Founder's Day Address 2026 by Director BARC

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

It is a matter of profound honour and privilege to welcome you all on this august and solemn occasion — the 117th birth anniversary of Dr. Homi Jehangir Bhabha, the legendary founder and architect of India's nuclear program.

Today, we gather not only to pay our heartfelt homage to a scientist of extraordinary brilliance, but to celebrate the enduring legacy of a true nation-builder. Long before the nation charted its modern scientific pathways, Dr. Bhabha possessed the extraordinary foresight to recognize that self-reliance in advanced nuclear technology was essential for India's long-term energy security, technological sovereignty, and societal upliftment. His pioneering vision laid the foundation of this great Centre, transforming it into a global beacon of scientific excellence, innovation, and national pride.

Our institution continues to be anchored by Dr. Bhabha's core philosophy — that high-calibre scientific research must ultimately serve the people and the nation. From expanding the frontiers of indigenous reactor technology and fuel cycles to driving life-saving breakthroughs in healthcare and nuclear agriculture, his commitment to Atmanirbharta remains our guiding light.

As India rapidly advances in this Amrit Kaal, the responsibilities entrusted to us call for the same courage, intellectual rigor, and relentless pursuit of perfection that Dr. Bhabha personified. Reaffirming our collective resolve to

push the boundaries of science and technology, it is now my privilege to present our major achievements, over the past one year.

V1 Reactors

During the last year, research reactors Apsara-U and Dhruva were operated with high safety and reliability, achieving availability factor of 88% and 70%, respectively.

The reactors were extensively utilized for neutron beam research and isotope production. More than 425 cans were irradicated to produce radioisotopes for medical and industrial applications and 170 samples were activated for neutron activation analysis. Fission molybdenum targets were irradiated in Dhruva as per requirement.

Apsara-U reactor was successfully operated at changed position after shielding augmentation to utilise the thermal spectrum for detector testing.

Critical Facility was operated more than 70 times. ‘Special Neutron Detector’, ‘Gamma Compensated Ion Chambers’, ‘B-10 Lined Proportional Counters’ and miniature fission counters to be used for PHWRs were tested.

There has been significant progress in upcoming reactor projects of BARC.

The High Flux Research Reactor (HFRR) being established at BARC Campus, Visakhapatnam was approved by the Cabinet Committee. EPC contract related activities are in advanced stage.

Prototype units of the reactor coolant pump and the main heat exchanger have been installed at the test facility for integrated performance evaluation.

For Isotope Production Reactor, tendering process has been completed and ground work will begin very soon.

High Temperature Gas Cooled Reactor (HTGCR) project has recently received the financial and administrative sanction.

For developing cladding material of GCR, two approaches have been adopted. The first approach uses an advanced austenitic stainless-steel alloy and the second approach targets composite clad made of Zr-SiC fibres. Both of these are in development stages.

For all these three research reactors BSC is reviewing site, design and safety.

Conceptual design of a new small reactor was completed last year. This will act as neutron source for BNCT. This year DPR has been prepared and it will be put up for approval.

As a part of the nuclear energy mission, Four pressurised water reactors are being designed by BARC and NPCIL.

The detailed project report (DPR) of BSMR-200, has been approved by the Atomic Energy Commission and cleared by the Empowered Technology Group (ETG). The DPR of BSMR-300 and twin units of SMR-55 nuclear power plant has been released jointly by BARC and NPCIL.

The Physics design and characterization of the equilibrium and initial cores of BSMR-200 and BSMR-300 have been completed.

MoEF has issued ToR for all these reactors at Tarapur site.

Activities towards salt and fuel characterisation have been initiated for Molten Salt Reactor. A new cycle analysis code has been developed to simulate the intricate refuelling and reprocessing schemes for transition to ^{233}U-Th self-sustaining core.

