



# BARC

## NEWS LETTER

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### BARC OBSERVES FOUNDER'S DAY

(On October 29, 1999, the eve of Dr Homi Bhabha's birth anniversary, the fraternity of BARC observed the Founder's Day with warmth and fond remembrance of its illustrious Founder, Dr R. Chidambaram, Chairman, Atomic Energy Commission and Secretary to the Government of India, and Dr Anil Kakodkar, Director, BARC, addressed the staff members at Trombay. Dr Chidambaram distributed the Homi Bhabha Science & Technology Awards, Technical Excellence Awards and Meritorious Service Awards to the recipients of these awards at a well-attended function in the Central Complex Auditorium, BARC. He also gave away the prizes to the winners of the XIth All India Essay Contest in Nuclear Science and Technology.

As a tribute to Dr Homi Bhabha, Founder's Day lecture was delivered by Dr M.S. Chadha, former Director, Biochemical Group, BARC, on "Chemical Research and Environmental Needs."

The texts of Dr Chidambaram's and Dr Kakodkar's speeches are reproduced below.)

#### **Address by Dr R. Chidambaram, Chairman, Atomic Energy Commission & Secretary, Department of Atomic Energy**

##### *Members of the DAE family,*

The past year has been a year of very significant achievements by the Department of Atomic Energy. One state-of-the-art indigenously designed 220 MW(e) Pressurised Heavy Water Reactor (PHWR) attained criticality at Kaiga on September 24, 1999. Another 220 MW(e) PHWR, the third unit in Rajasthan, is expected to attain criticality in a few weeks. Two more units, one at Kaiga and one in Rajasthan, will achieve criticality next year. The performance of our

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ten nuclear power plants in the last three years has been consistently improving. In 1998-99, the overall capacity factor was 75%. For the period from April to September 1999, the capacity factor has touched a high of 78% which is higher than that in the Canadian Nuclear Power Plants.

The Vision-2020 discussions in 1995 have led us to conclude that it should be our endeavour to reach 20,000 MW(e) of nuclear installed capacity by the year 2020 as a first step. To achieve this objective, we plan to set up 220 MW(e) and 500 MW(e) PHWRs, 500 MW(e) Fast Breeder Reactors (FBRs) and Advanced Light Water Reactors (ALWRs). Construction work commenced on the two 500 MW(e) indigenously designed PHWR reactors at Tarapur last October. The preparation of the Detailed Project Report (DPR) for the construction of two 1000 MW(e) ALWRs at Kudankulam in technical

cooperation with Russia is underway and is expected to be completed in 2001.

To ensure long-term energy security, we have chosen to follow a "closed-fuel cycle" policy which calls for the setting up of reprocessing plants and breeder reactors. Our Fast Breeder Test Reactor at Kalpakkam, which went critical in 1985, has achieved all technological objectives. With the rich experience gained from its operation, the indigenous design and development of the 500 MW(e) Prototype Fast Breeder Reactor (PFBR) is progressing well.

An Advanced Heavy Water Reactor (AHWR) using Plutonium and Uranium-233 as fuel is being designed at the Bhabha Atomic Research Centre (BARC). AHWRs constitute a part of the third stage of our nuclear power programme, which will mark a transition to the thorium-U<sup>233</sup> cycle as it will use as fuel the U<sup>233</sup> obtained by the irradiation of thorium in PHWRs and FBRs.

The power programme has a support base ranging from fuel fabrication to electronics and heavy water facilities. Based on design and development at BARC, the Electronics Corporation of India Limited (ECIL) has produced the sophisticated Supervisory Control & Data Acquisition (SCADA) system for switchyard and power equipment for the new power stations in Rajasthan. The Nuclear Fuel Complex (NFC) developed a novel method for production of seamless zircaloy-4 square channels for the two Boiling Water Reactors (BWR) at Tarapur for the first time. Heavy Water Board, after making India self-reliant in the heavy water production technology, is diversifying into manufacture of organic solvents. At its plant at Talcher, it has set

*(Chairman's address continued on page 4...)*

**Address by Dr Anil Kakodkar, Director, BARC**

*Dr Chidambaram and Dear Colleagues,*



Founder's Day provides us an opportunity to pay homage to our founder, Dr Homi J. Bhabha. Undoubtedly, Dr Bhabha was a visionary and has created this very fine institution of which we are all proud members. It is no exaggeration to say that BARC today has achieved the capability to take up any technological challenge and there are several examples of our having met such challenges successfully for the Atomic Energy Programme as well as for other programmes of national importance.

Friends, past year has seen an all round progress in all our programmes. Research reactors DHRUVA and APSARA, all the three REPROCESSING PLANTS as well as a number of other Plants that we operate are doing extremely well. Work on the refurbishing of CIRUS is now in full swing.

The design and engineering development of Advanced Heavy Water Reactor (AHWR) is progressing well. The natural circulation loop set up specifically for the purpose of studying the phenomena and its stability in AHWR has provided experimental validation of our models in this area. The physics and thermal hydraulics design of AHWR has been further optimised. Facility for uranium separation which would separate Uranium-233 from irradiated thorium is in an advanced stage of completion.

The important landmarks in the development of Pressurised Heavy Water Reactor systems this year include commissioning of the first phase of the Facility for Integral System Behaviour Experiments (FISBE). This facility permits experimental simulation of accident scenarios and operational transients in Pressurised Heavy Water Reactors, thereby improving our understanding of the physical phenomena that occur under such conditions and also enable tests on relevant recovery methods and operational procedures.



*A section of the gathering of the staff at Trombay on Founder's Day.*

This year has also seen major gains in terms of data generation on fatigue and fracture behaviour of primary systems piping as a part of our effort to realise leak before break capability in Primary Heat Transport System of 50 MWe PHWR.

