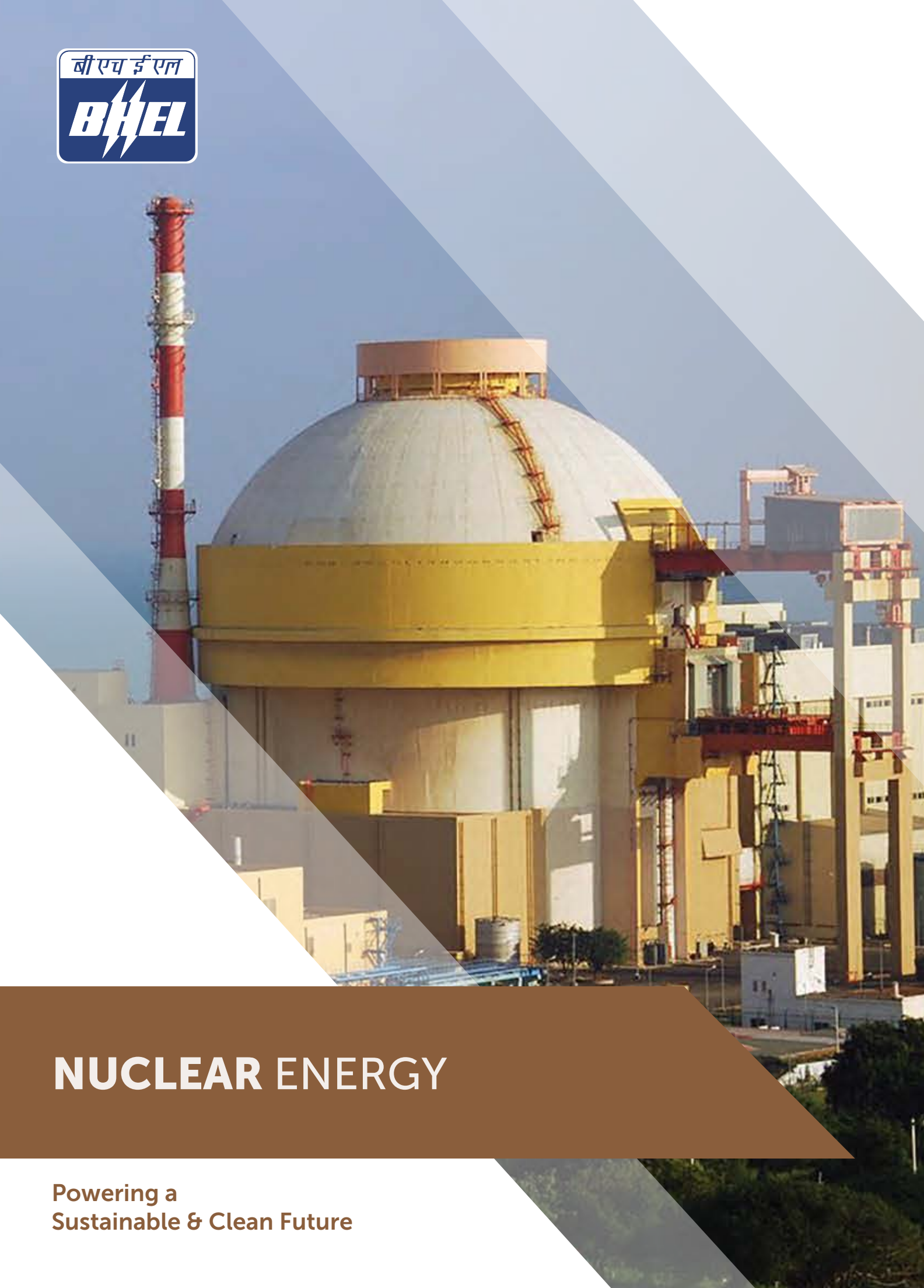


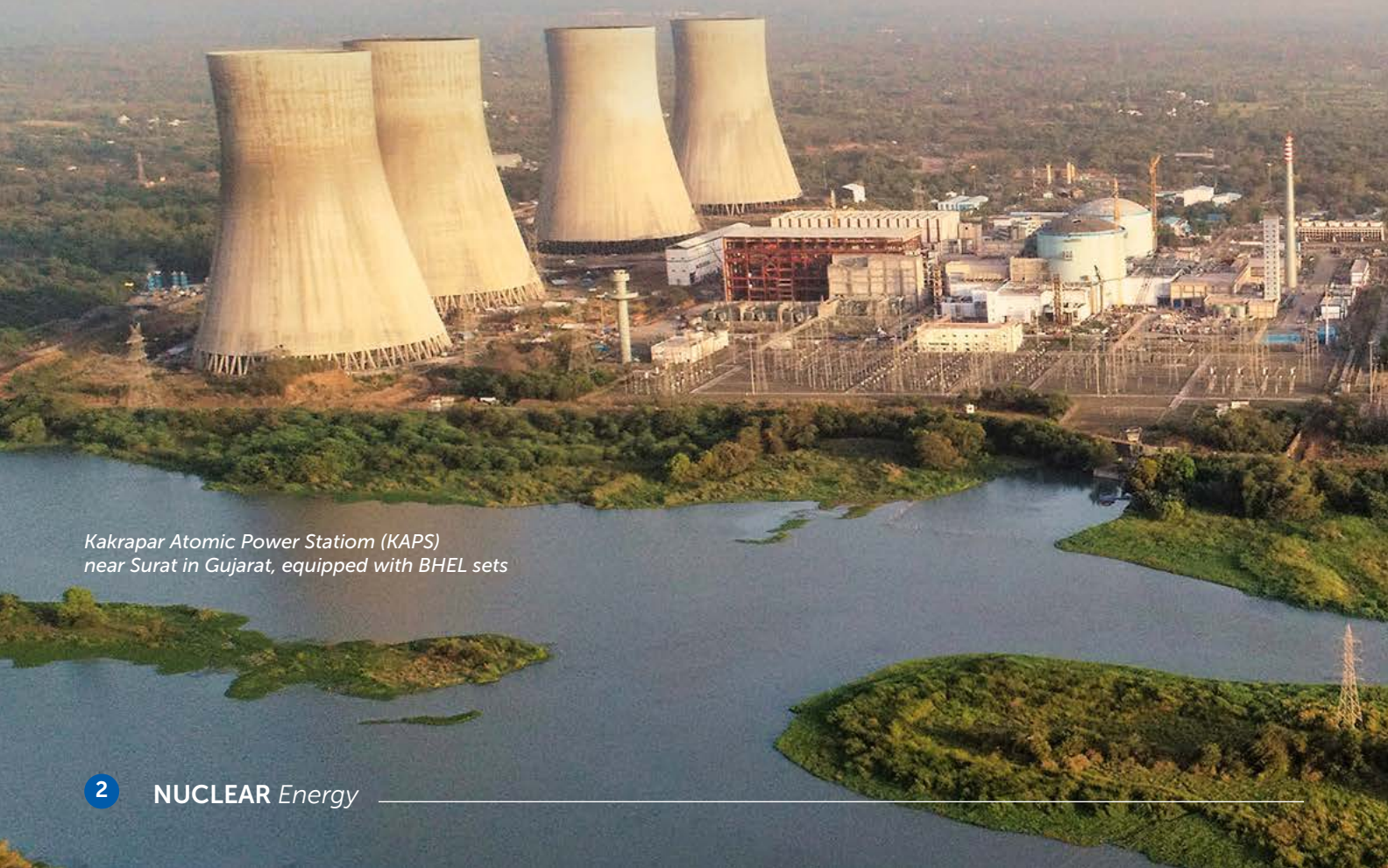
NUCLEAR ENERGY

Powering a
Sustainable & Clean Future

About BHEL

Established in 1964, BHEL is one of the largest & oldest engineering and manufacturing enterprises in India in the energy and infrastructure sectors. BHEL has a widespread network of 16 manufacturing facilities, 2 repair units, 8 service centres, 14 centres of excellence, 5 specialized institutes for carrying out advanced R&D in various engineering disciplines, and is currently executing projects at more than 150 sites across India and abroad. BHEL offers one-stop solutions backed by its core design, engineering and manufacturing strengths coupled with a committed pool of about 30,000 employees (including 9,000 skilled engineers), contemporary technologies and state-of-the-art manufacturing and testing facilities. The company undertakes projects and contracts in all modes including EPC, Supply, Supply & Supervision, Consortium partner, Contract Manufacturer, etc., as per customer requirement.

