

Founder's Day - 2024

Director's Address

Secretary DAE, distinguished invitees, senior colleagues of DAE family, ladies and gentlemen,

It is a great honour to stand before you and welcome all on this august occasion of the 115th birth anniversary of Dr. Homi Jehangir Bhabha—the visionary founder of this Institution.

This year, we completed a 70-year-long journey marked by excellent research and innovations. It is also the best occasion to remind ourselves how our legendary founder realised the requirement for a dedicated centre of excellence in nuclear science and technology at a time when worldwide such activities were in incipient stage. His commitment and approach to the development of this centre has profoundly shaped our journey, enabling the centre to rise as a beacon of knowledge and advancement in the area of nuclear sciences. Dr. Bhabha believed in the transformative power of nuclear technology for the betterment of society, thereby laying the groundwork for groundbreaking research and development. Over the decades, we have achieved remarkable milestones—from pioneering nuclear reactor technologies to advancing medical and other non-power applications of radiation.

As we celebrate our past, we must also look to the future. The path ahead is filled with opportunities for collaboration and discovery. It is time to embrace our founder's legacy of self-reliance and push the boundaries of knowledge to forge new paths in research and innovation that will have lasting impacts on our society.

While pursuing on the path lit by Dr. Bhabha's ideals, during last year BARC continued to carry out its mandated activities and successfully achieved the set goals. Our multipronged programmes encompass all fields of nuclear sciences, ranging from fundamental to applied research, technology development in the area of nuclear reactor & nuclear fuel cycle, high energy accelerators, health care, nuclear agriculture, nuclear medicine, water & water management and various other areas.

I take this opportunity to share some of the notable achievements during the year.

A. In the area of nuclear reactor and nuclear fuel cycle,

1. Research reactors Dhruva and APSARA-U operated with high availability factor. The reactors were used for irradiating 400 samples for radioisotope production. Utilization of neutron imaging facility at Apsara-U has just commenced. Critical Facility was operated on 69 occasions for testing of more than 135 samples which included nuclear detectors and activation of large volume samples for neutron activation analysis for various DAE units.
2. Production of fuel for Fast Breeder Test Reactor, Dhruva, Apsara-U and Special Plate Fuel Facility was maintained at required levels. Prototype Fast Breeder Reactor MOX fuel fabrication was continued at designated capacity.
3. Burn-up of first of its kind Apsara-U fuel sample was determined using thermal ionization mass spectrometry. APSARA-U fuel has crossed burn-up of 50000 MWD/T. The estimated value for one of the assemblies with relatively lower burn-up is 48000 MWD/T.
4. Graphite reflector assemblies were fabricated and supplied to APSARA-U. Antimony Pins Assembly for restart up of TAPS 1&2 was fabricated and loaded for Irradiation in Dhruva.
5. The backend facilities at Trombay, Tarapur and Kalpakkam for reprocessing of spent fuel and radioactive waste management continued excellent operation while extracting valuable materials for various applications and restricting radioactive material discharge. PREFRE-2 Tarapur and Plutonium Plant resumed operations successfully after refurbishment.
6. Post irradiation examination of pressure tubes from MAPS, RAPS and KGS was carried out. Post irradiation examination of Beryllia Reflector Assembly was carried out for the first time. Failure analysis of several out of core components of nuclear power plants was carried out. The established PHWR fuel failure criteria under LOCA, separate effect and integral LOCA tests are being performed. Till date about 300 tests have been conducted.

