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PROGRESS IN PEACEFUL APPLICATIONS OF NUCLEAR ENERGY DURING THE YEAR 1968/69

Statements by Member States

Note by the Director General

1. By 25 August 1969 four Governments had furnished statements for the information of the General Conference on the progress made in their respective countries during the year 1968/69 in peaceful applications of nuclear energy. The statements in question are reproduced below.

2. It is planned to consolidate these statements, together with such further statements as may subsequently be communicated, into a booklet [1] to be published later in the year, at which stage it will be possible to incorporate any emendations that may prove desirable.

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[1] Compare the booklet containing similar statements in respect of 1967/68 (GC(XII)/INF/101/Rev.1).

INDIA

1. Nuclear activities during the year reached a climax with the completion of India's first atomic power station at Tarapur about 100 km north of Bombay. On 1 April atomic energy made its debut in the country as a source of electricity when power at low level began flowing from the Tarapur Atomic Power Station. The Station will be reaching its full output of 380 MW(e) very soon.

2. Besides the completion of Tarapur and the continuous progress in the construction of the two other nuclear stations in the country - the 400-MW(e) Rajasthan Atomic Power Station at Rana Pratap Sagar and the first unit of 200 MW(e) of the Madras Atomic Power Station at Kalpakkam - there was considerable expansion of activities in other parts of the atomic energy programme.

3. The Bhabha Atomic Research Centre at Trombay continued its diverse research and development activities.

4. At the Isotope Division of the Centre, several new radiopharmaceuticals were developed for possible use in nuclear medicine; preliminary studies using these products have been conducted on animals. A number of carbon-14 and tritium labelled compounds were synthesized. Ten new carbon-14 labelled compounds were prepared by biosynthesis using the alga chlorella, and purified to obtain various uniformly-labelled amino acids. In radiation technology, considerable progress was made in developing a field irradiation unit "Gamma Shine"; a prototype of this unit has been made and tested. Besides its research and development activities, the Division also kept up its export of isotopes, equipment and services. Australia, Burma, Ceylon, Denmark, France, Korea, Kuwait, Lebanon, Romania, Taiwan, Thailand and the United Arab Republic are among the countries which bought radioisotopes, equipment or services from the Bhabha Centre during the year. Among radiation equipment sold were irradiation units "Gamma Chamber 900" exported to Lebanon and to Romania.

5. Besides production of radioisotopes and related equipment, the Bhabha Centre continued research and development work relating to applications of atomic energy in agriculture, industry, medicine, biology and other areas. The Biology Division of the Centre continued its plant breeding programme, among other investigations. Promising mutants of rice and groundnut developed by it are currently being subjected to field trials. A programme of work has also been taken up to induce dwarf mutants in otherwise potentially high-yielding varieties of rice.

6. Work on development of radiation preservation procedures for perishable foods was intensified at the Food Irradiation and Processing Laboratory of the Centre. With the completion of the facilities at the Laboratory, experimental programmes have been accelerated. Large-scale studies with mangoes and sea food (Bombay duck, shrimp and pomfret) have yielded promising results. Activities relating to radiosterilization of medical supplies were undertaken and facilities were made available for exposing other products to gamma rays. Plans have been completed for large-scale feasibility studies on grain disinfestation by gamma rays.

7. At the Fuel Element Fabrication Facility of the Centre, development work connected with the fabrication of fuel elements and components for future nuclear power stations was continued. The Facility meets the requirements for metallic fuel elements and sub-assemblies of the CIRUS and ZERLINA reactors at Trombay. In addition, it continued the production of high-density sintered UO_2 pellets. The Facility is also fabricating the initial half-charge for the first unit of the Rajasthan Atomic Power Station.

8. In the field of fast reactors, work was done at the Centre on the design of the Indian Fast Test Reactor and a pulsed reactor. Detailed analysis was made of the physics experiments carried out abroad. The Experimental Reactor Physics Section of the Centre directed its efforts towards the setting up of experimental techniques for subsequent use in the study of power reactor configurations. Planning for the Fast Reactor Research Centre at Kalpakkam was initiated. The design of the engineering laboratories has been finalized and it is expected that the laboratories will be commissioned some time next year.

9. The Electronics Division of the Centre designed and built an electronic digital computer, TDC-12. This fast computer is capable of performing 250 000 additions and subtractions in a second, and is intended for real time applications. This is the first real time digital computer developed in the country. Commercial production of this computer will be taken up by the Electronics Corporation of India Ltd. at Hyderabad, an industrial unit under the Department of Atomic Energy.

