

## WRITTEN ANSWERS TO UNSTARRED QUESTIONS

**GOVERNMENT OF INDIA  
DEPARTMENT OF ATOMIC ENERGY  
RAJYASABHA  
UNSTARRED QUESTION NO – 321  
ANSWERED ON 06/02/2025**

**MAJOR PROJECTS AND ACHIEVEMENTS OF DAE**

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Will the PRIME MINISTER be pleased to state:-

- (a) whether there are any major achievement in the field of science, technology and innovation;
- (b) if so, the details thereof since 2020;
- (c) whether any major scientific infrastructure has been completed/dedicated to the nation including Gorakhpur Nuclear Power Project, Haryana, since 2020;
- (d) if so, the details thereof;
- (e) whether any new projects and collaborations are planned/conceived by the Department; and
- (f) if so, the details thereof?

**ANSWER**

THE MINISTER OF STATE FOR PERSONNEL, PUBLIC GRIEVANCES & PENSIONS  
AND PRIME MINISTER'S OFFICE (DR. JITENDRA SINGH)

- (a) to (d) Department of Atomic Energy (DAE) consists of multi-disciplinary Nuclear Research Centres having excellent infrastructure for advanced Research and Development with expertise covering the entire spectrum of Nuclear Science & Engineering. The areas of research and development include Accelerator and Laser Technology, Advanced Electronics and Instrumentation, Agriculture, Physical sciences, Chemical sciences, Bio-sciences, Food Preservation, Water Desalination

and Water Purification, Nuclear Reactor Technologies, Reprocessing and Waste Management, etc.

The Gorakhpur Nuclear Power Project, Haryana is under construction.

The major achievements and scientific infrastructure completed/dedicated to the Nation since 2020 are mentioned in **Annexure-I**.

- (e) & (f) Department of Atomic Energy (DAE) is having excellent infrastructure for advanced Research and Development with expertise covering the entire spectrum of Nuclear Science and Engineering and related areas. The areas of research and development include Nuclear Reactor Technologies, nuclear fuel cycle (front-end and back-end), Accelerator and Laser Technologies, material research, Advanced Electronics and Instrumentation, Nuclear Agriculture, Food Preservation, Water Desalination, Water Purification, waste management etc. The vision of the Department of Atomic Energy is to empower India through technology, creation of more wealth and providing better quality of life to its citizens.

#### **Reactor Programmes**

The nuclear power reactor programme emphasizes on indigenous technology development for Indian Pressurised Water Reactor and Fast Breeder Reactor for 1st & 2nd Stage of Indian nuclear power programme as well as development of demonstration reactor design for realization of 3rd stage for long term energy security and for achieving net-zero carbon emission.

#### **Nuclear Fuel Cycle**

The nuclear fuel cycle will cover front-end as well as back-end of fuel cycle and will include (i) exploration & augmentation of uranium, thorium and other rare earth (RE) materials, (ii) expansion of fuel fabrication capabilities for sustained operation of existing and future reactors, (iii) development of advanced fuel for future reactors and (iv) construction & commissioning of integrated fuel recycle plants for pressurised heavy water reactor (PHWR) and fast breeder reactor (FBR) fuels.

### **Accelerators and Laser Programmes**

Indian accelerator programme is aimed at long term energy security in a sustained manner through phase-wise indigenous development of high energy accelerators for Accelerator Driven Sub-critical Systems (ADSS). This deployment will facilitate thorium utilisation and incineration of nuclear waste to reduce the environmental burden. The programme also emphasizes on development of indigenous medical cyclotron, heavy ion and rare isotope beam accelerator for medical isotope production, research and industrial applications. Development of Lasers will be pursued for a wide range of applications in the field of basic science, medical diagnostics, machine vision-based inspection systems and advanced additive manufacturing technologies for nuclear and industrial applications.

### **Advanced Technology Development**

This majorly comprises the technologies to support the reactor programme, nuclear fuel cycle programme, accelerator programmes and technologies for societal applications. Some of the technologies envisaged are technologies for reactor safety, hydrogen production, cryogenic technology, indigenous development of detectors & instruments and development of advanced metal joining techniques.

### **Societal Applications**

These programmes are directed towards development of radiopharmaceuticals for diagnostics and treatment of cancer, development & deployment of technology of large capacity food / grain irradiators. The programme also covers development of new crop varieties through radiation induced mutagenesis, seed breeding for food security, solid waste management and waste water management for reducing the human load on environment.

### **Frontiers in Basic Research**

The basic and applied R&D in fields of gamma-ray and radio astronomy, gravitational wave research, physical sciences, chemical sciences, biological sciences, material sciences and health physics.

### **Human Resource Development, Capacity Building, Skill Development and Collaborations**

DAE contributes to the enrichment of knowledge domain by way of support to basic research in nuclear energy and related frontier areas of science; interaction with universities and academic institutions; support to research and development projects having a bearing in DAE's programmes, and international collaborations in related advanced areas of research. Details of some important International Collaborations are listed below:

- (i) Laser Interferometer Gravitational – Wave Observatory-India (LIGO-India): The LIGO-India Project proposal is for the setting up of an interferometric gravitational-wave detector in India called LIGO-India as the third LIGO detector under an international collaboration with the LIGO-Laboratory, USA. The project is a joint project between the Department of Atomic Energy (DAE), the Department of Science and Technology (DST) from India, and the National Science Foundation (NSF) of the USA. This project is proposed under the Mega Science Consortium of DAE and DST set-up for funding large science projects. Of the various projects being pursued under the Consortium LIGO-India is the only Mega Science Project being set-up on India soil.
  
