

Kakrapar Nuclear Facility

July 22, 2020

The third unit of the Kakrapar Atomic Power Project (KAPP-3) in Gujarat achieved its 'first criticality' – a term that signifies the initiation of a controlled but sustained nuclear fission reaction.

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This is a **landmark event in India's domestic civilian nuclear programme** given that KAPP-3 is the **country's first 700 MWe (megawatt electric) unit, and the biggest indigenously developed variant of the Pressurised Heavy Water Reactor (PHWR)**. The PHWRs, which use **natural uranium as fuel and heavy water as moderator**, are the mainstay of India's nuclear reactor fleet. Until now, the biggest reactor size of indigenous design was the 540 MWe PHWR, two of which have been deployed in Tarapur, Maharashtra.

The operationalisation of India's first 700MWe reactor marks a significant scale-up in technology, both in terms of optimisation of its PHWR design – the new 700MWe unit **addresses the issue of excess thermal margins – and an improvement in the economies of scale, without significant changes to the design of the 540 MWe reactor**. ('Thermal margin' refers to the extent to which the operating temperature of the reactor is below its maximum operating temperature).

Four units of the 700MWe reactor are currently being built at Kakrapar (KAPP-3 and 4) and Rawatbhata (RAPS-7 and 8). The 700MWe reactors will be the backbone of a new fleet of 12 reactors to which the government accorded administrative approval and financial sanction in 2017, and which are to be set up in fleet mode.

As India works to ramp up its existing nuclear power capacity

of 6,780 MWe to 22,480 MWe by 2031, the 700MWe capacity would constitute the biggest component of the expansion plan. Currently, nuclear power capacity constitutes less than 2% of the total installed capacity of 3,68,690 MW (end-January 2020).

Achieving Criticality

Reactors are the heart of an atomic power plant, where a controlled nuclear fission reaction takes place that produces heat, which is used to generate steam that then spins a turbine to create electricity. **Fission** is a process in which the nucleus of an atom splits into two or more smaller nuclei, and usually some byproduct particles. When the nucleus splits, the **kinetic energy of the fission fragments is transferred to other atoms in the fuel as heat energy**, which is eventually used to produce steam to drive the turbines. For every fission event, if at least one of the emitted neutrons on average causes another fission, a **self-sustaining chain reaction** will take place. A nuclear reactor achieves criticality when each fission event releases a sufficient number of neutrons to sustain an ongoing series of reactions.