7. BARC Channel Inspection System (BARCIS) was deployed at Unit 7 of Rajasthan Atomic Power Project, and pre-service inspection of selected channels was successfully completed to meet regulatory requirements. Recently, New BARCIS inspection tool based on eddy current techniques for detection of ID surface opening flaws in the range of 91 micron to 455-micron depth in pressure tubes of PHWR has been developed for 540MWe PHWR.
8. BARC provided Indigenously developed special neutron detectors, technical guidance and supervision for first startup and low power physics experiments of RAPS-3, 220 MWe PHWR after coolant channel and feeder pipe replacement. The unit has been successfully synchronized to grid.
9. To obviate time consuming manual inspection and increase throughput, an X ray-based imaging system software has been developed for automatic detection of missing pellets in PHWR fuel pin and deployed at NFC Hyderabad.
10. An inter-laboratory exercises involving multiple DAE facilities for developing in-house reference materials for plutonium (PuO_2) and a certified reference material for bulk uranium (U_3O_8) was carried out.
11. BARC Safety Council has granted Ninety Seven Regulatory Clearances for various consenting stages of BARC facilities and upcoming projects.
12. In past, BARC contributed immensely toward design, development, safety analysis & safety reviews of 700 MWe PHWRs. BARC designed, developed fuelling machine for PFBR, which was subsequently tested for acceptance jointly by BARC & BHAVINI. The Mixed oxide fuel (MOX) for PFBR is being fabricated regularly by BARC. BARC developed specialized high temperature neutronic detectors and associated electronics, reactivity meter and diverse safety rod drop time measurement system for PBFR and provided support during commissioning of these specialized systems.

B. Among the other applications of nuclear energy are nuclear medicine and health care. There were very promising developments in this area during last one year.

1. Production, processing and supply of radioisotopes in the form of suitable radiochemical formulations was continued with supply of ~1750 Ci of radioisotopes. Among these ^{177}Lu , ^{131}I , and ^{99}Mo were the major contributors. ^{125}I and ^{106}Ru brachytherapy seeds and plaques were supplied to hospitals for the benefiting patients suffering from eye cancer. So far, around 33 ruthenium plaques of different configurations were supplied to various hospitals and the users' feedbacks confirm satisfactory performance of the supplied items. Supply of Yttrium 90 to RMC in highly pure form for medical use has also been continued as per requirement.
2. The technology of a Chlorophyllin based nutraceutical which acts as a radioprotector, developed by BARC has been transferred to a licensee. The product has obtained necessary approval from the Food Safety and Standards Authority of India (FSSAI), and has been launched by BARC licensee as AKTOCYTE tablets on 12th June 2024. It reduces radiotherapy induced damage to urinary bladder in pelvic cancer patients.
3. BARC's patented nitric oxide (NOx) releasing diabetic foot ulcer wound dressing technology, which was earlier transferred to Cologenesis Private Limited, completed Phase III clinical trials and received regulatory approvals from the Drug Controller General of India (DCGI) for launching. It is the first of its kind NOx releasing wound dressing in India approved for use.

C. Another area where BARC contributes significantly is the food and water security. Some important developments in this area are as followed.

1. Eight crop varieties developed by BARC have been very recently released and notified for commercial cultivation in India. These include, 1 Groundnut variety (TG 88), 1 Mustard variety (TJM2), 1 Sesame variety (TLT-10), 2 wheat varieties (TRVW-155 and TJW-153) and 3 rice varieties (CTLM, BARC KKV-16, Sanjeevani). Notably, this is for the first time that Wheat and Sesame varieties

have been released from BARC, and with these, the total number of varieties released by BARC now stands at 70. The newly released varieties are high yielding, tolerant to environmental stresses such as heat or salinity and resistant to different diseases.

2. In some other developments related to BARC technologies in agriculture sector, 325 quintals of breeder seeds of BARC varieties were supplied to many agencies and farmers in several states. "Foliar Spray of Thiourea" was recommended by All India Co-ordinated Research Project, AICRP-soybean, for achieving higher soybean productivity.
3. A hybrid desalination plant comprising of 4.5 MLD sea water reverse osmosis (SWRO) and 0.5 MLD Multi-Effect Distillation – Thermo Vapor Compression (MED-TVC) plants has been commissioned at IREL, OSCOM, Odisha with indigenous membrane elements and know-how of MED-TVC technology. It will meet full requirement of process and potable water of OSCOM unit. BARC water purification technologies were deployed in 200 equivalent villages across country for removal of various contaminants like arsenic, fluoride, iron, nitrate and salinity. Some of the location include the challenging Border Outpost sites of Rajasthan & Gujarat, the Platforms of Central Railway, Mumbai and Deen Dayalu Coach of Northern Railway, New Delhi.
4. BARC's patented hybrid granular sequencing batch reactor (HgSBR) technology was transferred to 27 private companies. Total sixteen HgSBR technology based plant of capacity ranging from 5 KLD to 1.5MLD have been installed.