- (ii) Square Kilometre Array (SKA): The Square Kilometre Array is an Intergovernmental Radio Telescope Project being planned to be built in Australia and South Africa. SKA is the next generation Radio Telescope, has almost completed the design stage for phase-I. Early science is expected to be possible from around 2025 or so. The capabilities of SKA-I will be phenomenal, for a variety of science goals and applications, and will far surpass that of any existing or planned radio astronomy facility. The SKA is a truly international telescope, with India being one of the member countries in the SKA organization and hence involved in the design and operation of SKA-I. SKA has formed a number of science

working groups which are working towards achieving their long-term science programs. The astronomers in India too have started working on a long-term strategy towards the use of the SKA in the Country.

(iii) DAE has signed MoUs with 16 International partners viz. USA, Russia, IAEA, France, UK and Northern Ireland, Bangladesh, Vietnam, Bulgaria, Republic of Malawi, Argentina, Uzbekistan, Peru, Ghana, Kazakhstan, AFCONE and ASEAN, for collaborative research and training programme.

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## ANNEXURE-I

1. Chlorophyllin containing oral tablets (AKTOCYTE) developed, by joint efforts of Bhabha Atomic Research Centre (BARC), Advanced Centre for Treatment, Research and Education in Cancer (ACTREC), Tata Memorial Hospital (TMH) and a private pharma company, as an adjuvant to cancer radiotherapy. The tablets approved by Food Safety and Standards Authority of India (FSSAI) as nutraceutical.
2. Cost effective NOx releasing dressing, first of a kind in India, is developed by BARC for the treatment of diabetic foot ulcer and other chronic wound. The product has been approved by Drugs Controller General of India (DCGI) for the manufacturing & commercialization.
3. New Radiation Medicine Centre (RMRC) Kolkata has been set-up and operationalised. This centre is providing cancer diagnostic and therapeutic services for cancer treatment to people of north-east region and diagnostic support to nearby hospitals.
4. Cost effective <sup>106</sup>RuBy (Ruthenium Brachytherapy) plaques for Eye Cancer Treatment developed and supplied to twelve hospitals in the country.
5. Indigenous development and clinical translation of radiopharmaceutical agents such as Y-90 labelled glass microsphere, Bhabhaspheres, for liver cancer treatment, <sup>90</sup>-Y-labeled hydroxyapatite (HA) particles for radiation synovectomy of large joints <sup>177</sup>Lu-labeled hydroxyapatite (HA) particles for radiation synovectomy of medium-size joints.
6. Using radiation induced mutagenesis along with cross breeding, BARC has developed new varieties in oilseeds (groundnut, mustard, soybean sunflower and sesame), pulses (urdbean, mungbean, pigeonpea and cowpea), rice and jute, wheat etc. which have been released for commercial cultivation across the country. Since 2020, twenty-five new improved crop varieties have been developed and released for commercial cultivation. These crop varieties have desirable traits such as high yield, disease resistance, early maturity, climate resilience, biotic and abiotic stress tolerance etc.
7. Under the triparty MoU between BARC- National Cooperative Consumers' Federation of India Limited (NCCF) and Department of Consumer Affairs (DoCA), large scale trials were carried out for storage of irradiated onions in

cold storage facility under the controlled conditions. The stored onions were found to retain the quality attributes after 7.5 months and were marketed successfully.

8. Food preservation technologies developed for jamun product, sprouts & sweet corn kernels, stuffed baked food, intermediate moisture shrimp, fish soup powder, ready-to-eat (RTE) intermediate moisture (IM) fruits cubes were developed and technology were transferred to different firms for commercial deployment.
9. Several membrane assisted technologies have been developed at BARC for desalination of brackish and seawater and purification of contaminated water for drinking purposes at domestic and/or community levels. Desalination and water purification includes purification with respect to microbiological decontamination, arsenic removal, iron removal, de-fluoridation, salinity and hardness removal. The technologies have been transferred to several private entrepreneurs on non-exclusive basis for commercialisation and field deployment.
10. BARC has successfully deployed membrane water filtration technology to 200 equivalent villages including BSF post of at Gujrat and Rajasthan Boarder, CSTM and Central railways stations in Mumbai and Deen Dayalu Coach of Indian Railways.
11. BARC has developed Hybrid granular Sequencing Batch Reactor (hgSBR) technology for treatment of sewage waste water. The technology was successfully used in the Kumbh Mela in 2021 and is being deployed in Kumbh Mela 2025. The technology has been successfully transferred to private entrepreneurs for commercialisation.
12. Radiation grafted cellulose based filtration technology for ionic dye removal from textile effluents has been developed successfully demonstrated in a textile plant at Jodhpur.
13. Hydrogel has been developed which can absorb and retain water up to 500 times its weight for agricultural usage in arid areas in the country.
14. BARC has developed radiation hygienisation Technology for treating dry sewage sludge & converting into organic manure. 100 tons/day dry sludge hygienisation plants have been set up and operationalized by Indore Municipal Cooperation with technological support from BARC.

15. Shesha, a technology that works on bio-methanation, has been developed for managing bio-degradable kitchen and garden waste from small housing society. The bio-gas produced during the process can be used as fuel & remaining process waste as manure.
16. BARC has developed green hydrogen production technologies for contributing towards target of net zero.
  - i) Two thermochemical processes namely; integrated process of Iodine-Sulphur (I-S) and Copper Chlorine (Cu-Cl) have been developed and successfully demonstrated for hydrogen production at pilot scale at 150Nlph.
  - ii) Alkaline water electrolyser (AWE) technology developed and demonstrated and has been gradually scaled up to 1MW. Technology transferred to public sector unit such as BPCL
17. BARC has set-up MACE (Major Atmospheric Cherenkov Experiment) telescope, largest telescope in Asia, at Hanle, Ladakh to explore gamma-ray sky in the energy range above 20 GeV.
18. Indian cargo Scanner based on gantry mounted dual energy LINAC has been successfully developed and is ready for demonstration.
19. Low Intensity High Energy Proton Accelerator (LEHIPA) with beam energy 20MeV was successfully operated at rated on beam energy.
20. FBTR (Fast Breeder Test Reactor):
  - Using the indigenously designed and developed fuel of Uranium Carbide and Plutonium Carbide FBTR attained its rated capacity of 40MWt on 7 March, 2022 with TG generating 10MWe and connected to grid.
  - Tungsten Carbide pellets were fabricated as part of the life extension activities of the reactor.
21. Metal Fuel Development:
  - The 'Sub-assembly level Metal Fuel Fabrication Facility' to fabricate 1.0 meter long sodium bonded metal fuel pins for sub assembly level irradiation in FBTR was inaugurated by Dr. Ajit Kumar Mohanty, Chairman, AEC & Secretary, DAE on May 28, 2024.
  - Pyrochemical process based on molten salt electro-refining is ideally suited for reprocessing spent metallic fuels from FBRs. In these

endeavors, a Pyro Process R&D Facility has been set-up and commissioned. Electro-refining of 10kg uranium metal has been successfully demonstrated in this facility during 2022-2023.