Among the other developments in vertical 1,

In the area of post irradiation examination, pressure tube rolled joint stubs from KGS-1 were studied for hydrogen determination, metallography and fracture toughness. Detailed characterization of irradiated APSARA-U fuel assembly and mechanical testing of archive and irradiation surveillance coupons of RPV from KKNPP1 has been carried out. Failure analysis of out-of-core components from various nuclear reactors was also performed.

An automated robotic system, for high temperature resistant precise boron coating on metallic disc with uniform thickness, was developed for fabrication of gamma compensated boron lined ionization chambers and counters.

Root cause of critical low-pressure (LP) steam turbine vibration issues in TAPS-1 were accurately diagnosed and successfully resolved permanently by hybrid approach of analysing operational vibration signals and integrating them with first-principles physical modelling.

Antimony beryllium source was irradiated in Dhruva and results fabricated Photo Neutron Source (PNS) Assemblies were supplied for TAPS-1/2 start up.

BARC has developed a first-of-its-kind enriched B-10 certified reference material (CRM) in accordance with ISO guidelines. It is certified for B-10 isotopic abundance (%), total boron, total carbon, and nine trace impurities to support the quality control of PFBR control/safety rods.

BARC Safety Council accorded a total of 122 regulatory clearances for various facilities and projects. Further, two important Safety Guides on ‘safety in laser facilities’, and ‘Cyber security of I&C systems and physical protection systems’ were published.

V2 Nuclear Fuel cycle

Fuel for FBTR, Dhruva and Apsara-U research reactors was fabricated as per requirement to ensure reactor availability at the desired power level. Fabrication of LEU target plates for Fission Molly plant was also continued. Fuel fabrication plant at Tarapur continued to produce fuel pins at designated capacity for second stage of nuclear power programme.

Bulk, trace and isotopic composition analytical services for the chemical quality control of Pu based fuels, mixed carbide fuels and uranium silicide fuels were continuously provided using a variety of techniques. Further, methods were developed for quantification of U, Th and Pu in fluoride based MSR fuels. Radiochemical determination of burn-up of different fuels was also carried out.

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

Among the new fuel recycle projects, the activities at INRP, Tarapur and FRFCF, Kalpakkam are in full swing. Civil construction has been mostly completed. Equipment erection is in progress. Piping has commenced in FRFCF and will commence soon in INRP. These facilities will also have waste management plants.

Projects related to new fuel fabrication facilities such as Fuel Fabrication Facility at Tarapur for U-Pu Mox fuel from spent fuel of PHWR, Fuel Fabrication Plant at FRFCF Kalpakkam for U-Pu Mox fuel from spent fuel of PFBR and technical labs 1, 2& 3 for metallic Pu base fuel development and fabrication are progressing with desired pace.

Construction and procurement activities for operationalisation of TL-3 and TL-10 service buildings have been initiated.

Similarly, low level waste management plant at TL-7 and other waste management projects at Vizag have also made very good progress.

Among other developments in nuclear fuel cycle area

Installation and testing of ‘Cold Crucible Induction Melter’, a third generation melter, was completed at BARC Facilities Kalpakkam. The target temperature of 1150°C was achieved and vitrification of the inactive glass frits was also demonstrated.

Indigenous technology for producing strontium selective crown ether for recovery of strontium-89 from high level waste and separation of Y-90 from Sr-90 was demonstrated at kilogram product per batch scale.

For nuclear forensics applications, a method was developed to characterize legacy californium-252 source using high resolution Gamma Spectrometry coupled with neutron multiplicity counting.

An alpha spectrometric method was developed for categorization of Pu at Becquerel level.

A novel polymeric substrate containing selective extractant was developed for quantification of ^{241}Am at ultra-trace level.

Excellent Americium-Curium separation was achieved by stabilizing the unusual +5 oxidation state of Americium for preparation of high purity Americium source.

Some of the technical services plants at a RLG were reconfigured and augmented to substantially improve plant performance and capacity.

V3 Accelerator and Lasers

During last one year, 'Folded Tandem Ion Accelerator' i.e. FOTIA and 'Low Energy High Intensity Proton Accelerator' i.e. LEHIPA were operated for more than 1700 hours and 1300 hours, respectively.

