Founder's Day Address 2025 by Director BARC

Respected Chairman AEC & Secretary DAE, distinguished guests, senior colleagues of the DAE family, ladies and gentlemen,

It is a matter of great privilege and deep honour to welcome you all on the occasion of the 116th birth anniversary of Dr. Homi Jehangir Bhabha, the visionary founder of this great institution.

Dr. Bhabha, the scientist of extraordinary brilliance, was a nation-builder who foresaw the transformative potential of atomic energy at a time when India was still taking its first steps toward scientific self-reliance. Guided by his vision, foresight, and dedication to progress, Dr. Bhabha established this Centre, which has since evolved into a beacon of innovation, excellence, and national pride.

As we gather today to pay tribute to our founder, we also reaffirm our collective resolve to carry forward his legacy with renewed vigour, creativity, and zeal. The challenges and opportunities before us call for the same spirit of vision, scientific curiosity, and self-confidence that Dr. Bhabha personified.

Our multi-disciplinary programmes have advanced steadily, encompassing fundamental and applied research, reactor and fuel-cycle technologies, advanced materials, accelerators, and radiation applications for healthcare, agriculture, water management, and industry. These collective efforts reflect the strength and depth of our scientific community and the enduring relevance of Dr. Bhabha's philosophy of self-reliance and innovation.

It gives me immense pleasure to share some of the significant accomplishments under various verticals of our mandate achieved during the year that exemplify our continued pursuit of excellence.

A. Let me begin with the primary mandate of BARC i.e. nuclear reactors and fuel cycle.

During last one year, our research reactors Dhruva and Apsara-U, continued to operate safely with desired availability factor. Critical facility was

operated on 67 occasions. Among other activities, the reactors were used for irradiation of a total of about 500 samples for fulfilling the requirements of radioisotopes for medical and industrial use, testing of several nuclear detectors, activation of many samples & foils, worth measurement of indigenously developed hafnium plates, testing of Gamma Compensated Ion Chambers (GCIC) for TAPS-1, power range monitors, start-up instrumentation system manufactured for RAPP- 8, irradiation of antimony pin assembly for fabrication of start-up source for TAPS-1&2 and Integral experiments were conducted with Molten Salt Reactor fuel to validate theoretical estimates.

For post irradiation examination, detailed metallography examination, fracture toughness, DHC velocity measurement and flaw characterisation of irradiated pressure tubes from PHWRs were carried out. Detailed post irradiation examination of Re-circulation pipeline from TAPS-1 was also carried out. The outcome was useful for life assessment and quantification of internal safety margins of reactor components.

Among others activities, 10 Photo Neutron Source Assemblies for TAPS 1 & 2 were fabricated and delivered.

An integral test facility 'CONSIST' (CONtainment System Integral Simulation Test) has been recently commissioned at Tarapur for safety studies on containment thermal-hydraulics. The facility will be useful for the design validation of upcoming PWRs.

The continued research reactor operations were enabled by regular fuel fabrication and delivery for fuel for Dhruva, Apsara-U and FBTR. Indigenously developed uranium silicide dispersion fuel has proven its robust performance in Apsara-U with burn-up level of 55000 MWD/Te. Fuel Fabrication Plant at Tarapur continued to fabricate fuel elements for Prototype Fast Breeder Reactor at designated capacity. Fabrication of LEU target plates for Fission Molly plant was also continued. Targets were irradiated at Dhruva for production of fission moly as per requirement.

For augmenting the Dhruva fuel production, a 1600 MT Extrusion Press has been installed & commissioned. At Dhruva reactor an on-power irradiation facility for fission moly was designed and tested for enhancing production.

Reprocessing and waste management facilities at Trombay, Tarapur and Kalpakkam have continued to operate efficiently, maintaining high standards of safety, sustainable throughput, and radiological control.

Vitrification plants have made remarkable strides. The hot commissioning of the new vitrification unit, AVS-3 at Tarapur, which incorporates advanced off-gas treatment, was successfully completed. Roll-in-roll-out concept for Joule melter was incorporated.

Intermediate Level Waste treatment in WIP-Kalpakkam achieved a record throughput, Zr-Hull decontamination was demonstrated in pilot scale using advanced decontamination system. Tc-99 recovery from nuclear waste was demonstrated in pilot plant scale.

An Organic Liquid Waste Incineration System was successfully erected and hot commissioned at ETP for the management of spent solvents originating from high level liquid waste partitioning and contaminated oils from radiological facilities.

Titanium-alloy based heat exchangers with enhanced corrosion resistance were designed and five of them were fabricated indigenously and delivered to backend facilities as an alternate to SS 304L Thermosyphon evaporators.

In continued pursuit of intensification of nuclear chemical processes, a pulsed disc and doughnut based solvent extraction pilot-plant was successfully demonstrated for uranium refining in the front-end meeting the design intents of capacity, uranium recovery and purity.