- An experimental facility for demonstration of pyro-processing operations using U-Pu-Zr alloy in maximum 250 g per batch was inaugurated by Chairman, AEC on 28<sup>th</sup> May 2024.

22. **CORAL (Compact Reprocessing facility for advanced fuels in Lead shielded cells)** facility is the only plant operating in the world to handle carbide fuel, has been relicensed by AERB upto 2028 for its continuous Operation. 66<sup>th</sup> campaign for the reprocessing of 155 GWd/t Burnup FBTR fuel was successfully completed and the preparatory works for the 67<sup>th</sup> campaign is in progress.
23. **Demonstration Fast Reactor fuel Reprocessing Plant (DFRP)**, a unique facility which can handle both carbide and oxide fuel was dedicated to the nation by Honorable Prime Minister during January 2024. The plant was hot commissioned during April 2024, and two successful campaigns for processing FBTR spent fuel were completed. The strategic material recovered by processing the balance dissolver solution has been dedicated to the nation in the presence of Chairman, AEC and Secretary, DAE during June 2024.
24. Reactor Design and Fast Reactor Technology: Development of Automated Vehicle for the Pre-Service Inspection & In-Service Inspection of Dissimilar weld in PFBR (DISHA-V2).
25. Electronics & Instrumentation: Design and Development of CPU card using indigenously developed Shakti microprocessor by IITM and other I/O cards to overcome component obsolescence.
26. Establishment of the UHRTEM: Ultra high resolution transmission electron microscopy, a state of the art facility equipped with advanced detectors has been pivotal in analysing metallic, ceramic samples, contributing to the understanding of their structure-property relationships.
27. The Remote Internal and Orbital Welding Technology was developed in collaboration between private industry. This achievement highlights the advancement in welding techniques, enabling precise and efficient welding

in challenging and confined spaces, opening new possibilities for various industries.

28. Indigenous manufacturing of Ni-base superalloy billets: As part of a project sanctioned by Office of the Principal Scientific Advisor, GoI, a new Ni-base superalloy for use in boilers operating at high temperatures has been indigenously manufactured through a multi-organisation collaborative effort involving Indira Gandhi Centre for Atomic Research (IGCAR), Mishra Dhatu Nigam Limited (MIDHANI) and Nuclear Fuel Complex (NFC).
29. A-TIG welding technology for welding of 304 L SS spiral pipes used in LIGO-India project has been developed in collaboration with RRCAT, Indore. The ease of implementation of A-TIG for making spirally welded precision beam pipe for LIGO-India has demonstrated significant cost reductions over other competing welding technologies.
30. Development of CVD Pyrolytic Graphite Coatings for Molten Salts, Uranium Melting and Furnace Crucible Applications and Yttria coated HDG crucible with SiC interlayer for reactive (U-Zr) alloys melting.
31. A facility for studying the structural stability simultaneously at various pressures and temperatures by X-ray diffraction has been established at beam line of INDUS-2, RRCAT (Raja Ramanna Centre for Advanced Technology) through collaborative efforts of scientists from IGCAR & RRCAT units.
32. A state of art “High Resolution RBS detector (HiRBS)” with an energy resolution of 1.6 keV at 400keV, corresponding to a depth resolution of 2 to 3 Å and improved mass resolution is installed with a beam line of 1.7 MV tandetron accelerator. It is a unique and first facility in India. Also, control system for 1.7 MV tandetron has been developed indigenously.
33. The Upgraded Online Nuclear Emergency Response System (ONERS-2) with provisions for radiological consequence assessments using Time-Dependent Source Terms is installed along with Numerical Weather Prediction & Dispersion Models on the High Performance Computing System at the Nuclear and Radiological Emergency Monitoring Cell, AERB Mumbai. The ONERS is used by NREMC-AERB for monitoring of emergency exercises and training purposes.

34. A C-Band Doppler Weather Radar and 205 MHz Wind Profiler are installed at Kalpakkam site under 'Application of Space Science & Technology' initiative between DAE & Indian Space Research Organisation (ISRO).
35. Met-Ocean Data Buoy with integration of Radiation Monitor deployment in coastal waters of Kalpakkam site for radiation field input in the Online Decision Support System from sea area.
36. An Online Chemical Emergency Response System (CERS) with chemical sensors, dispersion models and GIS based impact assessment modules is developed for Chemical Disaster Management at industrial sites. The first version of CERS is implemented for Ammonia storage facilities of FACT Cochin, Kerala.
37. An Integrated Radiation Monitoring Facility (IRMF) was commissioned for providing Radiation monitoring services (in-vivo and in-vitro) to radiation workers (~3000 workers per year) of DAE units at Kalpakkam site (as per AERB regulatory requirement) and Radiation monitoring services (decontamination & treatment) to public during any radiation emergency (as per NDMA requirement).
38. "Mobile Health – Wellness Program for the Rural Population" is being implemented in the rural areas in and around Chengalpattu region with DAE developed Technologies.
39. Cadmium Zinc Telluride (CZT) single crystals for Gamma Radiation Detection and Lead Zinc Niobate - Lead Titanate (PZN-PT) single crystals for transducer applications have been developed.
40. Online Isotope Monitoring System consisting of dedicated detectors for detecting alpha, beta and gamma radiations and associated electronics has been installed by IGCAR in one of the pre-dominant wind sectors of Kalpakkam site.
41. The indigenous production of Sr-89 is an important societal need and a valuable import substitution; it is a pure beta emitter with a half-life of 50.5 days and used for palliative care of bone metastatic cancer. Production of Sr-89 with high specific activity at Fast Breeder Test Reactor (FBTR), Kalpakkam was successfully demonstrated. The product satisfied all the Quality Control Parameters as per the US, European and International Pharmacopeia. Bio-distribution study in progress.