While LEHIPA was mainly used by machine users for beam characterisation and performance assessment, FOTIA delivered proton and heavy ion beams to various users for variety of experiments including external Particle-Induced Gamma-ray Emission, biological effectiveness, proton and neutron capture and prompt fission experiments.

Utilising experience gained under Indian Institutions and Fermilab Collaboration, indigenously developed software platform “BARC PARAS” i.e. ‘BARC Particle Accelerator Realtime Automation System’ has been developed for LEHIPA Upgradation for supporting real-time control and data acquisition.

The work for establishing Infrastructure for various accelerators, such as High-Power Proton Linac, Electron Linac and SUBHIR (Stable and Unstable Beam for Heavy Ion Research) facility at Vizag have been initiated.

BARC has also taken a step towards developing High Power Proton Cyclotron with beam energy reaching up to 800 MeV as an alternate to High Power Proton Linac. Activities have been initiated with optimisation studies to identify technical specifications of major systems.

Indigenous development of Klystron has been taken up for electron accelerator programme. The fabrication of the Klystron is completed. Further work is in progress towards final assembly of the system.

V4 Societal Application

In the area of nuclear agriculture

Recently, seven crop varieties developed by BARC in collaborations with various ‘State Agricultural Universities’ (SAUs), have been released and gazette-notified for different states of India, taking the total number of Trombay crop varieties to 79.

The new verities include 1 rice, 2 wheat, 1 sorghum, 2 mung bean and 1 sesame variety. These verities offer desirable characteristics such as dwarf stature which helps prevent lodging, high yield, bio-fortification, disease resistance, bold seeds, climate-resilience and cultivation in other than usual season.

The Trombay seed varieties are very popular with farmers. This year more than 350 quintals of Trombay groundnut and mustard breeder seeds were sold all across the country.

Two Trombay mutant rice varieties together represented approximately 37% of the total indented foundation paddy seeds for the state of Chattisgarh in Kharif 2026.

Maharashtra State Seed Corporation Limited (Mahabeej) sold over 17,000 quintals of Trombay variety seeds to farmers for sowing in new season.

Another very important non power application of nuclear technologies is use of radioisotopes in healthcare and industrial sector. During last year more than 1800 Ci of medical radioisotopes were produced and supplied in the suitable radiochemical formulations.

Other deliveries included doses of yttria-alumino-silicate glass microsphere formulation (BhabhaSphere), yttrium-90 for radiopharmaceuticals, Cs-137 pencils for blood irradiators, ruthenium-106 (RuBy) plaques and iodine-125 Ocu-Prosta seeds.

Similarly, in developmental work,

An ambient temperature-transportable freeze-dried kit for the preparation of Technetium-99m-Hynic-TOC was developed. It helps to avoid the requirement of dry ice during transportation.

An organic ligand Tetrofosmin, used in the ^{99m}Tc-Tetrofosmin radiopharmaceutical was successfully synthesized as an import substitute.

The production capability of enriched Lutetium-176 (Lu-176) has been doubled and it was used for preparation of 1200 Curie of Lu-177 based radio-pharmaceuticals.

About 400 radiation sources consisting of beta, gamma, conversion electron, low energy gamma & positron sources were fabricated and supplied to different industries, universities and other DAE units.

Hot trials for batch processing of 50 Ci iodine at Cirus Iodine Processing Facility were completed successfully.

BARC also contributes significantly in spin-off technologies.

A process for sea water desalination with ‘Zero Liquid Discharge’ (ZLD) was developed which includes recovery of high-purity salts. A pilot-scale unit was setup and demonstrated successfully.

A 5.0 MLD sea water reverse osmosis desalination plant commissioned at OSCOM by BARC is now fully operational and public distribution of 1.5 MLD of desalinated water has commenced in the nearby villages.