From making India self-reliant in power generation to setting up power-plants in Africa, CIS, South-East Asia and Far-East, BHEL has contributed close to 200 GW of power-generation capacity. BHEL has also been deeply involved in other industrial and strategic sectors offering our customers a comprehensive portfolio of products, systems and services in power (nuclear, hydro, solar and thermal), transmission (sub-stations, transformers, shunt-reactors, instrument transformers, switchgear), railways (rolling stock, propulsion, traction motors, transformers, etc.), defence, aerospace, oil & gas, battery energy storage systems & EV chargers and stand-alone products such as compressors, heat exchangers, motors, pumps, valves, etc., adhering to international standards. Besides a formidable presence in India, the company has a widespread footprint spanning 89 countries across all the inhabited continents of the world.

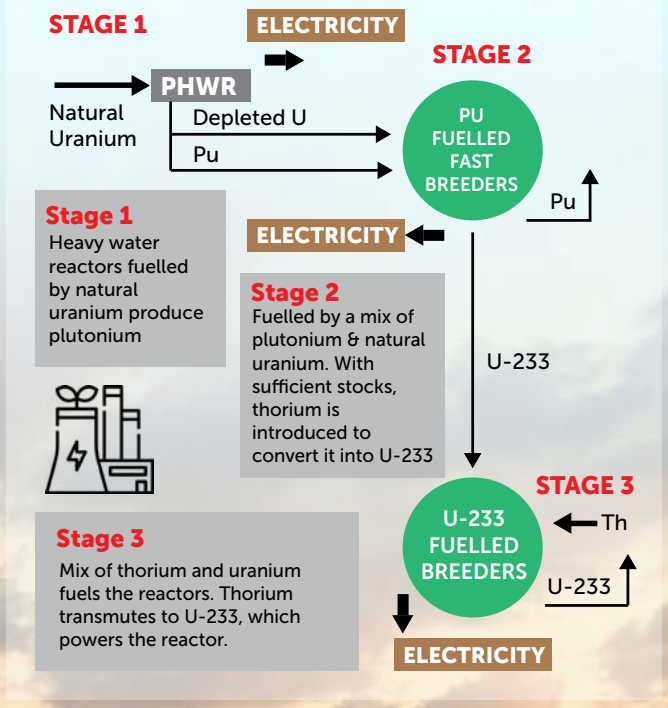


Kakrapar Atomic Power Statiom (KAPS) near Surat in Gujarat, equipped with BHEL sets

A leader in the Indian Nuclear Power Industry

BHEL has been involved in development of India's Indigenous Nuclear Power Programme since its inception. The Three Stages of Indian Nuclear Power Programme, as envisioned by Dr. Homi Jehangir Bhabha, the father of Indian Nuclear Programme, has been successfully supported by BHEL by providing sustainable solutions for over 5 decades. The company has dedicated infrastructure and trained manpower to address the stringent quality and safety requirements for various components/ equipment for a Nuclear Power Plant during design, manufacturing and testing complying with the international codes and standards. BHEL has proven its capability in design, manufacturing and installation of both Primary and Secondary Side components/ equipment of Nuclear Power Plants. **BHEL is among few players in India with capability to execute EPC project for a Nuclear Power Plant.**

INDIA'S THREE-STAGE NUCLEAR PROGRAMME



Out of the 22 Reactors operating in India, BHEL has supplied Steam Turbines Generator sets for 12 Plants, contributing nearly 50% of Country's total installed capacity of 6.78 GWe

BHEL's experience in Nuclear Power Projects

BHEL is the only Indian company with the unique capability to design, manufacture, supply and install Nuclear Steam Turbines.

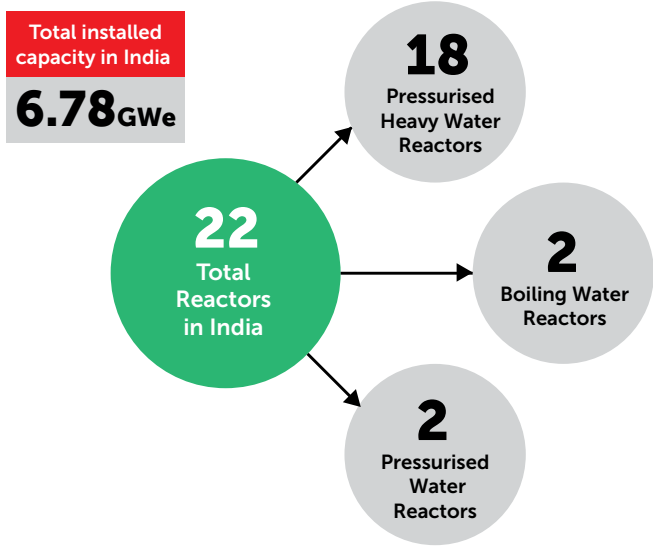
For the First Stage of India's Nuclear Power Programme, BHEL's contribution started with the first Indigenously built 220 MWe Nuclear Power Plant at Madras Atomic Power Stations (MAPS), Kalpakkam, Tamil Nadu.