42. Pilot scale production of radio isotopes (Y-90 & P-32) for the benefits of society was initiated during April, 2024.
43. Modification of 731 dummy sub assemblies (DSA) and internal buffing of ~100 nos. of grid plate sleeves in mission mode was carried out at PFBR site.
44. The PFBR Transfer Arm (TA) Outer Tube (14.5 m long) and Shielding sleeve Assembly was rectified including manufacturing of part of outer tube no. 2 (3.6 m long) and hard faced sleeves of Guide Assembly within very stringent tolerances.
45. Installation of major solar PV plant of capacity 2.297 MWp taking the total installed capacity to 3.1 MWp.
46. A 400 m<sup>3</sup>/day Tertiary Water Treatment Plant (TWTP) was commissioned on 11<sup>th</sup> January 2024 to utilise treated sewage water for the condenser cooling water system of central air-conditioning plant at IGCAR as a green initiative in line with water conservation.
47. Civil engineering activities ranging from recent design to Construction of Laboratory Buildings at IGCAR such as: Construction of Doppler Weather Radar (DWR) Building, Construction of RHIDS & SGIDS Building, Construction of Wind Profiler Building, Construction of Sodium Complex building, etc.
48. Indus-1 and Indus-2 synchrotrons are operating successfully as national user facilities for scientists and engineers from all over the country. These synchrotron facilities are operated in round the clock mode with Indus-1 operating more than 6500 Hours and Indus-2 operating for more than 5500 hours annually. Users from more than 140 different universities, national labs, and institutes have been regularly using the Indus beamlines for their research activities. Researchers from more than 20 different industries are also regularly using the Indus beamlines for their research and development activities. More than 1000 user experiments are carried out at the Indus beamlines annually at Indus beamlines and more than 200 papers are published annually from the research work carried out at the Indus beamlines. INDUS-1 was upgraded with installation of combined function magnets, improved vacuum chambers, beam position monitors, associated electronics, control systems and power supplies to achieve better beam quality and

availability for beam users. Two Pinger Systems, one vertical and another horizontal were installed in INDUS-2 for improved beam dynamics studies.

49. Raja Ramanna Centre for Advanced Technology (RRCAT) has developed an electron beam radiation processing facility at Indore with indigenously developed 10 MeV, 6 kW Electron Linac. RRCAT has also developed 10 MeV, 10 kW electron Linac for food irradiation requirements. Development of high power electron Linacs, as above, is a major technological achievement as it involves mastering of several cutting edge technologies simultaneously. RRCAT has developed an electron beam radiation processing facility at Indore which is now operating in commercial mode for electron beam sterilization of medical devices. Several medical device manufacturing industries are using the facility on a regular basis. More than 75 lakh medical devices have been sterilized at the Electron beam radiation processing facility at Indore since 2022.
50. Commissioned 190 Tera Flops Kshitij-5 High Performance Computing Cluster. Commissioned Open source infrastructure and rolled out work flow based applications for paperless working and Software applications with Digital Signature Certificate (DSC) and multilingual integration to move towards e-Governance.
51. SHIVAY: Design, Development LN<sub>2</sub> based Refrigerated Transportable System Sheetal Vahak Yantra (SHIVAY) and transfer of technology to one MSME & M/s Tata Motors Ltd. Tata Motors developed prototype 20 ft. & 32 ft. reefer. The 32ft. reefer, with improved thermal design, took only 35 minutes to cool down from room temperature to -20°C of chamber temperature. In a single filling the 32ft reefer can maintain a temperature for ~ 38 hrs. The cost per hour for refrigeration is very significantly (~25%) lower than the conventional systems. Based on similar technology, “MATSYA” reefer for novel fish transport application was developed, installed on fishing vessel SAGAR HARITA” and it was taken for fishing expedition. Biological analysis, conducted by Central Institute for Fisheries technology (CIFT) team revealed almost no generation of pathogen and resulting damage during storage.
52. Incubation of Laser based Metal Additive Manufacturing (Laser Metal 3D-Printing) machines.

53. Transfer of Technology of AGNI-RAKSHAK - Raman optical fibre based distributed fire sensor system, OncoDiagnoScope, Tuberculoscope, Neelbhasmi, and Raman Probe to industries.
54. Indigenous development of high power Nd:YAG lasers of up to 2 kW average power and 40 kW peak power and up to 2 kW CW fiber lasers for remote material processing applications like cutting and welding in nuclear field for refurbishment and maintenance of Indian nuclear power plants.
55. Development of diode pumped solid state green lasers for medical program of BARC.
56. Four new beamlines have been commissioned and have been made available to the national user community in the Indus-2 complex. These include: Engineering Applications beam line, Angle Resolved Photoelectron Spectroscopy beam line and X-ray Magnetic Circular Dichroism beam line.
57. A new Transmission Electron Microscope (TEM) facility has been commissioned at RRCAT. This is a state of the art 200 keV field emission gun-based TEM system.
58. Electron beam radiation processing facility at Indore is a major facility and has been commissioned with Licenses from Atomic Energy Regulatory Board (AERB) and Food and Drugs Administration (FDA) and quality management system in year 2022.
59. Setting-up of fabrication, processing and testing facility and cryogenic infrastructure like Horizontal Test Stand for 650 MHz Super Conducting Radio Frequency dressed cavity.
60. Construction of Cleanroom facility comprises of areas of cleanliness ISO class 8 to ISO class 4 is completed for assembly & processing of 650 MHz Super Conducting Radio Frequency dressed cavity to be used in High intensity proton accelerators of DAE.
61. A large DC magnetron sputtering deposition system, for coating of metallic thin films (Ti, NEG) in vacuum chambers/components of particle accelerators, has been developed and commissioned in UHV Lab. This system is capable of coating vacuum chambers up to 3500 mm long and cross section dimension up to 290 mm.
62. Incorporation of AIC RRCAT PI-HUB Foundation for translation of RRCAT developed technologies.