*(Director's address continued on page 6...)*

(Chairman's address continued from page 2 ...)

up a pilot plant for the production of D<sub>2</sub>EHPA (Di 2 Ethyl Hexyl Phosphoric Acid) based on BARC technology. Plans are underway to set up another pilot plant to produce TBP (Tributyl Phosphate), also based on technology from BARC.

The past year has also been an excellent year for the safety record of our facilities. The Nuclear Power Corporation of India Ltd. (NPCIL) is a member of the World Association of Nuclear Operators (WANO), which was formed after the Chernobyl accident to improve nuclear power plant safety, by sharing of experience among nuclear operators, and actively participates in WANO activities. In January 1998, a WANO peer review was conducted at the Kakrapar nuclear power plant. Another WANO peer review has been planned at the Narora nuclear power plant in early 2000. Safety is a matter of culture and our continuous and strong emphasis on it, both in design and in operation, has paid rich dividends. NPCIL has the track record of 150 reactor years of safe operation.

Recently, there have been some reports in some foreign media about Uranium Corporation's mining operations at Jaduguda. A team of doctors and scientists specialising in the health effects of radiation, including the Civil Surgeon of the Bihar government, and the Tata Main Hospital at Jamshedpur, has conducted an exhaustive medical survey in the villages around Jaduguda and was convinced that the disease pattern around the area has to be ascribed to the unfortunate malnutrition and poverty prevalent in the area and has nothing to do with radiation exposure. I must add that the correct picture has been published in leading newspapers like the *Indian Express* after their correspondents visited Jaduguda.

There was, last month, a criticality accident in a Uranium Conversion Facility operated by a Private Company in Japan, caused by violation of regulatory directives and safety imperatives. The Safety Review Committee of Operating Plants (SARCOP) of AERB, after examining the details, has stated that such an accident is unlikely in India but has, as a measure of abundant caution, asked for a re-examination of relevant plans and this is being done. It has been recognised all over the world that our safety record is very good and this is because no directive of the AERB has ever been violated. In spite of this, there has been a recent report in some sections of the press that "there may be a nuclear accident in India in the not-too-distant future". Such a statement, made without any scientific basis, is a symptom of the technological diffidence in some persons who consider that, as a nation, India is not capable of dealing with high technology. Homi Bhabha did not think so. I do not think so. And there is no doubt that all of you, who have a spectacular record of achievements, do not think so. Technological diffidence is an invitation to technological colonialism. I am sure all of us will continue to work to prove that India's high technology capabilities are as good as those in developed countries.

The Atomic Energy Regulatory Board (AERB) stringently monitors the safety record of India's nuclear facilities. The AERB has set up during the year an independent Safety Research Institute whose main objective will be to carry out and promote safety-related research and analysis in areas relevant to regulatory activities. There is synergy between design and engineering safety on the one hand and regulatory safety on the other and the regulator can, therefore, help the designer to speedily sort out complex problems. This has

happened under the present Chairman of the AERB, Prof. P. Rama Rao who will be completing his three year term next month and has already taken up the responsibility of the Vice-Chancellorship of the Central University at Hyderabad.

On 11<sup>th</sup> and 13<sup>th</sup> May 1998, we carried out tests of five nuclear devices of advanced designs. Since then, we have obtained rock samples at the test sites by drilling carried out by the Atomic Minerals Directorate for Exploration & Research through the emplacement points and nearby areas. Scientists from BARC have estimated the yields from the seismic and radioactivity measurements, and from analysis of the data from other close-in measurements carried out at the time of the tests. These have confirmed the initially declared yields for all the devices. A good deal of these measurements and analyses have already been published through articles in *Current Science* and *BARC Newsletter*. Though most seismic specialists from abroad have endorsed the success of the tests, there are sporadic attempts by one small group of so-called "experts" to question the yields of our tests. I am not sure whether this reflects deliberate disinformation or honest incompetence. One more fact is worth mentioning. In the IAEA General Conference, which concluded on October 01, 1999, there was hardly any reference to our nuclear tests, which would imply that the world has now recognised the reality of India as a Nuclear Weapon State.

Since its inception, our nuclear programme has been characterised by a holistic approach. Thus, while power generation is indeed a matter of priority, non-power applications of nuclear energy in areas such as medicine, agriculture and industry are given equal emphasis in our R&D programme. The Isomed Plant, the facility in Trombay for sterilisation of medical products operated by the Board for

Radiation & Isotope Technology (BRIT), has completed 25 years of successful operation and has been providing sterilisation service to medical industries in and around Mumbai. There are three other such units functioning in different parts of the country. Three units of Gamma Chamber 5000 have been supplied to Indonesia and Myanmar through the IAEA and to Egypt against open global tender.

We have an extensive network of aided institutions under the Department of Atomic Energy engaged in fundamental research and such research is also carried out in our main R&D units. At the Tata Institute of Fundamental Research (TIFR), a LINAC booster for the existing Pelletron Accelerator has been developed. The Giant Metre Radio Telescope of TIFR is already providing valuable astrophysical data and will be formally inaugurated soon. A 450 MeV Synchrotron Radiation Source (SRS) Indus-1 became operational at the Centre for Advanced Technology (CAT), Indore, in April 1999 and the first results from experiments with it are expected to be available by the end of the year. We have an abiding interest in fusion because of its potential for clean and safe power generation and have set up an experimental programme at the Institute for Plasma Research, Gandhinagar. The first indigenously built Tokamak ADITYA has been operational since 1989 and our second generation experiment, a steady state superconducting Tokamak, is currently under fabrication and is likely to be the first of its type in the world.

