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UNIT-3 OF KAIGA ATOMIC POWER PROJECT -3&4 ATTAINS CRITICALITY

Unit-3 of Kaiga Atomic Power Project , situated in north Karnataka, successfully started its first nuclear chain reaction (first criticality) at 10:10 hrs on February 26, 2007. The milestone was achieved well within the approved costs and time schedule. The unit will now be put through a number of further commissioning checks to progressively enhance its power output to its rated level of 220 MWe. In his communication to the Chairman, AEC, the prime minister Dr. Manmohan Singh conveyed his warm congratulations to all the members of the team involved in this effort, and wrote "This development testifies to the impressive capability developed by our Department of Atomic Energy in the indigenous design and construction of nuclear power plants, which is central to the country's three-stage nuclear programme."

The first pour of concrete marking the zero date of construction was held on March 30, 2002. The criticality has been achieved in less than 5 years period which is comparable with international bench marks.It is the 17th nuclear power unit and the 220-MW capacity Kaiga 3 is the country's seventeenth nuclear power plant. With this the total installed nuclear power capacity will be increased from 3900 MWe to 4120 MWe, when unit commences commercial production of electricity after completion of mandatory tests.

MILESTONE:2006-07
ACHIEVEMENTS OF THE DEPARTMENT OF ATOMIC ENERGY

The year 2006-07 was epoch-making for the Department of Atomic Energy. The Department achieved many successes. 500MWe PHWR Tarapur Atomic Power Project-3 achieved first criticality on May 21, 2006 and was synchronised to the grid on June 15, 2006. 220 MWe PHWR Kaiga-3 achieved first criticality on Feb 26, 2007. India signed an agreement to join ITER on November 21, 2006. Homi Bhabha National Institute, a deemed to be university, started functioning during the year. Following is the brief description.

NUCLEAR POWER PROGRAMME

DAE has been pursuing a 3-stage Nuclear Power Programme. The first stage, which is already in the commercial domain, comprises the setting up of pressurized heavy water reactors that use natural uranium as fuel. The second stage, which is in the technology demonstration stage, is geared to set up fast breeder reactors using plutonium produced by reprocessing of spent uranium fuel from the first stage. The third stage, in the technology development stage, will be based on the thorium-uranium-233 cycle, in specifically designed reactors.Uranium-233 is obtained by irradiation of thorium.

The programmes relating to nuclear power have been built on the multidisciplinary R&D infrastructure of the Department.

Pressurised Heavy Water Reactors and Light Water Reactors

The Nuclear Power Corporation of India Ltd. (NPCIL) operates 16 reactors (14 pressurised heavy water reactors and 2 boiling water reactors), with a total capacity of 3900 MWe. In addition, it is engaged in the construction of 6 nuclear power reactors, of which four are pressurised heavy water reactors of 220 megawatt each and two are light water reactors of 1000 megawatt each, totaling 2880 MWe capacity.

During the calendar year 2006, generation of electricity from nuclear power plants of NPCIL was 17794 million units (MUs).

The Unit-4 of Rajasthan Atomic Power Station Reactor operated continuously for 373 days, breaking an earlier record. Unit-1 of Kaiga Atomic Power Station also recorded uninterrupted operation for 356 days.

The World Association of Nuclear Operators (WANO) completed peer reviews of the atomic power stations at Kakrapar, Narora, Kaiga, Rawatbhata and Tarapur. Its review for the Atomic Power Station at Kalpakkam was carried out in January, 2007. These reviews indicated that the condition and performance of the stations matched those at the world level. The Company offered its TAPP-3 unit for pre-startup Peer Review by an expert team of WANO. This was the first ever review of its kind in Asia. Similar reviews for RAPP-5 and Kaiga-4 are also planned next year.

NPCIL is constructing additional nuclear reactors at Kaiga (Karnataka), Rawatbhatta (Rajasthan) and Kudankulam (Tamil Nadu) Construction of Kaiga-3&4 project was completed by more than 90%. These units are expected to attain criticality during 2007. The overall progress of RAPP-5&6 has crossed 80%.

The Kudankulam Nuclear Power Project-1&2 , which are light water reactors, have also reached an

Kudankulam Nuclear Power Project-1&2

Model Layout for 700 MWe PHWR

advanced stage of construction, with an overall physical progress of 72.3%. All the major equipment, including reactor pressure vessels, steam generators, primary coolant pumps and turbo-generator, etc. were delivered at site.

New Projects

Towards new projects at Kudankulam (Tamilnadu), Kakrapar (Gujarat), Rawatbhata (Rajasthan) and Jaitapur (Maharashtra), for which in principle approval of the Government of India was obtained earlier, various pre-project activities have started. For Kudankulam-3&4, clearance of the Ministry of Environment and Forest was also obtained.

Detailed design work for 700 MWe units progressed well and actions required for the procurement of long delivery items have been initiated.

R&D Support to Power Technology

The programmes relating to nuclear power have been built on the multidisciplinary R&D infrastructure of the Department. The research centres of DAE provide strong research and development support to power technology.

BARC has extended strong R&D support to the nuclear power programme in the areas of reactor technology, advanced fuel development, research reactor operation and up-gradation and waste management and storage.

A new system for balancing of the unbalance created by 'B Ram' movement of Fuelling Machine Head (540 MWe PHWR) was developed and tested by BARC. Differential Pressure Reducing Valve for fuel handling system of 220 MWe and 540 MWe PHWRs was manufactured, tested and commissioned. Man-rem saving tools such as end fitting blanking assembly were developed for 540 MWe PHWR. As a part of the aging management of coolant channels of PHWRs, sliver samples from Zr-2.5% Nb coolant channels of KAPS were analysed for deuterium pick-up. To accurately measure axial hydrogen pick-up profile in 220 MWe PHWRs, a circumferential scraping tool was developed. A Sludge Lancing Equipment was commissioned at KAPS site.

Post-irradiation examination of Zr-2.5% Nb pressure tube fabricated at NFC Hyderabad revealed excellent performance of the tube. An automated Gamma Scanner for inspection of irradiated pressure tubes of PHWR was designed and fabricated by BARC. A Special Ion-exchange system developed for removal of gadolinium nitrate from the moderator in the presence of boron was used during the first criticality of TAPS-3. Flux Mapping System for 540 MW reactors was commissioned at TAPP-3. Reactor instrumentation for nuclear power measurement for control and protection of the plant was developed.

Various severe accident scenarios were analysed for VVERs (pressurised water reactors). Fuel Channel Growth Measurement Device was designed, fabricated and used in measurement irradiated Fuel Channels of TAPS-1 & 2. Boron carbide control blade assemblies and Channel fastener assemblies were fabricated and supplied to TAPS reactor. Computational thermal analysis of Control Rod Drive Mechanisms of a nuclear reactor was performed.

The research and development efforts of NPCIL remained focused on reducing the unit energy cost through improving plant efficiency as well as plant availability factors, reducing project gestation period and improving plant safety.

R&D support to power technology included Coolant Channel Facilities for 220 MWe reactor, Laser based bellow lip cutting and re-welding machines and Bellow removal, rolling grooves dressing up machine and 4-way air operated high pressure valve for Fuelling Machine, etc.

Programmable Digital Comparator Systems and Reactor Regulating System, etc. were fab-

ricated, installed and com-missioned successfully at Kaiga-3.

Laser cutting of 612 bellow lips and a number of high pressure feeder coupling studs was successfully carried out with indigenously developed fibre-coupled solid-state YAG lasers during En-Masse Coolant Channel Replacement (EMCCR) campaign at the Narora Atomic Power Station Unit-1.

A laser based in-service-inspection system was developed at RRCAT for the inspection of the inner surface of Lead Mini Cell dissolver vessel for use at Reprocessing Development Lab at IGCAR, Kalpakkam.

FRONT-END FUEL CYCLE

The Nuclear Power Programme has a number of ancillary operations which form the Nuclear Fuel Cycle. The 'Front-End' of this Cycle includes mineral exploration, mining, and processing of ore, and fuel fabrication. Heavy water is used as moderator and coolant in PHWR.