63. Infra-red Free Electron Laser Facility to outside RRCAT users.
64. A major milestone of the country's first K500 Superconducting Cyclotron has been successfully achieved by accelerating and extracting out first harmonic heavy ion beams (Nitrogen 4+ up to 420MeV, Oxygen 5+ beam up to 363MeV, Neon 6+ beam up to 438 MeV energy) and delivered to the users for nuclear physics experiments in frontier research. Currently, 30 MeV/A heavy-ion beam energy from K500 Superconducting Cyclotron, is the highest beam energy available in India.
65. Installation and Commissioning of 30 MeV Medical Cyclotron Facility at Chakgaria campus, Variable Energy Cyclotron Centre (VECC), Kolkata.
66. Commercial production and supply of FDG Radiopharmaceutical (for diagnosis of cancer) started since June, 2020, on regular basis.
67. Commercial production and supply of Radiopharmaceuticals, 18F-Sodium Fluoride (for bone scanning), and Gallium-68-PSMA (for diagnostics of Prostate cancer) have been started.
68. Production and successful human application of Thallium-201-Chloride Radiopharmaceuticals (for conducting Cardiac studies) successfully carried out first time in India.
69. PET radiopharmaceutical, Copper-64-Chloride (for Therapy + Diagnostic of cancer) produced on trial basis from solid target of Zinc-68 (Jointly with BRIT), using 30MeV Cyclotron.
70. SPECT radioisotope Iodine-123 (for Diagnostics of thyroid cancer) produced on trial basis from solid target of Tellurium-124 (Jointly with BRIT), using 30MeV Cyclotron.
71. Germanium-68/Gallium-68 generator produced on trial basis from solid target of Gallium-Nickel alloy electroplated target (Jointly with BRIT) using 30MeV Cyclotron. It will minimize import cost of generator.
72. SPECT radioisotope Lead-203 (Pb-203) (for imaging and also cancer therapeutic applications) produced, first time in India, on trial basis from low cost natural thallium target (Jointly with BRIT), using 30MeV Cyclotron.
73. Development of First indigenous 18 MeV Medical Cyclotron (MC18) in India is in Progress at VECC in collaboration with BARC.

74. A multicusp negative Hydrogen ( $H^-$ ) ion source has been indigenously developed at VECC and successfully tested. This ion source is to be used in 18MeV Medical Cyclotron, under indigenous development at VECC.
75. Magnetic field mapping of SmCo Ion-source is completed.
76. Fabrication of coils for switching magnet is completed.
77. The solid target station was designed and fabrication drawings were prepared. Manufacturing of all components has been completed.
78. Developed indigenously and successfully tested the 2nd single-cell niobium-make Superconducting Radio-frequency cavity (to be used in high energy high intensity proton linear accelerator) for ions with velocity factor (b) 0.61 times the velocity of light, achieving the gradient of 26 Million Volt/meter at 2 Kelvin temperature, with unloaded Quality Factor (Q0) of  $2 \times 10^{10}$ .
79. Design, development, installation and commissioning of high power (120kW) RF Amplifier for K130 Cyclotron has been done and successfully operating round-the-clock with Cyclotron.
80. For Radioactive Ion Beam Facility, installation & testing of low energy beam transport (LEBT) line connecting  $1+$  ECR (2.45 GHz) and  $n+$  ECR (6.4 GHz) have been carried out. Rare Isotope Beam (RIB) of  $^{11}$ -Carbon,  $^{43}$ -Potassium and  $^{111}$ -Indium produced in RIB facility built around the K130 Cyclotron at VECC.
81. Irradiation studies have been carried out for indigenously developed Reactor Pressure Vessel (RPV) Steel.
82. Developed and installed Irradiation setup at high current at MSBL, Medical Cyclotron Facility (MCF).
83. A national experimental campaign of Indian National Gamma Array (INGA), consisting of state of the art Clover HPGe detectors, was carried out in two phases since 2020 (2020-2021 and 2023-2024), using light and heavy ion beams from K-130 cyclotron at VECC, Kolkata. Total about 35 nuclear physics experiments have been performed by users from various national universities, IITs and other institutes, as well as by users from VECC.
84. Outstanding research work carried out by VECC scientists on experimental nuclear physics and theoretical studies, using state of art detector facilities

and computational techniques, which has led to about 200 publications in high impact peer reviewed international journals since 2020.