10. The Laser Group of the Division recently built and operated a helium-neon laser. It is also working on the development of several types of lasers, e.g. gas laser, helium-neon laser, ruby laser, neodymium-doped glass laser, argon ion laser, carbon dioxide laser and liquid laser.

11. Measurements were continued at Bombay and ten other stations in the country of bomb-produced radioactivity in the atmosphere and in surface deposits. Analytical work on various food samples from Bombay, and milk samples from country-wide stations for ^{137}Cs, ^{90}Sr and ^{40}K was undertaken.

12. Consistent with the policy of development of indigenous know-how for nuclear power generation, work on engineering systems for the second unit of the Rajasthan Atomic Power Station has been undertaken by the Bhabha Centre.

13. About 100 new institutions, representing nearly 1500 radiation workers, joined the Film Badge Service of the Directorate of Radiation Protection during the year. The service now covers 1110 institutions and monitors a total of nearly 13 500 radiation workers in the country. The Directorate has also developed and built a wide variety of instruments, most of them specially suited for work under the widely varying climatic conditions encountered in field use. The Electronics Corporation of India Ltd. at Hyderabad is mass producing some of the instruments developed by the Directorate.

14. At the Tata Institute of Fundamental Research a wide range of experiments in nuclear physics (nuclear reactions and nuclear spectroscopy), on nuclear and electron magnetic resonance, in chemical and solid state physics, on primary cosmic rays with high altitude balloon flights, in high energy physics through bubble-chamber film analysis, in hydrology and other isotope-based geophysical studies, in radioastronomy, in molecular biology, etc. are in progress. For example, the study of defects produced by ionizing radiation in solids is in progress, with a view to understanding their effects on the conductivity and atomic diffusion of irradiated solids.

15. The operation of five telescopes and two magnetic spectrographs for the Tata Institute-Osaka City University-Durham University neutrino experiment at a depth of 2400 metres in the Kolar Gold Fields is being continued.

16. In oceanography rapid geochemical reactions occurring in the upper layers of the oceans were studied using natural thorium-234 as a tracer. These studies lead to a value of about 50 years for the residence time of chemically active elements like thorium in ocean water.

17. The 530-metre long cylindrical radiotelescope at Ootacamund for studies in radio-astronomy is expected to be operational during 1969.

18. The National Computation Facility based on the CDC 3600-160A computer system completed its fourth year of operation, and is now operating 24 hours a day throughout the week, except for Sundays.

19. In Operations Research, in collaboration with the Power Project Group of the Department of Atomic Energy, a computer programme has been developed for computing the optimal mix of thermal, hydro and nuclear power generation. Using this programme, an analysis has been carried out for the planning of power requirements in the northern-region grid.

20. The Atomic Minerals Division of the Department is continuing the underground development work at the Narwapahar and Bhatin deposits and in the assessment of nickel and molybdenum reserves at Bhatin.

21. Among industrial units associated with the Department is Indian Rare Earths Ltd., which is responsible for commercial exploitation of the mineral sands in the country. For the first time the Company sees signs of being able to export a sizable quantity of rutile. It may be noted that hitherto rutile has always been imported.

22. All the major construction and erection works of the Uranium Corporation of India Ltd. at Jaduguda have been completed. The uranium mill was commissioned for commercial production in May 1968.

23. A Nuclear Fuel Complex is being set up at Hyderabad with the object of attaining self-sufficiency in fuel element supplies for the country's nuclear power programme.

24. At the Electronics Corporation of India Ltd., Hyderabad, there was steady progress in the production of the following new items:

(a) Components such as carbon and metal film resistors, tantalum capacitors, germanium power transistors, zener diodes, silicon rectifiers and thermoelectric modules;

(b) Nuclear instruments for medical, agricultural, research and industrial purposes; and

(c) Instrumentation and controls for nuclear power stations.

A separate unit of the Corporation, known as the Power Reactor Instrumentation Division, undertakes work of fabrication and assembly of control panels, consoles and instruments for nuclear power plants.

25. It is proposed to set up a heavy water plant alongside the Rajasthan Atomic Power Station to produce 100 metric tons per year of nuclear-grade heavy water.

26. The Bhabha Atomic Research Centre will be building an AVF variable energy cyclotron at Calcutta during the Fourth Five Year Plan period, in collaboration with the Saha Institute of Nuclear Physics.

