

63rd Republic Day of India**26th January (Thursday), 2012****09:00 hrs*****Address by******Dr. Ratan Kumar Sinha******Director, BARC***

Dear Colleagues,

I convey my hearty greetings to all of you on the occasion of the 63rd Republic Day of our country. Every year, as a part of this celebration, we salute our national flag. We remember with reverence the members of our armed forces, who provide security to our country.

The function provides us an opportunity to review the highlights of our recent activities and some major achievements during the past year. Taking stock of the programmes of our vast organisation of over 15000 colleagues is a voluminous exercise. Therefore, on this occasion today, I intend to touch upon several representative activities and resultant outputs, just to provide glimpses of our achievements during the recent past. A larger version will be placed on our web-site and also printed in BARC Newsletter.

Research Reactors

Research reactor Dhruva continued to be well utilised for isotope production, research, material testing and human resource development. The users included research scholars from various academic institutions. During the year 2011, nearly 1000 radio-

isotope samples were delivered for medical and other uses. One hundred and sixty-seven samples were irradiated in pneumatic carrier facility for various research purposes. An additional tray rod was installed in one of the fuel positions to meet the increased demand of radio-isotopes. Special boron alloy samples for the development of shut off rod materials for light water reactors and cobalt slugs for Blood Irradiators are also being irradiated in the tray rod. A prototype fuel assembly consisting of AHWR fuel pins is being irradiated in reactor, since June 2011, to study the irradiation behavior of thorium based mixed-oxide fuels.

Steps have been initiated to refurbish/replace various equipment and components of the 25 year old Dhruva Reactor to ensure its continued availability and safe operation. As a part of safety upgrade, two trolley mounted diesel engine driven pump sets were commissioned to provide uninterrupted core cooling during extended power outage condition.

Defueling and core unloading of Cirus reactor were completed during the year. Work on the upgradation of Apsara reactor to a 2 MW reactor is in progress.

Operation of the Critical Facility for Advanced Heavy Water Reactor (AHWR) was done on need-based manner several times, for various experiments; for example, for the measurement of moderator temperature coefficient of reactivity and for testing of detectors.

In addition to the design of a 30 MW High Flux Research Reactor (HFRR) design of a 125 MW research reactor for bulk irradiations and isotope production has commenced. Both these projects are proposed to be initiated during the XII Plan.

R&D and life-management support for Nuclear Power Reactors

Support for Operation of Nuclear Power Plants

BARC has developed and supplied BARCIS (BARC Channel Inspection System) to NPCIL for in-service inspection of coolant channels of 540 MWe PHWRs. Using this system, inspection of 16 coolant channels of TAPS-4 were recently carried out.

A Circumferential Scraping Tool for pressure tubes of 540 MWe PHWRs has also been developed to obtain sliver samples from rolled joint region of pressure tubes for the evaluation of hydrogen content in the samples.

A full scale mock-up trial of boat sampling system designed for removal of samples from the weld regions of core shroud of TAPS-1 & 2 was successfully conducted.

Control elements containing boron carbide were manufactured for TAPS-1&2.

Advanced Heavy Water Reactor (AHWR) Engineering Development

The AHWR Thermal Hydraulic Test Facility (ATTF) is a full-height experimental loop for AHWR, being built at Tarapur to simulate the integrated thermal-hydraulic behaviour of AHWR. The construction of the main facility building housing various systems of the facility simulating AHWR as well as the annexe building housing the electrical and control equipment has been completed.

AHWR design provides excellent flexibility in using different types of fuel. To demonstrate this capability, it was shown that 3.6% enriched uranium fuel can provide a discharge burn-up of nearly 60,000 MWd/Te.

Development of Computer Codes

A thermal hydraulic system code has been coupled with an indigenously developed 3-D space kinetic code and the coupled code used to simulate various reactor transients.

Based on the liquid film analysis, a mechanistic tool has been developed for the prediction of the design margin in the AHWR bundle and the code validated with data

under Boiling Water Reactor conditions. The results indicate a possibility of enhancement of the power from AHWR after experimental validation.