85. Commencement of commercial operation of 700 MW Pressurised Heavy Water Reactor, KAPP-3 at Kakrapara on 30 June'23. KAPS-4 – 2nd in a series of 16 indigenous 700 MWe PHWR commenced commercial production on 31 March 2024.
86. Launching of ASHVINI: NPCIL and NTPC signed a supplementary Joint Venture agreement to develop nuclear power facilities in the country.
87. Till date 43 radiopharmaceutical products are approved for clinical use, both diagnostics and therapeutics.
88. TMC has now expanded to six other hospitals located in Varanasi (2), Guwahati, Sangrur, Visakhapatnam, Chandigarh and Muzaffarpur.
89. Major Atmospheric Cherenkov Experiment (MACE): Asia's largest Gamma Ray telescope is installed at Hanle, Ladakh to study the universe.
90. Rare Earth & Titanium Theme Park, Bhopal: First time production of Rare Earth Metals in the Country in the Rare Earth and Titanium Theme Park, Bhopal. Lanthanum and Cerium metals produced successfully.
91. Fission Molybdenum-99 Plant, Mumbai: Production towards commercialization of Fission Moly (work horse for nuclear medicine) started in Dhruva reactor in 2023. Subsequently, Fission Moly plant is commissioned and dedicated to the nation by Hon'ble Prime Minister in May 2023.
92. Radiation processing of Agricultural produce: KRUSHAK facility is upgraded and being used for enhancing self-life of onions, mangoes (for export). Technologies developed for the preservation of perishable commodities, e.g. Jamun, Strawberry, Lichi, Chiku, legume sprouts, fish soup powder, de-bittered karela juice, banana drink, gluten free multigrain flour, low glycemic food, millet idli, moisture fruit cubes, and moisture shrimp).
93. Crop varieties developed and released: Using radiation-induced mutagenesis, hybridization, and tissue culture techniques, 70 crop varieties have been developed, released and approval obtained for commercial cultivation.

94. Liquid Nitrogen based SHEETAL VAHAK YANTRA (SHIVAY) & its variants: A spinoff of cryogenic technology deployable for refrigerated transport of – (a) Farm produce; (b) Fish; (c) Vaccine etc.
95. Superabsorbent BARC-Hydrogel (MRIDAMŔT) (मृदाअमृत) – Superabsorbent polymer hydrogel developed using natural polymer graft-co-polymerized with synthetic precursor by gamma-rays.
96. Hybrid granular sequencing batch reactor (hgSBR) – for effective decentralized wastewater treatment in a single treatment tank.
97. SHESHA – Technology for wet waste management and rapid Bio-composting: A Rapid Composting Technology for decomposition of dry leaves, kitchen waste and temple waste.
98. Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) is commissioning a 500 Mwe Prototype Fast Breeder Reactor (PFBR) project at Kalpakkam, Tamil Nadu. Integrated commissioning of PFBR is in advanced stage of completion. 1150t of Primary sodium filling, its purification, commissioning of indigenously developed sodium pumps, isothermal testing, loading of 12 nos. of absorber rods, 114 nos. of blanket sub-assemblies etc., are few of the major milestones completed.
99. Government has accorded approval to carry out pre-project activities for 2X500 MWe twin unit of FBR 1 & 2 project at Kalpakkam, Tamil Nadu.
100. Monitoring and Control System (MCS) is indigenously designed and developed web-based Network Management Software for Satellite Communication. The 7.5m dia Antenna is used for tracking EMISAT either in LHCP or RHCP in S-Band or in both LHCP and RHCP in X-Band.
101. Radiation Oncology Information Systems (ROIS): The System deals with capturing the details of Radiotherapy treatment given to a cancer patient.
102. X-Ray Baggage Inspection Systems (EC SCAN 6040): ECSCAN 6040 is an indigenous X-Ray baggage inspection system designed and developed in association with BARC. It is designed for screening hand baggage, suitcase, bags and small parcel in Airport, Railway station, Metro stations, Government offices, Banks, Hotels, Malls and Restaurants. It uses multi energy detectors coupled with scintillator to discriminate object into organic,

inorganic, metal and high-density material with four colours (Orange, Green, Blue and Black).

103. 1.8M Tracking Antenna & Control systems: Unmanned Aerial Vehicles (UAV) are increasingly used as platforms for Intelligence, Surveillance, Reconnaissance and disaster management, both in military and civilian applications and to assist in rescue mission management.
104. Network Based Fingerprint Identification Software for NODRS: Network Based Fingerprint Identification Software used to monitor and control the doses received by radiation workers within nuclear fuel establishment through fingerprint identification. The software is deployed across all NPCIL sites and other DAE units.
105. Intelligent Biometric Access Controller (iBAC): It is an embedded system developed in-house for access control system. iBAC is a controller which controls access to the doors/gates based on the information it receives from Smart Card readers and biometric readers connected to the controller.
106. Antenna System for Aditya Mission: ECIL has also supplied 18m Antenna in association with BARC for Aditya Mission. An 11m Ku Band Monopulse Tracking Antenna, which is completely in-house designed & developed has been supplied to MCF, Hassan.
107. Wearable Health Monitoring Device: ECIL successfully deployed Health Monitoring Device (EC-VIKRAM) during the peak of COVID Pandemic. This device is designed for measuring vital parameters Viz. Body Temperature, Blood Oxygen (SpO<sub>2</sub>), Heartbeat Rate, Respiration Rate and NIBP (Blood Pressure). This device helps Doctors and Health Workers to monitor the vital health parameters of the COVID affected patients remotely.
108. Indigenous C4I Computer Consoles: ECIL has designed, developed and standardized the Rugged Indigenous computers for C4I applications for both BrahMos and Akash C4I systems. These indigenous computers have resulted in saving significant amount of foreign exchange.
109. Automatic Dependent Surveillance – Broadcast (ADS-B): ECIL has indigenously developed the ADS-B dual redundant receiver system for Indian Navy and has successfully completed User Evaluation Trials.