27. A project for nuclear research in agriculture under the Special Fund component of the United Nations Development Programme started functioning at the Indian Agricultural Research Institute, New Delhi. The purpose of this project is to expand research and training facilities for radiation applications in agriculture at the Institute and at three other centres - the Bhabha Atomic Research Centre at Trombay, the Indian Veterinary Research Institute at Izzatnagar and the National Dairy Research Institute at Karnal.

28. The possibility of low-cost power production as a result of the scaling-up of nuclear power reactors to large sizes and the scope for reduction in the production costs of water by desalination as a result of advancing technology are of major significance for large power consuming industries and agriculture in India. Production of ammonia by electrolysis of water, of phosphatic fertilizers through the electric furnace and of aluminium are some of the important industries. Low-cost power can also be profitably used for pumping of under-ground water, where available, for agriculture; alternatively, desalinated water can be made

use of even for agriculture under controlled conditions in arid regions. The development of agro-industrial complexes based on the utilization of low-cost power and water in the vicinity of the power plant has been studied by a working group set up by the Atomic Energy Commission with special reference to Indian conditions. Two regions were considered for specific project evaluations:

(a) The Gangetic Plain in Western Uttar Pradesh, where underground water is available, along with fertilizers, for use for agricultural purposes; and

(b) The Kutch-Saurashtra area, where the use of desalinated water for agricultural purposes is envisaged.

The group has submitted a preliminary report. Further work is continuing on detailed investigations.

PAKISTAN

INTRODUCTION

1. The Pakistan Atomic Energy Commission (PAEC) is charged with the development of the nuclear power programme and the application of radioisotopes and radiation in medicine, agriculture and industry. It is also engaged in collaborative research with universities and other scientific and development institutions and organizations of the country.

NUCLEAR POWER

2. Pakistan's first nuclear power station, having a generating capacity of 137 MW(e), is in an advanced stage of construction near Karachi. The plant is a natural uranium heavy-water type. It is expected to become operational in 1970.

3. A second nuclear power station is being planned for the northern part of East Pakistan. Its generating capacity is expected to be 200 MW(e) and it will form the base-load station in the western grid of East Pakistan.

4. PAEC is making a survey of power requirements in the country and the part nuclear power has to play in this respect. Studies are also in progress on the feasibility of establishing dual-purpose, nuclear power plants, especially on the Mekran Coast of West Pakistan, where there is a great dearth of water.

AGRICULTURE

5. Useful development work is being carried out in the agricultural field at the Atomic Energy Agricultural Research Centre, Tandojam and the Atomic Energy Centre, Dacca. Certain improved varieties of food and cash crops have been evolved which are under observation. Efficiency of fertilizer applications is under study. Plans are under way for the application of the sterile male technique for the eradication of certain crop pests. A number of collaborative research programmes have been undertaken with various local development organizations. The Agency is providing helpful assistance in these projects.

6. An Institute of Radiation Genetics has been set up at Lyallpur, West Pakistan and a similar Institute is under construction at Mymensingh. An Irradiation and Pest-Conrol Research Institute is being planned at Tengi, East Pakistan for work on pest control and preservation of food on a pilot-plant scale.

HEALTH

7. PAEC has initiated a regular programme of establishing Medical Radioisotope Centres at the principal medical institutions of the country. At present, such Medical Centres are in operation at Karachi, Lahore, Jamshoro, Multan and Dacca. Two more Centres are almost complete at Chittagong and Rajshahi. Several thousand patients suffering from malignant diseases have been referred to the Medical Centres and diagnostic investigations have been carried out. Out of these a few hundred patients were given suitable radiation therapy.

INDUSTRY AND OTHER APPLICATIONS

8. A number of useful instruments for the industrial use of radioisotopes have been designed, constructed and used by the Atomic Energy Centres at Lahore and Dacca. Gamma-radiography has, in many cases, been used for checking joints in natural gas pipe-lines and finding defects in castings and moulds.

9. The Commission is collaborating with the Karachi Port Trust in tracing the movement of sand and silt near Karachi harbour. It is also assisting the East Pakistan and West Pakistan Water and Power Development Authorities in locating underground water resources.

10. Work on the harnessing of solar energy for small-scale but important uses such as rural lighting, running low-power irrigation pumps for villages and operating small, family-size stills to convert brackish water into fresh water, has been initiated at the Atomic Energy Centre, Lahore and at Karachi.

