

Founder's Day Address 2022

by

Director, BARC

Respected Guests, my colleagues, ladies & gentlemen,

This is the day when we gather every year to pay homage to one of India's greatest science visionaries and the founder of this institution, Dr. Homi Jehangir Bhabha. It is his 113th Birth Anniversary today and it's a matter of great honour and pride for me to be standing in his shoes as I extend warm greetings to all present here on the Founder's Day of the Institution.

When India attained independence, the science and technology ecosystem of the country was rather underdeveloped and required charismatic and dynamic leadership to create a roadmap for rapid progress and development. Dr Homi Jehangir Bhabha, with his pathbreaking research experience, broad vision and an undiluted spirit of patriotism, proved to be an able choice to take forward the national agenda. The development of atomic energy was a platform from which he launched several programmes and initiatives across diverse domains, ranging from space, electronics, metallurgy, instrumentation, health physics, radiation technologies and its applications to health care, agriculture, industry and so on, setting the

course for an all-round growth of science and technology in the country. As we celebrate the seventy five years of independence as Azadi ka Amrut Mahotsav, it is his philosophy that guides us towards achieving excellence in all areas of nuclear and allied sciences.

Dear colleagues, as you are all aware, the advent of the Covid 19 vaccine, and wide spread vaccination programme has almost eliminated this scourge during the last one-year. The country has bounced back from the impact of pandemic and embraced the path of development with renewed vigour. Despite the challenges and the hangover of the pandemic, BARC continued to carry out its mandated activities and successfully achieve the set goals. Our multipronged programmes encompass all fields of nuclear sciences, ranging from fundamental to applied research, technology development across the entire gamut of nuclear fuel cycle, health care, nuclear agriculture, nuclear medicine, water management etc. Various other areas, leading to the development of socially relevant technologies has always been one of the mandates.

I shall now be presenting some of the notable achievements in various areas during the year.

A. The Indian nuclear programme follows a closed fuel cycle and I shall now bring out some of the important activities and achievements in the front-end and back-end programmes

1. Research reactors Dhruva and Apsara-U continued to operate with a high level of safety and availability for radioisotope production and served as a national facility for neutron beam research. The overall Availability factor for Dhruva was 72 % and for Apsara-U was 69 %. About 460 isotope samples were irradiated during the year. Irradiation of fission Moly targets has been commenced at Dhruva.
2. Critical Facility for Advanced Heavy Water Reactor was operated on 76 occasions. Utilization of the facility was continued for testing of nuclear detectors and irradiation of large volume samples for Neutron Activation Analysis.
3. Production of fuels for Dhruva reactor and APSARA(U) reactor continued to be carried out to the desired levels.
4. Record production of Fast Breeder Test Reactor (FBTR) fuel was achieved after upgradation and modification of fabrication line. As a result, FBTR achieved 100% power for the first time since criticality.
5. Special Plate Fuel (SPF) facility was hot commissioned. Fabrication of LEU plate fuel for Fission Moly targets has commenced and initial set of plates were delivered to fission moly plant at BRIT.

6. Post Irradiation Examination (PIE) of pressure tube from MAPS was carried out and the root cause of cracking was established. Failure analysis of several out-of-core components was carried out to establish the root cause of failure.
7. BARC has developed LOCA qualified nested corrugated capsules for use as pressure sensing elements in indigenously designed differential pressure transmitters required for reactor process control systems.
8. Operation of WIP for treatment of High-Level Liquid Waste (HLLW) involving partitioning of waste was continued to be carried out during the year. Concentrates were vitrified, achieving volume reduction factor of about 7000.
9. Operation of Waste Management Facilities have continued to cater to the management of waste arising from various nuclear and radiological facilities of BARC Trombay.
10. Design, Development and Installation of Corrosion Loop (CLOE) as a part of India's In-Kind Contribution to Jules Horowitz Reactor, France was completed. Commissioning of Prototype process Loop was successfully carried out at High Pressure & Temperature.

B. It has always been our strong intent and an important mission to contribute to the food security, water security and other societal applications. Some important developments in this area are as follows

11. During the past year, seven Trombay crop varieties have been released and notified for commercial cultivation. These comprise two rice, four mustard and one groundnut variety. We have released 56 numbers of seed varieties so far.
12. A *Trichoderma virens* mutant-based biopesticide formulation has been registered with Ministry of Agriculture and Farmers Welfare, making it the first mutant microbe to be cleared for commercial application as a biopesticide.
13. A SOP has been developed for sea route shipment of radiation treated mango to reduce the freight charges and enhance the trade volume. A commercial trial shipment of one container carrying 16 Tons of Kesar mangoes was sent to USA and successfully marketed.
14. A SOP was developed for commercial deployment of radiation processing technology for preservation of onions and potatoes. It successfully preserved 28 tons of potato and 65 tons of onion up to 8 months.

