

Republic Day 2025 Address by Director BARC

Dear colleagues and fellow citizens

Today, as we celebrate the 76th Republic Day of India, I stand before you filled with a profound sense of pride and gratitude. I thank you all for your pride in our nation, a vibrant democracy forged in the crucible of freedom, and gratitude for the unwavering spirit of scientific inquiry that fuels our institute.

Our founding fathers envisioned a nation built on the pillars of knowledge and innovation. They understood that scientific advancement is not merely about technological breakthroughs, but about empowering our people, improving their quality of life, and addressing the challenges that confront our nation.

Our nation's journey towards progress has been indistinguishably linked to scientific advancements. From harnessing the power of the atom to exploring the vast sphere of knowledge in all domains, Indian scientists have consistently pushed the boundaries of human knowledge. Our institute, a beacon of scientific excellence, plays a vital role in this endeavour.

Our responsibility extends beyond the confines of our laboratories. As scientists and engineers, we have a unique obligation to serve society. We must translate our research into tangible solutions that address the pressing challenges facing our nation – from ensuring energy security and food security for future to improving healthcare and improving quality of life of fellow citizens.

Our centre has an atmosphere that provides boundless opportunities, nurtures young minds, ignites curiosity, and fosters a culture of innovation.

As you are aware, we recently reorganised all our activities under clearly defined verticals aligned with our mandate. Let's recapitulate some of the key progress our centre achieved last year within these verticals.

Vertical – 1: Reactors Programme

1. All Facilities and Projects of BARC have functioned with excellent Safety record under the regulation of BARC Safety Council.
2. Research reactor Dhruva continued to operate with a high level of availability and irradiated around 400 samples for isotope production. A cluster of 10 Antimony pins was fabricated, tested and installed in reactor for irradiation for making antimony-beryllium neutron source for start-up of TAPS-1 after long shut down.
3. Our other major research reactor, Apsara-U reactor operated with availability factor of around 88%. Regular utilization of beam tube neutron imaging facility has commenced and is being efficiently used for testing of detectors and research work. Critical Facility was operated on 62 occasions for analysis of several samples.
4. More than three hundred fifty radioactive sealed sources were prepared using various radioisotopes produced in research reactors and supplied to different industries, universities and other DAE units for calibration, oil exploration and training and other purposes. Isotopes were used for hydrological studies carried out in spring-shed areas of Nashik region of Maharashtra to find out source of recharge and Yamuna flood plains of NOIDA region to establish river water-groundwater interconnections for sustainable water resource management.

5. Continuing the extensive contribution to the nuclear power programme, post irradiation examination (PIE) was carried out for pressure tube irradiated for 15 effective full power years in RAPS-2. Failure analysis was carried out on out-of-core components from various PHWRs and BWR. A Fuelling Machine operated ID measurement tool was developed and tested at Kaiga Generating Station -II in Rehearsal Facility Tube. It takes only 1-2 hours to complete one channel measurement against 10-16 hours for currently available technique.
6. Post irradiation examination (PIE) was also carried out for beryllia reflector assembly of APSARA-U.
7. BARC continuously works on development of new reactors in line with the technological growth and requirement of the country. Among the upcoming reactors, there has been significant progress in physics design of the 5 MWth GCR core. Various core physics parameters, independent control & shutdown system worth and detailed core flux & power profiles have been estimated. First phase of MSR experiment were stated in critical facility. A new loop type small pressurised water reactor of 200 MWe is being designed. It is a transition version PWR where secondary systems of 220 MWe PHWRs will be used.
8. Among other developments in this area, high temperature growth kinetic equations were generated for various phases evolved during the LOCA transient in zircaloy-4 fuel clad material.
9. A generic real-time engineering simulator facility based on an in-house developed 3D multipoint space-time kinetics configurable modelling framework, has been setup for upcoming Pressurized Water Reactors.

10. A process has been optimized to obtain more than 93% dense impervious SiC tube at 1500 °C in vacuum high temperature reactor applications.

Vertical – 2: Nuclear Fuel Cycle

11. Under nuclear fuel cycle activities, regular production of fuel for FBTR, Dhruva reactor and Apsara-U reactor was carried out to ensure reactor availability at the desired power level. Fuel fabrication for PFBR also continued while adhering to stringent quality standards.