RESEARCH AND DEVELOPMENT

11. In support of the practical applications of atomic energy, research and development work is in progress at the Atomic Energy Centres at Lahore and Dacca and at the Pakistan Institute of Nuclear Science and Technology (PINSTECH) which has a 5-MW swimming-pool reactor facility. Production of radioisotopes from the PINSTECH reactor has started. Researches in theoretical and experimental nuclear physics have been undertaken in collaboration with local educational institutions. Certain developmental work has been carried out in electronics instrumentation. Basic work is in progress in radiation and nuclear chemistry.

SEARCH FOR NUCLEAR MINERALS

12. PAEC has undertaken a scientific survey of nuclear minerals in the country. In East Pakistan encouraging deposits of a number of minerals including rutile, ilmenite and zircon have been discovered. Pilot plant for their exploitation is being planned. In West Pakistan a significant deposit of uranium and traces of other valuable minerals have been found in Dera Gazi Khan and Gilgit Agency respectively. Detailed investigation to find out the extent of such deposits and the chemical and economic evaluation of the extraction of low-grade ores are in progress.

SOUTH AFRICA

Summary of nuclear research work: 1968/69

INTRODUCTION

1. Details of the South African nuclear research programme have been described in an earlier summary. [2] During the past twelve months the research facilities available have been supplemented in two important respects:

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[2] See document GC(XII)/INF/97/Rev. 1., statement H.

(a) The power of the Atomic Energy Board's research reactor SAFARI I has been raised to the full design rating of 20 MW, and the reactor is now regularly operated at powers of between 10 and 20 MW according to demand; and

(b) A new 18 000 curie cobalt-60 radiation source has been fully commissioned and is in regular use for radiation chemistry experiments. Its main purpose, however, will be the study of potential large-scale applications of radiation such as sterilization, chemical processing and food preservation.

2. In addition a universal rig for the reactor has been acquired and will be used primarily for the irradiation of locally produced fuel samples under varying conditions.

3. These acquisitions have added yet further impetus to the various aspects of nuclear research being undertaken in the Republic, and the following status report may be of interest to Member States working along parallel lines.

NUCLEAR POWER

4. Following on the completion early in 1968 of the first report on the economic feasibility of introducing nuclear power in South Africa, work on the second phase of the investigation is now well advanced. These studies include the consideration of enriched-fuel reactor systems, and should be completed by the end of 1969.

5. The Electricity Supply Commission's Nuclear Power Section is now making active preparations for South Africa's first nuclear power station, which should be in operation in 1978. In preparation for this the Atomic Energy Board has formed a Site and Installation Licensing Division which is formulating licensing philosophy and procedures.

NUCLEAR MATERIALS

6. The mining industry drilled more than 130 000 feet during 1968 in its search for uranium, and some of the promising results are being further investigated. The number of applications for prospecting rights, from mining companies and from private individuals, is increasing considerably.

7. Research work on the Purlex process [3], for extracting high-purity uranium direct from gold-plant slurries, has now been completed and several mining companies are taking steps to install full-scale Purlex-type plants. The "Felix" project for improving leaching efficiency at reduced cost has successfully reached the pilot plant stage. This process aims at the more efficient use of oxidizing agents in the acid leach system, the agent used being ferric sulphate.

8. The UO_2, UF_4 and UF_6 experimental programmes are approaching finality and it is now possible to produce UO_2 pellets of high standard on pilot plant scale. The moving-bed UF_4 reactor of the Nuclear Fuels Corporation is now operating successfully, and a detailed study of the possibilities of producing UF_6 in South Africa is nearing completion.

9. Work on the specification of high-purity, nuclear-grade uranium, was concluded. Methods are being developed and equipment commissioned for the analysis of large numbers of geological samples on a routine basis by neutron activation techniques.

HEALTH AND SAFETY

10. An interesting study now being carried out relates to the dispersion and dilution of air-borne effluents. Inactive tracers are being used for the study, and the subsequent fall-out is measured by activation analysis. The results will be applicable to problems

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[3] See document GC(XII)/INF/101/Rev. 1, statement 24, para. 4.

connected with accidental release of activity from reactors, as well as to conventional air pollution.

11. The International Pneumoconiosis Conference held in Johannesburg early in 1969, included a session on radon hazards in uranium mining and processing. This subject is of special interest in the study of South African mining conditions.

REACTOR PHYSICS

12. The first experiments on the critical assembly PELINDUNA-ZERO involving the measurement and analysis of reactor physics parameters on a four-element assembly have now been completed. The assembly is now being changed to an arrangement of seven shorter elements, a mock-up of the original PELINDUNA power reactor design.