Synthesis of strontium selective crown ether has been successfully demonstrated. The product is an import substitute having crucial application in recovery of Sr-90 from HLW for application to radio-medicine and for radioactive heat source.

Neutron Well Coincidence Counter with He-3 neutron detector, FPGA based electronics and interfacing software has been developed.

An Indigenously developed Thermal Ionisation Mass Spectrometers was installed and commissioned for precise isotopic ratio measurements of spent nuclear fuel.

Among the upcoming research reactors, the design of Isotope Production Reactor (IPR) has been completed. It is a dedicated facility to primarily produce medical radioisotope and special isotopes for India’s self-reliance by substituting imports and producing advanced isotopes for future nuclear medicine applications. The project has been granted in-principle approval and proposal for administrative and financial sanction is in advanced stage for its setup at BARCF, Visakhapatnam.

Similarly design of High Flux Research Reactor (HFRR) has been completed. Activities will commence soon at the site. This reactor will deliver thermal neutron flux five times higher than current reactors to meet rising demand of neutron beam research.

Another small reactor of 30 kW is being designed for medical applications. It is a LEU-fuelled reactor with natural convection cooling by light water for Boron Neutron Capture Therapy (BNCT) which will require less frequent refuelling. Reactor building layout is complete and DPR preparation is underway.

BARC is also designing small modular demonstration reactors for power production. The lead unit of Bharat Small Modular Reactor (BSMR-200) will be established jointly with NPCIL in a DAE site. Several technology development experiments have been performed. Similarly, work is also progressing at high pace for SMR-55. In-principle approval has been received for both of these projects.

Further, an indigenous High Temperature Gas Cooled Reactor (HTGCR) is being developed to deliver process heat at ~650 °C for hydrogen production by in-house developed copper-chlorine thermocycle. The reactor will use LEU fuel, CO_2 coolant, and graphite as moderator. This reactor marks a step toward non-electric power applications of nuclear energy.

In the area of fuel fabrication, construction activities of new plants continued at Fuel Fabrication Facility (FFF)- Tarapur for U-Pu Mox fuel, at TL-1,2& 3 at BARC- Vizag for metallic & carbide fuel and Fuel Fabrication Plant at Kalpakkam for U-Pu Mox fuel from PFBR.

Construction activities at New recycle and nuclear waste management plants, INRP-I at Tarapur, FRFCF at Kalpakkam continued at desired pace. Activities towards process system erection at Nuclear Waste management laboratory TL-7 are also moving at desired pace.

BARC Safety Council commemorated its illustrious journey of 25 years in successful regulation of BARC facilities. During the year, BSC granted 72 regulatory clearances and published two new safety documents.

B. BARC has a strong programme on accelerators with multiple accelerators in operation. During last year

Proton acceleration of up to 2 Million electron Volt has been demonstrated using Terawatt laser facility in BARC with Thomson parabola spectrometer for detecting ion acceleration.

During last one year, the BARC-TIFR Pelletron-LINAC Accelerator facility was used for a total of 41 experiments by users from DAE and non-DAE institutions. In a recent study, “polar” and “equatorial” near-scission protons have been observed in heavy-ion induced fission reactions for the first time.

Table-top electron acceleration of upto 4 MeV was demonstrated using a 200 TW laser system through laser–matter interaction. Acceleration was quantified using electron spectrometer, designed and fabricated in-house.

As an in-kind contribution to Fermilab’s project of Proton Improvement Plan II (PIP-II), BARC had earlier delivered a large capacity (2 kW at 2 K) custom built helium refrigerator consisting of cold box and helium compressors to Fermilab, USA. Presently, the 2 K helium refrigeration system is undergoing installation and commissioning at Fermilab site.

C. There are several non-power applications of nuclear energy such as crop variety improvement, food preservation, water purification and treatment and health care. There were very promising developments in this area during last one year.

Beginning with the agriculture and food preservation,

An early-maturing variety of sorghum developed by BARC and University of Agricultural Sciences, Raichur having higher grain yield and disease resistance has been gazette notified and released for the farmers of Karnataka.

First mutant banana variety of India, TBM-9, developed in collaboration with National Research Centre for Banana, Trichy, was released and Gazette notified. TBM-9 has a dwarf stature and shorter crop duration, it is lodging resistant and requires no propping/staking. Notably, this is the 72nd crop variety released by BARC.

Six of our previously released oilseed varieties were gazette notified for extending the area of cultivation to additional states.

Three mustard varieties and one ground nut variety developed by BARC have been included in the National Mission on Edible Oil- Oilseeds.

Five Trombay Aestivum Wheat genotypes have been selected by ICAR-AICRP as parents in national crossing programs to develop high-yielding wheat lines across the country.