On the eve of the 90<sup>th</sup> birthday of our founder, Dr Homi Bhabha, and as we near the beginning of the next millennium, I would like to say that we should keep on working for enlarging the contribution of nuclear energy to peace, health and prosperity of the country. We should work for operationalising

simple and innovative technologies to lower the capital cost and to shorten the gestation period for construction of nuclear power plants, and to improve continuously the safety of all nuclear fuel cycle activities. We are considered by the people of this country as the torch-bearers of self-reliance – which I now define as immunity against technology denial. We are also considered as catalysts of high technology areas, directly or indirectly related to nuclear technology. We should strive – all in our own different ways – to improve the quality of life of the citizens of this country and to ensure national security so that India becomes a developed country in the broadest sense of the term.

Thank you.

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*(Director's address continued from page 3 ...)*

Development of Catalytic Recombiners, a system meant for mitigating the hydrogen related risks in an accident situation, has also reached an advanced stage. Different techniques for physical/chemical deposition of catalyst on substrates have been tried out with very encouraging results. What is now left is to choose one of them on the basis of techno-economic parameters and engineer a field usable product.

Technology contributions from BARC to the reactor units at Kaiga and Rajasthan cover several computerised control and instrumentation systems performing a wide variety of functions such as the plant protection, control of important processes and operator support functions. Programmable digital comparator system, dual processor hot standby process control system, dual processor hot standby reactor regulating system, PSS rod monitoring unit, channel temperature monitoring system, digital recording system, on-power refuelling machine control system, Supervisory Control and Data

Acquisition System (SCADA), radiation data acquisition system and a large variety of radiation monitoring instruments are some of the areas of important inputs from BARC. BARC has also supplied thoria pellets for purpose of power flattening during the initial stages of reactor operation. It is worth mentioning that our development of SCADA system is attracting a number of other agencies requesting for its supply or technology transfer.

In support of operating power stations, recently the vibration diagnostic technique was tried out with a larger shaker enabling further improvements. The improved INGRESS with its delivery system which can carry out garter spring relocation in wet channels of PHWRs as well as improved scrape sampling tool is in an advanced stage of testing. Fifth campaign of decontamination using BARC developed process was successfully carried out recently at Kalpakkam.

The programme of progressive introduction of MOX fuel in reactors at Tarapur is going on well. KAMINI reactor at Kalpakkam, a Uranium-233 based system designed in BARC, has reached its full power level of 30 kW. The mixed carbide fuel in Fast Breeder Test Reactor (FBTR) continues to perform extremely well. The year has also seen significant developments for the fuel for Prototype Fast Breeder Reactor (PFBR).

A major milestone was achieved in the radiation waste management programme with the inauguration of country's first Solid Storage Surveillance Facility (S3F) at Tarapur. India has thus become the fourth nation in the world to have such a hi-tech facility. The Waste Immobilisation Plant in Trombay is in an advanced stage of completion.



In the area of Isotope and Radiation Technology applications, the work on setting up of Food Irradiator for potatoes and onions is progressing well at Lasalgaon near Nashik. In order to promote radiation processing using industrial electron accelerators, 2 MeV Electron Accelerator is being shifted to Vashi, Navi Mumbai, and a new Electron Beam Centre is being set up at Kharghar in collaboration with SAMEER. Multi centric trials on phosphorus-32 coated stents for use in angioplasty procedures are yielding encouraging results.

Technology development is our strong point. Work on development of radiation shielding windows is progressing as per plan. A few old radiation shielding windows have been successfully refurbished.

Folded Tandem Ion Accelerator, an indigenously designed and fabricated system, is one of the few of its kind operating accelerators in the world. FOTIA is in final stages of commissioning. FOTIA will deliver light and heavy ion beams with a terminal voltage of 6 MV to be used in basic and applied research in Nuclear, Atomic and Material Science. The BARC-TIFR Pelletron Accelerator Facility which has now completed 11 years of successful operation has already made a large impact on the international scene by the research programme conducted at this facility. For adding a Superconducting Linac Booster to the Pelletron, 15 quarter wave resonators which are high technology items have been successfully fabricated in our Central Workshops. Work on the RF and control electronics towards realisation of Superconducting Linac Accelerators is also in progress at this Centre. Two Thermal Ionisation mass spectrometers have been built and are ready for delivery to the users.

The first phase of constricted arc plasma generator programme worked out in collaboration with the

Vikram Sarabhai Space Centre has been successfully completed.

Heat shrinkable shape memory alloy sleeves have been developed and are being supplied for the LCA Project. On the basis of BARC's support, ECIL has been awarded a contract for development of stabilised antenna platform for MMR of LCA.

Compact Electrolyzer for supply of oxygen has been developed for the Navy. The system is being repackaged to withstand the mechanical loading environment. Construction of 6300 MP/day Nuclear Desalination plant at Kalpakkam is progressing well.

ANUPAM supercomputer has been commissioned at the National Centre for Medium Range Weather Forecasting, Delhi, thus providing a successful alternative to currently used Cray X-MP dual processor resulting in considerable saving of expenditure on maintenance of the obsolete super computer. BARC supercomputer is able to execute the full suit of the weather forecasting programmes in comparable time. A supercomputer consisting of eight Pentium-III nodes connected through high speed switch has now reached a sustained speed of 2 giga flops. A web based remote monitoring and control system has been developed and a technology synergiser is soon to be launched to bring in greater interaction between researchers and users of research.

Technology for the synthesis of di-ethyl hexyl phosphoric acid, (D<sub>2</sub> EHPA) an important metal extractant in the organo phosphorus series, was transferred to Heavy Water Board. The process has now entered into commercial scale production at Talcher with very high product quality. Apart from fulfilling the need for this solvent, this effort has also lead to useful and productive programme for workers at HWP, Talcher.

