used in this field. Construction work on a heavy ion accelerator was started this year at the new Institute for Heavy Ion Research near Darmstadt. The accelerator will attain a maximum energy of 10 MeV per unit mass for heavy ion up to uranium.

Plasma physics and nuclear fusion

33. The Institutes for Plasma Physics at Garching near Munich and of the Jülich Nuclear Research Centre are the most important centres of activity in the fields of nuclear fusion and direct energy conversion. Progress has been obtained from this work during the past year. Following the successful operation of theta pinch and stellarator devices, a Tokamak apparatus is going to be installed at the Institute for Plasma Physics at Garching.

Solid state physics and materials research

34. In accordance with the priorities set in the Third German Nuclear Programme, solid state physics and materials research were intensified during the period of time reviewed in this paper. Nuclear methods in particular are being applied in this field in the corresponding institutes of the nuclear research centres at Garching, Jülich and Karlsruhe.

35. In order to concentrate further the available highly qualified scientific personnel and expensive equipment, two Institutes for Solid State Research were founded recently at Jülich and Stuttgart respectively. At Jülich, mainly nuclear methods will be applied to the investigation of metal properties and the dynamics of solids, while the Institute at Stuttgart, run by the Max Planck Society, will be mainly concerned with the study of semi-conductors and insulators.

36. Construction work for the French-German very high neutron flux reactor at Grenoble is continuing according to schedule, and good progress was made during the past year. When the reactor comes into operation in 1971, it will be a unique facility, especially for research in solid state physics. A number of technically

advanced high resolution spectrometers and beam guiding systems for high intensity neutron beams were already devised last year and are now under construction.

ISOTOPE AND RADIATION TECHNOLOGY

37. The techniques by which radioisotopes are applied were improved at various research laboratories. Application studied ranged from soil science and the movement of underground water, through investigations into the structure of technically interesting substances to the study of wear and tear in machines and pipelines. Work was increased on pest control by way of the sterile-male technique. The development of radionuclide batteries for technical and medical use was continued. The field of application for neutron activation analysis was broadened.

38. Development work on radiation technology in industry was intensified. Studies were made of the techniques applied in radiation-induced chemical synthesis, the polymerization of plastics and of wood-plastic combinations for surface finishing improvement of the quality of textiles and the sterilization of medical articles.

INTERNATIONAL CO-OPERATION

39. As has been noted already in the preceding paragraphs, an important part of the nuclear activities of the Federal Republic involves international co-operation. About 20% of the entire national budget for nuclear research and development are devoted to this purpose. The Federal Republic takes an active part in the nuclear programmes of the Agency, the European Nuclear Energy Agency, CERN and EURATOM. Special efforts were made during the last year to initiate a reorganization of the joint research establishments of EURATOM in order to create an improved basis for new long-term research programmes which, for the first time, might also include non-nuclear activities.

40. The 300 MW(e) "SNR" fast breeder reactor prototype power station is planned as a joint enterprise of Belgium, the Federal Republic, Luxembourg and the Netherlands, as has already been mentioned.[2/]

2/ Para. 11 above.

41. It has also been mentioned that the Federal Republic, the Netherlands and the United Kingdom concluded an agreement early this year for the further development and joint exploitation of the ultracentrifuge process for uranium enrichment,[3] in order to meet the fuel requirements of their increasing nuclear power stations in the years to come. Discussions with Belgium and Italy who are interested to participate in the tripartite collaboration have begun.

42. Discussions are under way between industrial interests in France, the Federal Republic and the United Kingdom about plans for the co-ordination of nuclear fuel reprocessing.

43. A new alternative for the big 300 GeV proton synchrotron project of CERN is at present being examined by the Members of that organization. The new design is characterized by greater technical flexibility and economy than the original concept.

44. The French-German very high flux reactor of the Max von Laue - Paul Langevin Institute at Grenoble has entered its final stage of construction and will be completed near year.[4]

45. During the past year bilateral co-operation in nuclear science and technological development was also intensified. As additions to the arrangements for scientific exchange already existing with many countries, the Federal Republic signed further bilateral agreements with Argentina and Brazil in 1969, with Spain in April and with Chile in August of this year. Similar agreements are currently being negotiated with India and Pakistan.

3/ Para. 17 above.

4/ See also para. 36 above.

GREECE

INTRODUCTION

1. During the period 1969-70 there was continued progress and expansion in the work of the Greek Atomic Energy Commission. The collaborative research with universities and other scientific institutions and organizations, within the country as well as abroad, is proceeding most satisfactorily.