Heavy Water Production

The Heavy Water Board (HWB) operates six heavy water plants in the country.

The production, specific energy consumption and safety record of all the operating Heavy Water Plants during April-December 2006 was excellent with production exceeding the scheduled target. Energy saving measures were successfully adopted at various heavy water plants.

HWP, Kota implemented schemes that enabled the plant to have a continuous run enhancing the production. The plant also commissioned a pressure swing adsorption nitrogen plant. HWP, Hazira replaced high capacity booster cooling water pumps with low capacity pumps in upgrading plant and also carried out certain modifications.

Tri Butyl Phosphate Plant, Talcher

HWB successfully executed the seventh export order of 13 MT of heavy water to South Korea in November 2006. The Board also entered into a contract with a US firm for supply of 4400 kg of nuclear grade heavy water for making deuterated compounds.

The Board, that also diversified into the production of solvents required for DAE, produces organo-phosphorous solvents such as D_2EHPA and TBP (tri butyl phosphate) at Talcher facility. These products meet the international quality standards.

Production of solvents required for extraction of rare material at Talcher has also enabled HWB to venture into developing technology for extraction of rare material (Uranium) from weak phosphoric acid.

Dune cutting with an inset of buried temple, Brahmagiri mineral sand deposit, Puri district, Orissa.

Setting up of a Technology Demonstration Plant at Heavy Water Plant, Kota, for heavy water clean up continued.

HWB also took up various R&D and process development activities essential for Nuclear Power Programme like production of enriched Boron through distillation at HWP, Talcher, Centralised Uranium Conversion facility at Tarapur and Kalpakkam with recyclable uranium oxide (UO_2) powder manufacturing capability.

The Board initiated actions for development of alternate applications of deuterium/ heavy water both in life sciences as well as technological fields. It also entered into an MoU with one of the leading Optical Fibre manufacturers for regular supply of 3% dry deuterium gas.

As a result of massive energy conservation measures over the years and stabilization of the captive power plant at HWP, Manuguru, the plant started exporting power to APTRANSCO since September 02, 2006. The revenue earned will amount to Rs 11 crore during the current financial year 2006-07.

Civil works for Boric Acid Enrichment Plant through Ion chromatographic route at Manuguru was completed. Boron Enrichment Plant reached advanced stage of completion.

^{18}O is one of the isotopes having application in nuclear medicine and biochemical research. HWB embarked on distillation route for production of $H_2{}^{18}O$ at 99% purity and engineering has been completed.

During the period of report, all the heavy water upgrading requirements of Dhruva/Cirus reactors were fulfilled.

Exploration

The survey and exploration activities of the Atomic Minerals Directorate for Exploration and Research (AMD) continued to meet the increasing demand of atomic minerals especially uranium The salient achievements during the report period were as follows :

- 6632 tonnes (U_3O_8) of additional uranium resources were established at Lostoin, Wahkyn, West Khasi Hills district, Meghalaya; Chitrial, Nalgonda district, Andhra Pradesh, and Rohil, Sikar district, Rajasthan.
- Significant uranium mineralization was intercepted in Srisailam quartzite at Chitrial and Banganapalle quartzites both in Nalgonda district, and Koppunuru, Guntur district of Andhra Pradesh; in the basement granite in Alva Bade - Kandkiras block, Bastar district, Chhattisgarh; albitised rocks in Rohil, Sikar district, Rajasthan; albitised calc silicate rock at Raghunathpura-Khalra, Mahendragarh district, Haryana; and in the Mahadek sediments at Lostoin and Wahkyn, West Khasi Hills district, Meghalaya.
- Drilling was initiated in areas of Nalgonda district, Andhra Pradesh; Raigarh district, Chattisgarh; Belgaum district, Karnataka; Durg district, Chhattisgarh and Shivpuri district, Madhya Pradesh.

Promising uranium anomalies were located in the Proterozoic and Phanerozoic basins at various places in the country.

- 3.85 tonnes of columbite-tantalite and 2.60 tonnes of beryl as by-product were produced, and additional reserves of over 2700 kg of columbite-tantalite were estimated.
- 120.69 million tonnes of total heavy mineral resources were estimated as an inferred category (reconnoitory stage) along the 30 km coastline at Brahmagiri deposit, Puri district, Orissa.
- Large-scale test studies for recovery of uranium on Tummallapalle ore were carried out at Technology Demonstration Pilot Plant, Jaduguda.

Mining & Ore Processing

Uranium Corporation of India Limited (UCIL) produces uranium required for pressurized heavy water reactors of the country.

During the report period, the operating units of UCIL showed improved capacity utilization. Narwapahar mine and Jaduguda Plant continued to maintain their excellent performance in terms of production and processing of uranium ore respectively, more than the installed capacity. Turamdih mine also improved its capacity utilization.

Uranium Processing Plant under construction at Turamdih, Jharkhand

The company has been implementing a massive expansion programme of constructing several new mines and plants. Construction of Banduhurang and Bagjata mines progressed as per schedule. Turamdih Process Plant is expected to be commissioned very shortly. Pre-project activities for other projects viz., Mohuldih in Jharkhand, Tumallapalle and Lambapur-Peddagattu in Andhra Pradesh and Kylleng–Pyndengsohiong, Mawthabah (KPM) in Meghalaya made progress.

The Indian Rare Earths Ltd. (IREL) pursued its activities relating to recovery of uranium from various secondary resources.

37-element fuel bundles for 540 -700 MWe PHWR Units

Fuel Fabrication

In addition to meeting the regular reload fuel requirement of all the operating PHWR 220 units and BWRs, NFC manufactured and supplied the entire initial full core fuel requirement of the second PHWR 540 MWe unit (TAPP-3).

At NFC, the full core re-quirement of Seamless Calan-dria Tubes, Pressure Tubes and Garter Springs for the forth-coming Rajasthan Atomic Power Project (RAPP-6), Coo-lant Tubes & Garter Springs for replacement requirement of NAPS-1 & NAPS-2, were also successfully manufactured and supplied to NPCIL well ahead of schedule.

For efficient utilization of uranium resources, NFC successfully manufactured large quantities of PHWR fuel bundles containing Depleted Uranium material.

Sufficient quantities of 23.1 metre long 9Cr-1Mo tubes required for eight Steam Generators for PFBR were manufactured by NFC and supplied to M/s. L&T. This is the first time that large quantities of such extra long tubes with special material were manufactured in India.

Thorium Oxide Certified Reference Materials were developed by NFC, which is considered to be the workhorse for the future thorium based nuclear power programme.

The first batch of Titanium half alloy hydraulic tubes were produced by NFC for the Aeronautical Development Authority, which is a critical component in the Light Combat Aircraft. This development is considered to have a huge economic potential.

The New Zirconium Oxide Plant for enhancing the production capacity of zirconium oxide powder to 600 tpy reached advanced stage of completion.

At BARC, 36 bundles PHWR MOX (mixed oxide) bundles were discharged from Kakrapar Atomic Power Station, after a burn up of approximately 11,000 megawatt day/tonne.

For nuclear fuel analysis, a microcontroller based direct reading atomic emission spectrometer was developed.

Neutron activation analysis technique was standardized to estimate rare earth elements in B, Cd and Gd and uranium ores.

BACK END FUEL CYCLE

The Back-End of the Cycle covers reprocessing of spent uranium fuel and management of nuclear waste.

Reprocessing & Waste Management

The facilities at Trombay, Tarapur and Kalpakkam for reprocessing of spent fuel from research/power reactors operated well. Plutonium Plant at Trombay resumed operation after the upgradation for improved process performance and safety. Spent fuels from both CIRUS and Dhruva were reprocessed. The re-processing plant at Tarapur continued to reprocess the spent fuel from PHWRs. Flow sheet for recovery of plutonium and americium from fluoride matrix was developed using a combination of solvent extraction and precipitation techniques.

The radioactive wastes generated at various stages of nuclear fuel cycle are catagorised as low, intermediate and high level wastes. The plants for management of all types of

radioactive wastes operate at many nuclear facilities. The high level wastes, generated in very small quantities, are fixed in glass matrix.