The Pipe Inspection Gauge (PIG) system developed earlier in BARC has gone through successful trials at the test facility of Indian Oil Corporation at Faridabad, and is now ready for field trials in Barauni-Patna pipeline. Based on the success of this development, plans have been drawn up for building pipe inspection gauges for larger diameter pipelines.

Friends, what I have narrated above is not a comprehensive list of our achievements which indeed is very long. I wish to congratulate all of you for yet another very successful year of our achievements. We now should take higher strides and to enable that happen, we must augment our capability through strong linkages with our colleagues in academic institutions and other national laboratories. I am happy that efforts in this direction are also bearing fruits. The programme of our joint activity on thermal hydraulics studies related to Advanced Heavy Water Reactor (AHWR) as also the Centre for Software Verification and Validation are taking shape at IIT Mumbai. Our extensive linkages with various Agricultural Universities in Maharashtra, large scale component test work being done in the institutions like the Structural Engineering Research Centre, Chennai and Nuclear Engineering Programme with IIT Kanpur are some examples of new initiatives in this regard. I am sure, through these linkages, we will be able to add strength to our programme both in terms of extended resource as well as in terms of its quality.

Finally, I am sure all of you will agree with me that our strength lies in our excellent traditions in which we have been brought up and we have the onus of bringing up our younger colleagues. These traditions are a part of legacy Dr Bhabha has left for us. Let us all rededicate ourselves to the memory of

Dr Bhabha and to the programmes of this great organisation.

Thank you.



*Dr R. Chidambaram, Chairman, AEC, Dr A. Kakodkar, Director, BARC, and other senior officers of BARC appreciate Dr Bhabha's bust installed at the Central Complex Auditorium at BARC.*

## FOUNDER'S DAY LECTURE

Dr Homi Bhabha's love for Nature and his concern for the Environment is reflected in the gardens and plantations he thoughtfully and painstakingly nurtured in the institutions he built. They bear a testimony to his great sense of aesthetics.

Dr Mohindra S. Chadha, former Director, Biochemical Group, BARC, dealt with some of the issues related to environment in his lecture, "Chemical Research and Environmental Needs." His lecture highlighted the impact of growing population, increasing pollution, decreasing availability of water, and shrinking of natural sinks for containment of chemical pollutants. The menace of pollutants generated by chemical and related industries and growing use of fossil fuels for energy requirements





*Dr Anil Kakodkar, Director, BARC, greets Dr M.S. Chadha, former Director, Biochemical Group, BARC, before the latter delivered the BARC Founder's Day Lecture.*

and the impact of human, animal and municipal waste on the environment and human health were discussed. Some possible remedies based on both chemical and biological research were presented. The role which biotechnology can play in solving environmental problems was discussed. Specific references were made to the development of environmentally benign strategies for pest management.



*Dr R. Chidambaram, Chairman, AEC, releases the Special Issue of 'BARC Newsletter' on the Founder's Day.*

Prior to the Founder's Day lecture, Dr R. Chidambaram, Chairman, AEC, released the special issue of *BARC Newsletter* which was brought out as a homage to Dr Homi Bhabha and

which contains some of the research papers that won various awards.

## CHAIRMAN PRESENTS DAE AWARDS TO STAFF

The Department of Atomic Energy (DAE) instituted an Award scheme in the year 1993 for Scientific and Technical Excellence to recognise meritorious achievements, for nurturing excellence and for fostering creativity among the members of the DAE staff who are engaged in Research, Development and Engineering in the frontiers of Science & Technology dedicated to the development of the nation.

The Award scheme consists of three categories of awards.

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

These awards are given annually.

1. **Homi Bhabha Science & Technology Award** for 1998 is the highest among the three awards. It consists of : (a) a citation, (b) a medal, and (c) a cash award of Rs 50,000/- and is given to two members of staff from this year.

This award is given to an Engineer/Scientist who has made outstanding contributions towards the advancement of science and/or technology based on original research in the frontier areas of science or frontline development in engineering and

technology which would reflect excellence commensurate with national/international standards. This year the award was given to :

- (i) Dr P.K. Gupta of Laser Biomedical Applications Section, Centre for Advanced Technology, Indore.
  - (ii) Dr B.N. Jagatap of Laser and Plasma Technology Division, Bhabha Atomic Research Centre, Mumbai
- (i) **Dr P.K. GUPTA** was conferred the Homi Bhabha Science & Technology Award for the year 1998 for his valuable contributions to the area of biomedical applications of lasers.



Dr P.K. Gupta receiving the Homi Bhabha Science & Technology Award, 1998, from Dr R. Chidambaram, Chairman, AEC

A major achievement of Dr P.K. Gupta relates to the demonstration of the efficacy of the use of autofluorescence spectroscopy from human tissue for cancer diagnosis. Using this system developed by him, Dr Gupta has carried out *in-vitro* studies on autofluorescence from human tissues, from different organs and has obtained an excellent discrimination in respect of malignant and benign tumors and normal tissues. His work has led to the development of a prototype system for clinical use and to the initiation of preliminary *in-vivo* studies.

Dr Gupta and his colleagues have conducted studies on narrow band width light effects on cellular cultures and animal models with a view to elucidating the rather intriguing therapeutic effects of low level laser irradiation reported in several clinical studies. They have observed Nitrogen ( $N_2$ ) laser dose-dependent changes in the proliferation of the cells in the epidermal layer of the skin of albino rabbits. Their studies have indicated that the increased proliferation observed at certain doses may be one of the mechanisms contributing to the clinical observation of faster wound healing following Nitrogen ( $N_2$ ) laser irradiation.