110. Development of Dual View X-Ray Baggage Inspection System: ECIL with close association of BARC developed Dual Energy detectors for X-Ray Baggage Inspection System as an import substitution.
111. Indigenous Programmable Logic Controller (PLC): ECIL in association with BARC has developed 'Safe and Secure' Programmable Logic Controller (PLC) (NUCON PLC). The product incorporates safety and security features for applications in strategic sector and has been deployed for applications in space and nuclear sector.
112. Development of Dual View X-Ray Baggage Inspection System: ECIL in association with BARC has developed Indigenous Dual View X-Ray Baggage Inspection System (DV-XBIS). It provides dual view of object being scanned. Advanced image processing features and AI applications make the product efficient and independent of operator's skill. The product is also capable of detecting organic threats including narcotics and explosives.
113. Hydrogen Steam Concentration Monitoring System (HSCMS): ECIL has developed and qualified Hydrogen and Steam Concentration Monitoring System (HSCMS) based on Quadruple Mass Spectroscope designed by BARC. The controlling and monitoring of critical parameters of the HSCM system is carried out by using in-house Programmable Logic Controller (PLC) along with customised HMI.
114. Tri-band Antenna: ECIL has indigenously designed and developed Triband Antenna (S/X/Ka band) feed system with auto-tracking feature in all the 3 bands for high data rate satellite-based communication applications in strategic sector.
115. Advanced Radiation Monitoring System: As part of Advanced Radiation Monitoring System, towards continuous measurement of radioactivity in the Nuclear Power Plants, Alpha and Beta Aerosol Monitor, Spectroscopic Iodine Monitor, Inert Radioactive Gas monitor, Process Media Monitor and Accident Monitor were indigenously developed.
116. GPS & GIS Based Mine Recording System: An RFID based solution for GPS & GIS Based Mine Recording System has been designed and developed in-house by ECIL. The system has successfully completed the user evaluation

trials based on Project Sanction Order received from Indian Army under Make II category.

117. Solid State Cockpit Voice and Data Recorder (SSCVDR) - ECIL has redesigned the SSCVDR to record flight parameters like altitude, temperature, rotor speed, acceleration, wind speed, etc., acquired by the sensors mounted on the aircraft. The SSCVDR has completed Safety of Flight Tests (SOFT) and got clearance for Dornier platform from RCMA, Hyderabad in December 2021.
118. X-Band RF Seeker: Successful firing trials of the indigenously developed X-Band Radio Frequency Seeker for Indian Missile Program.
119. Ku Band Airborne SATCOM Terminal: The SATCOM terminal deployed on TAPAS Unmanned Aerial Vehicles (UAV) met the customer requirement and the flight trials were successful.
120. Integrated Power Management System (IPMS): Successfully designed and developed IPMS for CVRDE, Avadi for efficient power load management of next Generation Battle Tank for the Indian Army.
121. Mobile Integrated Network Terminal (MINT): Successfully developed, integrated and demonstrated 4G LTE MINT on NCNC basis under Make II category of DAP 2020 to Indian Army.
122. Radiation & Gas Monitoring System (RGMS): Indigenisation of Centralised networked system for Radiation and Gas Monitoring to strengthen the National Security and bolster the 'Make-in-India'.
123. Chemical, Biological, Radiological and Nuclear Detection (CBRN) Protection solution: ECIL along with BARC and DRDO has consolidated expertise towards providing CBRN solutions to vital installations to obviate possible CBRN threats arising out of malevolent activities of antinational groups.
124. EM Management System - EMS 2.0: Development of EVM Management System (EMS 2.0) for Election Commission of India.
125. Calorimeter: ECIL in collaboration with BARC has Indigenously developed Calorimeter which is one of the most accurate non-destructive system used for quantitative measurement of heat energy for Special Nuclear Materials (SNM).

126. Single Board Computer: Component Object Model (COM) based VME bus Single Board Computer (SBC) has been developed in collaboration with CnID, BARC. It is intended for use in special projects and would also help in obsolescence management of systems in service.
127. Chamber Inspection System (CIS): Indigenously developed system mainly used for inspection & analysing the sealed chambers (Non-Habitable Areas) in Nuclear platforms.
128. Anti Drone System (ADS): Man Portable ADS consists of C2 software with RF detectors with Omni directional jammers.
129. Emergency Radio: V/UHF Emergency Radio (30-500 MHz) has been developed for voice & data communications.
130. ECSCADA Linux Ver. 1.0: ECSCADA Linux Ver. 1.0 was developed in-house and supplied to ISRO, IPRC and BPCL, Kota.
131. Airborne Satcom Terminal: 0.43/ 0.6/ 0.73 M Airborne Satcom Terminal indigenously developed with state-of-the-art technology and supplied to the DEAL, DRDO. It provides high-quality broadband communications via satellite across airborne platforms by providing excellent RF performance with high pointing accuracy under extreme environmental conditions.
132. Ship Installed Radiac System: System design was upgraded as part of obsolescence management and supplied to Indian Navy.
133. Ku band carbon fibre reflector Antenna System: Designed 1.2 M Ku band carbon fibre reflector Antenna System with Monopulse tracking feed system for UAV Tracking and 4.2 M Ku Band carbon fibre reflector, trailer mounted Antenna System for GEO satellite communication for DEAL, DRDO.
134. Strong motion seismic Instrumentation: Prototype hardware & software development of Seismic Sensor, Local Recorder & Central recording of the system successfully completed. Final evaluation & Type tests are in progress.
135. Dual Volume Gamma Ion Chamber: Gamma Ionization Chamber was developed for the purpose of high gamma radiation detection during accident condition in Light Water reactor as a part of ARMS project.
136. Plastic Wall Ionization Chamber: A plastic wall air pressurized Gamma Ionization Chamber was designed and developed for the purpose of low energy gamma radiation detection. The chamber could detect over 100 $\mu$ R/hr to 5R/hr with gamma energy as low as 25KeV.