India has become one of the six countries who have developed the Joule Heated Ceramic Melter (JHCM) and set up such facilities for vitrification of high level waste.

Health, Safety & Environment

NPCIL has registered about 260 reactor years of safe and radiation accident free experience of operation. The atomic power stations at Kakrapar, Narora and Kaiga won many safety awards. At BARC, various severe accident scenarios were analysed for VVER reactors.

The Heavy Water Plants also maintained their Excellent Safety Performance during the period. The Plants at Kota and Tuticorin won various safety awards.

BARC provided operational radiation protection services and surveillance at all the nuclear power plants and fuel reprocessing plants. Premature Chromosome Condensation Assay for high-dose accident dosimetry was developed. Twenty five monitoring stations of the Indian Environmental Radiation Monitoring Network (IERMON) were upgraded with solar powered environmental radiation monitor with GSM-based data communication.

BARC published, as a benchmark, a DVD Handbook of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) of the US-DOE and NEA (Paris). India is formally recognised as a contributor in ICSBEP.

NUCLEAR POWER PROGRAMME-STAGE-2

Fast Reactors

The Indira Gandhi Centre for Atomic Research (IGCAR) is engaged in the design and development of liquid sodium cooled fast breeder reactors (FBRs), backed by reprocessing.

Prototype Fast Breeder Reactor at Kalpakkam

The Fast Breeder Test Reactor (FBTR) was operated successfully and the mixed carbide fuel reached a burn-up of 155 GWd/t, without any fuel failure. 13 irradiation campaigns were completed so far for FBTR. With major improvements and modifications carried out in the systems, the availability factor for the reactor, which was 72% in the twelfth campaign, was brought to 95% in the thirteenth campaign. Four sodium pumps have given trouble free performance with a cumulative operating time of 5,50,000 h.

The Bharatiya Nabhikiya Vidyut Nigam Ltd. (BHAVINI) is constructing a 500 megawatt (e) Prototype Fast Breeder Reactor (PFBR) at Kalpakkam, Tamilnadu. It is a pool type reactor using a mixed oxide of uranium and plutonium as fuel, the design and technology of which were developed at IGCAR.

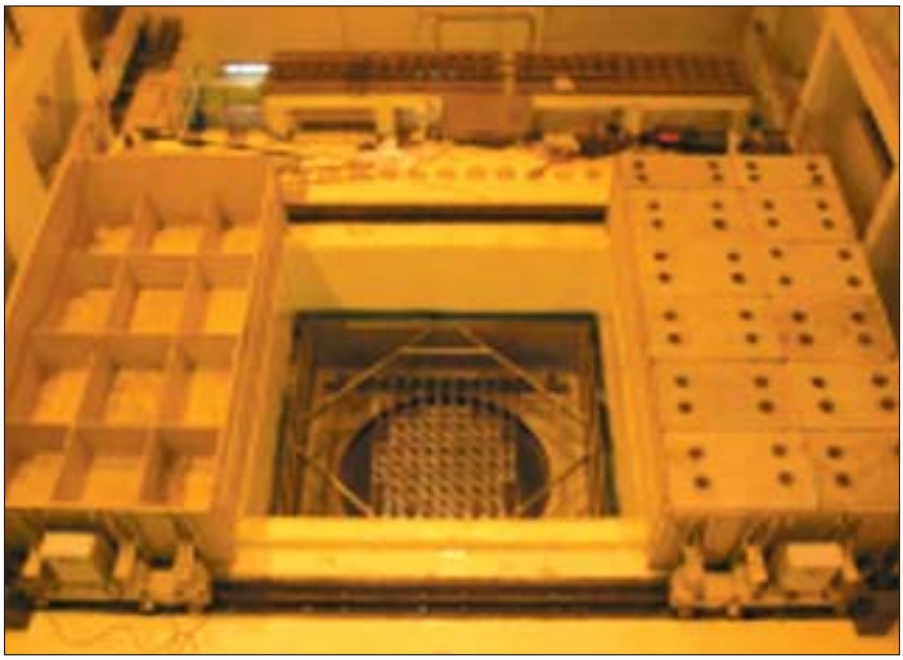
During the report period, the construction of the outer perimeter wall of PFBR, around the Nuclear Island Connected Buildings (NICB) raft was completed. The construction of reactor vault commenced and concreting progressed. The construction of 8 NICB superstructures and peripheral buildings also progressed.

Fabrication of the over dimensional components like Main Vessel and Thermal Baffles reached advanced stage of progress. Also the fabrication of sodium storage tanks is nearing completion.

Control system design for the Inclined Fuel Transfer Machine and Cell Transfer Machine was carried out at Trombay. A pair of low enriched uranium coated inconel 600 neutron sensors was prepared to monitor neutron flux in PFBR.

PFBR MOX fuel underwent burnup of 60 GWd/t as against target of 100 GWd/t.

IGCAR continued to provide design and research and development support to PFBR. Important components like safety vessel, main vessel and inner vessel and sodium tanks were under manufacture at site.



Top of Reactor Block showing shield trolleys and Fuel Support Girders

Many of the reactor components are under advanced stage of fabrication by the Indian industry.

FBR-Back End Fuel Cycle

CORAL Facility continued to provide support for the development of remote replacement technology of various gadgets deployed in high active facilities. Fabrication and erection works in Demonstration Fuel Reprocessing Plant (DFRP) were carried out. Activities connected with the Head End Facility were in progress to integrate with DFRP

Towards closing the fuel cycle, the design of the integrated Fast Reactor Fuel Cycle Facility for reprocessing spent fuel from PFBR and fabricating the fuel pins from recovered fuel, also commenced.

Efforts continued for full power operation of the Steam Water System of the Steam Generator Test Facility (SGTF). Testing of various components in sodium and the setting up of the full-scale simulator for PFBR made good progress.

Non-destructive methodologies were established to detect damage of concrete structures. Eddy current technique was developed for non-destructive microstructural characterization of M-250 grade maraging steel and for in-service inspection of modified 9Cr-1Mo tubes of steam generator test facility.

NUCLEAR POWER PROGRAMME-STAGE-3

Thorium Based Reactors

Thorium utilization is the long term core objective of the Indian Nuclear Power Programme for providing energy security on sustainable basis.

BARC is engaged in developing a 300 megawatt(e) Advanced Heavy Water Reactor (AHWR). This endeavour aims at developing expertise for thorium utilization and demonstrating advanced safety concepts.

At Trombay, the development, manufacture and supply of shut-off rod drive mechanism and PC based test console for testing and qualification of drive mechanisms for the AHWR was completed.

Fabrication of metallic uranium fuel clusters for reference core of AHWR critical facility was completed and all the reactor block components were installed. ThO_2 fuel pellets required for making the reference core of the Facility was also supplied. Installation of the new line for the fabrication of fuel for critical facility for AHWR was in progress.

Post-Irradiation Examination of ThO_2 fuel pins of PHWR Thoria bundle irradiated to 11,000 MWd/tM showed excellent in-reactor performance.

Other Reactor Systems

Compact High Temperature Reactor

Compact High Temperature Reactor (CHTR) calculations were done at BARC to estimate the effect of Niobium impurities in the structural material. A criticality benchmark based on the ^{233}U fuelled research reactor KAMINI was internationally peer-reviewed and published as a benchmark in the 2006

Accelerator Driven Sub-critical System

A self-sustaining Th-U cycle in a heavy water moderated ADS system, supporting 500 MWe power and 60 GWd/T fuel burn-up, was evolved using a 1 GeV proton beam of 30 mA current from a LINAC. Developmental work for new neutron kinetic code for Accelerator Driven System was initiated. Electron Beam Welding technology for RF cavity & other critical components was developed at Trombay for the ADS program.

For development of high current Accelerator Driven Subcritical System (ADS), VECC took up simulation work on the main magnet of 10MeV cyclotron to facilitate studies related to handling space charge dominated beams relevant for a compact Cyclotron. Assembly of components like power supplies, ion source coil, plasma chambers, motors and gears, remote control devices as

well as providing water supply connection and electric power to the various components have made progress.