HIGHLIGHTS AND DEVELOPMENTS

2. A well-equipped laboratory for the production of the commonly used radioisotopes has been constructed at the Democritus Nuclear Research Centre (DNRC), together with associated laboratories for their chemical, physical and biological control. A number of short-lived radioisotopes are dispensed to hospitals, industries, public institutions and organizations in Greece, thereby satisfying approximately 50% of the rapidly growing demand for radioisotopes for scientific, medical and industrial applications. A Radioactive Isotope Dispensing Centre has now been established through which foreign and local radioactive isotopes used in Greece are provided, controlled and distributed.

3. The research and development programmes require the support of special major facilities. A Computer Centre has therefore been established which consists of two computers, a CDC-3300 coupled to a CDC-1700 instrument.

4. A new accelerator facility has been ordered and is expected to become operational by the middle of 1971. It consists of an 11-MeV T11/25 tandem Van de Graaff and a 3-MeV electron Van de Graaff. A building to house the facility is under construction.

5. An increase in the power of the 1-MW research reactor to 5 MW is expected by the beginning of 1971.

6. Research at the Physics Department of DNRC has been carried out in the fields of nuclear physics, plasma physics, solid state spectroscopy, radiation damage and theoretical and experimental high energy physics. The Nuclear Physics Group devoted its efforts to the design and installation of the new accelerator facility. In plasma physics, research on low frequency waves in gas discharges was carried out and preparation has been made for the installation of a Q-machine for plasma production. The Solid State Spectroscopy Group, employing Mössbauer, neutron

diffraction and nuclear quadrupole resonance (NQR) techniques, devoted its efforts to studies on magnetic properties of ferrites (Mössbauer and neutron diffraction) and the crystal structure effect on radiation damage (NQR). Moreover, by the end of the year, preparations for work at liquid helium temperatures had been completed and Mössbauer studies of iron salts in frozen non-aqueous solutions started. The low-temperature irradiation facilities (liquid nitrogen loop) were completed, so that neutron irradiation of metal samples in the reactor core could be performed successfully, and the annealing spectra of the irradiated samples (resistivity measurements) have been taken. The activity of the Theoretical Physics Group has been directed to problems of dynamics in strong and electromagnetic interactions. In high energy physics the anti-proton-proton experiment at 2.5 GeV/c was completed, and in collaboration with other laboratories the hydrogen bubble chamber of the European Organization for Nuclear Research (CERN) has been exposed to K^- mesons and anti-protons having momenta of 8.25 GeV/c and 4.5 GeV/c respectively. Emphasis has been put this year on the education of the graduate students in collaboration with the University of Athens and the orientation of the physicists to problems relevant to the research programmes of the different Groups. The High Energy Physics Group and the Theoretical Physics Group were especially active in this direction.

7. The major research areas in which the various Groups of the Department of Biology have been involved are biochemistry (fats, proteins, nucleic acids, enzymology, photosynthesis), plant biology (genetics and physiology of fungi), entomology (ecology, physiology, nutrition, irradiation of the olive fruit-fly), virology-bacteriology, marine biology and the biological control of radioisotopes.

8. The Reactor Department has been operating the reactor at 1 MW for two shifts a day. Its main activities were four beam experiments, one experiment at the thermal column, two loop experiments (one in low temperature), activation analysis through three pneumatic systems and activation for radioisotopes production. Another activity has been the creation of a bone bank, and several bones sterilized by the gamma irradiation of the reactor were distributed to various hospitals. The Nuclear Power and Safety Group participated in the negotiations for the purchase of the first nuclear power reactor.

9. The primary interests of the Electronics Department during 1969-70 have been research on and development of instruments and devices for nuclear and medical electronics, digital systems, analogue systems and control.

10. The Health Protection Department is responsible for the environmental monitoring, radiation protection education and the preparation of rules and regulations in Greece. The Health Physics Service is responsible for the radiological protection within DNRC and runs a personnel dosimetry service for all Greek radiation workers.

11. In the Chemistry Department, the Nuclear and Radiochemical Analysis Group carried out several neutron activation and other analyses. There was an extensive collaboration with the Paediatric Clinic of Athens University for the study of "cystic fibrosis", a project which is also supported by the Agency. A large number of analyses (determination of trace elements) were also carried out for the benefit of several industrial firms and institutions. The delayed neutron method was also developed for the determination of uranium in ores, so that uranium analyses at a rate of 70 to 80 per day could be carried out for the project "Research on uranium deposits of Northern Greece". The Radiation Chemistry Group participated in the project "Sterilization of bones for medical uses" by providing dosimetric facilities. The Group responsible for the chemical control of radioisotopes continues to expand its activities as production increases; a Jarrell-Ash emission spectrograph was installed for this purpose during the period in review.

