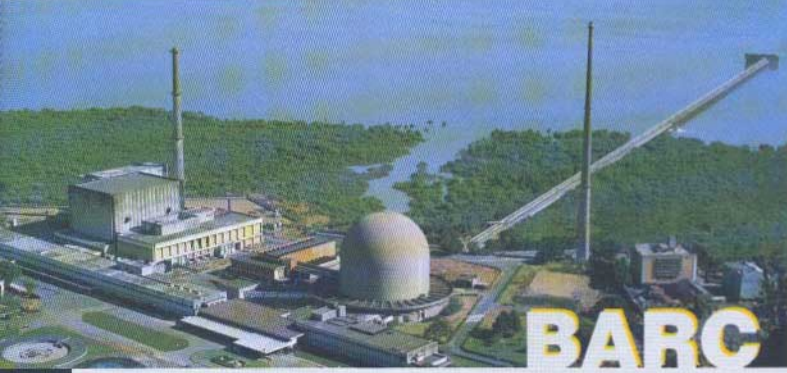


BARC NEWSLETTER

No. 226
November
2002

BARC FOUNDER'S DAY CELEBRATIONS

(Like in the past, the scientists, engineers and other staff of BARC observed October 30, 2002 as Founder's Day in honour of Dr.Homi Bhabha. This year the Founder's Day celebrations were spread over two days. A highlight of this year's celebration was the visit of the Hon. Prime Minister Mr Atal Behari Vajpayee to BARC on October 31, 2002. On October 30, 2002 at BARC Training School Hostel Auditorium, Anushaktinagar, some of the DAE awards for 2001 were given away by Dr.Anil Kakodkar, Chairman, Atomic Energy Commission. The winners of the XIV All India Essay Writing Contest in Nuclear Science and Technology were also felicitated. Chairman, AEC and Director, BARC addressed BARC scientists and engineers and Mr S.L. Kale, former Managing Director, NPCIL, delivered Founder's day lecture.

On the next day, i.e. on October 31, 2002, the prestigious DAE and INS awards were presented by the Hon. Prime Minister at the Central Complex auditorium, BARC. Hon'ble Prime Minister dedicated the following plants/facilities to the Nation: a. KRUSHAK - Krushi Utpadan Samrakshan Kendra, Nasik District; b. Sea Water Desalination Plant, Kalpakkam; c. Medical Cyclotron - PET Facility, Radiation Medicine Centre, Mumbai; d. Dedication of refurbished Cirus reactor, BARC and e. Uranium- Thorium Separation Facility, BARC. The Prime Minister addressed the scientists and engineers on topics related to the development of nuclear energy in India for peaceful applications. The Prime Minister was accompanied by H.E. Mr Mohammed Fazal, Governor of Maharashtra, Hon. Mr Vilasrao Deshmukh, Chief Minister of Maharashtra, Hon. (Ms) Vasundhara Raje, Minister of State for Atomic Energy in the Union Cabinet, Hon. Mr Chhagan Bhujbal, Deputy Chief Minister of Maharashtra, Dr.R.Chidambaram, Principal Scientific Advisor to Govt. of India, and a galaxy of other distinguished invitees. The texts of the Prime Minister's speech, and the addresses of the Chairman, AEC and Director, BARC, on the occasion of Founder's Day celebrations, are reproduced below.)

Address by the Hon'ble Prime Minister

Friends,

It is a pleasure to be with you at this prestigious centre of scientific research.

Celebration of your Founder's Day with awards for excellence is an apt tribute to Dr Homi Bhabha — who is often called the father of India's atomic energy programme.

Contents

Dr Bhabha was much more than that. He was a brilliant scientist and an outstanding science administrator. But most of all, he was a pioneering visionary, who understood the importance of indigenous scientific research for self-reliant development.

Visionaries like Bhabha have shaped the scientific temper of our country. India is today at the forefront of the Knowledge Revolution – which drives the New Economy. For this, we owe a huge debt to the excellence of our scientific and technical personnel.

Much of this talent finds its way abroad. From the Silicon Valley to Microsoft, from biochemistry to robotics – expatriate Indian scientists and engineers are present in every corporate organisation and in every field of research.

Prime Minister's address. Seen on the dais from left are Dr Anil Kakodkar, Chairman, AEC, Dr R. Chidambaram, Principal Scientific Adviser to Govt. of India & President, Indian Nuclear Society, Ms Vasundhara Raje, Minister of State for Atomic Energy, His Excellency Mr Mohammed Fazal, Governor of Maharashtra, Hon'ble Prime Minster Mr Atal Behari Vajpayee, Hon'ble Mr Vilasrao Deshmukh, Chief Minister of Maharashtra, Mr Brajesh Mishra, Principal Secretary to Prime Minister and Mr B. Bhattacharjee, Director, BARC

We need to retain some of these skills in our country for our own accelerated progress. That is why I am happy that we have today honoured scientists and engineers who have made special contributions to our atomic energy programme. I am also glad that the Indian Nuclear Society awards have covered a wider domain of research. I congratulate the recipients of the DAE and the INS awards.

Recognition is an important motivating factor; so are opportunity and rewarding professional avenues. The Scientific Advisory Committee to the Cabinet – headed by our Principal Scientific Adviser, Dr Chidambaram – has been considering how to optimise the benefits to the country from its scientific research institutions. It should also tackle the challenge of recruiting the best scientific talent into our research institutions and retaining them there. We have to nurture an environment, which encourages the innovative spirit and welcomes creative ideas.

In this context, it is heartening to see that so many young students participated in the DAE essay contest. They are our future scientists and engineers. They will become our ambassadors, carrying the message of science based development to various parts our country.

India's atomic energy programme started here in Trombay about half a century ago. It has come a long way since then. The various institutions of the Department of Atomic Energy have notched up stellar achievements in basic research and technology development. They have commercialized a wide range of developmental applications.

Radiation technology has developed high-yielding, disease-resistant varieties of rice, jute, pulses, groundnuts and mustard. The Trombay black gram and groundnut varieties are now cultivated all over the country.

Radiation processing has also emerged as an important technology for preservation of agricultural commodities, sterilization of medical products and upgrading of food hygiene. Cereals, pulses, vegetables and dry fruits can be preserved by this method. The Krushak plant at

Lasalgaon will use gamma radiation to prolong the freshness of onion, which is the region's most important agricultural product. By increasing the shelf life, it would be possible to maintain onion prices at lower levels. As everyone knows, the price of onions can even bring down a government in our country.

The Medical Cyclotron, which has just been inaugurated, has important applications in cardiology, neurology and oncology. The Nuclear Desalination project has a direct link to supply of clean drinking water to our coastal areas. The Cirus reactor refurbishing has granted a further extension of life to India's first nuclear research reactor.

These and hundreds of other innovations have strengthened the developmental dimension of our atomic energy programme. It is important to recognize their value to society.

We emphasize this, because in some circles abroad atomic energy seems to raise only visions of the atom bomb or of nuclear war. Ever since our first nuclear tests in 1974, we have been denied technologies and products on the unfounded suspicion that they may be applied to a weapons programme.

These technology-denial regimes have irritated us; they have also retarded our progress. But they did not stop us. They brought out the best in us. Our scientists in atomic energy, space and other high technology areas achieved success after success with indigenously developed expertise. As so many times before in history, we proved that sanctions do not devastate a society. They put it on to greater heights of innovation and achievement. Our atoms for peace programmes continue to flourish and expand.

The most imperative developmental application of atomic energy today is for nuclear power. It is a sad fact that India's per capita energy consumption is among the lowest in the world. Power shortages constitute an important infrastructural hurdle to our rapid economic development.

It is well known that nuclear power is one of the most environment-friendly forms of energy. It is a cleaner energy alternative to fossil fuel. It is more cost efficient in the long term. At present, nuclear power meets just 2% of our overall electricity needs. This will have to change soon.

Mr Bhattacharjee, Director, BARC presenting a memento to Hon'ble Prime Minister Mr Atal Behari Vajpayee

We have eight nuclear power plants under construction which will add around 4000 Megawatts to our installed power capacity by 2008. We have an even more ambitious target of generating 20,000 megawatts of nuclear power by the year 2020.