Hydrogen Energy

Research and development work on thermo-chemical process for hydrogen production was initiated at Trombay. Process simulation studies and design details of an experimental set up were worked out. Site preparation and procurement action have made progress.

Fusion Reactor

The Institute for Plasma Research successfully operated Aditya tokamak to get 100 kA, 80 ms plasma. The experiments carried out included pre-ionization and start-up studies, effect of gas puff on edge fluctuations, Current drive experiment and others. Operations of Aditya faced failure of the pulse power transformer, possibly caused by the fatigue in the windings. The fault is being rectified.

During the report period, commissioning of the Super-conducting Steady State Tokamak (SST-1) was in progress. One of the major activities of SST-1 was to prepare its cryostat and vacuum vessel for plasma operation. A number of plasma diagnostics and two poloidal limiters were installed on SST-1 vacuum vessel. IPR also completed the engineering design of a suitable magnet for confining the electron-positron plasma in a combined Paul-Penning Trap. This design was released for fabrication to Bharat Heavy Electricals Limited.

India joined the International Thermo-nuclear Experimental Reactor (ITER) as one of the seven Parties. The others are China, European Union, Japan, Korea, Russia and USA. It will contribute equipment worth nearly 500 million US dollars to the ITER project and will also participate in its subsequent operation and experiments.

Apsara Reactor. The Reactor has completed 50 years of successful operation.

ADVANCED TECHNOLOGIES & RADIATION TECHNOLOGIES AND THEIR APPLICATIONS

The Research Centres of DAE have been engaged in the development of advanced technologies such as research reactors, accelerators, lasers and others, and radiation technologies having applications in the fields of medicine, agriculture, industry and research.

The major activities in these fields during the report period are outlined as follows :

Advanced Technologies and their Applications

Research Reactors

BARC's research reactors Apsara, Cirus and Dhruva continued to operate satisfactorily. These were

Hot cells for producing radioisotopes

utilized for basic and applied research, radioisotope production, material testing and training. Feasibility studies were carried out for upgrading the existing Apsara reactor to a 2 MW reactor with enhanced facilities. Dhruva continued to serve as a national facility for neutron beam research.

Accelerators

DAE organisations, especially the Variable Energy Cyclotron (VEC) at Kolkata, Raja Ramanna Centre for Advanced Technology in Indore and BARC have established capability in the design, construction and operation of accelerators used in nuclear research, isotope production and radiation processing.

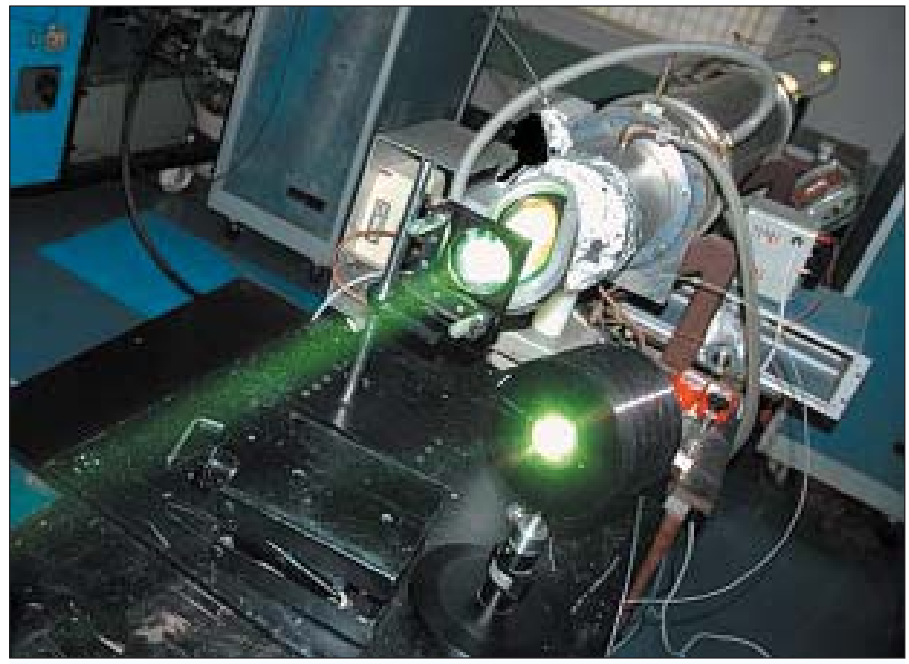
At BARC, switching Magnets Assembly for Folded Tandem Ion Accelerator (FOTIA) was manufactured.

For the second phase of BARC-TIFR LINAC pro-gramme, a LINAC control system was commissioned.

KALI-5000 was operated upto 450kV 30kA, 100 ns and used for high power microwave generation and flash X-ray experiments.

During the report period, setting up of a Superconducting Cyclotron, A Radioactive Ion beam Facility and a Medical Cyclotron continued at VECC. The Variable Energy Cyclotron set up here, was used for research in nuclear physics and nuclear chemistry, and production of radioisotopes for various applications.

At the Raja Ramanna Centre for Advanced Technology (RRCAT), 352 MHz solid state RF amplifiers of 20W, 40W & 300W, and an Electron Cyclotron Resonance (ECR) for operation at 2450 MHz were successfully developed. A switching magnet was fabricated for the 6-MeV folded tandem ion accelerator at Trombay and a 2.5m long undulator was built.



100 Watt kinetically enhanced copper vapour laser developed at RRCAT

The 500keV Industrial Accelerator located at BRIT was routinely operated for process development and modification of products such as rubber tiles and cross linking of polythene sheets etc.

Lasers

At BARC, a protytype super ultra-high precision single mode dye-laser Monochromator was fabricated. A novel experimental set-up for measurement for temperature in the range of micro Kelvin (150-900 mK) of laser cooled atoms was developed.

Under the laser technology development programme of RRCAT, following were the developments:

- A new reflecting element, an all-metal axicon mirror, was used to generate good quality hollow conic beam from a Gaussian beam with high power conversion efficiency;
- A highly efficient diode-pumped continuous wave Nd:YAG laser generating 375W of output;
- Power in multimode operation with an electrical-to-optical conversion efficiency of about 24%;
- A conduction cooled Nd:YAG slab end pumped by laser diodes and generating a maximum output power of 180W with an optical-to-optical conversion efficiency of 37.9%, and slope efficiency of 42.3%;
- A Green laser beam of more than 100W power was generated, by intracavity frequency doubling in a diode side-pumped Q-switched Nd:YAG rod laser;
- High power quantum well laser diodes covering a wavelength range of 740 to 1000 nm. The maximum peak power obtained was 5.3 Watt in pulsed operation. Arrays of these laser diodes consisting of 6-10 elements, were developed and tested;
- Development work in the field of copper vapour lasers (CVL) was carried out, on high power kinetically enhanced CVL, copper bromide laser and use of fiber Bragg grating as a temperature sensor. An Nd: glass disk amplifier stage was set up at RRCAT, and incorporated into the two-beam high power Nd: glass laser chain to enhance its output power by a factor of 2. This will be used for studies of intense thermal x-ray generation.
- Two S-20 optical streak cameras were set up at RRCAT for

experimental investigations on laser driven intense shock propagation in thin foils of different materials.

• At Trombay, a prototype super ultra-high precision single mode dye Laser Monochromator was designed, fabricated, tested and delivered.

Other Technologies

A Fibre Optic Temperature Sensor was designed and developed at RRCAT. The Centre also demonstrated a novel technique of simultaneous generation of multi-keV monochromatic, point, twin x-ray sources of ~20 ns pulse duration in a laser driven vacuum diode and its suitability for radiographic application.

The Optical Coherence Tomography (OCT) setup was used for various applications. A real time OCT setup incorporating a hand-held probe was assembled, characterized and used for imaging micro-structures of human fingernail and skin.

For optical trapping of objects near liquid-air interface, two new approaches were developed at RRCAT. These can be applied where conventional optical tweezers do not work.

A technique for detecting de-bond patches between two similar or dissimilar materials bonded together was perfected through vibration analysis of the response of bonded and de-bond surfaces.