RADIOISOTOPE PRODUCTION

13. Apart from the increased experimental capacity now available in the reactor SAFARI I as a result of its increased power, it is now also possible to expand the manufacture of radioisotopes considerably to satisfy the rapidly increasing demand for them in South Africa. Evidence of the increasing use can be found in import figures for 1968, when the total imports of radioisotopes into South Africa amounted to 28 682.1 curies as compared with 11 077.5 curies in 1967.

14. South Africa continues to maintain a small but significant export of specialized neutron-deficient isotopes made by the Council for Scientific and Industrial Research. These include isotopes such as beryllium-7, cadmium-109, cerium-139, sodium-22 and strontium-85.

BIOLOGICAL STUDIES

15. Among research projects completed has been an investigation into the extracorporeal irradiation of blood, the preliminary results of which were presented at an international symposium on the clinical and experimental use of extracorporeal irradiation at the Weizmann Institute in Israel. In addition, work first begun a few years ago to develop improved methods of scanning the placenta in pregnant women with the aid of radioactive compounds, has resulted in publication of two such methods which have been favourably received. Yet another method is now being investigated.

16. The studies on carbohydrate derivatives, aimed at the production of a synthetic antibiotic, continued. Preliminary studies on the addition of acyl nitrites to 1.2-unsaturated sugars, and the investigations of various chemical transformations of the adducts have presented a facile route to the required compounds. A paper on this aspect of the work has been submitted for publication.

17. Limited though South Africa's nuclear research activities may be in relation to those of some of the larger advanced Member States, they are nevertheless vigorous and tangible results of benefit both to herself and to the world in general are clearly evident. The Government of the Republic remains willing to collaborate with Member States working in similar fields and in particular to entertain requests for technical assistance from developing countries, especially those in the region of Africa and the Middle East.

VIET-NAM

Progress in the Peaceful Uses of Nuclear Energy in 1968-69

INTRODUCTION

1. During the past year the regular activities have been proceeding in a normal manner. Research activities on the other hand, have suffered to some extent from the manifold difficulties due to the war and break-down of the irradiation device in the VNR-1 reactor.

REGULAR ACTIVITIES

2. The regular activities included:

(a) Production of radioisotopes for local needs;

(b) Diagnosis of disorders of the thyroid gland by the radioactive method;

(c) Treatment of cancerous tumours by gamma rays;

(d) Monitoring of the radioactivity of air and water;

(e) Personnel monitoring by photographic films;

(f) Monitoring at facilities using ionizing radiation sources, as a part of the activities of the National Radiation Protection Commission.

RESEARCH ACTIVITIES

3. Research activities were restricted mainly to the applications of nuclear energy in medicine and agriculture.

4. Studies on primary cancers of the liver in Viet-Nam were undertaken in the Isotope Laboratory of the Cho Rây Hospital under a research contract with the Agency.

5. Under another research contract with the Agency, the Nuclear Research Centre at Dalat and the Radioisotope Laboratory of the Directorate of Agricultural Research participated in the Co-ordinated Programme of Research on the Use of Induced Mutations for Rice Improvement.

6. In the field of fundamental research, the Science Faculty of Saigon is beginning to develop research in nuclear physics.

7. The Nuclear Research Centre at Dalat carried out technical studies on the feasibility of installing a 5000 Ci ^{60}Co gamma source for preservation of foodstuffs.

8. Following the stimulus given by the Sub-Committee on Energy Resources and Electric Power, which met in Singapore in 1968, we have studied the technical and economic aspects of introducing nuclear electric power in Viet-Nam.

TRAINING AND EDUCATION

9. During 1968 Viet-Nam benefited from a number of training and advanced training fellowships awarded by the Agency and friendly countries. The local training of nuclear technicians and scientists was, however, not neglected; the teaching of atomic and nuclear physics was included in the syllabus of the Science Faculty of Saigon and an introductory course on radioactive techniques was held at the Pharmaceutics Faculty of Saigon.

10. With a view to facilitating teaching, the Atomic Energy Office published a "Glossary of Nuclear Terms" in Vietnamese as a part of the activities of the National Commission for Scientific Terminology. In addition, a French-Vietnamese nuclear dictionary is in the press.

11. Finally, the problem of popularization of the nuclear sciences continues to receive our full attention. A book entitled "The Atomic Treasure" has been published in Vietnamese in order to acquaint the general public with the benefits of uranium fission.