In the area of municipal waste management, Nisargruna biodegradable waste treatment technology has been a very popular spinoff technology. Based on this technology, 400 plants are operational across country. For liquid waste treatment, the BARC developed hgSBR technology has been transferred to 40 firms and more than 30 plants have been installed.

Now coming to

V5 Basic Science Programme

Isospin-driven quenching of pre-scission proton emission was demonstrated using fission coincidence measurements in heavy-ion induced reactions at 'BARC-TIFR Pelletron Facility'.

An indigenous broadband magnetic resonance facility comprising 'Ferromagnetic Resonance' (FMR) and 'Electron Spin Resonance' (ESR) was established for comprehensive characterization of quantum and nuclear materials.

A new Multimodal Elemental Neutron imaging and ACtivation Applications facility (MENACA) has been successfully commissioned at Apsara-U, significantly enhancing its radioanalytical and radiography capabilities.

The 'National Facility for Neutron Beam Research' (NFNBR) at Dhruva reactor was utilized by more than 150 research groups while BARC beamlines at Indus synchrotrons were used by more than 520 users from universities, institutions, national labs and industries across the country.

MACE telescope of BARC at Hanle has been operating and providing data continuously. Last month on 19th, it detected a strong, very-high-energy gamma-ray flare from the radio galaxy NGC 1275, which is about 230 million light-years from Earth.

A novel transition metal based high entropy spinel oxide consisting of oxides of Iron, Cobalt, Chromium, and Manganese was synthesized through solid state synthesis route. It demonstrated very good performance as high-capacity anode in lithium-ion batteries and as electrocatalyst in water splitting reaction for green hydrogen generation.

A novel hybrid molecule named Lysostilbene, which is a combination of stilbene and chloroquine, was synthesized. It can target lysosome biogenesis and repair in pancreatic cancer cells at nano-molar concentrations, which could pave the way for a novel chemotherapeutic approach for pancreatic cancer.

A novel and critical molecular target has been identified in cancer cells that plays a pivotal role in DNA repair and confers strong resistance to chemotherapeutic agents. Targeting this vulnerability with a small molecule markedly enhances the sensitivity of multiple cancer types to chemotherapeutic agents, offering a promising strategy for more effective and selective cancer treatment.

A new mitochondria targeted derivative of curcumin was synthesized which showed potent anti-cancer efficacy in tumour bearing animal models. It has promising translational potential as an adjuvant to cancer chemotherapy.

Cell-free DNA samples from 50 lung cancer patients were analysed through ultra-deep sequencing and in-house developed computational pipelines. The analysis matched with the standard clinical tumour tissue biopsy with eighty percent concordance.

BARC is now a member of the 'Consultative Committee for Ionizing Radiation '(CCRI) under the 'International Committee for Weights and Measures' (CIPM). BARC is the 'Designated Institution' (DI) for ionizing radiation metrology in India.

V6 Advanced Technology Development

Development of new and indigenous technologies is one of the core domain expertise of BARC. During last year there were several significant technological developments.

In the area of hydrogen production technologies,

The first of its kind facility of 'Cu-Cl Thermochemical Cycle' was coupled with Fast Breeder Test Reactor for nuclear heat to produce hydrogen. The campaign established the feasibility of hydrogen production using nuclear heat and all performance markers were as per the design intent.

An advanced 0.5 MW alkaline water electrolyser stack has been indigenously developed and successfully integrated with the 1 MW electrolyser plant being established in collaboration with BPCL at Kochi International Airport. The system was operated successfully at 15 bar pressure and 99.9995% hydrogen purity with nearly 75% electrical and 30% thermal energy efficiency.

Significant advancements were made in the previously developed Iodine-Sulphur (IS) thermochemical process for hydrogen production. These include modifying the process to co-produce sulfuric acid at required concentrations alongside hydrogen.

Among some of the other technological milestones

BARC has developed two indigenous import substitute turbomolecular pumps. One is the next-gen 80 l/s turbomolecular pump, AnuTurbo-80, with vastly improved performance, boosting the compression ratio five times more than earlier and now has a high-efficiency motor operating at 36,000 rpm. The motor of second pump operates at 72,000 rpm, providing 10^{-8} millibar vacuum at 70 l/s and compression ratio of 10^{6}.