Experimental Programme on Nano-fluids

Several experiments performed with different nanofluids for heat transfer behaviour under pool boiling conditions showed that the Critical Heat Flux (CHF) increases significantly even with a small concentration of nanoparticles dispersed in water.

Fuel Development and Supply

Production of fuel assemblies for Dhruva reactor as well as for FBTR is being continued. Fabrication of MOX fuels for the first core of PFBR was continued and fuel pins are ready for initiating the assembly work at Kalpakkam.

The programme for the development of manufacturing technologies for advanced fuels for FBRs has progressed substantially. A few pins of metallic fuel containing U have been supplied to IGCAR for test irradiation in FBTR. Cermet fuels comprising 15 and 30 wt% UO_2 dispersed in U metal powder were characterised in terms of microstructure. As a part of the development of high conducting fuels, UO_2 containing 5% BeO was made and characterised in terms of microstructure and coefficient of expansion. Thermo-physical property evaluation, micro-structural studies and fuel-clad compatibility tests of U-Zr alloys, proposed to be used as blanket material, have been carried out.

(Th- U^{235}) O_2 fuel pin cluster and AHWR type (Th-Pu) O_2 fuel pins with varying Pu content were manufactured for experiments in AHWR Critical Facility, followed by irradiation in Dhruva reactor. A fabrication flow sheet for the manufacture of ThO_2 - $^{233}\text{UO}_2$ has been developed with the objective of reducing the personnel radiation dose involved in the manufacture of fuel for AHWR. Fabrication trials have been carried out for the manufacture of fuel and components for Compact High Temperature Reactor (CHTR) using surrogate materials.

Two model fuel assemblies containing natural uranium silicide with high uranium loading (i.e. 4.4 gm/cc) were fabricated for the new core of Apsara reactor to establish the parameters to fully develop the fabrication technology. I am glad to announce that the fabrication of actual fuel for the new Apsara, using indigenous enriched uranium has started last week in Trombay.

Reprocessing and Waste Management

The Plutonium Plant at Trombay continued to operate safely and irradiated research reactor fuel bundles were reprocessed.

The Kalpakkam Reprocessing Plant (KARP) crossed a new milestone in 2011 by processing the highest number of batches in one year.

For the first time in the country, a process has been developed for the synthesis of Hydroxyl Amine Nitrate (HAN) as an alternate solvent in spent fuel reprocessing.

Waste Management Facilities at Trombay and Kalpakkam operated safely and provided services with regard to the management of liquid and solid wastes to all the plants and facilities at these DAE Centres, duly maintaining environmental discharges well below the authorised limits.

Spent radiation sources received from all over the country, after their utilisation, were safely disposed.

Many of the installed systems of the newly built Power Reactor Thoria Reprocessing Facility (PTRTF) and Additional Waste Tank Farm (AWTF) at Trombay were cold commissioned. Vitrification technology employing Cold Crucible Induction Melter crossed another milestone by successful completion of simulated waste feed experiments. Complete design and engineering inputs were provided in respect of waste management plants of Fast Reactor Fuel Cycle Facility (FRFCF) at Kalpakkam.

Nuclear Recycle Board - Operations and Projects

The Power Reactor Fuel Reprocessing Plant (PREFRE – II) at Tarapur, which was inaugurated in January 2011 and hot commissioned by June 2011, started production since July 2011. Excellent operating performance in terms of safety, throughput and product quality has been achieved by this plant. Erection of equipment in the Project Power Reactor Fuel Reprocessing Plant at Kalpakkam (P-3A) is progressing well.

Radioisotopes and Radiation Technology

Radiotracer investigations using ^{82}Br as dibromobiphenyl were carried out for the detection of leaks in a shell-tube type high-pressure heat exchanger system in refineries.

A dry distillation process to enhance production and supply of ^{131}I was developed and implemented.

BARC continued to provide an interface to industry for developing and deploying radiation processing applications such as rubber composites, cable insulation, nano composites, railway liners etc.

Health, Safety and Environment

Radiation Detection

Development of beta gamma hand and foot monitor using state-of-the-art large area thin plastic scintillation detectors has been completed and the system has been deployed.