We will apply our indigenous financial and technological capacities to meet this objective. At the same time, we welcome participation of other countries in these major projects.

While inviting foreign partners to join us in this important development sector, we urge them to dispel any misconceptions about our nuclear weapons programme. We have been transparent about it. The reasons for our nuclear testing in May 1998 are well known. We emphasise our nuclear doctrine of minimum credible deterrence. Our nuclear weapons programme was developed totally indigenously. It did not violate any of our international obligations. It is limited in scope.

Our nuclear power programme has an entirely different development objective. We have repeatedly said that every cooperative project in nuclear power would be open to international safeguards. We would urge the high priests of non-proliferation to look around and tackle the clandestine and illegal development and transfer of nuclear and missile technologies, rather than targeting countries, which have played by the rules. They might then be persuaded to look at atomic energy in India as an engine of growth and progress, and not through the prism of nuclear weapons.

At the Rio Summit ten years ago and more recently at the Sustainable Development Summit in Johannesburg, the world reiterated its determination to curb emissions of the harmful greenhouse gases which degrade our environment and play havoc with our climate systems. Even as I speak here, Environment Ministers of the world are gathered in Delhi to discuss action to promote the objectives of the Kyoto Protocol on Climate Change. It is truly ironic that we are lectured on our moral obligations to clamp down on emissions, while being denied international technological cooperation for the one alternative, which can achieve this without penalising our development.

I would like to urge our scientists and engineers to continue on the path of innovations and inventions, which have taken our atomic energy programme to this advanced stage. I hope the Fast Breeder Reactor can be commercially exploited soon. I hope that you will achieve early success in the viable generation of nuclear energy from thorium. This would be a major technological break-through for India which has some of the largest reserves of thorium in the world.

Friends,

All of you here are the inheritors of a great legacy. It is in your hands to carry that tradition forward. You must continue the pursuit of excellence. Your work must always remain relevant and responsive to national needs and aspirations. It should aim to keep India at the cutting edge of science & technology. The support and best wishes of the nation will always be with you in these endeavours.

Jai Hind.

Address by Chairman, Atomic Energy Commission

Dear Colleagues,

At the outset, let me express my heartiest greetings to all the members of DAE family on the occasion of Founder's Day-2002. This year's Founder's Day is a special one because our beloved Prime Minister, along with several dignitaries, is going to be with us as we pay our respects to the memory of our founder Dr Homi Bhabha.

Dr Bhabha has given us a vision of developing indigenous and self-reliant capability in nuclear sciences and technologies and deploying their applications for the benefit of our nation. It is a matter of some satisfaction that we have made significant all-round progress on the road map to realize Dr Bhabha's vision despite hurdles.

Time and again it has been emphasized that nuclear power is an inevitable option for a large developing country like ours. Improvement in the quality of life of our people will necessitate a substantial growth in our power sector and the share of nuclear energy in the total power production profile must increase rapidly so that the carbon dioxide emission arising out of

Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary to Government of India addressing the audience on the occasion of Founder's Day 2002

burning of fossil fuels is correspondingly reduced. With the rapidly depleting fluid hydrocarbon fuels, nuclear energy is also destined to serve as a sustainable and environmentally benign primary energy source for meeting the future demands of the transportation sector. It is thus important that we not only augment our nuclear power generation capacity based on presently developed technologies as early as possible but also master new technologies which enable access to a much larger energy potential in our uranium and thorium resources, provide energy at higher temperatures, incorporate further advanced safety features and arrive at an even superior solution to the management of long lived radioactive wastes. We have a well defined strategy to meet these objectives and given the comprehensive scientific and technological capability, carefully nurtured over the years, there is no doubt that we will meet these challenges with success.

Our operating nuclear power plants generated a total of 19,481 million units of electricity during the last year, recording an increase of about 13% over the corresponding figure for the previous year. The overall capacity factor achieved last year by Nuclear Power Corporation of India Limited (NPCIL) was 85%, which is comparable to the best in the world. Many nuclear power plants exhibited monthly availability factors of 100%. At the same time, we have maintained an excellent safety record. WANO Expert Teams have carried out Peer Review of four nuclear power reactors in India. In line with keeping our commitments regarding the preservation of the environment, most of the operating power plants have also obtained Environment Management System (EMS) certification as per ISO 14001.

Construction of six new nuclear power plants at three sites commenced during the year. These included Kaiga-3&4 (2x220 MWe) in the state of Karnataka, Kudankulam 1&2 (2x1000 MWe) in the state of Tamil Nadu and Rajasthan 5&6 (2x220 MWe) in the state of Rajasthan. Coupled with the two 540 MWe nuclear power plants under construction at Tarapur in Maharashtra, these reactors, when completed, will raise the installed nuclear generating capacity in the country from the present 2720 MWe to 6680 MWe. The reactors under construction at Tarapur are progressing ahead of schedule and have achieved a cumulative physical progress of 50%. Construction of other reactor units is also progressing ahead of schedule.

We would reach a total nuclear capacity of 6680 MWe by the year 2008 and intend to achieve 10,000 MWe by the year 2012 to reach the objective of 20,000 MWe by the year 2020. In order to achieve this, given the nuclear resource profile available within the country, we have also done considerable work on the design and development of plutonium-uranium oxide fuelled, 500 MWe Prototype Fast Breeder Reactor at Kalpakkam. While the pre-project activities for the construction of this reactor are already in progress, we would soon launch the main project. The indigenous mixed uranium-plutonium carbide fuel of the Fast Breeder Test Reactor, which has been in operation since 1985, has recently reached a burn up of 100,000 megawatt day per tonne without a clad failure.

Audience seen seated at the gathering of the Founder's Day celebration at Training School Hostel on October 30, 2002

A significant reduction in the construction time and in the cost of key inputs, namely, nuclear fuel and heavy water, are expected to make nuclear power even more competitive. Nuclear Fuel Complex (NFC) and Heavy Water Board (HWB) are the two major industrial units of DAE responsible for providing these key imputs. During the last two years, NFC has achieved a major breakthrough by manufacturing Zircaloy–4 thin walled seamless calandria tubes for the 500 MWe PHWRs being installed at Tarapur. Such thin walled seamless tubes have been manufactured for the first time in the world. HWB has realized a cumulative reduction in specific energy consumption of over 25% in the last three years. This has resulted in a total saving of about Rs.190 crores. We have also supplied a small quantity of heavy water to the Republic of Korea this year. In an effort to diversify the activities of HWB, Heavy Water Plant, Talcher, in Orissa has set up plants for the production of solvents for metal extraction, DEPHA and TBP.

Behind the success of our nuclear power programme lie a very strong R&D base, our mastery over the entire nuclear fuel cycle and our strong and dynamic human resource development programme. In addition to providing R&D inputs, which include surveillance and life assessment of various components of existing power reactors and fuel cycle facilities, design and fabrication of several gadgets and equipment needed for the smooth operation of the reactors and the extensive post irradiation examination of fuel and structural materials, BARC has the responsibility to develop the concepts and the technologies needed for our future generation reactor systems. Advanced Heavy Water Reactor (AHWR) development is a part of this effort to evolve an innovative reactor system with advanced safety features based on passive systems on one hand and the use of thorium for energy production on the other. The Detailed Design Report for AHWR is now ready. Extensive reviews prior to the decision on its construction are currently under way. Given the vast thorium resources available in our country, AHWR is going to be an important development for us.

As mentioned earlier, human resources development has always remained an important activity of this Department. At present three training schools located in Mumbai, Indore and Hyderabad are imparting post graduate level orientation training to trainee officers. In addition, NPCIL runs a specialized training programme for O&M engineers. One of the notable initiatives taken during the last year has been the introduction of DAE Graduate Fellowship Scheme under which selected M.Tech students in various IITs will be adopted by DAE during their M.Tech course and will later join the Department. This scheme has been received well. We are further strengthening DAE related research linkages in our academic environment.

While energy constitutes an important input to support development, there are equally important applications of Atomic Energy in the areas of food and agriculture, availability of water, health, spin-off technologies and national security.

