

## **Founder's Day Address**

By

**K.N. Vyas**

**Director, BARC**

**Friday, 28<sup>th</sup> October 2016**

Dr. Sekhar Basu, Chairman, AEC, Senior Members of the DAE Family, Distinguished Invitees, Representatives of the Media, my dear Colleagues, Ladies and Gentlemen,

It is indeed a matter of great pleasure and proud privilege for me to extend a warm welcome to all of you to the Founder's Day functions scheduled today.

It has been our tradition to pay respectful homage to our visionary Founder, Dr Homi Jehangir Bhabha, on his birth anniversary, the 30<sup>th</sup> October every year. The 107<sup>th</sup> Birth Anniversary of Dr. Bhabha falls over the weekend this year and hence this function is held today. This is an occasion for introspection on our performance and achievements of the past year, as well as

to re-dedicate ourselves to continue to do our best in providing maximum benefits from the application of nuclear science and technology to our great nation and its people.

I will describe about the performance highlights of BARC during the last one year in various areas of our mandate, just to have a glimpse of the typical range and nature of our works and achievements.

**I start with some of our achievements in Nuclear Power related R&D, support to NPCIL and Research Reactor.**

1. UT based technique has been developed for detection of nodules on outer surface of coolant channels using BARC Inspection System. This was successfully field deployed at various PHWRs during recent ISI campaign.

2. Retention of core melt within the calandria of PHWR and AHWR has been demonstrated in a fully simulated experimental set up. In addition, a mini core catcher experiment has been completed. Such experiments will

provide an independent database for development of our indigenous core-catcher designs.

3. An integrated test of different passive systems was carried out to demonstrate that AHWR can withstand severe accident in case of prolonged station black out up to 7 days.

4. Dhruva Reactor was operated at rated power throughout the year and logged an availability of ~72.7% and a capacity factor of ~64.7%, which is the highest ever since it's commissioning.

**Our teams made laudable achievements in developing and producing Advanced Nuclear Fuels & Special Materials.**

1. For the first time, PIE of two fuel bundles from 540 MWe (TAPS-1&2) reactor have been carried out in New Hot Cell facility, where performance of fuel bundles with 37 fuel elements have been examined.

2. Process flow sheet was developed for making plate fuel elements with natural uranium based  $UAl_2/UAl_3$  compounds dispersed in aluminium matrix and with Al-alloy clad as target elements. These elements are to be used for the production of  $Mo^{99}$  medical isotope.

3. A High vacuum high temperature pressing and sintering unit of 100 Tonne capacity has been commissioned at our Vashi Complex, for making beryllium metal and beryllia ceramic to near net shape and to their near theoretical density. The unit is integrated with hot ejection facility and is capable of making dense shapes of metal and ceramics with diameters up to 300 mm.

4. Specific grade of beryllia ceramic having high dielectric constant has been developed for use as heat sink in high power output electronic devices, such as multiplexer for communication satellites.

5. Carbon nano-tube incorporated light weight bullet proof jacket has been successfully developed and tested for the armed forces.

**We continued to make commendable contributions in the field of reprocessing and waste management.**

1. PREFRE-2 reprocessing plant at Tarapur continues to give excellent performance and achieved highest ever through-put in the year 2015. Kalpakkam Reprocessing Plant (KARP) performed very well. Advanced vitrification and treatment plants at Tarapur also gave best ever performance in 2015.

2. PHWR spent resin cementation system has been commissioned for the first time in plant scale at WIP Kalpakkam. The spent resin received from MAPS was fluidized and fixed in cement matrix successfully. ILW treatment system continued to operate very well and one more waste storage tank of KARP has been emptied.

3. A centrifuge decanter system has been successfully commissioned at Plutonium Plant Delay Tank for collecting muck and operation of ten batches has been completed.

4. Multi step solvent extraction process was employed for the separation of high specific activity  $^{90}\text{Sr}$  from PUREX-HLLW. This activity was used to separate carrier-free  $^{90}\text{Y}$  in acetic acid medium using two stage supported liquid membrane generator system developed in-house, for radiopharmaceutical applications.