Dosimetry

Automated microprocessor based calibration systems have been designed and fabricated for use in personnel dose monitoring and quality assurance.

The patient dose in diagnostic X-ray radiography examinations is estimated using the dosimetric quantity called Entrance Surface Dose (ESD). ESD measurements were carried out using thermoluminescent dosimeter during different X-ray examinations at BARC Hospital since January 2011 and the data for 800 patients were acquired.

Monitoring of Radiation Workers and Environment

Environmental safety surveillance, radiation protection and industrial hygiene services in the front-end nuclear fuel cycle were provided to all operating units of Uranium Corporation of India Ltd., Indian Rare Earths Ltd. and Nuclear Fuel Complex. Radiation dose to occupational workers was found to be well within the limits prescribed by AERB.

Environmental Impact Assessment was carried out for the uranium mining projects at Gogi, Karnataka and Monazite Processing Plant at Chatrapur, Odisha. Baseline environmental survey was carried out for BARC, Vizag and Uranium mining project at Tummalpalle.

Emergency Preparedness and Response

Two new Emergency Response Centres (ERCs) have been established at Institute for Plasma Research, Gandhinagar and RMP, Mysore. Two hundred sixty security personnel were trained on Radiation Emergency Response.

Physical Sciences and Applications

Physics

The TACTIC telescope at Mt.Abu has been upgraded with improved focal plane optics and electronics, resulting in improved detection sensitivity, by a factor of about 2.

Thermal Ionisation Mass Spectrometer (TIMS) for Boron Isotope Ratio analysis has been developed for Heavy Water Plant at Manuguru.

A study on the use of Accelerator Driven Systems (ADS) as U-233 breeders showed that by a suitable choice of the effective neutron multiplication factor (Keff), it is possible to produce power in excess of the requirement for the accelerator, without significant loss in the U-233 production rate.

Reactor physics design studies of an electron accelerator based sub-critical neutron multiplying system were carried out.

A number of experiments on Small Flux Compression Generators were carried out during the last year with an impressive current gain of 40 and more achieved consistently. A plasma focus based fusion device was developed to generate more than 10^9 neutrons per pulse.

Estimation of energy release is important in nuclear safety of fast reactors. 1-D and 2-D coupled neutronic-hydrodynamic codes have been developed for dynamic simulation of pulsed fast reactors.

A process for preparation of nano-sized phase titanium oxide semiconductor catalyst by sol-gel route has been developed.

Chemistry and Radiochemistry

A new method for size and shape controlled synthesis of Resorcinol-Formaldehyde (RF) beads has been developed and tested satisfactorily for the extraction of Cs from alkaline waste.

An electrodeless co-deposition technique for the fabrication of Stainless Steel wire gauge supported Pt-Pd catalysts for hydrogen mitigation and production of the supported catalyst in large quantities has been developed, meeting the requirement of the Catalytic Hydrogen Recombiner Test Facility at Tarapur.

Mg-Pd composite powders, that reversibly store about 3.5 wt.% hydrogen upto 15 cycles under mild conditions of pressure and temperature, have been developed.

For developing bacteria resistance in fabrics, a simple route of its functionalisation with silver nanoparticles is established. Such fabrics have potential for application in societal, clinical and high-end areas like defence and space.

The facility for correlated measurement of positron lifetime, annihilating electron momentum, age and momentum correlation has been set up.

A novel tripodal diglycolamide was evaluated as an extractant for actinides by batch solvent extraction and Supported Liquid Membrane (SLM) studies.

Materials and Metallurgy

Experimental conditions were optimised for the separation of yttrium, which forms a major constituent, in the raffinate phase from a chloride feed.

As a part of our work for the production of fuel for High Temperature Reactors, TRISO coating unit was commissioned for handling uranium oxide fuel kernels. A centrifugal granulator coating facility to produce the carbon overcoat on TRISO particles was also commissioned.

PFBR requires antimony – beryllium neutron source for start up of the reactor. A couple of hot pressed beryllium blocks with requisite specifications have been recently fabricated in the beryllium related facilities at Turbhe. The first stack is expected to be delivered by March end 2012 and balance by the end of the year.