Twenty third crop variety TPG-41 developed at BARC using mutation-breeding technique was released this year. This groundnut variety has superior yield and has been released on all India basis for cultivation by Varietal Identification Committee under the large seeded/confectionary category. The indent for breeder seed production for BARC developed groundnut varieties for 2002-03 stands at 30% of the national seed indent, up from 10 % in the previous year. The corresponding number for BARC black gram varieties is 44%. Four groundnut varieties have entered into the final year of evaluation before qualifying for identification/release. Based on technology being provided by DAE, radiation-processing plants are coming up in the private sector and foundation for one plant was laid at Vasai near Mumbai. Again, based on technology transferred by DAE, one electrical cable manufacturer commissioned its Electron Beam Machine for cross-linking of cables.

The Advanced Centre for Treatment, Research and Education in Cancer (ACTREC) at Kharghar, Navi Mumbai was commissioned in March 2002. The existing Cancer Research Institute was relocated to the new site with the clinical research wing and an educational complex to be commissioned later this year.

On the technology front, the Anupam system has now achieved a sustained speed of 43 Giga Flops. This development, which is still evolving, has given the much needed computational support for our programmes. A miniature underwater radiation resistant close circuit TV camera, developed by BARC, is finding applications in in-service-inspection of coolant channels of nuclear reactors. Continued work on sensors developed at IGCAR has led to the successful demonstration of polymer electrolyte based sensor for the measurement of hydrogen content in zircaloy components used in PHWRs. BARC has developed a process for the preparation of ultrapure (six 9 purity) elements like gallium and arsenic for semi conductor devices. The indigenously built cyclotron at VECC, Calcutta, has been used to produce gallium-67 isotope which has applications in diagnostics as a radio-pharmaceutical.

Scientists in HWB developed the flue gas conditioning technology and transferred it to a private party. Two orders for implementing this technology, one in Gujarat and another in Punjab, have already been received.

Scientists at the Institute for Plasma Research have established the technology for medical waste disposal using plasma pyrolysis technology. This environment friendly technology converts organic waste into commercial by-products. A pilot plant, which can dispose of medical waste up to 25 kg per hour, has successfully undergone tests at Gujarat Cancer Hospital for the past several months.

Electronics Corporation of India (ECIL) has developed several new products for strategic applications which include - sensor packages for underwater vehicle, training simulator for naval applications, surveillance & monitoring system of radio spectrum, radio controlled improvised device for detecting, pre-detonating or jamming explosive devices and conveyorised compact parcel viewer to detect concealed objects, fire-arms or powdery substances in parcels.

It is a matter of considerable satisfaction that the BARC developed Aerial Gamma Spectrometry System, which was recently used in an International Atomic Energy Agency (IAEA) campaign to locate orphaned (lost) radioactive sources in Georgia, stood the test of rough terrain and bad weather conditions and provided an excellent service. IAEA has highly appreciated our contribution to this field. Similarly our technological contributions to The European Centre for Nuclear Research (CERN) in constructing the largest particle accelerator, viz., Large Hadron Collidor (LHC) as well as the CMS and ALICE experiments have received wide appreciation. Several Units of the Department such as CAT, BARC, TIFR, VECC, SINP, IOP, along with a number of Universities, are

collaborating in this effort. Vietnam – India Nuclear Science Centre at Dalat in Vietnam was inaugurated in January this year.

A special feature of this year's Founder's Day is the inauguration of some of the important facilities, developed by BARC at the hands of Hon'ble Prime Minister. These facilities represent important milestones in taking applications of Atomic Energy to our society in the areas of food preservation, desalination of sea water and advanced health diagnostics, besides making further advances in nuclear reactor and fuel cycle technologies. I wish to compliment everyone involved in this development.

While we are proud of our achievements we are also conscious of the tremendous challenges that lie ahead and the expectations of our country that we must fulfill. Ours being a science based programme, we must also continue to nurture an environment of excellence in research and innovative technology development. Dr Bhabha laid an excellent foundation for all of us for this purpose. Let us all rededicate ourselves to the ideals and vision that Dr Bhabha gave. This year we are particularly fortunate to be able to do so in the august presence of our beloved Prime Minister.

Address by Director, BARC

Hon'ble Mr Atal Behari Vajpayee, Prime Minister of India, His Excellency Mr Mohammed Fazal, Governor of Maharashtra, Hon'ble Mr Vilasrao Deshmukh, Chief Minister of Maharashtra, Ms Vasundhara Raje, Minister of State for Atomic Energy, Hon'ble Mr Chhagan Bhujbal, Deputy Chief Minister of Maharashtra, Dr R. Chidambaram, Principal Scientific Adviser to Govt. of India & President, Indian Nuclear Society, Dr Anil Kakodkar, Secretary to Govt. of India, Department of Atomic Energy & Chairman, Atomic Energy Commission, galaxy of other distinguished Invitees before me that includes some of our respected members of the present Atomic Energy Commission, Dr Raja Ramanna, Mr Brajesh Mishra, Mr S. Prabhakaran and Mr V.K. Chaturvedi, former Chairmen of the Atomic Energy Commission, Dr. M.R. Srinivasan and Dr P.K. Iyengar, Prof. P. Rama Rao, Member of the DAE Science Research Council, Prof. M.M. Sharma the most Distinguished Chemical Engineer in India, other dignitaries from the Government of India and the Government of Maharashtra, winners of DAE/INS awards and of the DAE all India Essay Contest, my colleagues from BARC and other Units of the Department of Atomic Energy, Members of the Press and Electronic Media, Ladies & Gentlemen:

It is indeed a matter of great pleasure and proud privilege for me to extend a warm welcome to each one of the august gathering present here including those who have joined us outside this auditorium to celebrate the 93rd birth anniversary of Dr.Homi Jehangir Bhabha – the Founder of this great institution – Bhabha Atomic Research Centre. We are delighted that this year's Founder's Day celebration includes presentation of Indian Nuclear Society (INS) Awards along with Department of Atomic Energy (DAE) Awards to be followed by the address to the members of DAE family by none other than our beloved and most respected Prime Minister, Hon'ble Mr Atal Behari Vajpayee. As a mark of the most befitting way of showing our respect and paying homage to our Founder Dr Homi Bhabha, one of the greatest sons India has ever produced, we celebrate his birthday by taking stock of our achievements during the previous year and rededicating ourselves to our commitment for improving the quality of life of our one billion plus population through exploitation of nuclear science and technology by generating electricity that is safe, reliable and economical in addition to its eco-friendliness and through applications of radioisotopes and radiation technology in non-power generation areas like health care, agriculture and food preservation, isotope hydrology and nuclear desalination, in addition to their applications in the frontier areas of science

and technology. Being members of BARC family, we are equally committed to pursue nuclear science and technology for our national security and to stay in the forefront of nuclear science and technology which is essential for preserving the place of honour and dignity for India among the world community.

Address by Mr B. Bhattacharjee, Director, BARC at the Founder's Day celebration

This year has been yet another successful year in our development efforts to exploit nuclear science and technology both in the power and non-power sectors as we march forward towards our cherished goal.

Development Activities in the Power Sector

Our Research Reactors, Apsara and Dhruva, continued to operate safety and efficiently. Both the reactors were extensively used for basic and applied research, isotope production, material testing and manpower training.

At Apsara, a number of experiments were conducted for optimisation of shielding design for the proposed 500 MWe Prototype Fast Breeder Reactor as well as the Advanced Heavy Water Reactor.

At Dhruva, a 100 ton shielding tunnel has been installed for multi instrument neutron beam experimental set up for experiments under Inter-University Consortium for DAE facilities. A pool site inspection facility for underwater Post Irradiation Examination of fuel elements of Dhruva towards improving the fuel design for better performance was installed and commissioned.

Refurbishing of 40 year old Cirus reactor has been completed. Apart from various repair, replacement and overhauling jobs, several safety upgrades have been incorporated and the reactor has been given a new lease of life for another 15 to 20 years. Uranium metal production facility has upgraded production capacity through 500 kg ingots to ensure supply of fuel for Dhruva and refurbished CIRUS.

As you are aware, for a country like India with large population having a low per capita electricity consumption, the energy mix has ultimately to fall back on its own vast thorium resource (which is one-third of the world's total thorium reserve) in the long run for its energy security on sustainable basis. Towards realising this goal of thorium utilisation, the development of Advanced Heavy Water Reactor (AHWR) along with all the technologies involved in thorium fuel cycle continued to be assigned our major thrust in the past year.