Apart from his work on the biomedical applications of lasers, Dr Gupta's contributions include the development of a single mode frequency stabilised continuous wave carbon dioxide laser, investigations on its power tuning characteristics and the operation of a far-infrared laser in the spectral range of 80-90 $\mu$ m using ammonia ( $NH_3$ ) as the active medium. He proposed and demonstrated the feasibility of a method based on difference frequency generation of a frequency doubled  $NH_3$  laser and a  $CO_2$  laser for generating coherent radiation tunable around 16  $\mu$ m needed for the isotopic enrichment of Uranium.

Dr Gupta has been the first to develop a theoretical analysis for the  $NH_3$  laser and for the periodic and chaotic pulsations observed in the Raman  $NH_3$  laser output.

(ii) **Dr B.N. JAGATAP** was conferred the Homi Bhabha Science & Technology Award for the year 1998 for his notable contributions to a number of areas of laser physics and spectroscopy.

Dr B.N. Jagatap has carried out extensive research — theoretical as well as experimental, on a wide spectrum of problems pertaining to areas such as



*Dr B.N. Jagatap receiving the Homi Bhabha Science & Technology Award, 1998, from Dr R. Chidambaram, Chairman, AEC*

quantum optics, laser spectroscopy, photoionisation physics, collision physics, intense field laser-atom/molecule interactions, laser contract of atomic and molecular processes and laser cooling and trapping of atoms. At the basic level, his work has unravelled many a new and important aspect of laser-atom and laser-molecule interactions. At the applied level, his work has been very significant with regard to laser selective processes for high value materials.

Dr Jagatap's work on the spectroscopy and separation physics for U-233 clean-up bears the distinction of being the first detailed work on this subject. This work has generated the first ever spectroscopic data base for the U-233 system and has opened up newer possibilities on high resolution spectroscopy of the higher actinides and highly radioactive materials. This work is also extremely relevant to the Thorium utilisation programme of Department of Atomic Energy. Dr Jagatap's simulation work on laser polarisation induced population trapping in the even isotopes of zirconium has been of considerable significance with regard to the denaturing of this element. Since the isotope shifts in this system are extremely small, it is very difficult to employ the usual atomic vapour laser isotope separation (AVLIS) process for this separation task. Dr Jagatap's work has provided an

alternative approach for introducing the requisite selectivity in this process. He has also made commendable contributions to the identification of strategies for atomic vapour diagnostics and AVLIS process characterisation. The importance of these studies lies in the optimisation of throughputs, enrichment factors and recovery.

Dr Jagatap's research has had an impact on various areas of atomic, molecular and optical physics. His work has provided one of the first evidence of the fact that non-classical effects can be exhibited by macroscopic quantum systems and also a complete description of the statistics of photon emission from atoms interacting with squeezed vacuum. His spectroscopic experiments have not only been useful in high resolution Doppler-free spectroscopy but also in understanding velocity changing collisions through the most general spectral line shape. The high performance computing of exact intense field interactions developed by Dr Jagatap at BARC has made possible investigations on super-intense laser-atom/molecule physics, making BARC one of the few institutions in the world to be involved in this frontline activity.

2. The second category of the awards is the **Technical Excellence Award** for 1998. This award is conferred on an Engineer/Scientist who has made outstanding contributions and/or ideas or special efforts towards :

- (a) Development of a new or improved equipment, machine, material, process or device with proven results meeting the immediate user requirements or futuristic needs or bringing credit to the respective unit and/or leads to import substitution, transfer, etc.
- (b) Practical constructive ideas/suggestions leading to better utilisation of human resources, materials, processes, devices, etc., resulting in higher

efficiency and significant financial saving to the government ; and/or

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

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

The Award consists of : (a) a citation, (b) a medal, and (c) a cash award of Rs. 20,000/- (this amount was Rs. 10,000/- last year.)

The number of awards this year is two. This year the award was given to :

(i) Dr P.K. Vijayan of Reactor Engineering Division, Bhabha Atomic Research Centre, Mumbai.

(ii) Dr D.P. Fulzele of Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai

(i) **Dr P.K. VIJAYAN** was conferred the Technical Excellence Award for the year 1998 for his outstanding contributions to the area of heat transfer and fluid flow pertinent to nuclear reactor systems.



*Dr P.K. Vijayan receiving the Technical Excellence Award from Dr R. Chidambaram, Chairman, AEC*

Natural coolant circulation has an important bearing on the cooling of nuclear reactor cores but one of the major problems in understanding the behaviour of natural circulation in closed loops is the lack of generally acceptable scaling laws which are non-loop-specific. Dr Vijayan has proposed a scaling law for single-phase natural circulation loops that contain just two independent physical similarity groups. Testing this scaling law with the available data on single-phase natural circulation has validated it in a convincing manner. He has also been able to extend this scaling law to the stability behaviour of single-phase natural circulation loops. His work is frequently cited by researchers in this area as a very significant contribution.

Dr Vijayan has played a key role in the thermal-hydraulic design study of the Indian Advanced Heavy Water Reactor (AHWR) which is a natural circulation based boiling water reactor aimed at utilising the vast reserves of Thorium in the country. He has developed computer codes for predicting the steady state, transient and stability behaviour of AHWR and has set up a high pressure natural circulation loop to validate these computer codes.

Another major contribution of Dr Vijayan pertains to the development of the Facility for Integral System Behaviour Experiments (FISBE) which has recently been commissioned and is the only integral test facility outside Canada to simulate CANDU type PHWRs. It is provided with state of the art instrumentation and data acquisition system to carry out Loss of Coolant Accident (LOCA) and non-LOCA transient experiments. His work on natural circulation in figure-of-eight loops has been very important in relation to the assessment of the thermosyphon capability of PHWRs which has been

demonstrated in the course of the thermosyphon tests in NAPS unit-I.

