GOVERNMENT OF INDIA
DEPARTMENT OF ATOMIC ENERGY
RAJYA SABHA
UNSTARRED QUESTION NO - 489
ANSWERED ON 23/07/2026

NUCLEAR POWER PROGRAMME

489. SHRI S.R. SIVALINGAM

Will the PRIME MINISTER be pleased to state:-

(a) the progress achieved by Government in advancing the country's three-stage nuclear programme from uranium-dependent power generation towards long-term thorium-based energy deployment and enhanced nuclear fuel sustainability;

(b) the recent milestones achieved, including developments relating to Prototype Fast Breeder Reactor at Kalpakkam, enabling transition from plutonium-based second-stage systems towards thorium fuel utilisation in future reactor technologies and advanced nuclear applications; and

(c) the action plan formulated to accelerate thorium-centred nuclear energy expansion as part of the country's long-term clean energy security, strategic fuel independence and low-carbon power generation framework?

ANSWER

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

(a) To reduce the dependency on imported uranium and to insulate the Indian nuclear power programme from geopolitical risk, the Department of Atomic Energy (DAE) is pursuing the three-stage nuclear power programme to optimally utilise its domestic uranium resources and exploit its vast thorium reserves for long-term sustainable energy security. Based on a closed fuel cycle, the programme aims to multiply the domestically available fissile resource through the use of natural uranium in Pressurised Heavy Water Reactors (PHWRs) in the first stage, followed by the utilisation of plutonium, fissile material obtained from the reprocessing of domestic spent fuel of PHWRs in Fast Breeder Reactors (FBRs) in the second stage, and large-scale utilisation of thorium in the third stage through the production and utilisation of Uranium-233 bred from Thorium-232, thereby providing long-term energy security in a sustainable manner.

The first stage of the nuclear programme has been successfully achieved and India has acquired expertise in design, construction, commissioning, operation & maintenance, and front & back end of fuel cycle activities of indigenous PHWR.

India entered into second stage of three-stage nuclear power program when the indigenously designed and built Prototype Fast Breeder Reactor (PFBR) attained its first criticality in April, 2026. It is a significant milestone paving the way for third stage of the nuclear power program.

The Department has also undertaken sustained research and development for thorium utilisation. Thorium Oxide (Thoria) pellets have been used in the initial cores of operating PHWRs, and Thoria-based fuels have been irradiated in Bhabha Atomic Research Centre (BARC) research reactors. The irradiated Thoria pins have been reprocessed to obtain Uranium-233, which has been fabricated as fuel for KAMINI reactor at Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam. Studies have been carried out on the use of thorium in different reactor systems with regard to fuel management, reactor control and fuel utilisation.

Also, BARC is pursing Research & Development (R&D) on molten salt reactor (MSR) envisaged as one of the suitable technologies for thorium utilisation in a sustainable manner.

(b) Prototype Fast Breeder Reactor (PFBR) is an indigenous reactor designed by IGCAR that has achieved its First Criticality on 6th April, 2026 at 08:20pm, marking a key milestone in the history of second stage of Indian nuclear power programme.

As the principal architect of this indigenous reactor, IGCAR provided the complete technical foundation across all stages of design, development, testing, meeting regulatory requirements and commissioning. Some of the key areas of contributions from IGCAR towards PFBR:

Engineering and Testing: successfully 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 co-ordinating 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 during the first criticality of PFBR.

Demonstration of Clean Hydrogen Production using nuclear heat at Fast Breeder Test Reactor (FBTR), IGCAR

IGCAR achieved a global first on June 26, 2026, by demonstrating the successful production of clean hydrogen using nuclear heat. By integrating a Copper-Chlorine thermochemical cycle; developed by the (BARC), with the secondary sodium heating loop of the Fast Breeder Test Reactor (FBTR), this novel facility generated carbon-free hydrogen. This achievement marks a pioneering technological breakthrough and opens a promising pathway for large-scale, carbon-free hydrogen production using advanced nuclear reactors.

Nuclear-assisted Copper–Chlorine (Cu–Cl) thermochemical cycle-based hydrogen production offers a stable base-load alternative to renewable-powered electrolysis and supports co-generation of electricity and hydrogen within nuclear infrastructure. This technology has significant relevance towards decarbonisation of sectors such as fertilizers, refineries, transport and steel production, while supporting India's National Green Hydrogen Mission and Net Zero targets.

The programme also strengthens indigenous technological capability and aligns with the vision of "Atmanirbhar Bharat" through development of advanced clean energy systems. Future sodium-cooled Fast Breeder Reactors including FBTR-2 planned at Kalpakkam are proposed to have a facility for co-generation of hydrogen.

Further, Low Power Physics Experiments (LPPE) for validating the design parameters and turbine generator overhauling are under progress. On completion of LPPE, step wise regulatory clearance will be obtained and power will be raised towards synchronization to grid and full power operation.

(c) The Government's action plan for accelerating thorium-centred nuclear energy is based on the continued implementation of the three-stage nuclear programme for optimum utilisation of India's thorium resources. Thorium-232, being a fertile material cannot be directly used as fuel, it needs to be converted to fissile U-233 in a breeder reactor fuel using plutonium and then converted U-233 is utilize as fuel. Large scale use of thorium is expected when sufficient plutonium is available as driver fuel.

Research & Development (R&D) efforts are underway for development of technologies for thorium utilisation so that a matured technology is available before beginning of large scale deployment of thorium based reactor.

Molten salt reactor (MSR) is envisaged as one of suitable technologies for thorium utilisation. The DAE is in the process of development of molten salt reactor aimed to demonstrate the technologies required for the efficient utilisation of thorium. R&D on development and qualification of special materials, molten fluoride salt chemistry, component development is in progress for molten salt demonstration reactor.

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