A new miniature ‘thermal ionization mass spectrometer’ for boron isotopic analysis was developed and successfully deployed at a Heavy Water Board Facility. Under this programme to develop TIMS for applications ranging from heavy elemental analysis such as uranium / plutonium isotopic ratios to light elements such as lithium and boron, a total of 10 machines are under development. Two of these machines are ready for commissioning.

BARC has developed an indigenous technology for producing continuous carbon nanotube (CNT) fibre in kilometre lengths with tensile strength of 6 GPa and electrical conductivity of 8 MS/m. These have applications in advanced lightweight composites.

BARC in collaboration with Heavy Water Board developed technology for recovery of cobalt from secondary metallic sources.

Bringing together industrial capabilities and the technological expertise of our organisations, BARC and Heavy Water Board, signed a MoU with MIDHANI on 27th October to develop processes for recovering nickel and cobalt from plant reverts.

Similarly, a solvent extraction approach was developed for selective recovery of lithium from different secondary Li resources which showed ~90% Li extraction.

Thermoelectric power generator modules based on n-type Magnesium-Antimony-Bismuth and p-type Magnesium-Silver-Antimony, were developed as alternatives to conventional Bismuth-Tellurium based thermoelectric materials. These modules achieved a conversion efficiency of approximately 7.1% at a temperature difference of 250 K and a conversion efficiency of approximately 8.5% at 300 K.

Indigenously developed 'Electromagnetic Isotope Separator' has been successfully tested for the isotopic enrichment of Lu-176 and Ni-62 with isotopic enrichments greater than 99.9%.

A customized atomic layer deposition system has been indigenously designed, and developed for depositing ultrathin films of sub-nanometer thickness with precise mono atomic layer-level control.

A high reflection mirror having 33 thin film multi layers of Tantalum pentaoxide and Silicon dioxide is designed and fabricated inhouse with an aim of developing thin film coating technology for LIGO mirror. The developed mirror has a reflectivity of 99.930±0.002%.

Indigenous high-pressure helium screw compressor package, with maximum delivery pressure of 25 bar, has been developed and prototype manufactured through Indian company.

As a part of preparedness towards management of nuclear and radiological emergencies, BARC has developed state-of-the-art vehicle based ‘Mobile Radiological Assessment Laboratory’ (MRAL) for strengthening the response. These were deployed during major public events such as Independence Day Celebration and BRICS Summit.

A web-based application ‘Indian Registry of Occupational Dose’ (IROD), was developed and successfully implemented by hosting on ANUNET for the registration and management of occupational radiation dose records.

A technique was developed for detection of hydrogen-induced cracks in exchange towers of heavy water plant using phased array ultrasonic method.

During the last one year, 24 new BARC technologies have been released in public domain for commercialisation and 122 technology transfer agreements were signed. Some of the important transferred technologies are ‘Tungsten-filament based Scanning Electron Microscope’, ‘Passive Catalytic Recombiner Device (PCRD) Technology for hydrogen mitigation in nuclear reactors in accidental conditions’, and ‘USB Powered Tele ECG Machine’, ‘Process for the Recovery of Rare Earth’.

Two more AKRUTI centres have been established for disseminating and commercialising BARC technologies and bringing entrepreneurship from remote areas.

AIC BARC Anushakti Foundation signed six incubation agreements, which include five start-ups.

V8: HRD, Outreach and others

Activities presented here are realised with the tremendous efforts of all the workers in BARC and demand continuous efforts to augment human resources.

During the year, 202 trainees officer graduated. These included 185 TSOs of 69th OCES batch comprising 124 engineers and 61 science postgraduates, 8 ‘Trainee Defence Officers’ (TDOs), 5 executives from ‘National Thermal Power Corporation’ (NTPC) and 4 trainees of OCDF programme.