12. The Technological Applications Department was set up in 1968 with the task of contributing to the development of the economy of the country by introducing to industry advanced methods of production and inspection. It has developed the following activities:

(a) Non-destructive testing methods, especially industrial radiography and supersonic inspection;

(b) Use of radioisotopes as tracers in industry and hydrology;

(c) Radiodating (tritium and carbon-14);

(d) An irradiation facility, including a Van de Graaff electron accelerator (3 MeV, 1 mA - to be installed in the middle of 1971) and a cobalt-60 source of approximately 30 000 curies; and

(e) Applied thermodynamics, dealing basically with solar energy application and desalination of sea-water.

LOCAL TRAINING IN NUCLEAR SCIENCE

13. Sixteen fellowships were awarded to university graduates to study at the School of Nuclear Science and Technology.

14. Approximately 100 young scientists are obtaining research experience in the various laboratories of DNRC.

15. Thirty-five high-school teachers of physics participated in the Summer School of Atomic and Nuclear Physics, which has enabled them to introduce nuclear physics into their curriculum.

16. A seminar on ionizing radiation was organized for members of the staffs of several ministries and organizations, in order to inform them on matters regarding health and safety regulations in the application of radioactive materials.

17. Numerous seminars were also organized by scientists of the various Departments of DNRC, each in their particular field, including ionizing radiation, radiography, biology and chemistry; in addition, colloquia on nuclear physics and related subjects were organized by the Physics Department.

INTERNATIONAL CO-OPERATION

18. The High Energy Physics Group continued its collaboration with CERN and the corresponding groups of the Universities of Bologna, Liverpool and Vienna.

19. The Greek Atomic Energy Commission became the official representative of Greece to the European Molecular Biology Organization.

20. There is also collaboration with several universities and research centres such as the Brookhaven National Laboratory, Michigan State University, Oak Ridge National Laboratory and the Weizmann Institute of Science.

21. Greece had the honour to act as host country for the Symposium on Radiation Induced Cancer, sponsored by the Agency in collaboration with the World Health Organization.

TECHNICAL ASSISTANCE

22. The Agency greatly contributes each year to the promotion of research at DNRC by giving assistance in the form of fellowships, experts and equipment. Three research centres were renewed and four new ones were awarded. Many scientists of DNRC availed themselves of the opportunity to attend training courses, covering several branches of science, which were organized by the Agency.

23. The Greek Atomic Energy Commission, within the Government's programme for technical assistance to the African States, Members of the Economic Commission for Africa of the United Nations, will offer for 1970 ten fellowships of a duration of one year in the fields of technological applications of radioisotopes, raw material prospection and the installation and operation of research reactors.

SOUTH AFRICA

GENERAL

1. The increase in the power of the South African Atomic Energy Board's research reactor SAFARI-1 to 20 MW has enabled research to be undertaken on a much wider scale than before. Major new facilities installed during the past 12 months include the cyrogenic facility and the neutron diffractometer. The universal rig for the reactor is now being utilized for the irradiation of locally produced fuel samples under varying conditions.

2. In July 1970, it was announced that the Atomic Energy Board had successfully developed a unique new process of uranium enrichment and that a pilot plant for enriching uranium was already under construction. It is estimated that under South African conditions a large-scale plant based on this process would be competitive with existing plants in the West. Since the process holds appreciable possibilities of further development, research to achieve this is being pursued.

NUCLEAR POWER

3. A site for South Africa's first nuclear power station has been acquired at Duynefontein, not far from Cape Town, where it is proposed to erect up to six twin-reactor units eventually. The Electricity Supply Commission is accordingly busy with the further steps which will lead to the final selection of reactor type and contractor.

4. Some drilling and seismic investigations have already been carried out at Duynefontein and the Institute of Oceanography of the University of Cape Town has for the past year been doing physical oceanography covering sea-bed conditions and their effects on inlet structures, direction and velocity of currents, tidal characteristics etc. The Atomic Energy Board has been made responsible for radioactivy investigations including the establishment of permissible levels of concentration of radionuclides in liquid effluent discharged into the sea; micrometeorological studies will be carried out in collaboration with the Air Pollution Research Group of the Council for Scientific and Industrial Research (CSIR).

5. Co-operating in these studies, where appropriate, are the Department of Water Affairs, the Division of Sea Fisheries, CSIR and the Geological Survey Office.

NUCLEAR POWER ECONOMICS

6. A second report on the economic feasibility of introducing nuclear power in South Africa will be published in the last quarter of 1970. The report compares the performance of specific enriched uranium reactors with natural uranium reactors, all of the types considered being proven or employing a proven technology, and known to be economically viable.