A powder metallurgy based process for the manufacture of aluminum metal foam has been developed. With superior energy absorbing characteristics, this material is well-suited for use in transport package containers.

Life Sciences

The kinetics and dynamics of proteomic changes leading to the post-irradiation recovery of the extremely radioresistant microbe *Deinococcus radiodurans* were elucidated.

Uranium biorecovery - bioremediation studies revealed the potential utility of the marine filamentous nitrogen-fixing cyanobacterium *Anabaena torulosa* and of the genetically engineered *Deinococcus* strain.

Advanced Technologies and Applications

Electron Accelerators and High Power Electronics

The 10 MeV, 10 kW RF Linac at Electron Beam Centre, Kharghar, has been operated regularly at 3 kW beam power and utilised for experimental studies.

A 3/6 MeV dual energy compact linear accelerator for X-ray cargo scanning applications has been designed. The components of the prototype system have been re-engineered for regular production.

Remotisation & Robotics

BARC has transferred the technology of Digital Radiotherapy Simulator to industry. This simulator is useful for proper selection of size and orientation of the radiation beam for efficacious treatment of cancers.

BARC has developed a force reflecting tele-robot, which represents a new generation of remote handling technology with several advanced features.

A Mobile Robot agent has been developed for remote working in hazardous areas with a pay-load up to 3 kg and spherical workspace of 1100 mm radius.

A precision viewing head with servo-controlled autonomous tracking of cell arm has been developed that offers predictive viewing, 'look ahead of hand' mode of functioning, in cell operations.

Chemical Engineering and Technology

A Technology Demonstration Plant for the production of Sulphur Hexa-fluoride gas has been commissioned. Shrouded turbine and brake wheel impeller for helium refrigeration plant has been developed. A prototype compact electrolyser plant was successfully installed and commissioned. Lithium Metal Plant was commissioned and operated .

Computer Services

The BARC Anupam-Adhya parallel processing supercomputer with sustained performance of 47 Teraflops has recently been upgraded to achieve 512 Terabytes of storage capacity.

In the area of cyber security, BARC has developed and deployed a unique Secure Network Access System (SNAS) that integrates functionality of Firewall, Intrusion Detection System, Network Monitoring and client PC security.

Advanced Instrumentation

For up-gradation of control and instrumentation systems of Dhruva, reactor trip logic system, emergency core cooling system, startup logic system and alarm annunciation system have been developed, based on in-house developed programmable logic controller TPLC-32. Several highly customised sensors for nuclear reactor applications have been developed. These include Multipoint Ultrasonic Level Sensor, LOCA qualified Absolute Pressure Sensor, etc.

Electronics

A digital Self Excited Loop (SEL) based RF control system has been designed and successfully tested with the 150 MHz super-conducting resonators of BARC-TIFR LINAC.

A 150 W, 13.56 MHz solid state RF power amplifier has been designed, tested and installed for thin film deposition purpose.

An RF control system for 400 keV RF cavity has been designed and tested.

Seismology

With the objective of locating seismic events as accurately as reported by international seismological agencies, several new techniques and models have been implemented at BARC Seismic Data Centre. The location of most events occurring in and within the immediate vicinity of the country was determined with < 5% error.

Technologies for Safe Drinking Water

BARC has been carrying out the development of commercial size indigenous membranes and membrane-elements for safe drinking water application. The first batch of indigenously developed thin film composite reverse osmosis membranes has been loaded in the Nuclear Desalination Demonstration Project (NDDP), replacing the imported elements. The plant is operating round the clock.

As a part of the development of solar energy driven water purification systems, a solar photovoltaic (PV) energy driven water purification demonstration unit was designed, installed and commissioned at Trombay. It uses indigenous membrane for brackish water desalination and has capacity of 10 liters/h. It is portable, battery-less and stand-alone type.

Nuclear Agriculture

Plant Germplasm Registration Committee of National Bureau of Plant Genetic Resources (NBPGR), New Delhi has approved the registration of Bruchid resistant Trombay wild urid germplasm and Trombay groundnut mutant, TGM 112.