Based on the results of our in-house R&D efforts - because no other country in the world needs to pursue such reactor at this stage - the detailed project report for 300 MW(e) Advanced Heavy Water Reactor (AHWR) has been completed and it is being subjected to be a peer review. Detailed engineering of the fuel handling system and design validation of passive system are in progress. Designed for 100 years of life, AHWR is intended to generate 65% of its electricity from thorium based fuel. Following the current trends world over, it also incorporates lot of innovative

engineered safety features that are totally passive in nature to enable the reactor to automatically come to safe shutdown position under all conditions without intervention of any active control systems or plant personnel. Early induction of AHWR in our nuclear power programme is aimed at establishing all the technologies involved in Thorium fuel cycle on plant scale which, in turn, would assist us to move faster along the road map of our three-stage nuclear power programme foresighted by our Founder. Civil construction of the Critical Facility for conducting reactor physics experiments for Advanced Heavy Water Reactor and 500 MWe Pressurised Heavy Water Reactors is in progress.

To address some of the special energy needs of India, namely, (i) the need to provide compact long life passive power packs for unattended electricity generation in remote inaccessible areas which are not catered to by grid based electricity; and (ii) the need to provide alternate technology for large scale production of hydrogen which is unquestionably the transportation fuel for the future (since carbon based fuel supplying energy in large quantities to promote economic growth in developing countries like India would be completely disastrous not only for our own environment but also for the environment of the world), significant progress has been made in the design of a small Compact thorium based fuel High Temperature Reactor (CHTR) with lead cooling to generate about 40-50 KW(e) of electricity. Hydrogen powered automobiles should be inducted to replace petrol and diesel required for our transport sector. For this, the existing method of large scale production of hydrogen, namely, steam reforming of natural gas (CH4) at high temperature to produce hydrogen and carbon dioxide (which is not acceptable from environmental point of view) is to be replaced by a thorium fuelled high temperature nuclear reactor which will provide the heat source at about 800-1000°C that could be conveniently used either for thermo-electric generation of electricity or for hydrogen production from inexhaustible and eco-friendly water source by thermo-chemical splitting of water in presence of an inorganic compound (either calcium-bromine or sulphur iodine) operating in closed circuit.

Looking at the needs of the country at a still longer time frame in terms of breeding fissile U-233 from thorium and also in terms of reducing the technical complexities of geological repositories for storage of long lived high level radioactive wastes, Accelerator Driven Sub-Critical Systems (ADSS) for nuclear reactor is the latest addition to our nuclear programme activities. The ADSS concept has the inherent versatility for having any desired level of neutron density in the reactor core by varying the high energy proton beam from external accelerator without any risk of run away conditions of super criticality. Further, ADSS is convenient for breeding of fresh fissile U-233 material from its thorium blanket zone at the reactor periphery (which calls for thermal or fast neutrons at lower flux level of $0.5 - 1.0 \times 10^{14}$ neutrons/cm^2/sec to minimise formation of undesirable Pa-234). Simultaneously, one can ensure fast neutrons at a higher flux (~ 1.5×10^{15} neutrons/cm^2/sec) at the central core of ADSS to transmute the LLFP like iodine-129, cesium-135, technetium-99, Zr-93, Pb-109 into either short lived radio-nuclides or harmless stable isotopes. In fact, the highly radiotoxic TRU elements (Pu, Np, Am and Cm) which are generated during uranium fuelled thermal reactor operation (PS: Thus, TRUs which are only 1.0% of nuclear waste generated but add to 20,000 times of radioactivity compared to fission products after 1000 years), can be completely incinerated as nuclear fuel in the high flux fast neutron core (instead of burning in FBRs where these create problem of reactivity control) built around the spallation n-source. So, the ADSS core is an excellent configuration not only to burn the minor actinides (Np, Am, Cm) away but also to recover the useful fission energy from them. During last year, significant progress has been made in detailed analysis of this complex reactor system. The broad road maps for ADSS

development programme has been identified to initiate development work at sub-systems/ components level including development of materials of construction.

As a part of our total commitment to provide all the R&D supports to ensure growth of nuclear power programme, (i) full scale prototypes of the entire range of computer based control systems for TAPS 3&4 has been set up including the simulator for TAPS 3&4, (ii) first unit of Ram assembly for 540 MWe PHWR has been handed over to NPCIL and the assembly of the remaining four units are in advanced stage of completion, (iii) miniature under water radiation resistance CCTV for visual inspection of coolant channel of PHWRs (which was deployed for in-situ inspection at MAPS-1 coolant channels), (iv) wet scrapping tools for sliver sampling of coolant channels at RAPS and MAPS to enable estimation of their hydrogen pick-up level, (v) technology for manufacture of advanced sealing plug (Mark IV) for BARCIS has been transferred to NPCIL, (vi) a remote operated sludge lancing equipment for use in steam generators of KAPS was designed, developed and manufactured at BARC at a cost which is one-third of a similar imported equipment but with a much better performance and finally (vii) extensive support was provided for the life management of ageing coolant channels of our Pressurised Heavy Water Reactors at Kota and Kalpakkam. Using specially developed Integrated Garter Spring Repositioning System, and a Scrape Sampling System, the operating life of coolant channels of MAPS-I was increased from current 9.5 full power years to at least 10.5 full power years with a possibility to increase it further based on additional life management measures.

During the year, performance of all the three reprocessing plants in the country has been exceptionally good in terms of their throughputs, product quality and reduced volume of generated waste with strict adherence to the stipulated safety standards. An automated laser assisted fuel pin disassembly equipment has been developed and is under trials for applications in the head-end operation of the reprocessing plant. R&D activities were also extended for the development of co-processing and co-conversion flow sheets for MOX fuel fabrication needed for our AHWR spent fuel bearing thorium, uranium and plutonium.

A new reprocessing facility at Trombay has become operational to separate U-233 from irradiated thorium fuel on a plant scale which has established yet another vital link in the fuel cycle activities in India. The availability of U-233 will provide access to virtually inexhaustible source of energy from thorium in the country.

Another major achievement this year at the back end of our fuel cycle has been commissioning of Waste Immobilisation Plant (WIP) at Trombay for vitrification high level waste based on Metallic Induction Melter technology which has strengthened and reconfirmed our technical capability to handle high level waste as we expand our nuclear power generation programme. India is one of the seven nations in the world to have mastered this technology for vitrification of HLW.An Advanced Virtification System (AVS) utilising Joule Melter technology is being set up to enhance the vitrification capacity of the high level waste with increased availability factor.

Mixed carbide fuel with high plutonium content developed at BARC for the first time in the world has enabled FBTR at IGCAR, Kalpakkam to reach a milestone burn up of 100,000 MWD/Te. India is the only country in the world which is using high Pu mixed carbide fuel and its excellent performance demonstrates our competence in this high technology area.

Development in Non-Power Sector

Remarkable progress has been achieved in applications of Radioisotopes and Radiation Technology in the areas of health care, nuclear agriculture & food preservation and industrial uses.

To widen our ongoing programme on production of nuclear reactor based radioisotopes for

medical applications, BARC has established a Medical Cyclotron (producing 75 micro-amps of 16.5 MeV Proton Beam) coupled to a Positron Emission Tomography (PET) scanner at RMC, Parel which will supply primarily F-18 labelled radiopharmaceutical Fluoro Deoxy Glucose (FDG) to our needy people for the first time in the country. FDG has been identified as the molecule of the millennium for its efficacy (because positron emitting radionuclides results in superior tomographic imaging compared to scintigraphy from gamma emitting radionuclides) in diagnosis of cancer as well as cardiac and neurological disorders. Another important addition during the year in this area has been the development of vital Myocardial blood flow imaging agent, Te-99m-MIBI (Methoxy Isobutyl Isonitrile) and technology transfer of radiation processed hydrogel for treating burn, wounds and leprosy.

The 1800 m^3/d RO-based desalination plant coupled to MAPS has been commissioned and the plant is producing drinking water with 100 ppm TDS from sea water with about 30,000 ppm TDS. This RO-plant has many innovative design features resulting in low energy consumption of 4.5 $kWhr/m^3$ and longer membrane life. Construction of the 4500 m^3/d MSF plant for producing high quality water (<10 ppm) is in process in the same complex. Installation of plant equipment and machinery for the small (30 m^3/d) desalination unit being integrated with Cirus to demonstrate the sea water desalination using waste heat from the research reactor is nearing completion.