(ii) **Dr D.P. FULZELE** was conferred the Technical Excellence Award for the year 1998 for his eminent contributions to bioreactor technology and tissue culture of medicinal plants.



*Dr D.P. Fulzele receiving the Technical Excellence Award from Dr R. Chidambaram, AEC*

Bioreactors provide an opportunity to grow plant cells under closely controlled nutritional and environmental conditions and to manipulate them to produce desired bioactive compounds. Dr Fulzele has very successfully made use of different types of bioreactors for growing appropriate plant cells for the production of bioactive compounds such as anti-cancer, anti-AIDS and anti-malarial drugs. He has also been involved in the design and development of bioreactors for cell, organ, embryo and plantlet culture used in biomass multiplication and product biosynthesis. He has designed the first indigenous helix impeller for 50 and 100 litre bioreactors with a view to achieve good growth and production of cell cultures with proper mixing and adequate oxygen supply. In addition, he has developed several important on-line connections for bioreactors to avoid contamination while sampling.

A memorandum of understanding has been signed between BARC and M/s. Kabra Drugs Ltd., Indore,

for the transfer of bioreactor technology for large scale cultivation of plant cell cultures for the production of bioactive compounds. In this connection, Dr Fulzele has set up a bioreactor laboratory at Indore containing all infrastructure facilities for 50 and 100 litre bioreactors which will be equipped with the helix impellers designed by him. These bioreactors will be compatible with fed-batch, continuous, double stage, semi-continuous and batch operation modes.

3. The third category of the award is the **Meritorious Service Award**. This award is conferred on an employee with a minimum continuous service of 20 years who exhibits 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) a citation, (b) a medal, and (c) a cash award of Rs. 10,000/- (This amount was Rs. 5,000/- last year). The number of awards this year is six.

This year the award was given to :

- i. Mr M.C. Patil of Library & Information Services Division, BARC
- ii. Mr M.S. Pawar of Food Technology Division, BARC
- iii. Mr Pascol M. Gonsalves of Radiation Biology Division, BARC
- iv. Mr M. Kuppuswamy of Materials Science Division, Indira Gandhi Centre for Advanced Research, Kalpakkam
- v. Mr K.V. Radhakrishnan of Central Workshop, Indira Gandhi Centre for Advanced Research, Kalpakkam



vi. Mr Mahaddalkar of Reactor Services and Maintenance Division, BARC

i. Mr M.C. PATIL was conferred the Meritorious Service Award for the year 1998 for his commendable proficiency in library and publication services related duties.



Mr M.C. Patil receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC

Mr M.C. Patil is well reputed for his involvement with some of the important publication services related duties. He has demonstrated exceptional skill in rectifying a number of electrical and electronic circuitry based facilities in use for library and information services and putting them back in order and making them functional. He has been instrumental in setting up a modern automatic colour photography laboratory. In addition, his capable and constructive involvement with the various aspects of the mechanics of publication deserves a special mention.

ii. Mr M.S. PAWAR was conferred the Meritorious Service Award for the year 1998 for his creditable work in the field of food and biotechnology.

Mr Pawar has gained mastery over laboratory techniques relevant to food science and technology, biochemistry and food biotechnology. He has acquired a high level of proficiency in techniques

pertinent to protein isolation, purification and characterisation, enzyme kinetics studies, development of fishery and meat products and



Mr M.S. Pawar receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC

toxicological evaluation. He has displayed exceptional operational skills in respect of a number of specialised laboratory equipment and has established himself as an asset to the laboratory he is working in.

iii. Mr PASCOL M. GONSALVES was conferred the Meritorious Service Award for the year 1998 for his excellence in carrying out laboratory duties.



Mr Pascol M. Gonsalves receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC



Mr Gonsalves has acquitted himself very creditably in learning several surgical techniques on animals. He has acquired commendable skills in the preparation of several types of microbiological media, buffers, and other solutions which the laboratory needs. In addition, he has given an excellent account of himself in the operation of diverse laboratory facilities such as autoclaves, high-speed centrifuges, ultrasonicator and electronic balances. All told, Mr Gonsalves has demonstrated his capabilities in carrying out wide ranging duties in the laboratory.

iv. Mr **M. KUPPUSWAMY** was conferred the Meritorious Service Award for the year 1998 for his dedicated involvement with the operation and maintenance of cryofacilities.



*Mr M. Kuppuswamy receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC*

Mr M. Kuppuswamy has displayed exceptional skills and capabilities in operating and maintaining cryofluid plants - especially the liquid nitrogen facility and also the liquid helium facility at Kalpakkam. It is largely through his meticulous efforts, his devotion to duty and his willingness to shoulder responsibility that these extremely important facilities have performed remarkably well even under difficult conditions. His efforts have been crucially important

in keeping the plants running with minimal down time and in avoiding expensive and time consuming repairs.

v. Mr **K.V. RADHAKRISHNAN** was conferred the Meritorious Service Award for the year 1998 for his excellent skills pertaining to machining operations.



*Mr K.V. Radhakrishnan receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC*

Mr K.V. Radhakrishnan has contributed extensively to the machining of several precision components with very close tolerances for a number of important FBTR and other projects and facilities of IGCAR. As some typical examples of the machining of FBTR components, mention may be made of the fuel handling channel for the bottom part guide ring, control rod drive mechanism, convergent and divergent nozzles, deephole thermowell, and sodium pump fly wheel rectification part. Mr Radhakrishnan has displayed outstanding craftsmanship, talent and ingenuity while handling these varied kinds of demanding machining jobs.