A 40 kW DC thermal plasma reactor for mineral processing applications was developed and commissioned at Trombay. BARC has developed a twin source, triple collector magnetic sector isotopic ratio mass spectrometer for use in the Boron enrichment and Oxygen enrichment plants of the Heavy Water Board.

The DAE-Grid was setup between BARC, RRCAT, Indore VECC, Kolkata and IGCAR Kalpakkam using secure high-speed links over the public fibre optical network. The first version of the Advanced Static Assertion Checking Tool (ACE2) for functional verification of software was completed.

Production of microporous membranes using a heavy ion scanner, was demonstrated at BARC-TIFR Pelletron Accelerator facility.

The second batch of two 30K Cryocoolers systems was ready at RRCAT for field trial tests.

Isotope Processing

During 2006-2007, more than 52,000 consignments of various isotope products and radiation processing services were provided to customers across the country as well as some located abroad bringing in a sales turnover of Rs.40 crore.

Agriculture

A new groundnut selection, TG 38 was released for commercial cultivation. The area of cultivation of an earlier variety TG37A was extended. 65 tonnes of breeder seed of groundnut varieties TAG 24, TG26, TG37A were produced and distributed to different multiplying agencies. In moongbean, selection TM-96-2 and TM-98-50 (TJM-3) was released for commercial cultivation in Andhra Pradesh and Madhya Pradesh. In Soybean, selection TAMS-98-21 was released for commercial cultivation in Vidharbha region of Maharashtra

An intervarietal genetic linkage map based on a cross between two Indian wheat varieties Sonalika and Kalyansona was developed.

Food Processing

Nearly 300 tonnes of onion from a private entrepreneur were irradiated at BARC's Krushak plant at Lasalgaon, district Nashik, Maharashtra.

A team of officials from US Department of Agriculture, officials of Ministry of Agriculture, Government of India and APEDA visited KRUSHAK irradiation facility to explore the possibility of importing radiation treated mangoes to USA.

An MoU was signed between BARC and the National Centre for Electron Beam Food Research, Texas, USA for co-operation in the advancement of electron and X-ray irradiation technologies to promote

Soybean TAMS-38

food preservation, food safety and phytosanitary applications.

A 10 MeV /10 kW LINAC for food irradiation was installed and commissioned at RRCAT.

Healthcare

At Trombay, the important medical isotopes such as ^{99}Mo & ^{131}I were processed regularly in Tera Becquerel quantities and ^{153}Sm & ^{32}P in Giga Becquerel quantities, and supplied to end-users through BRIT for diagnostic and therapeutic applications. Tiny encapsulated sources of ^{125}I for brachytherapy of ocular cancers were made and supplied to Sankara Netralaya for clinical trials.

About 12300 consignments of ready to use radio- pharmaceuticals of Iodine-131, Phosphorous-32, Chromium-51and Samarium-153 were supplied to various nuclear medicine centres. 620 Ci of Mo-99 (TCM-2) was supplied for extraction of Tc-99m in hospitals. Over 45,000 Cold Kits for formulation of Tc-99m radiopharmaceuticals worth Rs. 2.5 crore were supplied to various nuclear medicine centres.

BARC will market through BRIT, a Radio-immunoassay (RIA) kit formulated for microalbuminuria. A PCR test for tuberculosis in a kit form developed in collaboration with JONAKI, BRIT is ready for multi-centric trials.

As part of the contract manufacturing job for a US company, the quality control assay of the ^{131}I-labeled antibody was carried out.

BRIT has signed an agreement for technology transfer for a new product 'Diagnobact' that is an infection imaging agent.

The Medical Cyclotron Facility at Radiation Medicine Centre supplied ^{18}FDG radiopharmaceutical for organ imaging, to hospitals within Mumbai worth Rs. 4.50 Crore.

Bhabhatron commissioned at the Indian Red Cross Society Hospital, Nellore, Andhra Pradesh

The first unit of indigenously developed ^{60}Co- Teletherapy Machine 'Bhabhatron' was commissioned by BARC at ACTREC, operated satisfactorily. An improved model of this machine was installed in a Red Cross Hospital in Nellore, Andhra Pradesh.

Nuclear & Biotechnological Tools

At BARC, tritiated water injection was undertaken for ONGC off shore oil wells (Neelam and Heera) for the first time and the job was executed successfully in three oil wells.

At Trombay, the commercial production and supply of ^{14}C urea capsule commenced.

During the report period, sealed radiation sources of total activity of about 600 kCi were fabricated and supplied for various industrial applications. 670 kCi of Cobalt-60 activity is expected to be transported from RAPPCOF, Kota.

A few old paintings from Mumbai museum were digitally radiographed and analysed.

A method for the synthesis of Ag nano-particles supported on inert material such as SiO_2 using gamma radiation, was developed.

Gamma Radiation Processing Services

At ISOMED Plant of BRIT sterilized about 12,200 cubic metres of different types of products. Expert services for plant commissioning dosimetry were extended by BRIT to five radiation processing plants in the private sector.

The BRIT's radiation processing plant at Vashi processed more than 1500 MT of spices and allied products during April to December 2006. It is expected to earn a total revenue of Rs.1 crore during revenue year 2006-2007.

Radiation Processing Plants in Private Sector

A new Gamma Irradiation Plant in the private sector was commissioned in Bangalore. Apart from supplying the ^{60}Co sources for the new plant, BRIT provided requisite technical guidance and facilitation services which enabled them to commission the plant. Seven more

private agencies have signed MoU with BRIT for setting up gamma irradiation plants.

WATER

BARC signed an MoU with the National Institute of Ocean Technology for providing consultancy on design review of 1.0 lakh litres/day Low Temperature Evaporation (LTE) desalination plant using ocean thermal energy gradient for sea water desalination.

ENVIRONMENT FRIENDLY TECHNOLOGIES

Nisargruna biogas plants were commissioned at five locations. About 50 tonnes of irradiated sludge was supplied for the field trials. The initial results have shown that the hygienised liquid can also be enriched with useful microbes like Rhizobium and can be utilized gainfully in agricultural practices.

Nisarg-runa Kitchen Waste (Bio-Degradable Waste) Based Bio-Gas Plant

BASIC RESEARCH

The research centres and the grant-in-aid institutions of DAE are engaged in the frontline basic research that ranges from mathematics to computers, physics to astronomy and biology to cancers. Following were the major activities in the field of basic research.

Mathematics and Computational Sciences

The ANUPAM - Ameya supercomputer, developed by BARC is a 512 CPU cluster and is the largest and fastest in the ANUPAM series.

At TIFR, algorithms for fast simulations in mathematical finance were developed.

At SINP, a Cray supercomputer was installed and large scale computations made progress.

Physics

The TACTIC gamma-ray telescope at Mt. Abu observatory was deployed for observation of four celestial objects.

Theoretical studies in astrophysics were continued with modeling of high frequency QPO (quasi periodic oscillations) in accreting binary systems and modeling of high energy spectra of black hole X-ray binaries.

SINP also successfully completed augmentation of the Indian National Gamma Array (INGA) facility.

At HCRI, work in the string theory continued.

Biology

An intervarietal genetic linkage map based on a cross between two Indian wheat varieties Sonalika and Kalyansona was developed at Trombay. Two marine cyanobacteria, namely *Synechococcus elongatus* and *Anabaena torulosa* demonstrated the capability of sequestering uranium from aqueous solutions.

Studies on the biological and health effects of chronic low level radiation in human populations exposed to high-level normal radiation areas (HLNRA) mainly located in Kerala continued.

To study the mechanisms behind low dose radiation effects using *in vitro* assay systems, a new low dose irradiator was established at the Kollam facility by BARC.

At SINP, several target proteins implicated in blood disorders and neurodegenerative diseases were cloned.