As on today, BHEL-supplied Steam Turbine Generator Sets for 10 units of 220 MWe and 2 units of 540 MWe (installed at Tarapur Atomic Power Stations- TAPS) are under commercial operations.

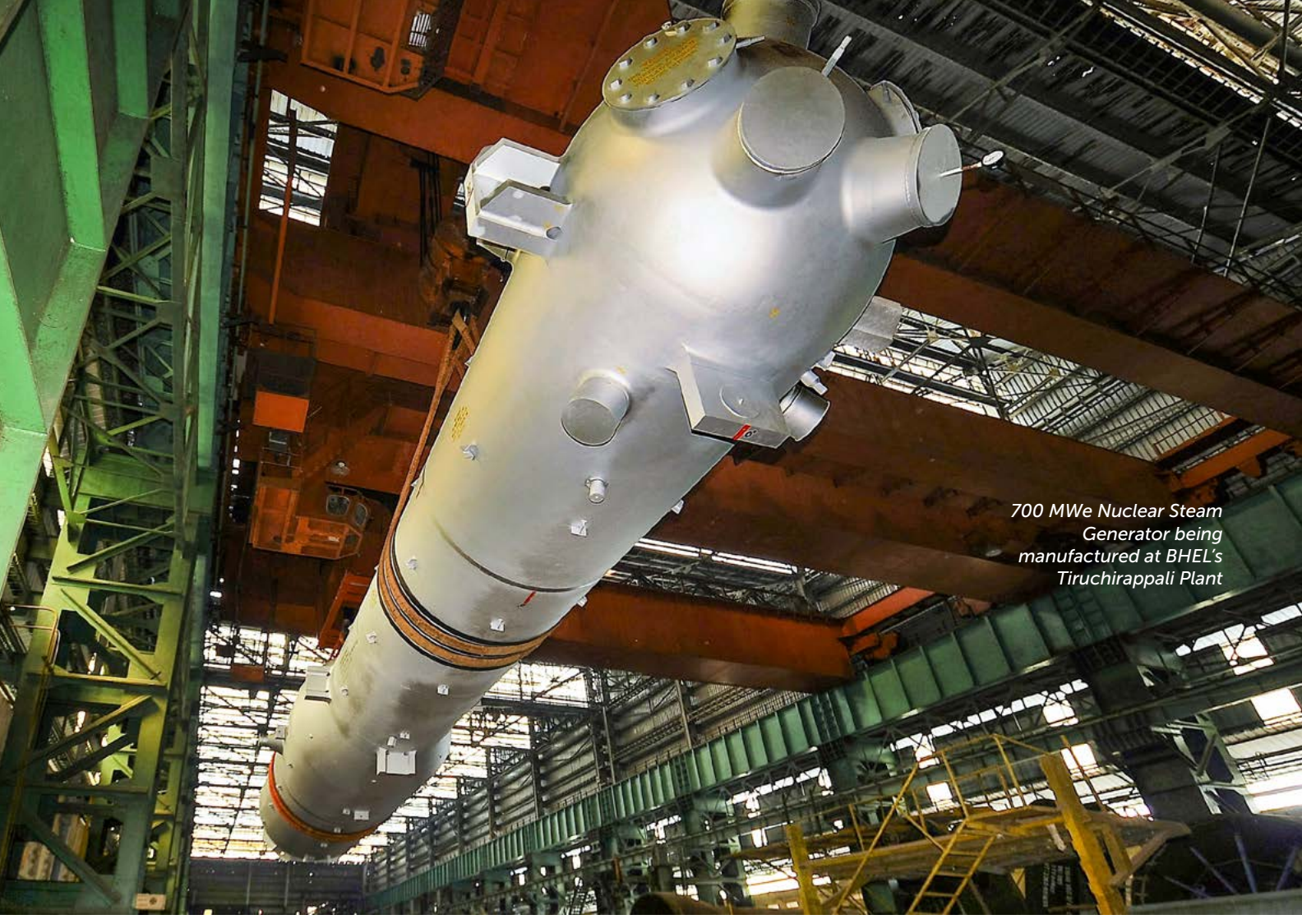
First unit of highest rated 700 MWe PHWR based Nuclear Power Plant, Unit 3 at Kakrapar, Gujarat has been synchronized in January 2021. BHEL is currently executing Turbine Island Package on 'EPC' basis for 10 Units of 700 MWe rated NPPs.