A 75 KLD radiation grafted adsorbent based plant has been installed at Jodhpur, Rajasthan to efficiently decolourise industrial effluents.

A 150 KLD hgSBR based sewage treatment plant (STP) was installed and operated to demonstrate for one year and handed over to Surat Municipal Corporation in August 2024.

A similar 250 KLD Plant was constructed near BARC Hospital, Anushaktinagar.

5. The 361st Nisargruna Plant, which can process 5 tons of biodegradable waste per day and has improved features like methane recycling, manure dewatering, and a methane storage system, has been installed at BARC Hospital. A novel, compact helical shaped digester cum waste converter named Shesha has been granted an Indian patent and a larger demonstration plant of 50 kg/day capacity was successfully installed at TSH.

D. Development of new technologies has always been one of core domains of BARC.

Several new innovative technologies have been developed during last year and many technologies have achieved higher scales.

1. The alkaline water electrolysis technology was scaled up and BARC has fabricated and tested the scaled-up prototype of 1MW capacity alkaline water electrolysis cell module. The technology is ready for incubation to achieve indigenous megawatt scale alkaline water electrolysis for hydrogen production.
BARC has been developing hydrogen generation technologies towards achievement of net-zero goal. A 150 NL/h pilot-scale facility of copper-chlorine thermochemical cycle for hydrogen production by water splitting was installed, commissioned and operated at design capacity.
A new 3 m³/h hydrogen generation plant is expected to be commissioned soon at Heavy Water Facility, RCF, Chembur. It is based on iodine -sulphur thermochemical process developed at BARC.
2. BARC in collaboration with NALCO has produced first indigenous certified reference material of Alumina (BARC - B1301). The CRM is produced as per ISO 17034 and ISO guide 35.
3. Continuous plutonium in Air Monitor has been jointly developed by BARC & IGCAR to detect airborne plutonium. This is based on indigenous silicon detector coupled to a multi-channel analyser. Electronics & associated software. field trials have been successfully completed at DFRP.

4. For the first time, extraction of high purity calcium metal was successfully demonstrated in a single step from its oxide.
5. Prompt fission neutron logging probe developed for on-site detection of uranium using indigenous sealed D-T neutron generator has been successfully tested in a bore hole at Kanyaluka field site, Jamshedpur.

E. BARC also works in forefront of research in basic and applied sciences. Some of the developments are enlisted here.

1. The indigenously built Asia's largest gamma ray telescope, MACE, was inaugurated on 4th October 2024 at Hanle in Ladakh as a part of the Platinum Jubilee year celebrations of the Department. The telescope demonstrated its capabilities with excellent observations and rare detection of flaring activity of the radio galaxy NGC 1275. A gamma ray flare from active galaxy Markarian 421 was simultaneously detected by MACE.
2. In the year 2023, on 04th August, Proton beam with peak current of 2 mA was successfully accelerated to 20 MeV, in Low Energy High Intensity Proton Accelerator abbreviated as LEHIPA. Since then, LEHIPA has been used by machine users, for more than 1000 Hrs of elastic scattering and irradiation experiments. These experiments were conducted primarily for optimization of beam size, beam position, beam stability and transmission of optimized beam with pace charge compensation.
3. LEHIPA used normal conducting setup, whereas Medium Energy High Intensity Proton Accelerator abbreviated as MEHIPA shall be using superconducting structures. These Superconducting structures will be operating at 2 Kelvin temperature. Towards this, indigenously designed and fabricated cryo-plant has demonstrated 2 Kelvin Superfluid Operation and 500 Watt helium refrigeration at 4.5 Kelvin.
4. Seven Tesla conduction cooled superconducting magnetic focusing lenses were designed and developed indigenously for the high energy superconducting proton accelerator. The magnets were shipped to Fermi National Accelerator Laboratory under Indian Institutions Fermilab collaboration

