



INDIA'S NUCLEAR VANGUARD

ENGINEERING THE 500 MW KALPAKKAM P

STRATEGICAL BRIDGE PLUTONIUM FUTURE

STAGE 2: PROTOTYPE FAST BREEDER REACTOR (PFBR)

Focus: Breeds more fuel than it consumes.

HEAVY WATER

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STAGE 3: THORIUM

Focus:
power
India's
reserv

Strategic Imperative: The 500 MW PFBR will produce plutonium from Stage 1 and physically convert it to unlock the Stage 3 Thorium future.

PAKKAM PFBR: OPERATING SPECIFICATIONS

CAPACITY & OUTPUT

500 MW
electrical
(MWe)

~40%
Thermal
Efficiency

CORE MECHANICS

**Sodium-cooled
Fast Breeder
Reactor**

MOX Fuel
(Plutonium +
Uranium oxide)

TIMELINE & STATUS

First Criticality:
6 April 2026

OVERSIGHT AGENCIES

Design Agency:
IGCAR

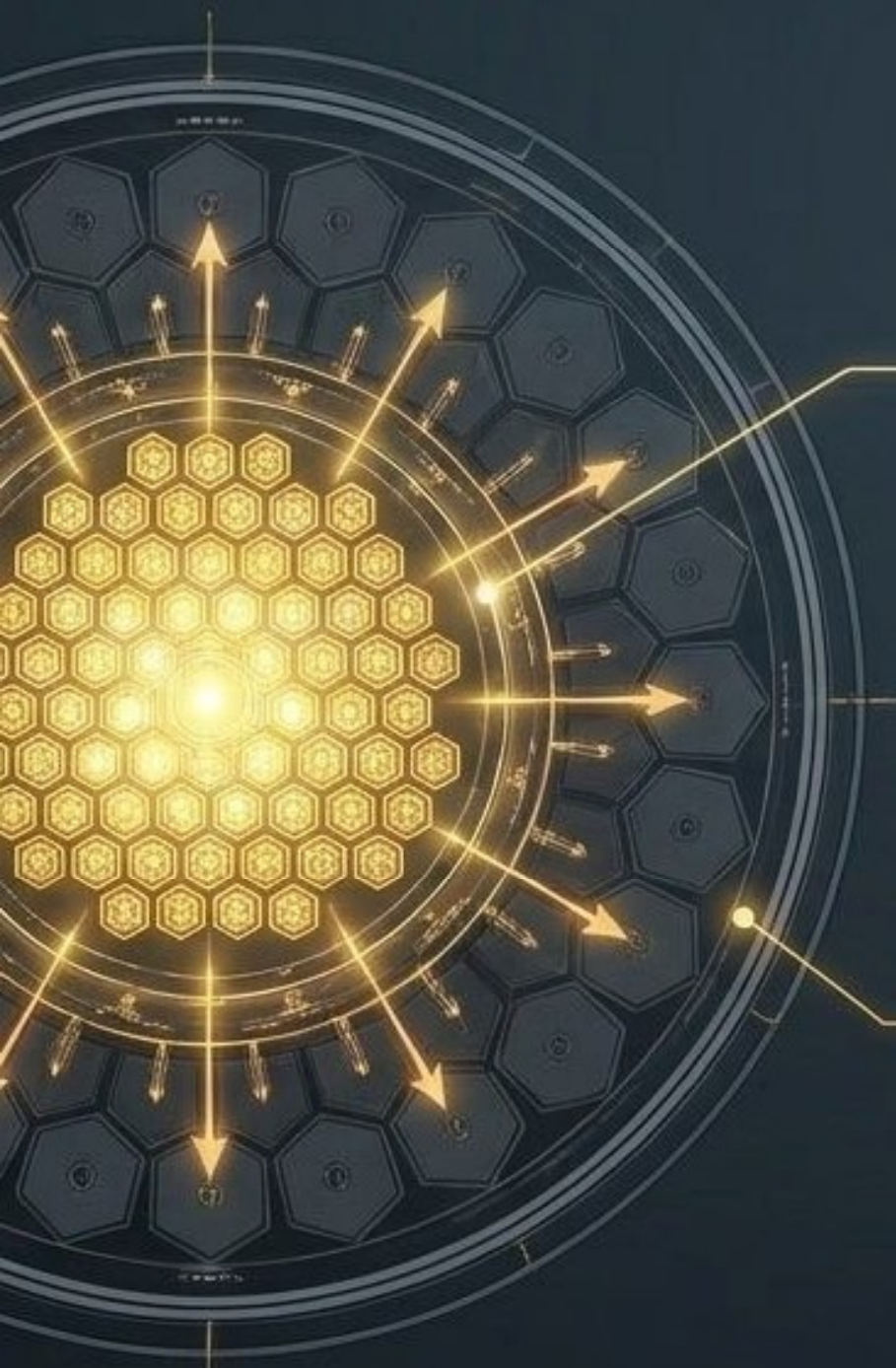
Owner:
BHEL

PHYSICS OF BREEDING: PRODUCES MORE FUEL THAN CONSUMED



In addition to traditional thermal plants, this reactor leverages fast neutrons to synthesize tomorrow's fuel while generating today's power.