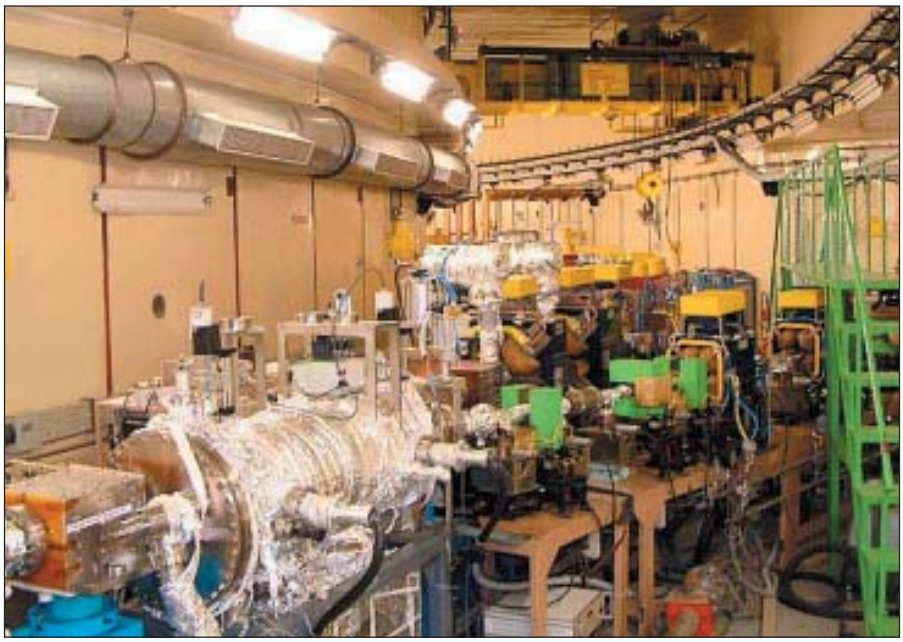
Cancer Research

During the report period, at the Tata Memorial Hospital (TMH) over 41,000 cases were registered and over 75,000 radiodiagnoses were conducted.

TMH runs Urban and Rural Outreach Programmes. Over 75,000 women were covered during the year in the 'Tata Memorial Centre Urban Outreach Programme', and about 40,000 persons were screened under the Rural Outreach Programme' in the districts of Ratnagiri and Sindhudurg, Maharashtra.

The TMH Tissue Bank is India's only ISO 9001:2000 certified Tissue Bank. In 2006, the Bank produced 800 grafts from tissue.

TMC's Telemedicine Project reached the third and final phase of linking Regional Cancer Centres and other centres in a network for cancer



Septum and kicker magnets installed in the injection straight section of Indus-2

care, education and research. Five Regional Cancer Centres were added to the network taking the network total to 25. Over 110 tele-consultations were done all over the country.

Synchrotrons & their Utilisation

The Raja Ramanna Centre for Advanced Technology (RRCAT) in Indore operates Synchrotron Radiation Sources Indus-1 & 2. During the report period, following were the major activities :

An Indus-1 beamline was used to study the fine structure in the energy dependent atomic scattering factors of many elements near their absorption edges. Data was used to determine the composition of buried interfaces in several multi-layers.

The 2.5 GeV synchrotron radiation source Indus-2, commenced operation. Starting with injection of electrons at ~550 MeV, a stored current of up to 38 mA was achieved and beam energy was ramped up to 2.4 GeV.

The first indigenously built front end was installed and commissioned on the high resolution X-ray diffraction beam line.

Cyclotrons & their Untilisation

For the superconducting cyclotron at VECC, assembly of RF cavities, cryopanels within the cavity, and electrostatic deflectors, magnetic channels etc. in their final positions has reached an advanced stage. Various power supplies were also successfully fabricated, tested and installed.

Fusion & Other Plasma Technologies

At BARC, KALI-5000 was operated up to 450kV, 30kA, 100ns and used for High Power Microwave (HPM) generation and Flash X-ray experiments.

Materials Science

Production of multifilamentary Nb-Ti Low Temperature Superconductor wire containing 492 filaments each of 40 micron size for fabrication of a 5 Tesla magnet progressed. The magnet will be used for characterisation of future strands.

At TIFR's National Facility for High Field NMR, new NMR techniques and methodologies were developed.

At RRCAT, a novel nucleation-trap approach was developed, based on which , a five litre Crystallizer was successfully used to grow large sized DKDP (78 x 46 x 75 mm^3,) and ammonium acid phthalate crystals (120 x 42 x 90 mm^3). Bismuth silicate and congruent lithium niobate crystals up to 2-inch diameter were also grown.

Carbon aerogels of different morphologies (monoliths, thin large sheets, cylinders and rasching ring etc) for different applications were developed. Using an in-house developed buffer assisted growth scheme, efficient room temperature photoluminescence was achieved from ZnO multiple quantum wells grown on single crystal (0001) Sapphire substrates by Pulsed Laser Deposition. Infrared transparent free-standing ZnS dome of diameter 80 mm, thickness 2 mm and radius of curvature 80 mm was successfully grown, using the chemical vapour deposition reactor developed in-house.

Extensive work on the magnetic shape memory alloy systems NiFeGa and NiMnIn was carried out at RRCAT, to study the giant magnetoresistance effect and large inverse magnetocaloric effect.

At the TIFR's National Facility for High Field NMR, new NMR techniques and methodologies were developed.

Interdisciplinary Areas

A number of research scholars from various academic institutions in the country utilized the DAE research facilities under the aegis of the UGC-DAE CSR.

International Research Collaboration

Collaboration with CERN on Novel Accelerator Technologies was launched by RRCAT in the upcoming Compact Linear Collider Test

Facility (CTF-3) and superconducting proton LINAC (SPL)-LINAC 4 projects at CERN. For the LINAC-4 project, design of the klystron modulator was completed and action was started to fabricate it at this centre.

Development of Gridview (Grid Monitoring Tool) and Fabric Management tools for CERN LHC grid under the DAE-CERN collaboration for Worldwide LHC Grid Computing (WLCG), continued at Trombay. The computer code PROFESS developed, was used to analyse eleven mandatory problems as a part of IAEA co-ordinated Research Programme FUMEX-II.

VECC is geared to assemble, test and then ship to CERN, detector modules for final assembly and commissioning of detector modules. This centre is now under the umbrella of Asia Pacific Software Functionality.

At SINP, 80,000 MANAS chips were fabricated and delivered to CERN.

The Institute of Physics continued collaboration in ALICE experiments and fabrication of photon multiplication detectors.

TECHNOLOGY TRANSFER AND COLLABORATIVE PROGRAMMES

Several Collaborative MoUs between BARC with outside agencies were signed for technology development/trouble shooting. Also, a number of technologies developed in BARC having immense societal benefits were transferred to agencies for further commercial exploitation.

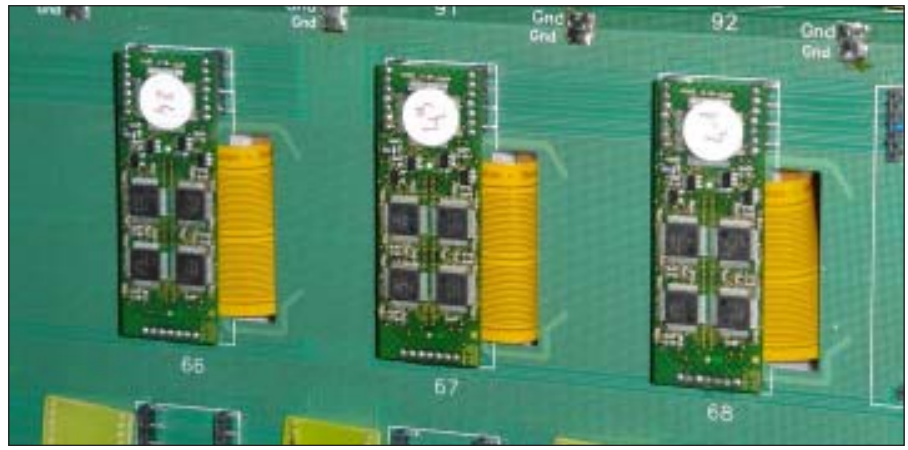
The MoUs signed by BARC included Radioactive Waste Safe Management Agreement with CEA, France; Contract farming of breeder seeds with 3 progressive farmers of Maharashtra; A collaborative programme on Maintenance Breeding Seed with University of Agricultural Sciences, Dharwad, Karnataka; Software development of Turbine Blade Damage and Shaft Crack Detection with NTPC, Noida, and R&D on Thermochemical Processes for Hydrogen Production from Water with ONGC, Mumbai. An MoU for setting up of Phosphatic Rare Element Extraction plant was signed with SPIC by DAE, IRE & BARC.