In our pursuit for using radioisotopes for health care of people, we have not forgotten the need of extending the benefits of nuclear medicines to the animal world. We are setting up a Veterinary Nuclear Medicine Centre at Parel, Mumbai, to strengthen the hands of doctors and students of veterinary science with advanced diagnostic and treatment facilities through a non-invasive diagnostic procedure based on nuclear imaging called γ-camera scintigraphy to replace the existing diagnosis procedure based on invitro Radio Immuno Assay (RIA). This veterinary nuclear medicine centre will also provide the most important link for the biomedical research community engaged in human medical science and veterinary medical research because nuclear medical imaging is unique in its functional/physiological basis. Further, the strong resemblance of animal cancers to human cancers are already established and animals with naturally grown cancers/diseases are always better models for research than lab-animals like mice/rats that have been induced with cancer/ diseases. Accordingly, strengthening of cancer research in veterinary science will go a long way in cancer research in human beings too.

While on the subject of our health care programme, special mention must be made of "NISARG-RUNA", an advanced Biogas Plant built by BARC at Anushaktinagar, Trombay, for eco-friendly disposal of kitchen wastes @ 4 tonnes/day to produce very high quality CH_4 gas (~ 75% conc against 50% in conventional Biogas Plant) and odour free solid manure (which, in turn, would produce vegetables to be recycled back to the kitchen).

Coming to utilisation of radiation technology in food processing not only to avoid food spoilage (which is normally in the range of 15-20%) but also to boost export of food products while extending the vital needs of price stability for our farmers, we had commissioned this year the 10 Te/hr POTON facility, renamed as "KRUSHAK" - KRUSHI UTPADAN SANRAKSHAN KENDRA, for low dose radiation processing (with 30-90 Gy) at Lasalgaon, Nashik District, Maharashtra, at a cost of Rs.7.0 crores to irradiate onions at 20-25 paise per kg. In our spice irradiation facility (based on 250 KCi Co-60 source) at Vashi, about 750 tonnes of various spicers/food products were processed and licence for processing Ayurvedic products has also been recently obtained.

Pursuing our strong programme in Nuclear Agriculture, we have added this year a new variety of groundnut mutant, TPG-41, which is a large seeded confectionery variety (with 65 gm of

100 kernel weight). This variety has been released through collaboration with the Mahatma Phule Krishi Vidyapeeth, Rahuri. Trombay groundnut varieties now account for 30% of total national indent for breeder seeds and TAG-24 variety has ranked 1st among the 33 varieties this year. Our TAG-24 and TG-26 varieties continue to spread in new States. Recently, these two varieties have been recommended by Acharya N.G.Ranga Agricultural University for cultivation in high rainfall area of north coastal/north Telungana Districts of Andhra Pradesh.

In Maharashtra, our black gram variety TAU-I (Trombay Akola Urid) which account for 44% of national indent for breeder seeds has covered over 95% of the area under black gram cultivation resulting in additional 1,30,000 tonnes (amounting to 24% higher yield) of annual production.

In industrial application of radioisotopes, the use of sealed sources and tracers for process optimization and trouble shooting including γ-scanning of column has been extended to a joint programme with Bharat Petroleum Corporation Ltd. (BPCL), Mumbai, and Engineers India Ltd. (EIL), Gurgaon, for development of tracer technology for applications in Fluid Catalyst Cracking Unit (FCCU) and a series of radiotracer experiments carried out for measurement of Residence Time Distribution (RTD) of gas and solid phases in three different sub-system of FCCU viz., riser, stripper and regenerator at BPCL. For tracing the catalysis phase movement, lanthanum-140 @ 25-30m Ci/test) was produced by activation of catalyst itself while imported Krypton-97 gas was used (@ 50 m Ci/test) to trace the gaseous phase. This has been the first radiotracer investigation in FCCU carried out in India.

Our Electron Beam Accelerator (2 MeV – 20 KW DC, ILU-6) was utilised for production of high technology products like cables/wires with low insulation thickness for high temperature application, heat shinkable material and cross linking of polythene 0-ring as import substitutes, colourisation of gemstones for exports, etc. It is now being upgraded with additional product handling system for increased utilisation. Realising the growing potential of industrial electron beam accelerators, our programme in collaboration with SAMEER for development of a range of electron accelerators (500 KeV – 10 KW DC, 3 MeV – 30 KW DC and 10 MeV – 10 KW RF) to cater to the entire needs of the industry is in advanced stage.

BARC has achieved a significant milestone this year by developing a 64 node Anupam P-IV Parallel Super Computer giving a sustained speed of 43 giga flops (Floating Point Operation Per Second). This Super Computer is 30 to 40 times faster than any other Parallel Supercomputer developed indigenously elsewhere in the country.

For the first time in the country, 3D Cone Beam Tomography system has been developed for industrial and strategic applications with exceptionally high resolution using a high dynamic range cooled CCD and constant potential x-ray generator.

Pu-236, an important tracer for the environmental and biological studies, has been successfully produced for the first time in isotopically pure form using proton induced reaction on Np-237 targets at 14 MV BARC-TIFR Pelletron facility. Availability of Pu-236 will significantly enhance the sensitivity of Pu-estimation of body burden of plutonium through bio-assay using α-spectrometry.

To augment the energies of the charged particles available from existing pelletron, first phase of inducting superconducting LINAC boosters consisting of three modules (out of total 7 modules) of quarter wave resonators (12 nos.) including the control system consisting of front-end RF-electronics and CAMAC based data acquisition system has been successfully tested with Silicon beam. This development - first of its kind in India – that was carried out jointly with TIFR has established the indigenous capability in

the field of advanced accelerator technology based on superconductivity.

For spectroscopic studies for laser separation of U-232 from U-233, about 300 micrograms of pure U-232 has been produced by irradiation of Pa-231 (that has been separated by processing 23 tonnes from insoluble residue from the monazite plant of IREL at Aluva, Kerala). Isotopic shifts of U-232 from U-233 was measured by a high resolution spectroscopy that needs only microscopic quantities of sample loading.

Assistance to Outside Institutions

Nickel-titanium-iron shape memory alloy components developed at BARC have passed all the stipulated air worthiness tests and have been successfully used in the light combat aircraft (LCA) test flights. Aeronautical Development Agency has accepted the supply of these components for several aircrafts. Software verification tools for verifying critical softwares for Light Combat Aircrafts (LCA) have also been developed.

Similarly, control and reporting system to Air Defence applications that have been developed in this Centre is ready for deployment.

Technical know-how has been provided to the Department of Ocean Development to set up a Pilot Plant at Udaipur for the separation of nickel, cobalt, copper and zinc from the solution generated during the processing of manganese nodules mined from Indian Ocean.

As a part of DAE-CERN collaborative programmes, BARC continued to supply the specialised components/sub-systems like silicon strip detectors for pre-shower radiation detection in CMS experiment at Large Hydron Collider (LHC) accelerator, Quench Heater Power Supplier (QHPS) for protection of super conducting magnets and the supervisory control and data acquisition for String-2 magnate test facility at LHC.

On a request from the International Atomic Energy Agency (IAEA), BARC extended the expert services of scientists along with the state-of-art in-house developed Aerial Gamma Spectrometry Systems (AGSS) and Survey Monitors to locate orphan radiation sources in Georgia. Superiority of our indigenously developed AGSS at BARC compared to those offered by the advanced countries and the technical competence of BARC scientists have been highly acclaimed by both IAEA as well as the Ministry of Environment, Georgia.

The actual list of achievement in BARC is too long to be covered in totality. However, before I conclude, I would like to take the opportunity to compliment all the members of BARC and of other units under DAE for assigning highest priority to safety while discharging their respective duties under the overall guidance of BARC Safety Council.

Friends,

In the light of the above account of BARC's achievements during the year, you would fully agree that the basic strength of our success lies in our multi-disciplinary structure and the tradition of exemplary work culture as a team that we have inherited as part of the legacy Dr Bhabha has left behind. To pay our homage to this visionary, let us rededicate ourselves with a greater sense of national pride and greater commitment for national needs to take this great R&D institution created by him to a greater height of excellence and relevance to the needs of our people.