ARCHITECTURE: CORE AND THE BLANKET



THE ENGINE: MOX FUEL ASSEMBLY

Composition: Plutonium-239 + U-238

Function: The primary site of fission, producing intense heat and emitting fast neutrons.

THE RAW MATERIAL: FERTILE BLANKET

Composition: U-238 & Thorium (U-232)

Function: Captures escaping fast neutrons and transmutes into new, usable fissile material.

FAST CONUNDRUM: DYNAMICS OF LIQUID SODIUM

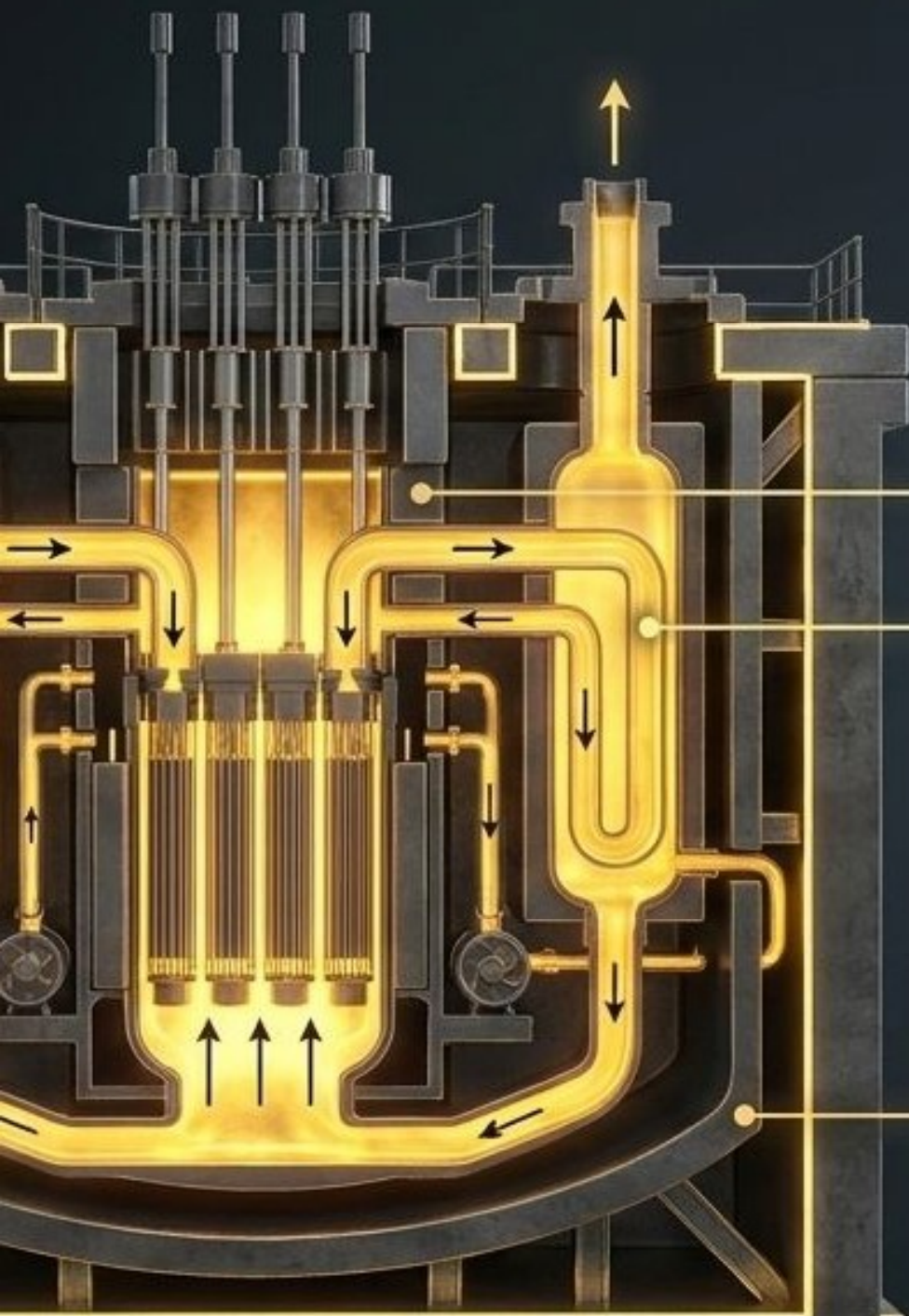
PHYSICAL PROPERTY	ENGINEERING ADVANTAGE
Thermal Capacity: Excellent heat transfer capabilities.	Enables highly rapid cooling of packed, high-energy fast neu
Operating Temperature: Operates optimally at 500–550°C (Inlet: 397°C / Outlet: 547°C).	Drives overall plant therm efficiency up to ~40%
Pressure: Operates at extremely low pressures even at elevated temperatures.	Eliminates the need for massive pressurized reactor containme