An MoU was signed bet-ween RRCAT and M/s. Mah-indra & Mahindra Ltd. for jointly building a high power CO_2 Laser System for welding of automobile transmission gear assemblies.

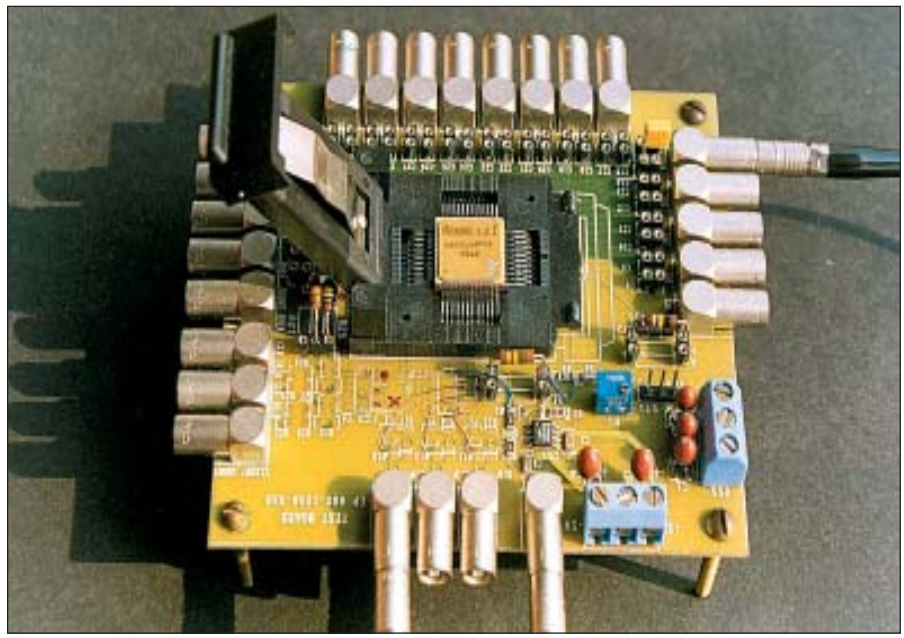
The technologies were transferred to industry included :

Kitchen Waste Based Bio Gas Plant transferred to seven more parties taking the total number to 30; On-Line Domestic Water Purifier taking the total number to 17; Medical Analyzer Software Technology to M/s. Larsen & Toubro Pvt. Ltd., Mysore, and Digital Medical Imaging System to M/s. Nucleotech Medical System International Ltd., Navi Mumbai.

Vasomon and Nivomon instruments developed with BARC technology, were launched by



Manas Chips fabricated at Saha Institute of Nuclear Physics



Experiment Bench of Manas Chips at Saha Institute of Nuclear Physics

M/s Larsen & Toubro Ltd for continuous monitoring of the cardiac output in Intensive Care Units and detection of peripheral vascular occlusive diseases.

National Security

BARC continued implementation of the necessary research and development as well as manufacturing activities required for national securities.

FINANCIAL PERFORMANCE OF PSUs

NPCIL registered a net profit of Rs. 1713 crore, earning per share of Rs.169 and paid dividend at the rate of Rs. 51 per share amounting to Rs. 514 crore to the Government of India for the financial year 2005-06. The net profit for the year 2006-07 upto December 2006 was Rs.876 crore (Provisional). NPCIL's bonds continued to be rated AAA by CRISIL and CARE.

The overall performance of UCIL during the year 2005-06 continued to be quite satisfactory. The turnover of the company increased up to Rs.257 crore posting a 9% rise over the previous year. The net profit stood at Rs. 32 crore registering a growth of about 10%.

During the year 2005-06, the turnover of the IREL was Rs.306 crore with foreign exchange earnings of Rs.66 crore. Profit before tax was Rs.77 crore, and it paid a dividend of 30% to the Government. The Company received the CAPEXCIL special export award for its impressive export performances during 2004-05.

Electronics Corporation of India Limited (ECIL) has been serving as an electronic arm of the Department of Atomic Energy to make the country self-sufficient in the field of Control & Instrumentation for Nuclear Power Plants in addition to supporting several other critical projects of the Department.

Major supplies of ECIL covered strategic sectors of Nuclear and Defence as well as Space and Security. A few of the noteworthy activities included the despatch of 32metre Deep Space Network Antenna Reflector Panels on proof-assembly to site, productionisation of Light Combat Aircraft (LCA)-MMR Antenna Platform jointly developed by BARC and ECIL, designation of ECIL as the prime production agency for BrahMos Weapon Complex, successful completion of field trials of Integrated Air Command Control System, execution of a sizeable order from Election Commission of India for supply of improved version of Electronic Voting Machines etc..

RESEARCH EDUCATION LINKAGES

In the areas of relevance to its programmes, DAE promotes scientific research, in collaboration with universities, educational/ research institutes and laboratories. This is done through the Board of Research in Nuclear Sciences (BRNS) and the National Board for Highter mathematics (NBHM).

During the period of this report, 90 new research projects were sanctioned. Financial sanctions were also issued for the various on-going research projects. Two fellowship were awarded under the Homi Bhabha Chair Scheme, Twelve fellowships were awarded under the Raja Ramanna Fellowship Scheme (Senior Scientists Scheme), thirteen fellowships were awarded under the K.S. Krishnan Research Associateship Scheme and twenty-four fellowships were awarded under the DAE Graduate Fellowship Scheme. Financial supports were extended to fully funded BRNS seminars as well as to partly funded seminars conducted by professional organisations on various topics of relevance to DAE.

NBHM provided financial support to about 80 institutions for purchase of latest books and journals in mathematics. It also distributed selected books to various colleges and universities under its book distribution scheme. A recurring grant of Rs. 2 crore was released to the Chennai Mathematical Ins-titute which runs a very high level undergraduate programme in

Control Room of Tarapur Atomic Power Station-4

mathematics. NBHM had selected a team of 6 students to participate in the International Mathematics Olympiad (IMO), held at Ljubljana, Slovenia. The Indian team won 5 bronze medals and one honorable mention.

NBHM financially supported 13 international conferences held in India, 13 national conferences and 9 Advanced Training in Mathematics (ATM) schools. Eleven research projects were funded.

NBHM will be hosting the next International Congress (ICM 2010) in India.

The Department has eight aided institutions (including an educational society) fully funded in terms of their recurring and non-recurring expenditure. Several joint projects have been undertaken amongst the DAE Organisations and the Aided Institutions.

The funds (Plan & Non-Plan) allocated to these Aided Institutions by the DAE during the financial year 2006 - 2007 were : Tata Institute of Fundamental Research (Rs.151.23 cr), Tata Memorial Centre (Rs.158.44cr), Saha Institute of Nuclear Physics (Rs.46.90 cr), Institute of Physics (Rs.14.92 cr), Institute of Mathematical Sciences (Rs.13.27 cr), Harish-Chandra Research Institute (Rs.12.24 cr), Institute for Plasma Research (Rs.109.81 cr), and Atomic Energy Education Society (Rs.25.50 cr).

The Department extended financial assistance of Rs. 6 crore to Cancer hospitals located in other parts of the country. It signed a Third Tripartite Agreement with the North-Eastern Council and the Government of Assam, for the revitalization of the Dr. B. Barooah Cancer Institute, Guwahati by way of financial support of Rs.10.44 crore.

DAE funded Tata Memorial Hospital for creating a better network between cancer institutions all over the country. The initiatives taken will lead to further gains in the DAE's outreach in the cancer care programme.