NUCLEAR DATA FOR REACTORS

7. In an attempt to resolve a part of the controversy about microscopic neutron cross-sections for natural uranium, careful measurements were done, using the Van de Graaff accelerator, on the inelastic scattering cross-sections for four of the lowest energy levels in uranium-238. These results confirm, in general, the commonly recommended values. A contribution based on this work was presented at the Second International Conference on Nuclear Data for Reactors in Helsinki in June 1970.

NUCLEAR MATERIALS

8. Prospecting for uranium is being actively pursued and exploration drilling has increased considerably. The number of applications for prospecting rights from mining companies and from private individuals continued to increase.

9. An intensive effort is being devoted towards research on the extraction metallurgy of low-grade uranium ores, this effort being in the form of a closely co-ordinated programme with the uranium mining industry, the Extraction Metallurgy Division of the Atomic Energy Board and the National Institute for Metallurgy.

10. Research work on the Purlex process has been completed, and most of the uranium plants in South Africa are now adopting this solvent extraction process for their full-scale production operations.

11. The improvements in uranium leaching efficiency brought about by recirculating the raffinate from the solvent extraction operation so as to increase the concentration of oxidizing agents have been demonstrated in pilot plant operations, and work is now being conducted on the introduction of such improvements to full-scale operations.

12. A major effort has been devoted to the development of techniques for the treatment of low-grade ores other than those derived from the residues of the gold mining industry. These ores are of a pegmatitic character and require techniques

different from those conventionally used in South Africa. A pilot plant to assess the economics of such processes for a particular ore body has been designed and will commence operations shortly.

13. Much effort has also been devoted to the development of resin-in-pulp techniques for the treatment of unfiltered and leach slurries and also to the fundamental chemical aspects of acid and alkaline leaching of uranium ores. Ore preconcentration techniques, bacterial leaching processes and various other aspects of uranium ore processing are also receiving attention.

14. A detailed economic and technical assessment of the production of uranium hexafluoride in South Africa has been completed. It appears that there may be significant economic advantages, not only for South Africa but also for purchasers of South African uranium, in establishing uranium hexafluoride production facilities in South Africa.

NEUTRON ACTIVATION ANALYSIS

15. Considerable progress has been made with multiple element analysis of geological samples by non-destructive and semi-non-destructive neutron activation analysis utilizing high-resolution γ-spectrometry. An automatic counting system for measuring relatively long-lived activities, and a fast shuttle-rabbit transfer and counting system for measuring short-lived activities are at present under construction. The latter system is also intended for routine determination of uranium and thorium in slimes-dam samples, low-grade ores and prospecting samples. The major part of the programme is directed towards geochemical investigations of a number of important geological systems.

HEALTH AND SAFETY

16. A study on the dispersion and dilution of air-borne effluents, in which harmless inactive tracers were utilized, was completed during 1969. The results obtained will be applied to South Africa's first nuclear power station.

17. A study on radon hazards in uranium mining and processing, which is of special interest to the South African gold mining industry, where uranium is mined together with gold, is being carried out. This study will shed much light on the incidence of lung cancer in mines.

RADIATION APPLICATIONS

18. The sterilization of surgical sutures is being carried out in the existing γ-radiation facility on a contract basis. Furthermore, a programme on wood-plastic composites has been launched and laboratory-scale experiments are well advanced. A pilot-scale impregnator is nearing completion and commercial-size specimens will be prepared in the near future. Studies are continuing on polymerization and telomerization reactions of ethylene in various solutions and encouraging results have been obtained.

19. Work is also proceeding in collaboration with the Department of Agricultural Technical Services on insect disinfestation in tobacco bales and on the eradication of the false coddling moth in citrus areas by sterile male release.

RADIOISOTOPE PRODUCTION

20. Although South Africa imported radioisotopes to the extent of 5225 curies during 1969, local production continued on a considerable scale and facilities were expanded with the erection of shielded glove boxes and with the completion of an apparatus for routine manufacture of technetium-99 generators. Attention is now being given to the preparation of sealed sources such as cobalt-60 and iridium-192.

21. CSIR has maintained the output of neutron-deficient isotopes such as beryllium-7, cadmium-109, cerium-139, sodium-22 and strontium-85, which South Africa exports regularly.

BIOLOGICAL STUDIES

22. Important clinical research which is at present under way includes the accurate determination of the glomerular filtration rate, using ytterbium-169, and the detection of brain tumours with smaller radiation doses to specific organs of the body.