For the year 2025-26, Department of Agriculture and Farmers Welfare, Government of India, has received a breeder seed demand of 2,450 quintals for two Trombay Groundnut varieties, which now constitutes 9.7% of the entire breeder seed indent for the groundnut crop in India.

During 2024-25, the Maharashtra State Seeds Corporation Ltd., Akola (Mahabeej), has produced and sold ~17,290 quintals of BARC seed varieties as certified seeds to farmers.

With the addition of a new food irradiation facility this year, the total food irradiation facilities in the country have reached to 31 which include 7 in the government sector.

In health care sector

Production, processing and supply of radioisotopes in the form of suitable radiochemical formulations continued. About 1865 Ci of radioisotopes were produced and processed for use in human healthcare, among which Lu-177 (965 Ci) and I-131 (847 Ci) were the major isotopes.

In pursuance of the philosophy of “Wealth from Waste”, recovery of Cs-137, Ru-106 and Sr-90 for societal applications were continued. Supply of in-house produced carrier free radio-pharmaceutical grade Y-90 to RMC was also continued.

Sixteen ready-to use doses of Yttria-90-Alumino-Silicate glass microspheres (BhabhaSphere) were formulated and supplied to various hospitals for treatment of inoperable liver cancer. Yittrium-90 labelled skin patches were supplied to multiple hospitals for the treatment of Keloid patients, while the supply of iodine-125 brachytherapy sources was continued for the treatment of ocular cancer.

Five new diagnostic studies have been initiated in RMC— four with Ga-68 based advanced PET-CT tracers and one with ^{99m}Tc based SPECT-CT tracer.

It has been a continuous endeavour to improve the health care facilities for DAE employees. Over the past year, infrastructure at BARC hospital has been strengthened to enhance patient care. Modern operation theatre complex, equipped with advanced surgical facilities, including the ability to perform complex cardiac procedures, has been

commissioned. The 17-bedded Intensive Cardiac Care Unit is now catering not only to patients with critical cardiac conditions but also those with respiratory failure, sepsis, and multi-organ dysfunction syndrome. The Artificial Kidney Dialysis Unit with 8 beds is providing in-house dialysis services for patients with end-stage renal disease. The Surgical Intensive Care Unit with 7 beds is commissioned to manage complex post-surgical cases.

D. Directed basic research is the corner stone of future development. During last year, there were some significant developments in this area.

Indian Environmental Radiation Monitoring Network (IERMON) has been expanded with installation in all the 28 States and 8 Union Territories of the Country, with total of 556 installations in 105 cities.

Certified Reference Material of Ferrocarbonatite for 6 major and 13 rare earth elements has been developed in collaboration with AMDER, Hyderabad for both solid and liquid based analytical instruments.

Boron carbide reference material has been developed for determination of the $^{10}B/^{11}B$ isotopic ratio.

The MACE telescope at Hanle, Ladakh, has detected strong gamma-ray flares from a distant galaxy OP 313 and radio galaxy NGC 1275. The galaxy OP 313 is at a distance of 8 billion light years from earth. The data collected on a sample of high redshift sources such as 3C 66A, 3C 216, 3C 454.3, have been analysed to investigate the very high energy gamma-ray emission above 70 GeV.

Thirty-four TACTIC gamma ray telescope mirrors were coated in-house with three-layer thin films specially designed for better adhesion and environmental stability. This development will extend the life and quality of light collector of TACTIC telescope.

The National Facility for Neutron Beam Research at Dhruva reactor was utilized by more than 200 research groups across the country from various universities and institutions for neutron scattering experiments.

An artificial protein with the capability of binding to protein of SARS-CoV2 virus was designed using AI-based tools. The protein was synthesized and the crystal structure of this protein was determined using protein crystallography beamline of Indus-2.

Recent experiment on fast neutron-induced fission of Th-232 at the FOTIA facility revealed that the total energy carried by the gamma-rays in fission of Th-232 is about 40-50% higher than the predictions of the existing models.

E. BARC has been at the forefront of technological advancements, with its focused research leading to the development of innovative new technologies. These technologies are transferred to licensees and BARC provides technical support till commercialisation. During the last year too, there were many noteworthy developments.

Since the beginning of this year, seventeen new BARC technologies have been released in public domain for commercialisation. Sixty one technology transfer agreements were signed with 53 companies for 43 different technologies. Seven new Akruti centres have been established for disseminating and commercialising BARC technologies and bringing entrepreneurship from remote areas.

Technology for high-efficiency distillation columns for separation of fluid mixtures was transferred to private entrepreneur. Eight high-efficiency distillation columns ordered by NPCIL have been shipped to NPCIL plants by the licensee in July 2025. This is related to Heavy Water upgradation towers at NPP sites.