15. A first of its kind Agro Irradiation Facility (AIF) has been designed, built and commissioned at BARC to demonstrate the utilisation of Cs-137 pencils as gamma source for radiation processing of food grains.

C. I shall now move on to some of the recent developments in the area of nuclear medicine and health care.

16. Import substitute ligands for myocardial perfusion imaging and PSMA-617, for treatment of prostate cancer were prepared in-house and supplied to BRIT for preparation of diagnostic kits. These cater to the annual needs of 24000 and 5000 patients respectively.

17. A simple one step fabrication method, avoiding the use of any organic solvent, has been developed for preparing a curcumin loaded composite gel. The biological application of this approach has been demonstrated in animal model for wound care and the technology has been transferred to a private firm.

18. 12 lots of carrier-free ^{90}Y -acetate solution were separated from $^{90}\text{Sr}(\text{NO}_3)_2$ solution recovered from PUREX-HLLW using two-stage SLM generator system and supplied to RMC, Parel for radiopharmaceutical applications.

19. Ru-106 plaques were produced and supplied to different hospitals for the treatment of eye cancers located adjacent to optical nerve. In continuation with the development of pediatric plaque, Type approval for hospital supply was received from AERB.

D. Development of new technologies has always been one of our core strengths, making BARC a technology powerhouse. Several of these technologies are transferred to industrial and other sectors for commercialization. In this context, I'm happy to announce that an Atal Incubation Centre at BARC (AIC-BARC) is being established under the Aatma Nirbhar Bharat initiative of DAE. The Technology Development cum Incubation Centre shall serve the objective of linking India's robust startup ecosystem to the nuclear sector. AIC-BARC has been approved by Atal Innovation Mission, NITI Aayog and first tranche of financial grant has been received. I shall now draw your attention to some of the important and noteworthy contributions in the technology domain.

20. A 20 K helium refrigeration system with completely indigenously developed turboexpanders was successfully tested up to a maximum operational speed of 120,000 RPM and an efficiency of

over 70%. This paves the way for the development and deployment of larger refrigerator systems.

21. Indigenous cargo Scanner using Dual Energy LINAC, has been qualified as per global standards.
22. An alkaline water electrolyser for hydrogen production comprising a first of its kind single stack of 50 kW module, producing 10 m³/h hydrogen, has been successfully developed and demonstrated. The technology has been transferred to six industries (including 2 PSU refinery majors: HPCL & BPCL).
23. BARC in association with ECIL and IGCAR has developed a safe and secure PLC, NUCON series 1000 and 2000. NUCON PLC was launched at ECIL to create awareness about them among DAE units and other departments.
24. The development of dual energy XBIS has been successfully completed. The acquired images meet the international standards.
25. BARC in association with ECIL has designed, installed and commissioned Antenna Servo Control system for the 18-meter indigenous deep space network. This will facilitate S and X band tracking and receiving capability for ISRO's deep space program.

26. An inflatable, rapidly deployable "Portable Personnel Decontamination Unit" (PPDU) has been designed and developed for use during Radiological Emergencies in Public Domain.

27. A cylindrical graphite ionization chamber was developed as reference standard for strength determination of high dose rate Co-60 brachytherapy sources and calibration of secondary standard. This will help in enhancing the accuracy of dose delivery to the patients treated by the high dose rate Co-60 brachytherapy source.

28. A flexible, free-standing and highly sensitive CNT paper-based sensor has been developed. This sensor has been successfully used for the detection of toxic gases like ammonia, nitrogen dioxide and hydrogen sulfide at ppb level.

29. Two demonstration plants based on radiation-grafted cellulose matrix for removal of colors from industrial dye wastewater were installed at Jodhpur, Rajasthan in collaboration with the Jodhpur Industrial Association. The demonstration plant with a capacity of 80,000 liters, consists of two units which can be operated either as standalone units or in tandem.

30. A compact permanent magnet based Thermal Ionization Mass Spectrometer for precise isotope ratio measurements of Lithium isotopes was developed and deployed.

31. Compact Vacuum Pumps suitable to maintain Ultrahigh vacuum in sealed vacuum chambers have been developed. The pumps can maintain high vacuum even in the event of power failure and will find usage in accelerator installations.

E. BARC also works and supports work on cutting edge basic sciences and applied sciences. I shall now mention some of the salient contributions on this front.