5. TBP based solvent extraction process flow-sheet was tested for the recovery of uranium from natural uranium based silicide fuel employing laboratory scale mixer settlers. This study was done for spent fuel of HFRR.

6. High resolution Large area silicon detectors for alpha particles have been developed and tested in collaboration at IGCAR for development of Pu in air monitoring at fuel reprocessing/fabrication facilities at IGCAR. Production of these units is underway for large deployment in fast reactor fuel reprocessing plants at IGCAR.

## **Let me now bring out some of the major outputs of our R&D efforts in Chemical and Physical Sciences**

1. A high end two-dimensional infrared spectrometer, first of its kind in India, which offers time resolution of a few tens of femto-second has been developed for advanced studies in chemistry and biology. A laser scanning confocal fluorescence lifetime imaging and single molecule spectroscopy setup has been developed, which is also first of its kind in India.

2. Novel lead-free X-ray shield has been developed by a facile solvent-free procedure which yields cost-effective standalone polymer-ceramic composite sheets. It possesses exceptionally superior mechanical behavior with stretchability of 400% even at a high loading of 80 wt% filler. A sheet of 560 microns could provide an attenuation of 99.5% for X-ray beam at 60 kV.

3. Second stage preclinical trial of DSePA, an indigenously developed radio-protector, has been successfully completed in collaboration with ACTREC.

4. Test facility for production of solar hydrogen using two-step hybrid sulfur thermo-chemical cycle has been developed. The high temperature (800°C) required for the thermo-chemical cycle is obtained using a 1.8m dia solar concentrator.

5. In search of super-heavy-nuclei, the average number of prompt neutrons that may be emitted in the spontaneous fission processes were estimated through compound nucleus excitation energy for atomic number ( $Z$ ) = 104, 116 and 124 for the first time.

6. A novel Glancing Angle Deposition (GLAD) thin film process has been established to develop multilayer-equivalent high performance broad-band antireflection coatings and devices for high power laser applications in the visible wavelength regimes.

## **BARC has continued the pioneering work in the field of application of radioisotopes**

1. The first of its kind Radiation Technology based 100 tons/day Sewage Sludge Hygienation facility is coming up at Ahmedabad. About 60% work has been completed and the plant is expected to be operational by October 2017. This would contribute to the Swachh Bharat Abhiyan and help making cleaner and healthier India.
2. Support to the Indian industry was continued using detailed radiotracer investigations in detecting leakage in high pressure heat exchanger systems at M/s IOCL, Panipat Refinery, Haryana successfully, resulting in substantial economic benefits.
3. Construction of new hot cells in Common Facility Building (CFB) is completed and is in commissioning stage. The hot cell facility at HIRUP has been operated commensurate with regulatory requirement for loading of Cs-137 source pencils in blood irradiator in addition to its continued utilization for fabrication of multi kilo curie level

Co-60 sealed sources for various medical and industrial applications in coordination with BRIT.

4. Polyurethane based foam modified through *gamma radiation grafting technique* has been developed which can separate oil/water from layered as well as from emulsified oil/water mixture. The material has promising applications for oil spill cleaning from water, purification of crude oil, emulsified waste water produced in industry and daily life. The material is scalable, mechanically flexible, extensively reusable and economic.

**During this period, it was possible for us to develop and transfer many new technologies for societal applications.**

1. A Bio-degradable oxocatalyzed polyolefin food packaging film was developed in collaboration with Institute of Chemical Technology, Mumbai. On disposal of these films in the open landfills, in presence of humidity and sunlight, the catalyst develops persistent oxidative radicals, which degrade the polymeric chains. The polymer

waste degrades completely within a period of 6-8 months without release of any toxic gases or any residue. The films developed using electron Beam/Gamma irradiation has improved mechanical and barrier properties. It is nontoxic, nonhazardous and safe when in long-term contact with food. The technology is currently being transferred to industry.

