

## Republic Day 2016

Good Morning,

Dear Colleagues,

Today, we are celebrating our 67<sup>th</sup> Republic Day. We have assembled here to salute our national flag, and express gratitude to the armed forces of our country, who make the nation secure. We also stay committed to the service of nation through our diverse and focused research and development program.

I will now mention some of our recent achievements.

We begin with the ones which have direct societal connection.

- A.1 For taking forward the BARC's genetically pure quality seeds programme, a total of 340 quintals of breeder seeds of Trombay groundnut varieties were produced and distributed to 19 agencies in nine states of India (Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and West Bengal).
- A.2 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 enterprise, the method has been successfully tested, bringing fluoride level from toxic to below permissible limits, in 10 different villages of Madhya Pradesh.
- A.3 A community-kitchen-project, based on BARC Nisargruna plant at Kurudampalayam in Tamilnadu, has proved very successful. Likewise, a Nisargruna plant at Yerawada Jail is processing ~ 3.5 MT of food waste daily and supplying methane equivalent to 4 commercial LPG cylinders to their kitchen. Last year we established 10 more Nisargruna plants taking the total number to 200.
- A.4 To provide low-cost surgical solution in the Healthcare, a robot having six-degrees of freedom has been developed for neurosurgery. The systems have been tested in the laboratory and are ready for trials in the Hospitals.

- A.5 Production of 50 units of Cs-137 glass pencils were completed for their deployment in blood irradiator. It is matter of pride that India is the first country to supply the Cs-137 in non-dispersive form for a societal application.
- A.6 Development of freeze-dried kits of Prostate Specific Membrane Antigen, PSMA-11, has been carried out for preparation of Gallium-68 - PSMA, as a potential diagnostic radiotracer for PET imaging of patients with prostate carcinoma.
- A.7 Microbiologically safe, ready-to-eat, mung-bean-sprouts were developed using radio-chemical treatment. This showed complete elimination of microbial load and insignificant effect on the sensory features even after storage upto 12 days.
- A.8 To provide a low cost solution for taking patients/disabled persons through staircase, a semi-automated staircase climbing handcart has been designed and developed for payload of about 70 kg and handle able by single person.

Now I may tell you some of the specific developments related to the success of our multidisciplinary activities.

- B.1 Indian environment & Radiation Monitoring Network programme (IERMON) has registered its international presence with installation of two customized IERMON systems at BHARATI, Antarctica, by the Indian expedition team of BARC. This will continuously monitor the cosmic and terrestrial components of gamma radiation there.
- B.2 BARC, in collaboration CDAC, Trivandrum, has developed and deployed a Network Management System – PRABANDH NMS – (Pervasive Resilient Accountable Bhartiya National Distributed Hierarchical Network Management System) for monitoring and managing large sized networks. This is a part of indigenization drive initiated to monitor and secure critical and sensitive networks of our country. This product has been successfully deployed in ANUNET (DAE wide area network), National Knowledge Network, Kerala University Network and NIC Networks.
- B.3 30 mCi of Yttrium-90 was delivered to Radio Chemistry & Isotope Group for radio-pharma development and testing for liver cancer treatment.
- B.4 A X-ray camera has been developed using the CsI: Tl single crystal based scintillator screen with a resolution of about 100  $\mu\text{m}$ . Devices based on fast scintillator BaF<sub>2</sub> have

also been developed to record spatial profiles of flash X-ray sources with 20 ns resolution.

- B.5 A single gap accelerating column table top neutron generator with neutron source strength of  $\sim 10^8$  n/s has been developed. This generator can be operated either in D-D or D-T mode. Both continuous as well as pulsed mode operation has been achieved in this generator.
- B.6 A 100kV, 25A Regulated High Voltage Power Supply (RHVPS) for 1.2MW klystron of RF power system has been designed, developed and commissioned at LEHIPA (Low Energy High Intensity Proton Accelerator). This supply was successfully operated up to 65kV along with klystron & RFQ. 1.2MeV proton pulsed beam was achieved at 200kW RF power.
- B.7 200m long, Nb-Ti based 30kA superconducting Cable-In-Conduit-Conductor (CICC) has been fabricated, tested and delivered to IPR, Gandhinagar for magnet fabrication towards national fusion programme.
- B.8 A novel uranium recovery process from lean carbonate leach liquor has been developed for very quick recovery of uranium. Process has been demonstrated at UCIL Mill (Tummalapalle) and selected as a reserve technology for UCIL.
- B.9 A facility has been developed for calibration and inter-comparisons of all active monitors and passive devices used for the measurement of radon, thoron and their decay products. This is envisaged as a national facility to be available to all institutes and universities engaged in radon research.
- B.10 BARC seismic network detected a presumed underground nuclear explosion conducted by North Korea on 06/01/2016. Signals from our seismic stations were analysed and the event was reported to authorities within about half an hour. Waveform recorded by seismic stations show good match with those recorded in the past from known events.
- B.11 A solar photo-bioreactor capable of treating domestic wastewater and simultaneously generating biomass is developed. Laboratory trials have shown that the bioreactor can cause significant reduction in the turbidity (50 NTU to 2 NTU), total organic carbon (43 ppm to 6 ppm), pathogen count (by four orders of magnitude) and phosphorus to below discharge limit.