5. The National Facility for Neutron Beam Research (NFNBR) at Dhruva reactor was utilized by more than 120 research groups across the country from various universities and institutions for neutron scattering experiments in condensed matter physics.
6. BARC scientists have discovered a unique domain in the Txp40 insecticidal protein crystal structure using protein crystallography beamline of Indus-2. A discovered domain structure is completely different from any of the known protein structures in Protein data bank and has been named as “Indus Domain” recognizing the Indus Synchrotron Beamlines.
7. A large Field of View neutron imaging set up is developed and installed at the Dhruva reactor’s neutron imaging beamline for conducting neutron tomography on samples up to 300 mm X 500 mm sizes. BARC has entered into an MoU and used the facility to examine a range of historical artefacts obtained from the Directorate of Archaeology, Maharashtra State.

BARC has always strived to keep updated with times and to introduce newer technologies for the infrastructure of the centre.

1. A indigenised micro hydro power unit of 15kW capacity was commissioned at PP lake. It presently generating electricity up to 7.5 kW from rain harvested water.
2. Fire services were augmented with Advance Mini Fire Tender, Fire Extinguishers Maintenance Van and Quick Response Tender which are custom designed and commissioned into firefighting services.
3. A new state-of-art digital studio has been established at New Training School Building for enhancing the scope of online classes as well as for creating digital contents.

The achievements enlisted here are very small part of elaborate activities of BARC during last year. Our scientists continued to contribute to the scientific knowledge in outstanding manner. The quantity and quality of the research work published by our scientists is reflected highly by the various indices. Several BARC scientists and engineers were honoured during last one year.

1. Dr. S. M. Yusuf has received the prestigious J. C Bose National Fellowship from the Department of Science & Technology, Government of India for his outstanding contributions in Scientific Research.
2. Dr. Aradhana Shrivastava has been elected fellow of The National Academy of Sciences, India.
3. Dr. Mohit Tyagi was selected as member of National Academy of Science (NASI). He has also been conferred SMC bronze medal by the Society of Materials Chemistry in December 2023.
4. Dr. B. Modak has been selected for membership in the Indian National Young Academy of Sciences (INYNAS).
5. Shri T V Dinesh of BARC Fire Service Section has been awarded with President's Medal for Meritorious Services, a distinction announced as part of the Republic Day celebrations of 2024.
6. Kum Elina Mishra was awarded the Young Engineer Award from Indian Society for Particle Accelerators.
7. Dr. Vinita Grover Gupta has been selected for the prestigious CRSI Bronze Medal for the year 2025 by Chemical Research Society of India.
8. Dr. Jyotirmayee Mohanty was among the 14 illustrious women to be decorated with DEVI AWARD-2024 in category of science, which is instituted by New Indian Express in New Delhi.
9. Dr. Veerendra K. Sharma, received INSA Distinguished Lecture Fellow (2024) in Physics.
10. Dr. P.K. Singh, has received CRS (Chirantan Rasayan Sanstha) Silver Medal 2024.
11. Dr. Mahesh Sundararajan received SMC Bronze Medal awarded by Society for Materials Chemistry & Tarun Datta Memorial Award by Indian Association of Nuclear Chemists and Allied Scientists (IANCAS).

Dear colleagues

It is also essential to acknowledge several talented individuals who have been part of our journey. I urge each of you to continue pushing the boundaries of knowledge, setting new standards of excellence, inspiring each other, and upholding the legacy. I would like to express my sincere gratitude to all who ensured that BARC continues to perform excellently. This included services provided by the Administrative Group, Medical Group, Engineering Services Group, Knowledge Management Group, Security Section, CISF, Fire Safety Section, Landscape and Cosmetic Maintenance Section, Transport & Catering Sections and many more who individually and collectively contributed silently to the success of this organization. Our acknowledgments are also due to the other service providers such as BARC Credit Society, State Bank of India, and Indian Post, who are stationed at our campus and provide services to our employees. Special thanks are also due to the unions and associations for their support and cooperation.

Let's carry the spirit of our founders forward, striving for excellence and making a difference in the world. Together, let's build a brighter future.

Jai Hind