

Kakrapar Atomic Power Project

Why in news?

The third unit of Kakrapar Atomic Power Project (KAPP-3) in Gujarat achieved its 'first criticality'.

What is KAPP-3?

- KAPP-3 is the first 700 MWe (Mega Watt electric) unit of India.
- It is the biggest indigenously developed variant of the Pressurised Heavy Water Reactor (PHWR).

What does achieving criticality mean?

- **First criticality** is a term that signifies the initiation of a controlled but sustained nuclear fission reaction.
- In the reactors of an atomic power plant, a controlled nuclear fission reaction takes place.
- **Fission** is a process in which the nucleus of an atom splits into two or more smaller nuclei, and usually some by-product particles.
- When the nucleus splits, the kinetic energy of the fission fragments is transferred to other atoms in the fuel as heat.
- This heat is used to produce steam to drive the turbines to create electricity.
- 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.

Why is this achievement significant?

- The achievement by KAPP-3 is a landmark event in India's domestic civilian nuclear programme.
- The PHWRs are the mainstay of India's nuclear reactor fleet.
- [PHWRs use natural uranium as fuel and heavy water as moderator.]
- Until now, the biggest reactor size of indigenous design was the 540 MWe PHWR.
- The operationalisation of this new 700 MWe reactor marks a significant scale-up in technology, both in terms of,
 1. Optimisation of its PHWR design (the new 700MWe unit addresses the

- issue of excess thermal margins),
2. 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 700 MWe reactor are currently being built at Kakrapar (KAPP-3 and 4) and Rawatbhata (RAPS-7 and 8).

What is the significance of 700MWe reactors?

- These reactors will be the backbone of a new fleet of 12 reactors to which the government gave approval and financial sanction in 2017.
- India is working 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 this expansion plan.
- Currently, nuclear power capacity constitutes less than 2% of the total installed capacity of 3,68,690 MW (end-January 2020).
- The civilian nuclear sector is gearing up for building a 900 MWe Pressurised Water Reactor (PWR) of indigenous design.
- For this, the experience of executing the larger 700MWe reactor design will come in handy.

What are the upgraded safety features in the 700MWe unit?

- PHWR design uses **thin walled pressure tubes**, instead of the large pressure vessels used in pressure vessel type reactors.
- This results in the distribution of pressure boundaries to several small-diameter pressure tubes.
- This lowers the severity of the consequence of an accidental rupture of the pressure boundary.
- The 700 MWe PHWR design has enhanced safety through a dedicated '**Passive Decay Heat Removal System**'.
- This system can remove decay heat (released from radioactive decay) from the reactor core without requiring any operator actions.
- The 700 MWe PHWR unit is equipped with a **steel-lined containment** to reduce any leakages.
- It also has a **containment spray system** to reduce the containment pressure in case of a loss of coolant accident.

How did India's PHWR technology evolve?

- PHWR technology started in India in the late 1960s.

- It was started with the construction of the first 220 MWe reactor, Rajasthan Atomic Power Station, RAPS-1.
- RAPS-1 was built under the joint Indo-Canadian nuclear co-operation,
 1. Canada supplied all the main equipment for this first unit.
 2. India was responsible for construction, installation, and commissioning.
- The first two units of PHWR using indigenously developed 220 MWe design were set up at the Narora Atomic Power Station.
- To realise economies of scale, the design of 540 MWe PHWR was subsequently developed, and two such units were built at Tarapur.
- Further optimisations were carried out when the upgrade to 700 MWe capacity was undertaken, with KAPP-3 the first unit of this kind.

Source: The Indian Express