In view of technology denial we have to make many critical items in-house so that we can carry on our functions without interruptions. I would now mention a few of these.

- C.1 A complete set-up, named BARC Vessel Inspection System (BARVIS) has been indigenously developed for underwater ultrasonic inspection of welds in the core belt region of the reactors. After obtaining AERB approval, BARVIS has been deployed in TAPS-2 and our inspection team has successfully carried out the inspection of the welded joints. This is a challenging task of international quality.
  
- C.2 To check the integrity of the tube of Steam Generators of KKNPP-2 (Kudankulam Nuclear Power Plant) **and** similar systems at high pressure, a rig was designed, manufactured and commissioned. The tubes have been tested at 720 bar for safety clearance.
  
- C.3 The 3D space-time kinetics code ARCH used for core simulations has been augmented with several reactivity feedbacks such as fuel and coolant density. It has been successfully coupled with the system code RELAP/MOD3.2 for coupled neutronic and thermal hydraulics simulations for AHWR.
  
- C.4 Test facility for production of solar hydrogen using two-step hybrid sulfur thermo-chemical cycle has been developed. Both the steps viz., decomposition of sulfuric acid and electrolysis of sulfur dioxide, have been demonstrated.
  
- C.5 Feasibility of isotopic enrichment of Gd-155 and Gd-157 from natural Gadolinium has been established using indigenously synthesized PMA-DB18C6 resin in column chromatographic mode.
  
- C.6 An integrated solvent extraction scheme was developed for the purification of erbium from its intermediate concentrate (4%  $\text{Er}_2\text{O}_3$ ). The process comprised adoption of two solvent systems namely, Aliquot 336 –and EHEHPA (thiocyanate and ethyl hexyl ethyl hexyl phosphonic acid) chloride and the purity of erbium was upgraded to around 80%. Final purity of >99 % erbium was achieved by ion-exchange method.

- C.7 An automated image analyser system capable of counting the tracks produced by fast neutrons in the CR-39 solid state nuclear track detectors has been developed. The system is capable of processing 20 detectors at a time in a time space of about 2 minutes. It is being used for extending neutron personnel monitoring services to DAE and non-DAE institutions.
- C.8 A scanning type whole body counting system based on HPGe detector has been commissioned at BARC Hospital for improved assessment of internal contamination due to gamma emitters such as I-131, Cs-137, Cs-134, Co-60, Zr/Nb-95 etc.

BARC continues to excel in the developments related to our research efforts,  
For example,

- D.1 Two prototype ASICs namely ANUPAL-II and ANUSPARSH-III have been designed, fabricated and tested using 0.35um CMOS technology. These are developed for use in Front end electronics for Indian Neutrino Observatory (INO). ANUINDRA-ASIC has been designed, fabricated and tested for use as Front –end electronics in ALICE Focal prototype experiment.
- D.2 A high end two-dimensional infrared spectrometer, which offers time resolution of a few tens of femto-second, and is first-of-a-kind in India, is 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.
- D.3 As part of international R & D efforts being pursued to improve the understanding of the hydrogen risk phenomenology in nuclear containments, BARC is participating in the OECD-NEA Hydrogen Mitigation Experiments for REactor Safety (HYMERES) project. We have actively contributed to the CFD-based scoping and benchmarking calculations for the experiments being performed in the PANDA (PSI, Switzerland) and MISTRA (CEA, France).

It is a constant endeavour of the department to continuously improve convenience, security and infrastructural support to employees. Towards that end,

- E.1 BARC has developed web based SMS portal for use of administrative, security and safety services. It allows SMS messages to be sent to mobile phones from network. This service is

being used by several groups in BARC. For example, Medical Division uses it for intimating status of Medical bills and by Personnel Division to disseminate information to job applicants and trainees and by BARC security for security related operations.