Twenty Five Nisargaruna plants have become functional during the previous year.

Technology Transfer

BARC has signed an MoU with the Government of Goa on Collaboration for Promotion of Science and Technology Based Development in the State of Goa.

Human Resources Development

An e-learning platform named as “Pathsala” containing a large number of video courses, nuclear power plant (NPP) simulators and e-lecture notes, has been launched and hosted on server for the benefit of trainees and faculty members of the BARC Training School.

Under the QUEST Continuing Education Programme started about two years ago, four sets of courses under the Electrical Sciences Group have been offered to employees of DAE units in Mumbai and many are taking advantage of these courses. I urge more employees to avail this opportunity to upgrade their skills.

The Homi Bhabha National Institute (HBNI) continues to grow and strengthen its linkages with several premier institutes. To date, 261 degrees and diplomas have been awarded under the various academic programmes. The number of enrolments under the different programmes continues to swell having crossed the 3000 mark, with the Ph.D. cases alone being above 1300.

Scientific Information Resources Dissemination

BARC, as the nodal agency for analysing the scientific productivity and inputs of DAE institutions, during XI Plan period, submitted a detailed report on DAE publications and their citation, based on inputs received from various units. BARC publishes close to 1100 publications in a year.

An exhibition on “Fusion Engineering” was organised. An “Author’s Workshop” conducted to motivate scientific staff to publish more in the International Journals was attended by about 800 scientific staff.

Public Awareness Programmes and Student Visits

Approximately 2000 students from fourteen institutions visited BARC during the year. Seminars and related events were conducted in seven educational institutions. These were attended by nearly 2500 students and teachers. To further strengthen this programme, nearly 100 scientists and engineers have been enlisted to form the BARC Media Committee. This team has participated in the recent events to spread the message of the programmes and activities of BARC and facts on Nuclear Energy. Very recently, BARC conducted exhibitions in DY Patil University, Kolhapur and at National Children's Science Congress, Jaipur where several thousand students participated.

Plan Projects

We will be soon approaching the end of the XI Plan period. The proposals for the XII Plan Projects are submitted to the Planning Commission. We must gear ourselves to utilise all the resources sought under current plan projects and deliver the outputs envisaged in the project reports. I earnestly appeal to all of you to continue to take timely actions in all aspects of the implementation of Plan projects.

Security and Physical Protection

The physical protection of our Centre is of paramount importance. I wish to compliment all the security personnel and thank all officers and staff of our Centre for their cooperation in effective implementation of high level of security.

I also acknowledge the excellent services of the Fire Service personnel who continue to maintain a strict vigil on the various establishments of our Centre.

The contributions of the personnel of our Floriculture and Landscaping Section, as evident by the beautiful ambience at this venue, are much appreciated. They have raised in the nursery 25000 saplings of different species of forest trees to be planted during monsoon this year.

Medical Services

Medical Services under the Contributory Health Services Scheme continued to provide excellent health-care services for the employees and their families very effectively.

Administrative Group

Administrative Group continued to provide its vital supporting function in the field of administration, establishment, including manpower planning, personnel data management, finance and accounts and security.

In my speech today, barring a few major highlights, I have not touched upon all the salient achievements earlier reported on the Founder's Day and Independence Day.

Conclusion

My dear colleagues, while we have been doing our best in the pursuit of our programmes, there is a need for further refining and enhancing the outputs from our Centre to meet the targets and enhanced expectations from the nation consistent with national development and economic growth. The negative perceptions in some sections of the society due to unfounded fears need to be addressed in multiple ways that include our demonstrating continued excellence and high relevance in all our deliveries.

I am sure, all of you will continue to put in your best efforts, so as to sustain our tradition of excellence with high relevance and value in the years to come.

Friends, therefore, on this very special day, let us all firmly resolve and rededicate ourselves to continue contributing to all facets of the Indian nuclear programmes and remain abreast with the frontier areas of nuclear science and technology to serve our nation for the betterment of the quality of life of the vast population of our country.

Thank you all. Jai Hind.