ANUCHITRA Deep Brain simulator, used for treatment of Parkinson type of diseases, has been developed in collaboration with Shree Chitra Tirunal Institute of Medical Sciences. The technology has been transferred to private entrepreneur for manufacture of prototypes ready for clinical trials.

BARC has developed an inorganic (metallic/ceramic) membrane reactor for enhanced hydrogen production during the decomposition of HI, NH_3 and H_2S. The technology has been transferred to industry which can produce in situ high-purity hydrogen (≥99.9%).

BARC has developed a handheld, battery operated portable radioisotope identifier device which can identify radioactive isotopes of medical, industrial and Naturally Occurring Radioactive Material categories in the energy range of 30 keV to 3 MeV. The technology was transferred for commercialisation.

First successful incubation under the Atal Incubation Centre (AIC) for the technology of "Handheld Gamma Spectrometer Based on CsI Single Crystal," has been completed by the licensee.

A 32 channel Neutron Monitoring electronics system for detecting atmospheric neutrons using BF_3 detectors has been developed, evaluated and delivered to at High-Altitude Research Laboratory, Gulmarg.

Bharat Petroleum Corporation Limited has fabricated first indigenously designed complete stack of 0.5 MW Alkaline Water Electrolyser (AWE) with capacity of 100 Nm^3/h hydrogen generation based on BARC design and will shortly commissioned it at Cochin International Airport Limited (CIAL) for transport application. Further, prototype of 1 MW AWE stack and Polysulfone-Zirconia mixed-matrix membrane diaphragm used in the electrolyser have been tested along with our licensee.

A laser-spectroscopy based compact online HDO monitor for detecting heavy water leakages from nuclear reactors has been developed in-house and installed at Dhruva. The import substitute instrument is capable of detecting up to 10 parts per billion by volume of HDO.

Material Management System (MMS) has been upgraded for tracking and monitoring of purchase files efficiently to achieve DAE's vision of paperless operation. It has been expanded as Satellite MMS to that caters to DCSEM, AERB, BRIT HQ and HWB HQ.

F. All the accomplishments outlined have been made possible by the exceptional workforce at BARC and the unwavering support provided behind the scenes by several workers. To sustain this progress,

A total of 179 trainees graduated in the 68th Batch (OCES-2024) of BARC Training School, which included 168 Trainee Scientific Officers for various units of DAE, 7 defence officers and 4 executives from National Thermal Power Corporation.

In 69th batch, 189 candidates were inducted into BARC Training School Mumbai as Trainee Scientific Officers (TSOs). In addition, 4 IPR TSOs, 9 TDOs, and 4 NTPC executives were also inducted.

More than 1300 Category-I &II trainees were recruited during last year.

BARC has successfully implemented One Nation One Subscription (ONOS) Phase-I for access of more than 13,00 e-journals from 30 leading publishers.

Awards

Several BARC scientists and engineers were honoured during last one year.

Dr. S M Yusuf, Distinguished Scientist and Former Director, Physics Group BARC has been awarded Rashtriya Vigyan Puraskar - Vigyan Shri in the field of Atomic Energy for year 2025.

Recipient of some of the other recognitions are

Dr. S. N. Achary, Chemistry Division

Dr. Manoj Kumbhakar, Radiation and Photochemistry Division

Dr. Aradhana Shrivastava, Nuclear Physics Division

Dr. Debasis Sen, Solid State Physics Division

Dr M K Gupta, Solid State Physics Division

Dr. V. K. Sharma, Solid State Physics Division

Dr. Anup Kumar Bera, Solid State Physics Division

Dr. Mohit Tyagi, Technical Physics Division

Dr. Jyotirmayee Mohanty, Radiation and Photochemistry Division

Dr. Santosh K. Gupta, Radiochemistry Division

Shri Dinesh T V, Chief Fire Officer, has been selected as a Fellow by Institution of Fire Engineers India. In addition, Shri S. J. Gadshi, Leading Fireman, and Shri J. S. Nagoankar, Fireman, were honoured with the Director General's Disc (DG Disc) by the Director General, Civil Defence & Fire Services, Ministry of Home Affairs.

Dear colleagues

I want to express my gratitude to everyone who has played a role in ensuring continued success of BARC. This includes the vital contributions of the Administrative Group, Medical Group, Engineering Services Group, Knowledge Management Group, Security Section, CISF, Fire Safety Section, Transport & Catering Sections, and many others who, both

individually and collectively, have worked behind the scenes to drive this organization forward. Our appreciation also extends to other service providers such as BARC Credit Society, State Bank of India, and Indian Post, who serve our employees on campus. Special thanks are due to the unions and associations for their ongoing support and collaboration.

Thanks to all the colleagues for their relentless hard work and commitment. Their efforts are what have shaped BARC into what it is today. Let us continue to honour the vision of our founder, relentlessly pursuing excellence and making a meaningful impact on the world. Together, we will pave the way for a better future.

Jai Hind