PARLIAMENT QUESTION: PROTOTYPE FAST BREEDER REACTOR

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The Prototype Fast Breeder Reactor (PFBR) indigenously designed and built at Kalpakkam in Tamil Nadu has successfully attained its first criticality on 6th April, 2026, marks a major milestone in realizing Dr. Homi J. Bhabha's three-stage nuclear power programme. PFBR is the forerunner for the second stage of its three-stage nuclear power programme. This achievement of attaining first criticality and further power operations paves way for the expansion of the second stage and eventually leading to third stage in future towards long term energy security.

Fast Breeder Reactors form a cornerstone of India's long-term nuclear strategy. By using Uranium–Plutonium Mixed Oxide (MOX) fuel and a Uranium-238 blanket to breed fissile Plutonium-239, the PFBR generates more fuel than it consumes. This is the first commercial fast reactor in India.

As the principal architect of PFBR, Indira Gandhi Centre for Atomic Research (IGCAR) a constituent Unit of Department of Atomic Energy (DAE) provided the complete technical foundation across all stages of development, testing, and commissioning. Some of the key areas of contributions from IGCAR towards PFBR:

Engineering and Testing: Providing comprehensive support for the design, analysis, testing, and validation of sodium systems, component assembly, and instrumentation, alongside rigorous inspections at every stage of the project.

Materials and Sodium Technology: Finalizing specialized nuclear-grade materials, advanced safe sodium handling, cleaning techniques, instrumentation, control systems and establishing manufacturing processes for critical components.

Equipment Qualification: Rigorously testing, fine-tuning, and fully certifying all necessary sensors, devices and equipment's for use in the reactor.

Design and Safety Assessment: Developing in-house computational codes for radiation shielding, thermal hydraulics, and reactor physics.

Indigenization: Developing in-house computational codes for radiation shielding, thermal hydraulics, and reactor physics. Achieving nearly 90% domestic manufacturing for PFBR's equipment and systems through extensive collaboration with Indian industries and handholding industries for gearing up to the stringent quality standards required for the fast reactor ecosystem.

Integrated commissioning: Technical support and manpower were provided during various stages of integrated commissioning and challenges were overcome with synergy and team work. To ensure the safe initial fuel loading and first approach to criticality, IGCAR executed several highly specialized tasks coordinating smoothly with different agencies involved:

Custom Fuel-Handling Systems: Designing, testing, and commissioning vertical direct fuel-handling machines required for the safe initial loading of nuclear fuel, alongside providing specialized training for commissioning personnel.

Under-Sodium Ultrasonic Imaging: Deploying an advanced ultrasonic imaging tool engineered to safely "see" through opaque liquid sodium, allowing operators to visualize internal reactor mechanisms enabling smooth fuel loading.

High-Temperature Robotic Inspection: Developing and deploying DISHA, a remote-controlled robotic vehicle specifically designed for inspecting critical welds between interspace of reactor vessels at high temperatures satisfying regulatory requirements.

Regulatory and Physics Support: Providing crucial reactor physics support and submitting comprehensive verification reports to assist with regulatory clearances. The theoretical reactor physics parameters estimated closely matched the reactor's actual performance during the first criticality of PFBR.

The reactor core of the PFBR is surrounded by a blanket of Uranium-238. Fast neutrons convert this fertile material into fissile Plutonium-239, enabling the reactor to produce more fuel than it consumes. The reactor is designed to eventually use Thorium-232 in the blanket. Through transmutation, Thorium-232 will be converted into Uranium-233, the fuel that will power India's third stage of nuclear energy based on thorium.

The first fleet of 10 indigenous Pressurised Heavy Water Reactors (PHWRs) of 700 MW capacity each, totaling to 7000 MW, is under various stages of implementation. This fleet also includes Mahi Banswara Project-1 to 4 (4 X 700 MW) which is being implemented by ASHVINI, a subsidiary of Nuclear Power Corporation of India Limited (NPCIL) and Joint Venture of NPCIL & National Thermal Power Corporation (NTPC).

The construction activities have commenced with the 'First Pour of Concrete' in the first project of the fleet i.e. Kaiga-5&6 (2 X 700 MW). Pre-project activities are under progress for the remaining projects of the fleet. Procurement of long delivery equipments and components are in progress for the fleet mode reactors in staggered manner. In respect of Mahi Banswara Project, foundation stone for the project has been laid by Hon'ble Prime Minister. Subsequent to Atomic Energy Regulatory Board (AERB) approval, excavation activity is in progress for Mahi Banswara Rajasthan Atomic Power Project -1 & 2.

The present installed capacity of 8780 MW would reach 22480 MW (including 500 MW PFBR being implemented by Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI)) by the year 2031/32, with the progressive completion of these fleet mode projects.

India is pursuing the Three-Stage Nuclear Power Programme to ensure long-term energy sovereignty. The programme is based on a closed fuel cycle, to achieve optimum utilisation of its limited uranium resources and exploit its abundant thorium reserves. In first stage, domestically available natural uranium is used as fuel in Pressurised Heavy Water Reactors (PHWRs), followed by reprocessing of the spent fuel of PHWRs to recover plutonium. In second stage U-238 is further bred into Pu-239 in Fast Breeder Reactors (FBRs) utilizing reprocessed Pu-239 as fuel. In third stage, only after adequate capacity of FBRs is installed, large scale utilisation of thorium will follow, making use of fissile uranium-233 bred from thorium in a breeder reactor initially utilizing Pu-239 as driver fuel.

Atomic Minerals Directorate for Exploration and Research (AMD), a constituent unit of Department of Atomic Energy (DAE), has the mandate to identify, evaluate and augment mineral resources of uranium in the country. As on date**,** AMD has established 4,42,800 tonne (t) *in situ* U_3O_8 located in the States of Andhra Pradesh, Telangana, Jharkhand, Meghalaya, Rajasthan, Karnataka, Chhattisgarh, Uttar Pradesh, Uttarakhand, Himachal Pradesh and Maharashtra.

To boost domestic uranium exploration, AMD has adopted integrated, multi-disciplinary approach (including geophysical, geological, geochemical and radiometric surveys and drilling) in identified thrust areas of the country. Further, AMD is utilising state-of-the-art technology, including heliborne geophysical survey and Artificial Intelligence (AI) & Machine Learning (ML) for mineral potential mapping in selected geological domains of the country. Additionally, new and state-of-the-art analytical equipment have been inducted to AMD's fleet to support its exploration programme.

This information was given by Union Minister of State for Prime Minister's office and Personnel, Public Grievances and Pensions, Atomic Energy and Space, Dr. Jitendra Singh, in a written reply in the Lok Sabha today.

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