2. A bio-pesticide formulation has been developed to kill mosquito larval population in water pools. Its efficacy has been tested under field conditions in different cities of India. The material is non-toxic to human population.

3. A simple and low cost method based on an innovative chemical agent is developed for removal of fluoride from contaminated ground water. In partnership with a private firm, the method has been successfully tested in 10 different villages of Madhya Pradesh.

4. Technology of turmeric based nutraceutical was transferred to a private firm for commercial production.

5. A simple, low cost and portable kit has been developed for detection of chromium in drinking water. This kit provides a much needed method for field detection of carcinogenic chromium (VI) in ground water particularly around the Ganga belt. Technology has been transferred to a private firm for implementation.

6. Indigenous development of dual energy X-ray baggage scanning system using the in-house developed photodetectors has been completed under collaboration with Bharat Electronics Limited. The significance of this development rests on the fact that for the first time in India, pixalated X-ray detectors, which are the most critical part of XBIS are designed and made in India.

7. Technology of polyamide based sea water desalting membrane capable of giving 99% salt rejection with sea water has been developed and transferred to a private firm. Production of commercial size membrane modules based on this technology has been started. This is the first time in India that the sea water desalting membrane and module have been made using indigenous technology.

8. We have commissioned and fine-tuned the Multi-effect Distillation-Thermal Vapour Compression (MED-TVC) technology by commissioning 240m<sup>3</sup>/day seawater thermal desalination plant.

**Significant contributions have been made in the field of Robotics and Remotization during the last one year.**

1. A semi-automated staircase climbing trolley has been designed and developed for material transfer through staircase, upto payload of about 70 Kgs, with single person without any other assistance. This is aimed at providing a low cost solution for taking patients/disabled persons through staircase.

2. A high precision portable surgical coordinate measuring mechanism has been developed for neuro-registration and neuro-navigation. A six-degree of freedom parallel robot for robot based neurosurgery has also been developed. The systems have been function tested in the laboratory. These are ready for clinical trials in the Hospitals. As against commercially available servo-controlled robotic surgical tools, these novel parallel type

architecture based robotic tools are first-of-its kind and provide low-cost surgical solution in the Healthcare.

3. As you are aware, BARC has developed the cobalt teletherapy machine Bhabhatron. There has been a continuous effort in improving the performance of 'BHABHATRON' in terms of dose conformity. Towards this, Multi-Leaf-Collimator (MLC) has been designed, developed and integrated with one of the BHABHATRON unit at ACTREC, Mumbai. Its performance evaluation has been successfully completed. It has shown better dose conformity to irregular tumor boundaries, leading to its superior clinical performance. Test reports have been submitted to AERB and regulatory approval is expected shortly.

**We have made major contributions to meet the specific requirements of our nation.**

1. Target search trial has been completed successfully for using indigenously developed X-band Active Radar Seeker using a stationary target during a captive flight trial.

2. A user acceptance trial for LWR Control systems at Integrated Test facility set-up in BARC was completed. These modules are in the process of being dispatched to site.

3. The Radiation and Gas Monitoring System (RGMS) has been delivered for project after completing the integrated testing and user acceptance trials. The development of indigenous Radiation and Gas Monitoring System is a major achievement for compact Light Water Reactor systems.

4. A Compact Electrolyser plant process skid for oxygen production, developed as a life support system. The system was tested and dispatched to site.

**We have continued to support our space programme in different areas.**

1. The indigenous development of Servo controller and 3 axis drives for the 4.6 m Ship-borne terminal has been carried-out by BARC and ECIL in the framework of a

contract by ISTRAC/ ISRO on ECIL. The unit is undergoing integration, functional and qualification tests on an indigenously developed single axis ship motion simulator.

2. A Collimator housing assembly and its supporting platform for Neutron radiography facility have been designed, manufactured and supplied to VSSC, Trivandrum under a MoU. The system has been successfully installed at VSSC.