12. In the back-end of cycle, all the Reprocessing Plants and waste management plant at Trombay, Tarapur and Kalpakkam sites continued to operate meeting the department's targets. Continued operation of Pump House Ion Exchange (PHIX) facility led to safe processing of 925 m³ of Intermediate Level Liquid Wastes. Plasma-assisted radioactive solid waste incineration facility achieved a processing rate of 1 ton per day.

13. In the area of front-end of fuel cycle, a hydrometallurgical process has been developed for recovering more than 90% of uranium present in the ore from a new uranium deposit found in Jharkhand. Process also recovers magnetite as a by-product.

14. A comprehensive extraction process was developed for the recovery of rare earths, Nb, Zr & Hf from hard rock deposit in Rajasthan. About 80% of rare earths values, along with other by-products, could be recovered from the ore.

15. Among the developmental works in the area of nuclear fuel cycle, an efficient Pulsed Disc and Donut Column contactor based solvent

extraction pilot-plant was successfully tested for uranium refining. Bulk 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 Radioisotope Thermoelectric Generator (RTG).

16. Lithium being one of the key elements for achieving the clean energy target, a chemical process flowsheet is developed for the recovery of Li from indigenous resources. A Lithium Carbonate product of 99% purity is produced with about 80% recovery from Bihar mica belt.

17. An Indigenously developed Thermal Ionisation Mass Spectrometers (TIMS) was installed and commissioned at Fuel Reprocessing Division, BARC for precise isotopic ratio measurements of spent nuclear fuel.

18. Large scale molecular dynamics simulation scheme was developed to evaluate atomic response of Sodium Borosilicate Glass matrix under displacement cascades originated from U-235 i.e. Pu239 alpha-daughter nuclei. All the physical properties and the leach rates could be estimated and changes with respect to pristine glass could be predicted satisfactorily. This computational protocol can be used for all kind of nuclear glasses.

Vertical – 3 Accelerator & Laser Programmes

19. BARC-TIFR Pelletron-LINAC Accelerator facility has been consistently delivering a variety of ion beams to diverse users, in round-the-clock operation, for carrying out research in nuclear physics and applied areas. In the last one year, a total of 37 experiments have been conducted utilizing the facility by users from DAE and non-DAE

institutions. For the first time, “polar” and “equatorial” near scission protons have been observed in heavy-ion induced fission reactions using this Facility.

20. BARC beamlines at Indus synchrotrons Indore have been operating round-the-clock for the benefit of Indian scientists and industrial users from across the nation. During the last five months, 198 users from various universities and institutes including 6 from Industry have utilized the beamlines.

Vertical – 4 Societal Application

21. BARC extensively contributes for technologies and product of high significance to society. Last year, eight new crop varieties developed by BARC were released and gazette notified for commercial cultivation by the farmers. These included two wheat varieties, three rice varieties and one each of mustard, *til* and groundnut. Further, 325 quintals breeder seed were supplied to many organizations/agencies and farmers in several states. The earlier released TAM108-1 mustard variety has become a popular variety in Vidarbha and presently covers 30% of the mustard-growing fields in this region.

22. BARC developed an import substitute dye-based reliable, user-friendly and cost-effective dosimeter ‘Anudose’ for dosimetry in the low dose range from 25 to 1000 Gy for application in fruit irradiation and the technology is now available for transfer.

23. In the area of healthcare, during the period July-December 2024, 785 Ci of radioisotopes were produced and processed for use in humans. Major of them were ^{177}Lu , ^{131}I and ^{99}Mo

24. Supply of ready-to-use doses of [^{90}Y]YttriaAlumino Silicate glass microspheres (BhabhaSphere) were supplied for inoperable liver

malignancy and ^{125}I sealed seeds were supplied for brachytherapy of ocular cancer patients. Freeze-dried kits based on in house synthesized HYNIC-TOC, used for patient doses of $^{99\text{m}}\text{Tc}$ -HYNIC-TOC for diagnosis of neuroendocrine cancers, were prepared and supplied to AIIMS (New Delhi) for clinical utilization. Supply of Ru-106 plaques and Y-90 continued as per the demand from various hospitals

25. A new diamide based ligand, Oxabicyclo dicarboxamide (OBDA), has been developed using multi-step organic synthesis, for efficient separation of ^{90}Sr and ^{90}Y from high level waste.

26. There have been many significant developments in some spinoff technologies. BARC's patented hgSBR (hybrid granular sequencing batch reactor) technology for wastewater treatment has now been transferred to total of 30. Three plants, each with 500 KLD treatment capacity are being installed at Prayagraj area for treating sewage and providing sanitation during the Maha Kumbh Mela 2025.