Any workshop would be proud to have someone of the calibre of Mr Radhakrishnan among its staff.

vi. Mr I.D. MAHADDALKAR was conferred the Meritorious Service Award for the year 1998 for his creditable contributions to Process Instruments Maintenance.



*Mr I.D. Mahaddalkar receiving the Meritorious Service Award from Dr R. Chidambaram, Chairman, AEC*

Mr I.D. Mahaddalkar had made significant contributions to the areas of installation, commissioning, maintenance, trouble shooting, and modification of process instrumentation systems. Among the different types of facilities he has been associated with, special mention may be made of in-pile loops, wet storage bag, moderator dump system, channel monitoring system, and failed fuel detection system, each having its own unique methods of measurement and control. He has given an excellent account of himself with regard to the rectification of DP gauges used in the flow monitoring system of Dhruva Reactor. This work demanded a great deal of application and skill and Mr Mahaddalkar met the challenge in full measure with exceptional proficiency.

## XI<sup>TH</sup> ALL INDIA ESSAY CONTEST IN NUCLEAR SCIENCE AND TECHNOLOGY

An All India Essay Contest was conducted for the eleventh successive year by the DAE in order to create awareness about nuclear science and technology among the undergraduate students. This year the two topics for the essay contest were :

- (A) "Progress & Prospects of Indian Nuclear Power and Non-Power Programmes", and
- (B) "An Important Scientific / Technological Discovery of the Century"

The contest was open to all regular undergraduate students. Essay could be written in any official Indian language or English. These essays were evaluated by two different panels comprising of scientists and engineers of BARC, NPCIL, BRIT and AERB.



*Dr R. Chidambaram, Chairman, AEC, with winners of the All India Essay Contest in Nuclear Science & Technology*

The writers of the top thirty seven essays were invited to Mumbai to make oral presentations of their compositions in twenty minutes before a panel of about six judges comprising of senior scientists and engineers drawn from DAE organisations. The judges then probed for ten minutes on various points made in their presentations. The top three prize winners were selected based on the combined performance in the written and oral versions.

On 29<sup>th</sup> October, 1999, Dr R. Chidambaram, Chairman, AEC, distributed the prizes to the following contestants :

*Prize Winners : Topic A - "Progress & Prospects of Indian Nuclear Power and Non-Power Programmes"*

- First Prize* : Anup Lohiya, II<sup>nd</sup> year B.Sc.,  
(Rs. 5,000/-) Amravati, English
- Second Prize* : D. Khanna, II<sup>nd</sup> year B.Sc.,  
(Rs. 3,000/-) Tiruchandur, English
- Third Prize* : Amar Kulkarni, II<sup>nd</sup> year B.Sc.  
(Rs. 2,000/-) Ratnagiri, Marathi

*Prize Winners : Topic B - "An Important Scientific / Technological Discovery of the Century"*

- First Prize* : Kum. Rashmi Kulkarni, I<sup>st</sup> year  
(Rs. 5000/-) B.Sc., Bangalore, English, "DNA"
- Second Prize* : Kum. K. Sahanbanu, III<sup>rd</sup> year  
(Rs. 3,000/-) B.A., Bhavnagar, Gujarathi,  
"Computers"
- Third Prize* : P. Thirumalaisamy, II<sup>nd</sup> year  
(Rs. 2,000/-) B.Sc., Coimbatore,  
Tamil, "Satellites"

In addition to the above prize-winners, there were several consolation prize winners.

## PRESIDENT OF VIETNAM VISITS BARC

His Excellency Mr Tran Duc Luong, President of the Socialist Republic of Vietnam, visited BARC on December 4, 1999. He was received at BARC by Dr R. Chidambaram, Chairman, AEC, and Dr Anil Kakodkar, Director, BARC.



Dr R. Chidambaram, Chairman, AEC, and Secretary, Department of Atomic Energy, welcoming H.E. Mr Tran Duc Luong, President of the Socialist Republic of Vietnam.

The President and the high level delegation accompanying him visited the Dhruva reactor.



H.E. Mr Tran Duc Luong, President of the Socialist Republic of Vietnam, and his delegation seen with Dr R. Chidambaram, Chairman, AEC, and Dr Anil Kakodkar, Director, BARC

The Socialist Republic of Vietnam has an ambitious programme for the utilisation of atomic energy. A good number of Vietnamese scientists and engineers are receiving training at BARC and other DAE establishments.

## BARC EXPORTS TL DATING PROGRAM

Nuclear Research Laboratory of BARC took up the development of a computer program for the development of a computer program for Thermoluminescence (TL) dating called TLDAT. The software, with built-in capabilities for data processing, data plotting, plateau identification, paleo-dose, annual dose and age estimation, accepts raw data in various formats of temperature and glow curve intensity. A number of noise removal options like averaging, low/high pass and minimum/maximum filtering, etc. are provided alongwith the conventional black body background subtraction. This program was developed by Dr D.K. Koul, BARC and Mr H.S. Vora, CAT. This work was published in three journals, viz., (i) *Appl. Radiat. & Isot.*, 45, 12 (1994) (Author : D.K. Koul), (ii) *Computers and Geosciences*, 21, 3(1995) Authors : D.K. Koul and C.L. Bhat, and (iii) *Ancient TL*, 15, 17(1997) (Authors: D.K. Koul, H.S. Vora, R. Koul and C.L. Bhat). After studying these papers, City University of Hongkong requested for this program. After making the software custom oriented, it was exported in the form of a CD-ROM in February, 1999. TLDAT, though developed for age estimation, can also be used for other applications like TL dosimetry.