**Let me bring out some of the recent achievements in Environmental Monitoring and Radiation Safety.**

1. Special monitoring systems like Portable Spectrometer were developed for 35<sup>th</sup> Indian Scientific Expedition to Antarctica by BARC team jointly with National Centre for Antarctic and Ocean Research (NCAOR), Goa. In addition to these, monitoring system under Indian Environmental Radiation Monitoring Network (IERMON) was also established at 'BHARATI' station and used for environmental radiation monitoring as well as detection and assessment of Thorium in certain locations.

2. A head and Neck phantom has been developed for dosimetry audit in advanced radiotherapy techniques. It will be useful for testing the accuracy of dose delivered to the target organ in advanced radiotherapy techniques. It represents average human head and neck in shape, proportion and composition. Implementation of dosimetry audit will improve the quality and accuracy of radiotherapy treatment.

**Continuous efforts are being made to improve infrastructural facilities in various BARC campuses.**

1. As a pre-project activity of proposed New Beryllium Facility at Pazhayakayal, Environmental impact assessment and environmental management plan for both terrestrial and marine have been completed in accordance with the terms and reference of MoEF&CC. The reports have been submitted to obtain environmental clearance.

2. Construction of New Electronics & Safety Complex has been completed and the facility is commissioned in BARC.

3. Under rain water harvesting program, water treatment plant for utilizing lakes located near PP and at foot of Trombay Hill, has been completed and commissioned leading to capacity augmentation of 35 million litres.

4. 6000litres capacity Liquid Medical Oxygen Facility was commissioned at BARC Hospital.

**In modern times, computational facilities and networking systems are an integral part of infrastructure. I will mention some of the major enhancements.**

1. BARC has developed a new parallel supercomputer '**ANUPAM-AGANYA**'. The system has been designed and integrated in-house by using commodity hardware and open source and in-house developed software. The peak performance of the system is 380 Teraflops and the sustained performance is 270 Teraflops.

2. BARC in association with CDAC, Trivandrum has developed Network Management System – **PRABANDH** which is meant for monitoring and managing large sized

networks. This has been successfully deployed in ANUNET, National Knowledge Network, Kerala University Network and NIC Network.

3. To facilitate the maximum usage of online digital library resources from off-campus premises, Scientific Information Resource Division (SIRD) has launched new facility named as “Home Office or Anywhere (HOoA)”. This facility is also extended to researchers for BARC outstation units.

### **Dear Colleagues,**

I have mentioned to you highlights of some of our achievements. The list of achievements is very long and due to constraint of time, I am not able to mention many of them. But I must acknowledge the contribution of all my colleagues in BARC, who have worked very hard towards achieving our goals and objectives.

My special thanks are to Medical Division, Administrative Group, Engineering Services Group, Landscape and Cosmetic Maintenance Section, Fire Services, BARC

Security and CISF. I also thank members and office bearers of associations and unions for their support, which made all our achievements possible.

While acknowledging these achievements, I must emphasize that we have plenty of challenges ahead. As you are aware, that under NITI Aayog directive, we need to define our 15 year vision, along with identification of deliverables for 3 and 7 years. Hence, we must clearly define our goals and not shift our focus from achieving the same. I am sure that with the coordinated efforts from all of us in BARC; that is scientists, engineers and administrators; we will be able to rise to the occasion to meet the future challenges in a manner consistent with the expectations and tradition of BARC.

Before concluding, I take this opportunity to announce that the BARC Employee's Family Relief Scheme support to bereaved family is enhanced from Rs.1.5 lakh to Rs.1.6 lakh with effect from 30.10.2016.

Colleagues, on this very special day, let us firmly resolve and rededicate ourselves to continue our pursuit of excellence in the frontier areas of nuclear science and technology for the betterment of the life of our fellow countrymen, as envisaged by our visionary founder Dr. Homi Jehangir Bhabha.

**Thank you and Jai Hind**