27. A novel, compact helical shaped digester cum waste converter named Shesha has been granted Indian patent (Patent File No.531960). A plant of 50 kg/day capacity was successfully installed at TSH premises in September 2024.

28. Rajasthan State Pollution Control Board (RSPCB) granted 'Consent to Establish (CTE) Radiation assisted Adsorbent technology for Textile Effluent Decolouration (RAd-TED) in one of the cotton printing and dyeing industry post performance evaluation of 75 KLD RAd-TED plant. The technology has been transferred to two vendors.

Vertical – 5 Frontiers in Basic Research

All the work described above is result of directed basic research over many years. Our efforts in basic research for tomorrow's requirements are continuing.

29. Two scientists from BARC participated in India's historic first North Pole mission during the solar winter of January to March 2024, which continued into the summer. The Linear Energy Transfer distribution of cosmic ray data collected during this mission has provided unique insights for predicting solar storms and understanding geomagnetic field fluctuations.

30. In order promote the use of neutron-imaging based methods in cultural and heritage sciences, the Directorate of Archaeology and Museums of Government of Maharashtra, has entered into an MoU with BARC to explore the potential of neutron-based non-destructive techniques set up at the Dhruva and APSARA-U nuclear research reactors for the characterization of ancient artifacts.

31. The National Facility for Neutron Beam Research (NFNBR) at Dhruva reactor was utilized by more than 70 research groups across the country from various universities and institutions for neutron scattering experiments in condensed matter physics.

Vertical – 6 Advanced Technology Development

Development of new technologies has always been the forte of BARC. In last year too significant progress was made in development of new technologies.

32. Based on BARC technology, 0.5MW Alkaline Water Electrolyser cell module with 100 Nm³/hour Hydrogen was fabricated under MoU with M/s BPCL. This is the only completely indigenous technology, using domestically sourced components.

33. BARC has developed a system for detachment of Calandria Tube from the rolled joint in 540 MWe PHWR. The technology with necessary technical specifications, operating & emergency procedures, documentation & drawings has been transferred to NPCIL for fabrication and deployment at TAPS 3 & 4 for replacement of calandria tubes.

34. Development of nested corrugated capsule based differential pressure transmitter for use in safety class IA systems of nuclear reactor has been completed. Prototype unit successfully passed qualification tests for radiation, high temperature and LOCA.

35. An in-house developed reference material for boron alloy is ready for release. The material is intended for use as control rod in a classified light water reactor.

36. Development of first of a kind, heated junction thermocouple (HJTC) based Discrete Level Sensor for direct measurement of level and temperature of coolant inside reactor pressure vessel of PWR has been completed.

37. An indigenous cyber-security tool for auditing isolated networks and computer systems has been developed. It analyses network traffic and executables to detect probable cyber security threats. This has been successfully used to audit more than 200 isolated systems in various facilities.

38. A state-of-the-art 100kVA motor drive unit has been designed, developed and realized for driving PHT pump motors. The development

addresses the challenging requirements of very high currents to be delivered at lower voltage levels while catering to the stringent safety and availability demands with ultra-low electromagnetic emissions.

39. Tungsten/silicon supermirror with multilayer of thin films of high density tungsten and platinum and low density silicon and carbon has been designed and developed achieving high reflectivity of ~ 90% in high energy X-ray band for high energy X-ray optics applications.

40. A non-intrusive acoustic emission based leak detection system for identifying leakage from pressurized systems was developed. The system consists of acoustic emission sensor, pre-amplifier, data acquisition module & leak identification algorithm which can identify leakage from pipe, valves, vessels, etc.

41. An indigenous stand-alone hyperspectral camera has been developed for spectral analysis. The instrument can scan over a line of 25 mm length with a spatial resolution of 40 μm and spectral resolution of ~12nm over a range of 400nm to 1000nm.

Vertical - Human Resource Development, Public Awareness & Outreach, Technology Transfer & Incubation, Indian & International Collaborations and Services

The pre-requisite for successful execution of such extensive variety of work is highly trained and talented manpower and high-quality infrastructure and support mechanisms.

42. To meet the scientific manpower requirements, 68th Batch of BARC Training School started with around 200 Trainees for OCES/DGFS programme from 12 disciplines.