PRIME MINISTER PRESENTS DAE AWARDS FOR 2001 TO STAFF

The Prime Minister Mr Atal Behari Vajpayee presented the DAE awards for 2001 to their recipients on October 31, 2002 at Central Complex Auditorium, BARC.

The Department of Atomic Energy instituted this Award Scheme in 1993 to recognise exceptional

accomplishments and meritorious achievements in Science and Technology, and to create a congenial milieu for nurturing excellence and fostering creativity among the members of the DAE staff who are engaged in Research, Development and Engineering in the frontiers of Science and Technology dedicated to the development of the nation.

The Award Scheme consists of three categories of awards:

1. Homi Bhabha Science and Technology Award
2. Technical Excellence Award
3. Meritorious Service Award

These awards are given annually.

The Homi Bhabha Science & Technology Award is the highest award among them. It consists of a citation, a medal, and a cash award of Rs.50,000/-.

This award is given to a maximum of two Engineers or Scientists who have made outstanding contributions towards the advancement of science and technology based on original research in the frontier areas of science or frontline development in engineering and technology, which would reflect excellence commensurate with nation and international standards.

This year the award was given to two scientists, Dr Ajit K. Mohanty of Nuclear Physics Division, BARC and Dr Dipak K. Palit of Radiation Chemistry and Chemical Dynamics Division, BARC.

Dr.Mohanty has made important contributions in the area of heavy-ion induced nuclear reactions, spanning the energy range from near-Coulomb barrier to relativistic energies. He has proposed new methodologies to analyse heavy ion collisions, such as, identifying the particle trajectories using Principal Component Analysis and Artificial Neural Network techniques. The models proposed by Dr. Mohanty are useful for understanding photon and dilepton spectra,

Dr Ajit K. Mohanty receiving the Homi Bhabha Science & Technology award from the Hon'ble Prime Minister Mr Atal Behari Vajpayee

which are two important signatures to identify the formation of Quark Gluon Plasma and its space-time evolution to the Hadron phase.

Dr Dipak K. Palit receiving the Homi Bhabha Science & Technology award from the Hon'ble Prime Minister

Dr.Palit's leading contributions in the field of ultrafast processes involved in photo and radiation chemistry include basic understanding of chemical bond rupture and reformation processes in time scales of a few femtoseconds. He has developed ultrafast spectroscopic techniques, which is unique in this country, for probing atomic level structures of molecules undergoing chemical reactions and the associated chemical dynamics. This is essential to develop strategies to control radiation and light induced processes.

The second set of awards is the **Technical Excellence Award.** A maximum of two awards

are conferred on Engineers or Scientists who have made outstanding contributions and special efforts towards:

(a) Development of a new or improved equipment, machine, materials, process of device with proven results meeting the immediate use requirements of futuristic needs of bringing credit to the respective Unit or leads to import substitution, technology transfer, etc.; or

(b) Practical constructive ideas and suggestions leading to better utilisation of human resources, materials, processes, devices, etc. resulting in higher efficiency and significant financial saving to the Government; or

(c) Handling of emergency or crisis situations exhibiting rare alertness and skill thereby averting accident/serious plant situation; or

(d) Highly efficient planning and execution of important assignment in multidisciplinary and multiorganisational time-bound projects of vital interest to the nation, and excellence in trouble shooting or overcoming or expeditious implementation of ongoing projects.

This year the award was given to two groups of four scientists, viz., Mr Anil Bhatnagar of Research Reactor Services Division, BARC, and Mr A.V.Kharpate of Research Reactor Maintenance Division, BARC; Dr. G. Venkateswaran of Applied Chemistry Division, BARC, and Dr.S.Velmurugan of Water and Steam Chemistry Laboratory, Kalpakkam, BARC.

Mr Bhatnagar and **Mr Kharpate** developed an innovative and intricate remote repair technique which has made a vital contribution to the refurbishment of the CIRUS reactor. This development involves design and fabrication of split sealing clamps, remote tightening tools and remote gauging assemblies. Remote repairing of a number of leaky flange joints was successfully performed within a 20 cm gap between seals located at about 4 m below the operating platform.

Hon'ble Prime Minister presenting the Technical Excellence Award to Mr Anil Bhatnagar

Hon'ble Prime Minister presenting the Technical Excellence Award to Mr A.V. Kharpate

Dr G.V. Venkateswaran receiving the Technical Excellence Award from Hon'ble Prime Minister

Dr Venkateswaran and **Dr. Velmurugan** have made outstanding contributions towards the development of novel processes leading to improved water chemistry parameters for Indian

Dr S. Velmurugan receiving the Technical Excellence Award from the Hon'ble Prime Minister Mr Atal Behari Vajpayee

Nuclear Power Reactors - which have resulted in the improved reactor performance. They have developed suitable chemical formulations for the decontamination of primary coolant circuits of nuclear power plants thus helping in minimising the background radiation fields. While Dr Venkateswaran's work is related to Boiling Water Reactors, Dr.Velmurugan's contributions pertain to Pressurised Heavy Water Reactors.

PRIME MINISTER PRESENTS INS AWARDS TO SCIENTISTS

Former Chairman of AEC, Dr. M. R. Srinivasan, Mr S.C. Hirenath, Chairman & Chief Executive, Heavy Water Board, Mumbai, Dr C. Ganguly, Chairman, NFC Board & Chief Executive, NFC, Hyderabad, Mr S. Bharadwaj, Director (Engg.), NPCIL, Mr P.K. Sarathy, Chief Executive Officer, TCE Consulting Engineers Ltd., Mumbai and two BARC scientists, Mr R.K.Sinha and Mr P.S.Dhekne, were conferred the prestigious Indian Nuclear Society (INS) Awards for 2001 by the Prime Minister Mr Atal Behari Vajpayee on October 31, 2002 at the Central Complex Auditorium, BARC.

One of India's outstanding engineers, **Dr. M.R. Srinivasan** can rightly be termed as a pioneer in the Indian nuclear power programme. Initially he worked at Apsara, Asia's first experimental reactor. His active association with nuclear power started in 1959 with the site selection and inviting of global tenders for the Tarapur project. He served as Principal Project Engineer of TAPS

Dr M.R. Srinivasan, former Chairman, Atomic Energy Commission receiving the INS Homi Bhabha Lifetime Achievement Award for 2001 from the Hon'ble Prime Minister Mr Atal Behari Vajpayee

until 1966 and then took over as Chief Project Engineer of Madras Atomic Power Project. This project was the first major effort in indigenisation of design, equipment and machinery for the PHWR programme. Under his guidance, construction of Narora and Kakrapar Power Stations also started, preparatory work on Kaiga project was completed, work on two more 220 MWe units at Rajasthan and on two 500 MWe units at Tarapur was initiated; and the agreement of cooperation betwen Soviet Union and India for setting up of two Light Water Reactors VVER-1000 was signed. During Dr.Srinivasan's tenure as Chairman of AEC (1987-90), NPCIL was formed and the Nuclear Power Station at Narora was commissioned.

Dr M.R. Srinivasan received the INS Homi Bhabha Lifetime Achievement Award. The award consists of Rs. 1,00,000 in cash and a citation.

Mr S.C. Hiremath, Chairman & Chief Executive, Heavy Water Board, Mumbai, is one of the few who has been associated, right from the beginning, with all the aspects and phases of the first totally indigenous industrial scale facility for the production of Heavy Water, based on

Mr S.C. Hiremath, Chairman & Chief Executive, Heavy Water Board, Mumbai receiving the INS Award 2001 from the Hon'ble Prime Minister

H_2S-H_2O exchange process set up at Kota, Rajasthan. He has made important contributions to the indigenous vendor development for critical equipment like H_2S gas boosters, process isolation valves etc., and in engineering of the HWP at Manuguru. Under his dynamic leadership as Executive Director (Operations) during 1998-2002 all the eight heavy water plants in the country showed quantum jumps in their performance in terms of production, reduction in specific energy consumption and safety.

Mr S.C. Hiremath received INS award for 2001 which consists of Rs. 50,000/- in cash and a citation.