## LOW-LEVEL RADIATION RESEARCH LABORATORY AT KOLLAM INAUGURATED

Dr Anil Kakodkar, Director, BARC, inaugurated the new building of Monazite Survey Project (MSP) on September 4, 1999 at Kollam, Kerala, and named it Low-Level Radiation Research Laboratory. Dr (Mrs.) A.M. Samuel, Director, Bio-Medical Group, BARC, presided over the function which was attended among others by former Director, Health Services, Kerala State, collaborating staff from state health department, senior executives of IRE, Kollam and Chavara, students and professors of University of Kerala and other distinguished invitees.



*Dr Anil Kakodkar, Director, BARC, inaugurating the new building of Monazite Survey Project at Kollam, Kerala*

Dr K.B. Sainis, Head, Cell Biology Division, BARC, welcomed the Chief Guest and other dignitaries. Dr P.S. Chauhan, former Head, CBD, and Project Manager, MSP, reviewed the history of the Monazite Survey Project and outlined the currently progressing investigations such as those related to congenital malformations in newborns in the population from high background radiation areas (HBRA) and normal background radiation areas

(NBRA), cytogenetic studies on adults and newborns, dosimetry, demographic survey for late onset diseases and recently started studies on germline DNA mutations and genetic polymorphism. He also elaborated on the future research goals of MSP.

Dr (Mrs.) A.M. Samuel, Director, BMG, emphasized the importance of research opportunities provided by this "nature's experiment" to study the effects of low level continuous irradiation on human population living in these areas for several generations and centuries. She was happy that these studies will now become a regular research activity of BARC under the banner of LLRRL. She also acknowledged the co-operation of IRE, Regional Cancer Centre, Trivandrum, and others and assured to strengthen these ties.

Dr Anil Kakodkar, Director, BARC, in his inaugural address appreciated the importance of the studies being carried out at MSP and their significance to people of the monazite belt. He also emphasized that the facilities at MSP (LLRRL) should be continuously updated so that people from other centres in the country will be encouraged to interact with BARC scientists to seek answers to the basic biological questions pertinent to the exposure of human population to continuous low level radiation. Comprehensiveness has to be accomplished in all the studies including dosimetry. He also felt that encouragement must be given to Universities and state level institutions to interact with our scientists and take up relevant projects through agencies such as BRNS. He desired that LLRRL should become a unique centre for research in this area of life sciences and health sciences.

Mr M.V. Thampi, Officer-in-Charge, MSP Laboratories, Kollam, proposed a vote of thanks.

Dr Kakodkar was shown the various facilities at LLRRL by Dr M. Seshadri, Project Manager, MSP.

## FORTHCOMING SYMPOSIA

■ The fifth biennial "Trombay Symposium on Radiation and Photochemistry" will be organised at BARC during January 12-17, 2000 under the auspices of the Board of Research in Nuclear Sciences, Department of Atomic Energy, in collaboration with Indian Society for Radiation & Photochemical Sciences. The scientific sessions include invited talks, in-depth discussions and poster presentations of contributed papers, broadly covering the following topics: Ultrafast processes; Solvation dynamics; Charge, electron and energy transfer processes; Excited states, ionic intermediates and free radical processes; Multiphoton excitation, ionisation and vibrational photochemistry; Gas phase photochemistry and dynamics; Industrial applications of radiation and photochemistry; Photo & Radiation chemistry in organised and microheterogeneous media; and Radiation & Photochemical studies on nanoparticles.

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■ Board of Research in Nuclear Sciences (BRNS) of the Department of Atomic Energy (DAE) is organising a "National Symposium on Water and Steam Chemistry in Power Plants and Industrial Units" (SWASCH-2000) in collaboration with Indian



Institute of Chemical Engineers (Mumbai Regional Chapter) at BARC, Mumbai, during February 23-25, 2000. The symposium will cover a wide range of topics related to the water and steam chemistry of relevance to power plants (nuclear and thermal), heavy water plants and the industrial units employing boilers. The scientific sessions will include invited lectures, contributed papers and poster presentations.

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Email: nmgupta@magnum.barc.ernet.in

## BARC SCIENTISTS HONOURED

• Dr M.K. Totlani of Materials Processing Division, BARC, has been selected to receive the "Corrosion Awareness Promotion Award" for the year 1998-99 by N.A.C.E. (National Association of Corrosion Engineers) International, India Section. The award was given in recognition of Dr Totlani's excellent research contributions in corrosion prevention, corrosion protection, corrosion management and corrosion awareness. Many of his developments in the field have been successfully applied in DAE programmes.

The award carries a plaque and Rs. 10,000/- in cash.



- Dr Satish C. Gupta of High Pressure Physics



Division, BARC, has been chosen to receive the Materials Research Society of India (MRSI) Medal for the year 2000 in recognition of his outstanding contributions to materials research with shock waves. The gas-gun instrument developed by him for materials research at high stresses and ultra high strain rates is a unique facility in the country. The award will be presented during the annual general meeting of MRSI to be held at Baroda during February 2-5, 2000.

- Dr Sudhir R. Jain, Theoretical Physics Division,

has received the "Anil Kumar Bose Memorial Award, 1999" for his work relating to geometric phases and response functions. This award is given by the Indian National



Science Academy (INSA) every year in Physical Sciences to a scientist of age upto 37 years. The award includes a medallion and a token amount of Rs. 1,000/- . After the award function, held at the INSA premises in New Delhi, Dr Jain was received by the President of India, Hon'ble Dr K.R. Narayanan. Dr Jain had received the INSA medal for young scientists in 1994 in the field of Physics. He works in the general area of "physics of complex quantum systems".

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

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