With the responsibility of the Central Agency for Recruiting scientific and technical cadre personnel of the Department of Atomic Energy (DAE), BARC has successfully concluded the recruitment process for Technical Officers and CAT 1 and 2 trainees. As part of this extensive initiative, approximately 4,000 employees have been inducted to various Units of the Department.

43. As a part of skilled human resource development and upgradation a Training and Certification Programme in Radiography Testing and Radiological Safety Level-2' was conducted as per AERB guidelines and 33 out candidates successfully qualified the certification programme.

44. A State-of-art digital studio and lecture halls were established at Training School Complex to provide e-learning through educational video contents of higher broadcast quality. Digital studio is equipped with interactive displays, 4K cameras with 4K video recorder, digital podium and high-quality acoustics.

45. Our Engineering services Group has been providing excellent infrastructure. It achieved more than 97% overall availability of all Civil, Electrical, Mechanical utility services & landscape maintenance. The Bhabha Botanical Garden at South Site was developed to serve as a botanical repository, three fully automated Poly houses were developed for growing and propagating exotic flowers, a new sewage treatment plant for hospital, a new six lane for labour entry portal through TVS gate

46. A virtual reality-based training and assessment tool has been developed to simulate scenarios for training radiological emergency responders without requiring real radioactive sources. The tool provides a realistic environment for handling orphan radioactive source incidents and evaluates responder performance during training.

47. A Biodosimetry Network in India has been established with seven laboratories from various organizations across the country as members. The labs participated in the first National Biodosimetry Exercise, demonstrating the nation's preparedness for emergency management. Additionally, the network also aims to exchange knowledge on various clinical applications of the biodosimetry assays.

48. One DAE One Subscription (ODOS) agreement for "Read and Publish" was successfully implemented at BARC. Around 70 open access articles were published in Gold Journals and in Hybrid Journals by BARC authors.

49. First successful incubation under the BARC-Atal Incubation Centre for the technology of "Handheld Gamma Spectrometer Based on CsI Single Crystal," has been completed by the industry partner and a gamma detector fabricated by the company has been delivered to BARC. Two more incubation agreements were signed by the incubation centre with industry partners. These are for the incubation of the in-house developed technology of "Process system for clean-up of dissolved oil and salt contaminated wastewater for gainful utilization" and "Development of Novel Electrocatalyst loaded Electrodes for Alkaline Water Electrolysis for Production of Green Hydrogen".

The splendid achievements of our colleagues are regularly recognised by various forums around the world. During last year

50. Dr. S M Yusuf is elected fellow of The World Academy of Sciences (TWAS)-UNESCO.

51. Dr.Sukhendu Nath has been elected as a Fellow of the National Academy of Sciences, India (NASI) and Dr. Celin Acharya was selected as a member.

52. Dr.Adish Tyagi has been selected for membership in the Indian National Young Academy of Sciences (INYAS).

53. Dr. Santosh Kumar Sandurand Dr. Rubel Chakravarty were elected as Fellows of Maharashtra Academy of Sciences for the year 2024

54. Dr.Jyotirmayee Mohanty has been conferred with the “SMC Distinguished Woman Scientist Award 2024” by the Society for Materials Chemistry.

55. Dr. Virendra Kumar was conferred with Dr. P. N. Pathak Memorial Award by The Association of Separation Scientists and Technologists.

56. Dr.Debasis Sen, awarded with Silver Medal by the Society of Materials Chemistry.

57. Dr M K Gupta received the N S Satyamurty Memorial Young Scientist Award by Indian Physics Association and Bronze Medal by the Society of Materials Chemistry.

Colleagues, as we conclude, I would like to express my sincere gratitude to all the service providers and various associations for their tireless efforts and support. I extend my heartfelt appreciation to everyone who has contributed to ensuring that BARC continues to perform at an exemplary level. This includes the services provided by the Administrative Group, Medical Group, Engineering Services Group, Knowledge Management Group, BARC Security, Anushaktinagar Security CISF, Board Guards Security Personnel, Fire Safety Section,

Landscape and Cosmetic Maintenance Section, and Transport & Catering Section, among others, who have collectively and individually contributed to the success of our organization.

Our acknowledgments also extend to other service providers such as BARC Credit Society, State Bank of India, and Indian Post, who are present on our campus and provide valuable services to our employees. A special thanks is also warranted for the unions and associations for their support and cooperation.

On this Republic Day, let us rededicate ourselves to the ideals of our Constitution – liberty, equality, and fraternity. Let us work together to build a stronger, more prosperous, and more scientifically advanced India.

Jai Hind