SMALL RELAY RACE: LOOP ARCHITECTURE



CRITICAL IMPERATIVE: Liquid sodium reacts violently with water. The intermediate secondary loop acts as a critical physical barrier, preventing direct reactor-to-water contact while seamlessly transferring 1253 MWt of energy.

PRIMARY SODIUM HEAT EXTRACTION



HEAT SOURCE

Extracts energy directly from the active reactor core.

TEMPERATURE DELTA

↑ Inlet Temperature: **397°C** ↑ Outlet Temperature: **500°C**

CONTAINMENT PROFILE

Driven by sodium coolant pumps, this loop becomes highly radioactive under neutron bombardment and is contained within the heavily shielded reactor building.

THE INTERMEDIATE BUFFER

FACE

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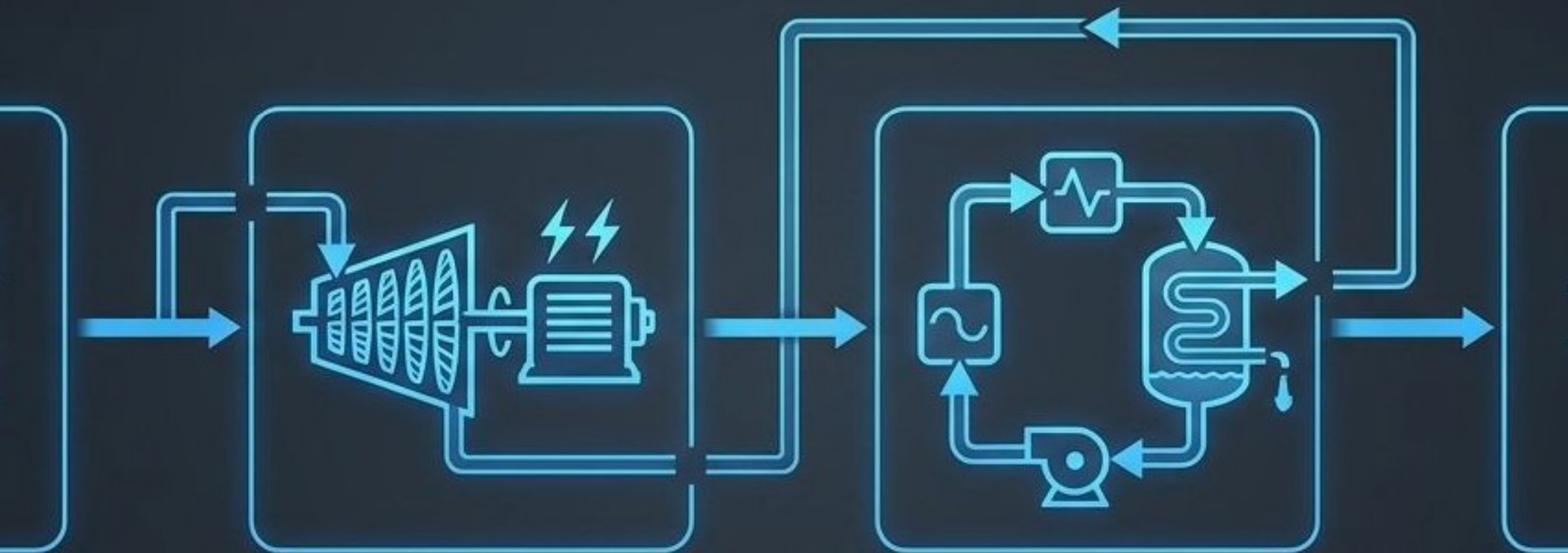
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**ISOLATION
SAFETY**

This second
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It effectively
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from the core
guaranteed
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breach.

STEAM GENERATION POWER BLOCK



POWER BLOCK

High-pressure steam drives a condensing steam turbine, aggressively spinning the generator.

EXHAUST CYCLE

Steam exhaust moves to the condenser, through the condensate pump, into the feed water heater, and loops back.

SIS: UNLOCKING THORIUM DESTINY

U-233

STAG
THORIUM R

ctrical output is highly valuable, but it is fundamentally a secondary benefit. The
alpakkam PFBR is the U-233 fissile material bred in its blanket—the exact fuel
assive, untapped thorium reserves and achieve absolute energy independence



Thank You