32. Under the programme to develop indigenous Certified Standard Materials (CRMs), dolomite and bauxite were prepared in collaboration with AMD and NALCO, respectively.

33. The new Atomic Molecular and Optical Science (AMOS) Beamline being developed at the undulator Port BL-5, Indus-2 Synchrotron has been fully installed and tested. It is used to carry out advanced research studies in photophysics, photochemistry and materials.

34. The Synchrotron beamlines at Indus-1 and Indus-2 have been operating round the clock for the benefit of scientists and industrial users. In the year 2022, 279 users from various

universities & institutes and 6 users from the industry have utilized the beamlines.

35. The MACE telescope at Hanle, Ladakh has been successfully operational for more than a year. During this period, the telescope has detected high energy gamma-ray emission from the Crab Nebula located in our Milky-Way Galaxy and energetic gamma-ray photons from an Active Galactic Nuclei Markarian 501 beyond our Galaxy.
36. BARC characterized the black hole in the black hole x-ray binary MAXI J1348-630 which was discovered in 2019. The characterization of astrophysical black holes by measuring their mass and spin gives an understanding of the formation and the evolution of black holes.
37. Two large area position sensitive compact Multi-Wire Proportional Counter (MWPC) detectors have been developed and successfully utilized at BARC-TIFR Pelletron-LINAC Facility, enabling the observation of exotic 'super-short mode' of fission in Mendelevium-257.
38. The Pelletron Accelerator has been consistently delivering a variety of ion beams round-the-clock to diverse users for carrying out research in nuclear physics. In the year 2022, 27 experiments

have been conducted by users from DAE and university institutions.

39. The National Facility for Neutron Beam Research (NFNBR) in Dhruva reactor was utilized effectively, with 53 experiments being conducted in condensed matter physics using neutron beams, by users all over India.
40. BARC developed supercomputer "PRAGYA" is being used extensively for Artificial Intelligence and Machine Learning applications.

F. Development and upgradation of infrastructure at BARC, both technological as well as towards employee welfare, is an ongoing process and some of the recent additions and improvements are as follows

41. Installation and Commissioning of TETRA network for real time transfer of background radiation data inside BARC campus for real time monitoring at ICCM, BARC has been completed.
42. Software solutions and infrastructure for employees such as delivery of pathology reports of CHSS beneficiaries directly to their email addresses, SARAL Pension Processing Module in AAIIS

and Cloud Computing Service 'Megh' have been successfully deployed during this period.

43. High efficiency continues to be maintained on the services front, ensuring more than 97% availability of all Civil, Electrical & Mechanical utility services during the period.

G. It is now my pleasure to mention some of the honours and awards bestowed upon BARC scientists during this period.

44. Dr. S. M. Yusuf received the Distinguished Lectureship Award of the Materials Research Society of India (MRSI).
45. Dr. Sugam Kumar has been awarded the 'The National Academy of Sciences, India (NASI)- Young Scientist Platinum Jubilee Award-2021'.
46. Dr. Ranjan Mittal received "MRSI Materials Science Annual Prize" for the year 2021.
47. Dr. R. S. Ningthoujam, has been selected for the prestigious MRSI Medal.
48. Dr. S. Krishnagopal was elected as a Fellow of American Physical Society.

49. Dr. A.K. Tyagi, Smt. Smita Manohar, Dr. (Smt) Gopika Vinod were elected as Fellows of Indian National Academy of Engineering.
50. Dr. (Smt) J. Mohanty was elected for SERB Power Woman Fellowship.
51. Dr. S.M. Yusuf and Dr. H.S. Misra were elected as Fellows of Indian National Science Academy.

Dear colleagues, in the limited time available, I have been able to bring out only a few representative contributions during this period. There is a lot more which goes on in various domains, and the excellence of our scientific and technological contributions is well reflected in the successes of our programmes and the outstanding quality and quantity of our published work, which score high on citation and various other quality indices. This could be achieved only due to the sustained efforts of our entire team scientists and technologists. I would like to take this opportunity to acknowledge the role played by every individual, section, division and group, who have contributed collectively to this magnificent team effort.

Sincere gratitude is also extended to personnel of auxiliary services and support personnel who have worked tirelessly behind the scenes and ensured that the machinery and ecosystem of BARC is kept running seamlessly. This includes services provided by Medical Group, Engineering Services Group, BARC Safety Council, Scientific Information Resources Division, Personnel & Accounts Divisions, Security Section, CISF, Fire Safety Section, Landscape and Cosmetic Maintenance Section, Transport & Catering Sections and many more who have individually and collectively contributed silently to the success of this organization. Our acknowledgements 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.

Thank you and Jai Hind