137. **Aerosol Monitor:** The Aerosol Monitor is designed for continuous measurement of volumetric activity of radioactive aerosols containing artificial Alpha and Beta emitting nuclides. It also measures effective equivalent in air for Rn-222 concentration for indoor application. It displays and transmits this concentration level, and generates audio visual alarms, when radiation level exceeds a limit set by the user.
138. **Special Component Manufacturing Facility (SCMF):** Advanced machines and equipment used for high precision manufacturing. State of the art machinery includes CNC Turn Mill Centre, 5 Axis Machining Centre, CNC Universal Grinding Machine, Gear Hobbing Machine, Vacuum Brazing Furnace, and other specialized equipment for precision engineering. Additionally, the facility boasts a Clean Room of Class 1000 to ensure optimal production conditions.
139. **Manufacturing facility for production of antenna of varying sizes from 0.45m to 32m along with a Compact Antenna Test Facility (CATF) for calibrating antenna feed systems. Additionally, a Carbon Fibre Reinforced Polymer Facility (CFRP) for building space-grade lightweight, high-stiffness antennas for high-frequency bands like Ka, Q, and V bands was also commissioned.**
140. **Facility for development, testing and qualification of Radiation detectors and Nuclear instruments. This includes Uranium Plating Facility, BF<sub>3</sub> Gas Generation & Purification Facility, Charcoal Coating Facility, Helium Leak Detection System, Vacuum degradation System, Thermal Cycling Facility for Detectors, Silicon Photo Multiplier & Scintillator Characterisation Facility. These facilities enable in-depth testing and advancement in the field of radiation detection technology.**
141. **Facility towards design, development, production, testing and repair of Solid State RF Power amplifiers to meet the requirement of the proposed superconducting accelerator program of DAE/ International Mega Science program.**
142. **Facility for manufacturing testing and calibration of X-Ray Generator which is approved by AERB has been setup. Production license for manufacturing of X-Ray Generator and Baggage Inspection System has also been obtained.**

143. Crystal growth system based on bridgeman technique: This facility is used for the growth and fabrication of Cesium Iodide (CsI) and Sodium Iodide (NaI) crystals, which are used in the production of radiation detectors for various applications related to radiation detection and measurement.
144. Carbon Fibre Reinforced Polymer Facility (CFRP) : This state of art facility was commissioned and mainly comprises of the Composite Autoclave machine, Five Axis CNC machine and the Three Axis Prepreg Cutter. This capability ensures meeting the stringent requirements of space vehicles. By using CFRP composite technology, the construction of large mammoth structures can achieve an almost 50% reduction in the overall weight of the antenna structure.
145. As part of Atmanirbhar Abhiyan of GoI, a Rare Earth Permanent Magnet Plant (REPM) to produce Samarium Cobalt based magnets utilizing indigenous source material for use in defence, space and DAE has been established at Visakhapatnam. The facility was dedicated to the Nation by Hon'ble PM Shri. Narendra Modi on the occasion of 'National Technology Day' on 11.05.2023.
146. A 5 million litres per day (MLD) hybrid sea water desalination plant is established at OSCOM, Ganjam district, Odisha based on technology developed by BARC. The Sea Water Desalination Plant facility was dedicated to Nation by Hon'ble Prime Minister on 05.03.2024.
147. A Rare Earth and Titanium Theme Park in Bhopal has been established at Bhopal with an objective to achieve self-sufficiency in production of RE metals and demonstrating the operations to entrepreneurs so as to encourage them to set up commercial operations and develop skilled workforce for the future. The facility to produce RE metals and recover RE from End-of -Life magnets has been operationalized. Other facilities such as production of LED/Lamp phosphors is under Installation.
148. UCIL has taken up & completed the augmentation of the mining operations at Bhatin mine by deepening of one of the winzes, development of levels delineating the ore body, up-gradation of critical equipment and procurement of new trackless machinery etc. Now mine development and operation (MDO) contracts has been awarded for Production and development of Bhatin Mine.

149. UCIL has taken up & completed projects under “Debottlenecking of Singhbhum and Tummalapalle operations” to remove hindrances and ensure smooth and sustained level of operations from its existing facilities in Singhbhum and Tummalapalle.
150. A Magnetite by-product recovery plant with capacity of 52.00 MT/day has been successfully commissioned at Turamdih Uranium Ore processing Plant for recovery of Magnetite from Uranium Ore tailings. This magnetite is positive revenue generating source from mill tailing as it can be directly sold to the prospective buyers without any further treatment as this Magnetite is readily saleable.
151. In April, 2020, UCIL commissioned the facility for the production of ‘Heat Treated Uranium Peroxide (HTUP)’ in place of ‘Magnesium Di-Uranate (MDU) at Turamdih Mill. With this, both the mills of UCIL in Jharkhand are now producing yellow cake in the form of HTUP which is of about 90% grade compared to around 70% for MDU. HTUP contains lower impurities and is easily soluble in nitric acid, and being of superior grade, will increase the efficiency of downstream processes.
152. Development of Decline at Rohil Uranium Project located in Khandela Tehsil of Sikar district of Rajasthan as a part of exploratory mining on behalf of AMD has been taken up and developed up to a depth of 40 meter from the surface so far. The Mining Plan for Rohil Project has been approved by Atomic Minerals Directorate for Exploration And Research (AMD)-Hyderabad in April-2024. Letter of Intent (LOI) has been granted by Government of Rajasthan for granting mining lease. Terms of Reference (ToR) have been obtained from MoEF&CC for environmental clearance. Base line studies have been completed and preparation of EIA & EMP Report is under progress. Upon submission of EIA&EMP to Govt. of Rajasthan, Public Hearing will be conducted by them. This would add another 220 tonnes to the existing Uranium Production.
153. Start of commercial operation of Kudankulam Units-1&2 (2 x 1000 MW), the largest electricity generating units in the country.
154. Start of commercial operation of first indigenous 700 MW Pressurized Heavy Water Reactors, Kakrapar Atomic Power Station, Units-3&4 (2 x 700 MW) and their dedication to the nation by Hon’ble Prime Minister.

155. Setting of World Record in continuous operation of 962 days by Unit-1 of Kaiga Generating Station among nuclear power plants of all technologies (presently second longest).
156. Continuous operation of nuclear power plants for more than a year 50 times. Of these on six occasions continuous operation of more than 700 days has been achieved.
157. Completion of 50 years of safe operation of Units 1&2 of Tarapur Atomic Power Station (TAPS-1&2), which are currently the oldest reactors in operation in the world.
158. Kudankulam Units-1&2 (2 x 1000 MW), the largest electricity generating units in the country and first indigenous 700 MW Pressurized Heavy Water Reactors - Kakrapar Atomic Power Station, Units-3&4 (2 x 700 MW) were commissioned in the period and dedicated to the nation.

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