For the 70th batch of TSOs, online examination was conducted for more than 93 thousand applicants at 176 venues spread over 52 cities across country. 266 candidates were selected for OCES and 24 for other programmes.

Further, 90 research scholars also joined the doctoral programme in BARC and 5 students joined DDFS programme.

As a part of outreach programme 150 officers from various units of DAE visited 110 institutes covering 23 states of the country and interacted with students.

SIRD has successfully implemented One Nation One Subscription (ONOS) at BARC with access of more than 13,000 e-journals from 30 leading publishers.

To enhance inhouse medical services for DAE family members, BARC Hospital at Trombay has taken several new initiatives. Some of these are

- Enhancement and Modernization of Neonatal Intensive Care Unit (NICU) Level – III Services with advanced respiratory support and many more facilities
- Radiology unit has enhanced the Radiology Multimodality Diagnostic services such as MRI Defecography and CT and MRI\ Cisternography for diagnosing cerebrospinal fluid (CSF) leak.
- Several new Diagnostic services introduced in-house such as Holter monitoring, Electro-encephalogram (EEG), Polysomnography, Ambulatory blood pressure monitoring and Pulmonary function testing (PFT)
- BARC Hospital has developed a dedicated advanced Assisted Reproductive Technology Level 2 clinic. The facility provides advanced fertility treatment technologies including In Vitro Fertilization (IVF) and includes an IVF Operation Theatre; 10K-class IVF laboratory equipped and A dedicated Andrology Laboratory.
- Surgical Unit has added flexible retrograde intrarenal surgery (RIRS) scope for offering advanced surgeries of kidney stones, state of the art surgical endo staplers and meshes for minimal invasive surgeries etc.

In all the activities, which I have mentioned, very effective support came from infrastructure services and design engineering experts. None of these activities would have been possible without contributions which included civil

engineering, design engineering, civil construction, ventilation electric power systems design and all the emergency systems in different facilities such as research reactors, radiological labs, nuclear NDT labs and corresponding new projects.

Excellent efforts of our engineering services, ensured more than 97% overall availability for all civil, electrical, HVAC, mechanical utility services at Trombay campus.

In addition to its core R&D mandate, BARC is committed to implementing the Government of India's Official Language Policy through initiatives at various administrative levels. These include Hindi proficiency training, workshops, Hindi Month celebrations, and many other activities. BARC started publishing a half-yearly science magazine in Hindi since 2025. Named 'Parmanu Vigyan', it aims to reach the general public across the country and highlight societal applications of science and technology.

Awards:

BARC scientists are regularly recognised by national and international bodies for their scientific contributions,

Dr. Amit Kumar, SSPD; Dr. Celin Acharya, MBD; Dr Mohit Tyagi, TPD; Dr. Raghunath Acharya, IRAD; Dr. R. Mittal, SSPD; Dr Shashwati Sen, TPD and Dr Soumyditya Mula BOD were elected as fellows of different national and international academies. Dr. Anup K. Bera, SSPD; Dr. Nilanjal Misra, RTDD; Dr Raghunath Acharya, IRAD; Dr. Sugam Kumar and Dr. Swayam Kesari, SSPD were awarded medals by various societies. Three personnel from the Fire Services Section, Shri B. C. Sahoo, Shri D. B. Wagmare and Shri S. B. Rahate were honoured with DG's Disc.

I would also like to take this opportunity to acknowledge the important roles played by Administrative Group, Engineering Services Group, Medical Group, BARC Safety Council, BARC Security, Anushaktinagar Security, CISF, Security Guard Board personnel, Public Relations Office, Fire Services Section, Landscape and Cosmetic Maintenance Section, Transport & Catering Services Section, contract workers and many more, who individually and collectively facilitated the smooth functioning of the organisation. Special thanks are due to BARC Workers and Staff Unions for their support and cooperation. I am also thankful to all the personnel of BARC Credit Society, State Bank of India and Indian Post who are stationed at our campus and have been providing good services to our employees.

Thank you & Jai Hind.