Hon'ble Prime Minister Mr Atal Behari Vajpyee presenting the Indian Nuclear Society (INS) Award for 2001 to Dr C. Ganguly, Chairman, NFC Board & Chief Executive, NFC

Dr C. Ganguly, Chairman, NFC Board & Chief Executive, NFC, Hyderabad has made several pioneering contributions in indigenous development and fabrication of Nuclear Fuels and has the unique distinction of manufacturing metallic and ceramic fuels bearing the three fissile isotopes U^{235}, Pu^{239} and U^{233}. He has played a key role in the development and production of the hitherto untried Plutonium-rich Mixed Uranium Plutonium Monocarbide fuel for the Fast Breeder Test Reactor (FBTR) at Kalpakkam and in manufacturing PuO_2 fuel pins for PURNIMA-1 and Al-U^{233} plate fuel for KAMINI research reactors. Under his leadership, NFC achieved unprecedented production of uranium oxide fuels, hafnium-free Zirconium oxide powder, zirconium sponge and Zirconium alloy ingots and components.

Dr C. Ganguly received INS award for 2001 which consists of Rs. 50,000/- in cash and a citation.

Hon'ble Prime Minister Mr Atal Behari Vajpyee presenting the Indian Nuclear Society (INS) Award for 2001 to Mr R.K. Sinha, Associate Director, Reactor Design & Development Group, BARC

Mr R.K.Sinha, Associate Director, Reactor Design & Development Group, BARC spearheaded the development of the methodologies and technologies for addressing major degradation mechanisms of coolant channels of Pressurised Heavy Water Reactors. He is responsible for the detailed design and development of the 300 MWe Advanced Heavy Water Reactor (AHWR), that would produce most

of its power from thorium and which has several passive and innovative features. He has successfully brought its design to maturity. Mr Sinha has conceived a Compact High Temperature Reactor (CHTR), a molten heavy metal-cooled reactor with passive safety, and successfully guided its preliminary design. He has also contributed significantly to the preparation of a detailed roadmap for third stage Indian nuclear programme.

Mr R.K. Sinha received INS award for 2001 which consists of Rs. 50,000/- in cash and a citation.

Hon'ble Prime Minister Mr Atal Behari Vajpyee presenting the Indian Nuclear Society (INS) Award for 2001 to Mr. S. Bhardwaj, Director (Engineering), NPCIL

Mr S. Bhardwaj, Director (Engineering), NPCIL, has been actively associated with different aspects of the design and engineering development of Pressurised Heavy Water Reactors (PHWRs) and NPCIL's indigenous efforts in developing fuel cycle technology for Indian conditions utilising different fuels, such as MOX, thorium and depleted uranium. Many novel approaches proposed by him have helped in the prediction of reactor performance and maximising of the power output. His technological contributions have been valuable particularly in the design of shutdown systems, reactivity mechanisms and coolant channel life management programmes. He is currently associated with the design of 700 MWe PHWR.

Mr S. Bhardwaj received INS award for 2001 which consists of Rs. 50,000/- in cash and a citation.

Hon'ble Prime Minister Mr Atal Behari Vajpyee presenting the Indian Nuclear Society (INS) Award for 2001 to Mr P.S. Dhekne, Officer-in-Charge, Computer Centre, BARC

Mr P.S. Dhekne, Officer-in-charge, Computer Centre, BARC was responsible for the design and development of microprocessor based statistical multiplexer, free space communication link, TCP/IP networking for PC-DOS to UNIX and also for the overall design and execution of parallel processing systems, data visualisation, network based information management system, web based remote instrumentation and control systems, BARC Technology Synergiser and many advanced communication facilities. His major contributions include those to the design and development of various models of high performance parallel computers based on a cluster concept of interconnecting powerful workstations or PCs on a low latency, high bandwidth network. The new ANUPAM-P-IV Computer consisting of 64 nodes developed by him has attained 43 Gflops of sustained performance which is 30-40 times higher than any indigeneously developed parallel computer. Many leading institutions in India such as ADA, VSSC, NCMRF, IITs, Universities and DAE users have been able to solve highly complex scientific and engineering related problems on ANUPAM systems, which were otherwise impossible on any available sequential systems, in a reasonable time frame.

Mr P.S. Dhekne received INS award for 2001 which consists of Rs. 50,000/- in cash and a citation.

The INS Industrial Excellence Award (2001) was given to **Mr P.K. Sarathy,** Chief Executive Officer, TCE Consulting Engineers Ltd., Mumbai. The Special Projects group of M/s TCE

Mr P.K. Sarathy of TCE Consulting Engineers Ltd., receiving a silver plaque and a citation from the Hon'ble Prime Minister

Consulting Engineers Limited (TCE) has made significant contributions to the design of the vertical type fuelling machine for the 300 MWe Advanced Heavy Water Reactor (AHWR). The design of the fuelling machine posed many challenges and these were successfully overcome through brainstorming sessions between BARC and TCE teams. This helped in choosing among the different conceptual designs and optimising the chosen design using the techniques of 3-D modelling and finite element analysis. TCE Consulting Engineers made valuable contributions to this work, exhibiting excellent insight and technical acumen.

Mr P.K. Sarathy received a silver plaque and a citation.

CHAIRMAN PRESENTS MERITORIOUS SERVICE AWARDS

Dr Anil Kakodkar, Chairman, AEC, presented the Meritorious Service Awards to their recipients at a function held at Multipurpose Hall, Training School Hostel, Anushaktinagar on October 30, 2002.

The **Meritorious Service Award** is conferred on a maximum of six employees with a minimum continuous service of 20 years or more, who have exhibited consistent improvement in skill, technology ability, including outstanding performance in the maintenance of equipment and facilities resulting in reduction in idle time and increase in effective utilisation. Emphasis is also on consistently high performance and achieving perfection in work.

The award consists of a citation, a medal and a cash award of Rs.10,000/-.

This year the awards were given to :

1. Mr B.B. Sawant, Technical Physics and Prototype Engineering Division, BARC
2. Mr A.M. Halaki, Molecular Biology and Agriculture Division, BARC and
3. Mr A. Vincent Paulraj, Physical Metallurgy Section, Materials Characterisation Group, IGCAR

Mr B.B. Sawant is conferred Meritorious Service Award 2001 for his innovative approach and very valuable contributions to the technology development of glass and ceramic materials and his continued outstanding performance during last thirty two years of service to the Department of Atomic Energy as a specialist glass blower.

Mr B.B. Sawant receiving the Meritorious Service Award 2001 from Dr Anil Kakodkar, Chairman, AEC

Mr Sawant is very versatile person. He has immensely contributed to the development and production of various types of glass to metal seals, ceramic to metal seals, ionization gauges (as import substitute), special tungsten filament

for rotating anode x-ray machine (as an import substitute) and many other areas. The technology of glass to metal seals for image converter photo-tube and image intensifier tube (operating under vacuum of 10^{-8}-10^{-9} torr) has been transferred to BEL, Pune for meeting the larger Defence requirements.

Additionally, he has assisted for the development program of special glasses. He has successfully melted and poured kodial and lead silicate glasses and has fabricated number of GM seals using indigenously developed glasses. As a result of his continued efforts and innovative approach, Mr Sawant has helped in saving precious foreign exchange by indigenising the products as import substitutes.

Mr A.M. Halaki is conferred Meritorious Service Award 2001 for his outstanding service of 32 years to the Department and excellent contributions to the program of Molecular Biology and Agriculture Division of BARC, Mumbai.

Mr A.M. Halaki receiving the Meritorious Service Award 2001 from Dr Anil Kakodkar, Chairman, AEC

His work is highly commendable as a laboratory assistant skilled in handling a variety of laboratory instruments such as Flow Cytometer, Phosphor Image Analyzer and even the recently installed automated DNA sequencer involving complex techniques. He has consistently improved his technical skills and has shown exemplary aptitude to learn new, sophisticated technologies. He has handled a variety of jobs such as animal dissection, preparation of media for tissue culture, asceptic techniques, preparation of solutions for molecular biological experiments and animal breeding etc.

Mr Halaki is very hardworking, dedicated and meticulous person. He is very well mannered and has always received compliments not only from all his colleagues and seniors but also from visitors and collaborators from other institutions. He has always helped a lot in organization of various seminars and workshops.