DAE provided financial support for organizing Olympiad programmes and for participation in International Olympiads in Physics, Chemistry, Biology, Mathematics & Astronomy. 18 students got medal in the final Olympiad

Human Resource Development

Implementation of two mainstream training programmes for recruiting officers, namely, one-year Orientation Course for Engineering Graduates and Science Post-Graduates (OCES) and Orientation Course for DAE Graduate Fellowship Scheme (DGFS) were carried out. The OCES programme was recognized as a post-graduate diploma programme.

BARC conducted a number of training courses to generate trained manpower to meet the mandatory requirement of radiation safety professionals of different levels.

HWB has planned to impart training to employees and stakeholders and endeavours to dedicate 5% of the working time per annum for imparting training to all the officials. For updating their skills, scientific and technical personnel of the plants were regularly nominated to the programs/workshops at various reputed organizations. The Board also organised in-house training programmes in Positive Health Management, Stress management for improving personal effectiveness and ensuring highest standards of Occupational Health.

Homi Bhabha National Insitute (HBNI) set up under the aegis of DAE with the status of a 'Deemed-to-be-University', will promote advanced degrees, viz., Masters and Doctoral degrees, largely with the help of the research centres and grant-in-aid institutions of the DAE. The academic activities of HBNI have started with effect from August/ September 2006. The framework for academic programmes has been evolved that aims at maintaining excellent academic standards.

Sponsored Research

The MoU between BARC and CEERI for the design and development of 6 MW peak, 24kW average power S-band klystron progressed well. An electron gun – collector test module was developed and components of the first prototype reached an advanced stage of development.

Collaboration between DAE and University Institute for Chemical Technology, Mumbai was actively pursued under the project titled "Centre for Knowledge based Engineering".

A consortium was formed amongst BARC, Vikram Sarabhai Space Centre and National Informatics Centre to develop Java based distributed 2D and 3D CAD/ CAM software. The original package, named CollabCAD, was developed by National Informatics Centre (NIC).

BARC has set up a remote on-line data acquisition satellite network. Six more remote sites were added to this network and a centralized network monitoring software was developed to monitor and manage the entire network.

Intellectual Property (IPR)

To protect the intellectual property created in the DAE Organisation, DAE-IPR Cell constituted by the Department, works as a nodal agency for all the IPR related matters including filing of patents within India and abroad. During the year 2006 the IPR Cell of DAE filed 14 patent applications including 2 in India, 4 under Patent Cooperation Treaty (PCT), and 3 each in Europe and USA, and 1 each in Canada and South Korea. During the same period

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Innovative Abduction Splint for preventing Hip Dislocation Following Hip Arthroplasty

Mr. Paramanandam.S.Vincent., Mrs. Daptardar A.A., Mrs. Badakere J.S.
Rehabilitation Services,
Tata Memorial Hospital, Mumbai

The Department of Rehabilitation services at the Tata Memorial Hospital (TMH) is engaged in working along with the patients towards achieving maximum independence.

Specialized supports for the patients, often custom made, is a necessary part of rehabilitation. Although these are available in the market, patients from low socio-economical backgrounds are not able to afford these. In order to provide cost effective and custom made appliances, the Rehabilitation and Research Centre of TMH was established at the Borges Home in Bandra, Mumbai.

There are 8,00,000 joint replacement arthroplasties done every year worldwide.

X-ray of dislocation of Hip Prosthesis

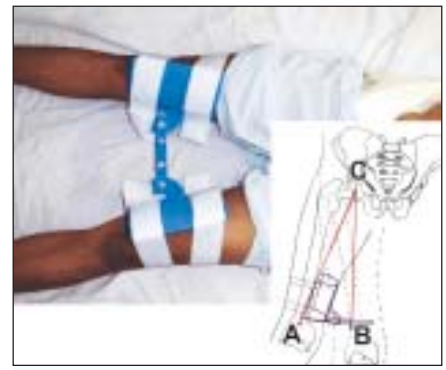
The majorities of dislocations happen within the first few days after surgery and diminish over the course of time. The incidence of hip dislocation is up to 1-2% if the case was uncomplicated pre-operatively but unfavorable pre-operative conditions increase this rate of incidence considerably. Generally the early dislocation after total hip arthroplasty is considered as a controllable complication. Patients who have undergone hip arthroplasty are frequently fitted with an abduction splint or brace to prevent early postoperative dislocations. Abduction splint is prophylactically used nowadays to prevent early dislocation. Prefabricated abduction braces available in the market are costly and it is not possible to prepare it in a minimally equipped centres. The static ones available have no angular adjustment and this may often lead to pressure sores. Hence it was decided to design and prepare a lightweight, comfortable and cost effective splint.

It was decided to pursue a planetary type of abduction splint. It was achieved through thigh plates on both sides with 0^0 to 90^0 of freedom of adjustment with every 10^0 of progression. The thigh plates were connected through adjustable bars depending on the amount of abduction desired. The materials used were locally available aluminium sheets, aluminium bars and velcro straps.

The operated leg was kept in the required angle and both the thigh plates were adjusted to the thighs. The angular plate was adjusted in a way that the thigh plates are parallel to the thigh. The angle of the operated leg always matches with the angle of ipsi-lateral angular plate.

This splint was compared to the available static splints. Many of the static splints do not provide any angular adjustment. PEHR splint does provide only bilateral hip abduction. Some flexion extension brace gives fixed abduction and the other locally made splints do not have any angular adjustments. This abduction splint provides unilateral as well as bilateral abduction adjustment. This provides high comfort. Soft foam covering gives good protection against the pressure sores. The firmness of the splint is optimal for the static splints but if necessary it can be achieved through increasing the thickness of the aluminum plate and strips.

This abduction splint was compatible with our expectations of



Donning of abduction splint

preventing hip dislocation, pressure sores, was easily adjustable, comfortable and costs only Rs 100/- whereas commercially available splints cost a minimum of Rs.1200/-.

In developing splint TMH also tested the feasibility to modify parts

to achieve a dynamic hip abduction splint which can provide controlled flexion and extension at the hip. Currently a means to provide the same is being investigated.

The researchers of the proposed abduction splint feel that the use of locally available material with a design that is easily assembled and requiring minimal infrastructure would be desirable and affordable to patients.

Continued Page from 17

14 previously filed patents were awarded to the Department both nationally and internationally.

OTHER ACTIVITIES

Crisis Management

To ensure emergency plans in high state of readiness, major nuclear facilities such as nuclear power plants and hydrogen sulphide based heavy water plants periodically carried out emergency exercises.

BARC Safety Council

BARC Safety Council continued its regulatory function to ensure safety of all the plants and facilities under its purview.

Science Research Council

DAE Science Research Council consisting of eminent scientists, continued with the peer reviews of basic research to ensure that highest possible level of excellence is maintained. The Council has launched a unique programme to encourage excep-tionally innovative research and development activities named as DAE-SRC Outstanding Research Investigator Award. Twelve recipients selected for this award continued their research work.

National Security

BARC continued implementation of the necessary research and developement as well as manufacturing activities required for national security.

Vigilance

Annual Action Plan relating to vigilance was carried out in the Department as well as its constituent Units.

Right to Information Act

The 'Right To Information' Act of Government of India, which came into force on October12, 2005, was implemented in DAE organisations and the mandatory information required under the act was posted on its website.

Public Awareness

DAE and its organisations continued disseminating public awareness about the important role of nuclear energy on the nation's economy and its benefical role in the life of common man.

Social Welfare

AKRUTI - KRUTIK – FORCE : Programme for Rural Advacement through Rural and Urban Technology Deployment was initiated by BARC towards the fulfillment of reaching science and technology to the masses.

At the various nuclear power plant sites, social welfare activities such as organising eye camps, health check-ups, renovation of primary schools, providing education facilities including computers, etc. were carried out. NPCIL sponsored publication of a science magazine in Braille language published by National Association for Blind, India.

International Relations

India has been designated member of the Board of Governors (BoG) of the International Atomic Energy Agency (IAEA) since its inception and has been taking active part in policy management and programmes of the Agency. India continued to offer training facilities, fellowships, scientific visits, etc. to foreign scientists and provided the services of its scientists for expert assignments to other countries both through IAEA and through the bilateral agreements for co-operation in the field of peaceful uses of atomic energy.

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