- E.2 Upgradation work of Dental Laboratory at BARC Hospital has been completed.
- E.3 Construction of Chemical Incinerator has been completed and the facility is commissioned.
- E.4 In order to further strengthen the security arrangements and physical protection systems of BARC premises, the Trombay Village Stores (TVS) area and the area between Western Sector & Gadkari Quarry, have been brought under the control of BARC (and CISF).

Dear Colleagues,

Let me now mention now some of our special achievements, made possible by the efforts of a large number of our colleagues.

- F.1 PREFRE-2 at Tarapur, and KARP at Kalpakkam, surpassed their previous records of excellent performance, with the highest ever capacity achieved in 2015.
- F.2 HLW Vitrification System of WIP Tarapur and ILW systems of WIP, Tarapur and Kalpakkam have created operational records by processing higher than their rated capacities. The Uranium Separation Plant at WIP, Kalpakkam was operated and Uranium from HLW was recovered successfully leading to emptying of one HLW storage tank of KARP. First time, the cement fixation of radioactive spent resin received from MAPS has been successfully carried out at WIP, Kalpakkam.
- F.3 Augmented alkali metal plant is now in regular operation and performing as per designed rate and quality.
- F.4 95% of the MOX Fuel requirement for the first core of the PFBR has been fabricated and supplied.
- F.5 A natural UO<sub>2</sub> fuel bundle with burn-up exceeding 22000 MWd/TU from KAPS-1 and a MOX fuel bundle from PHWR were examined in new hot cell facility (NHF) and was found to have performed satisfactorily.

- F.6 280 fuel clusters and required number of Al-shields, SS seal plugs were supplied to Dhruva for its continuous operation at full power of 100 MW.
- F.7 As a part of up-gradation of Control & Instrumentation of Dhruva reactor, computer based Trip Logic system and start up logic system was successfully installed and commissioned in Dhruva. Despite this necessary outage, Dhruva continued to operate at the rated power of 100 MW, with lower rate of fuel failure, and with an availability factor of about 76%. About 700 radioisotope samples were irradiated during the year. An adjuster rod was installed for production of  $^{60}\text{Co}$  of very high specific activity.
- F.8 Critical Facility (CF) for AHWR was operated on 66 occasions during the year for various experiments, mainly testing of nuclear detectors and irradiation of large volume samples for Neutron Activation Analysis (NAA).
- F.9 The production and qualification of a plant wide networked, Radiation and Gas Monitoring System (RGMS) for process monitoring of the nuclear plant and operating personnel, consisting of total 220 units in 28 types for project B1, has been completed and ready for shipment to site.
- F. 10 This year we will be celebrating 'World of Materials: role of materials and technology in national developments' on National Science Day. Apart from lectures on several topics, school and college students will be invited to visit various facilities inside BARC and observe materials science experiments.

Constant efforts are being made to make our technologies available to the Indian industries. Last year 25 technologies were transferred to 50 parties. These include,

- G.1  $\text{H}_2\text{S}$  sensors operable in 10-50 ppm range
- G.2 SMPS based sputter ion pump power supply
- G.3 In addition a Quadrupole Mass Spectrometer was developed by ECIL under BARC guidance for meeting the requirement of NPC for measurement of hydrogen and other gases, as part of safety measures in Nuclear Power Plants.

G.4 Also under a MoU between BARC and VSSC (Vikram Sarabhai Space Centre), a Collimator housing assembly and its supporting platform for Neutron Radiography facility was designed, manufactured and supplied to VSSC.

In the end, we must thank all our colleagues, who have worked behind the scene in keeping the vital services operational in our campuses all over the country, they include Engineering Services Group, Medical Division; Administrative Group, who take care of all functions in the fields of administration, establishment, manpower planning and personnel data management; Finance and Accounts. We also acknowledge Floriculture, Landscaping and Cosmetic Maintenance groups for the beautiful ambience of this venue and our gardens. Special thanks to all the association in BARC for extending supports in achieving all this. Campus security is of prime concern for our Centres all over the country. BARC security and CISF personnel have made commendable contribution in keeping this establishment incident free. Special thanks for the Fire Services personnel in our campus for protecting our personnel and equipment. All of them have worked with dedication and sincerity, which made these achievements possible.

Thank you

Jai Hind