Mr A. Vincent Paulraj is conferred Meritorious Service Award 2001 for his outstanding service of 28 years to the Department and commendable contributions in the field of metallography and photography to the program of Material Characterisation Group of IGCAR, Kalpakkam.

Mr A. Vincent Paulraj receiving the Meritorious Service Award 2001 from Dr Anil Kakodkar, Chairman, AEC

Mr Paulraj has developed outstanding skills in photography related to microscopy of materials in recopying and colour slide processing, and has made commendable contributions in developing and printing High Resolution Electron Microscope (HREM) images. Through his total dedication and commitment, he has produced international quality images using an indigenously modified apparatus.

Not only Mr Paulraj is having skills par excellence in specimen preparation for microscopy, he has shown keen interest in many other activities such as heat treatment of special alloys and failure analysis. Mr Vincent Paulraj is a multifaceted personality and has shown keen interest in various noble social services.

FOUNDER'S DAY LECTURE

Mr S.L.Kati, former Managing Director, NPCIL being welcomed with a bouquet from Mr B. Bhattacharjee, Director, BARC. Seen to his left is Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary to Government of India

Mr S.L. Kati, former Managing Director, NPCIL, delivering a lecture on the Founder's Day at BARC Training School Hostel

Mr S.L. Kati, Former Managing Director, Nuclear Power Corporation of India Limited, delivered this year's Founder's Day lecture on "Indian Nuclear Power Programme - Some Reminiscences". The growth of technology during the implementation of Indian Nuclear Power Programme was highlighted in this lecture. Particularly, his contribution in the design of 230 MWe PHWRs for RAPP, MAPP and NAPP and also in evolving new design concepts of NAPP were presented in detail. These included 100% double containment concept, physical separation of areas containing heavy water and light water systems and ball field end shield assembly among many other technical aspects. His crucial role in the design and development work of 500 MWe PHWR was also discussed.

XIVTH ALL INDIA ESSAY CONTEST IN NULCEAR SCIENCE AND TECHNOLOGY

The All India Essay Contest in Nuclear Science & Technology for regular full time students studying for graduation in any discipline was started by the Department of Atomic Energy in 1989 and has since been an annual feature. This year's contest is the 14th in the series. The topics for the contest were :

1. Electricity Generation from Nuclear Energy - Present Status and Future Scenario
2. Applications of Radioisotopes and Radiation Technologies for Societal Development

Winners of the DAE's 14th All India Essay Contest with Dr Anil Kakodkar, Chairman, AEC. Other dignitaries (left to right, chair row) are Dr J.P. Mittal, Director, Chemical & Isotope Group, Mr S.L. Kati, former Managing Director of Nuclear Power Corporation of India Ltd., Dr Anil Kakodkar, Chairman, AEC, Dr M.R. Srinivasan, former Member, Planning Commission and former Chairman, AEC, Dr R. Chidambaram, Principal Scientific Adviser to the Government of India, Chairman, Scientific Advisory Committee to the Cabinet and former Chairman, AEC, Mr B. Bhattacharjee, Director, BARC, Mr V.K. Chaturvedi, Chairman-cum-Managing Director, NPCIL and Mr S.K. Sharma, Director, Reactor Group and Engineering Services Group, BARC

Following were the prize winners :

Topic 1 : Electricity Generation from Nuclear Energy - Present Status and Future Scenario

First Prize (Rs. 5000/-) : Mr S. Rama Swamy, 2nd B.Sc. Tiruchendur

Second Prize : Mr Asutosh Pathak, Final year
(Rs. 3000/-) B Tech., Nagpur
Third Prize : Mr Sunil Kumar Chhipa, Final
(Rs. 2000/-) year B Tech, Udaipur

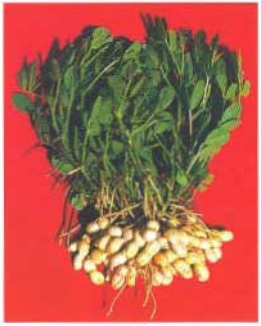
Topic 2 : Applications of Radioisotopes and Radiation Technologies for Societal Development

First Prize : Mr V. Sankara Narayanan, 3rd
(Rs. 5000/-) year BE, Tirunelveli

Second Prize : Mr N.V.N.S. Srinivas, 3rd year
(Rs. 3000/-) year B Tech., Hyderabad
Third Prize : Mr Pravin Pohekar, 2nd B.Sc.
(Rs. 2000/-) Dhamangaon

RELEASE OF NEW LARGE SEED GROUNDNUT VARIETY, TPG 41

A new confectionary groundnut variety designated as TPG-41 (earlier named as TG41) is released on August 2, 2002 for commercial cultivation by the Varietal Identification Committee, Indian Council of Agricultural Research on all India basis for irrigated *Rabi* summer situation.



TPG-41

It was developed by crossing TG-28A and TG-22 during 1992. In the evaluation trials at Trombay (1996-97), TG-41 gave higher pod yields and greater proportion of large seeds. In the All India Coordinated Varietal Trials (1998-2001), TG-41 has given a mean pod yield of 2,088 kg/ha and seed yield 1,414 kg/ha (superior by 14.2% and 23.3%, respectively over the best check variety), with an average 100-seed weight of 65g, greater proportion of sound matured seeds. TG-41 matures in 120 days with a fresh seed dormancy of 25 days, an important trait, which prevents *in situ* seed germination due to unseasonal rains when crop is ready for harvest. The seeds of TG-41 also showed an improvement for caloric value, protein and oleic acid. TG-41 is renamed as TPG-41, as a collaborative product between BARC and Mahatma Phule Krishi Vidyapeeth, Rahuri.

2ND DST/SERC SCHOOL ON "ISOTOPE TRACER TECHNIQUES FOR WATER RESOURCES DEVELOPMENT AND MANAGEMENT"

The second DST/SERC School on the above subject was organized by the Center for Water Resources Development and Management (CWRDM), Kozhikode in collaboration with BARC. The main objectives of the school were to familiarize the participants with various isotope application techniques in the field of hydrology with case studies. This would help in greater integration of isotopes in hydrological practices. About 18 participants from various State/Central Water Departments as well as from academic institutions dealing with hydrology attended the school.

The first two weeks of the school was held in CWRDM, Kozhikode, which was inaugurated by

Dr N. Ramamurthy, Chief Executive, Board of Radiation and Isotope Technology & Associate Director, Isotope Group, BARC giving away the certificates during the valedictory function.

Dr A.S. Rao, Advisor, Department of Science & Technology (DST). Lecture topics covered in the CWRDM part of the school included introduction to environmental and artificial isotopes in hydrology and a few selected applications in stream flow measurements, groundwater recharge studies etc. The participants were provided with demonstration of field techniques in Sasthamkotta Lake area and visits to various divisions of CWRDM including Nuclear Hydrology Division.

Dr E.J. James, Director, CWRDM, Kozhikode delivering the valedictory address

In the BARC part of the School, the participants were exposed to lectures on dam seepage, effluent dispersion and sediment transport in marine bodies using isotope techniques. Isotopes in studying groundwater salinisation, pollution, interconnection between water bodies and arid zone hydrology were also presented. Visits to various facilities in BARC such as Dhruva, Radioisotope Processing Laboratory in RLG, Stable Isotopes and Chemical Laboratory in HIRUP and Environmental Radioisotope Laboratory at BARC Hospital were arranged. The participants presented case studies where isotopes could be applied. A test was arranged to evaluate the performance of the participants.

Participants of the 2nd DST/SERC school

The faculty was drawn from institutes like National Institute of Hydrology (NIH), Roorkee, National Geophysical Research Institute (NGRI), Hyderabad, Department of Science and Technology (DST) besides BARC & CWRDM.

At the end of the school, a valedictory function was organized. Dr. E.J. James, Director CWRDM gave the valedictory address and Dr N. Ramamurthy, Chief Executive, Board of Radiation and Isotope Technology & Associate Director, Isotope Group, BARC gave away the certificates to the participants.

Edited and published by Dr Vijai Kumar, Head, Library & Information Services Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085.

Editorial Management : T.C. Balan; Computer graphics & layout : P.A.S. Warrier

BARC Newsletter is also available at URL:http://www.barc.ernet.in (for private circulation only)