On the Primary Side, BHEL has supplied critical equipment such as Nuclear Steam Generators (44 Nos.-highest by any manufacturer in India), Reactor Headers (96 Nos.-highest by any manufacturer in India), End Shields, Hair Pin Heat Exchangers etc. for rating upto 700 MWe.

In addition to its proven capability in Control & Instrumentation (C&I) on Secondary Side of Nuclear power Plants, BHEL has also successfully executed Control Centre Instrumentation Package for 700 MWe Nuclear Power Projects.



In 2018, situated in the southern state of Karnataka, NPCIL's Kaiga Unit 1 had created a world record of longest continuous operation of 962 days. The Steam Turbine Generator Set for the plant had been supplied by BHEL and is under operation since November, 2000.



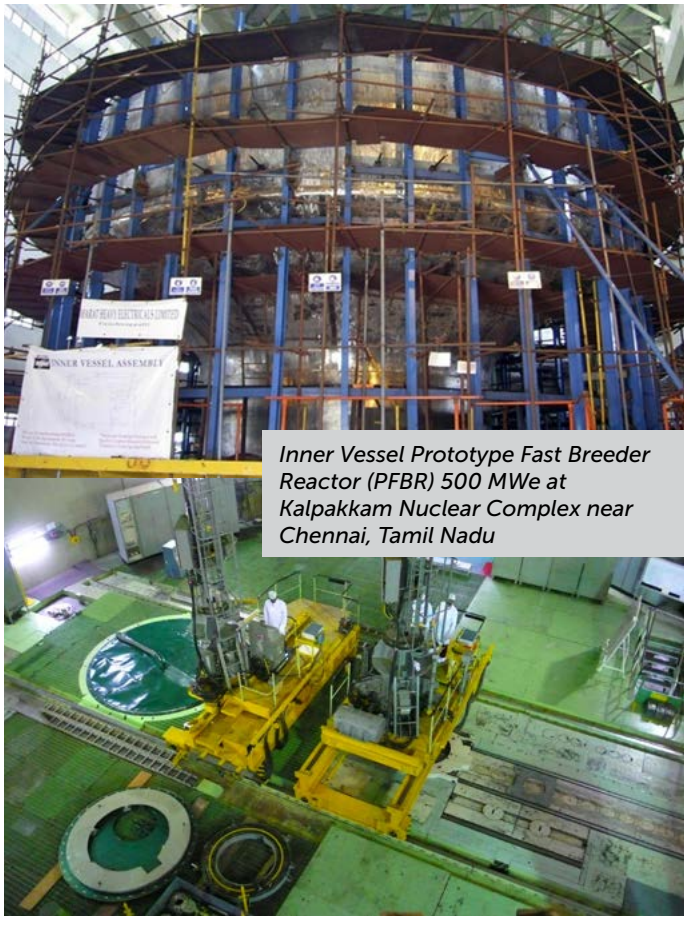
700 MWe Nuclear Steam Generator being manufactured at BHEL's Tiruchirappali Plant

For the Second stage of the Indian Nuclear Power Programme, BHEL has installed the Turbine Island for 500 MWe Prototype Fast Breeder Reactor (PFBR) under construction at Kalpakkam, Tamil Nadu. BHEL has also supplied and erected Inner Vessel and Thermal Baffle on the Primary Side.

For the third stage of the Indian Nuclear Power Programme, BHEL has developed the Secondary Cycle (Power Generating Side) for Thorium based 300 MWe Advanced Heavy Water Reactors (AHWRs) under agreement with Bhabha Atomic Research Center (BARC).

For the NPPs being established in India under foreign cooperation, BHEL has rendered its services for the erection and commissioning of Turbine Side for 2 x 1000 MWe for Kudankulam Unit-1 & 2 at Tamil Nadu. Currently, company is involved in erection and commissioning of both Primary and Secondary Side for 2x1000 MWe Kudankulam Unit 3 & 4 being supplied by M/s Rosatom.

With competences across both Primary and Secondary Side of NPP, BHEL is exploring avenues for export of nuclear components.



Inner Vessel Prototype Fast Breeder Reactor (PFBR) 500 MWe at Kalpakkam Nuclear Complex near Chennai, Tamil Nadu

Pressuriser erection in progress

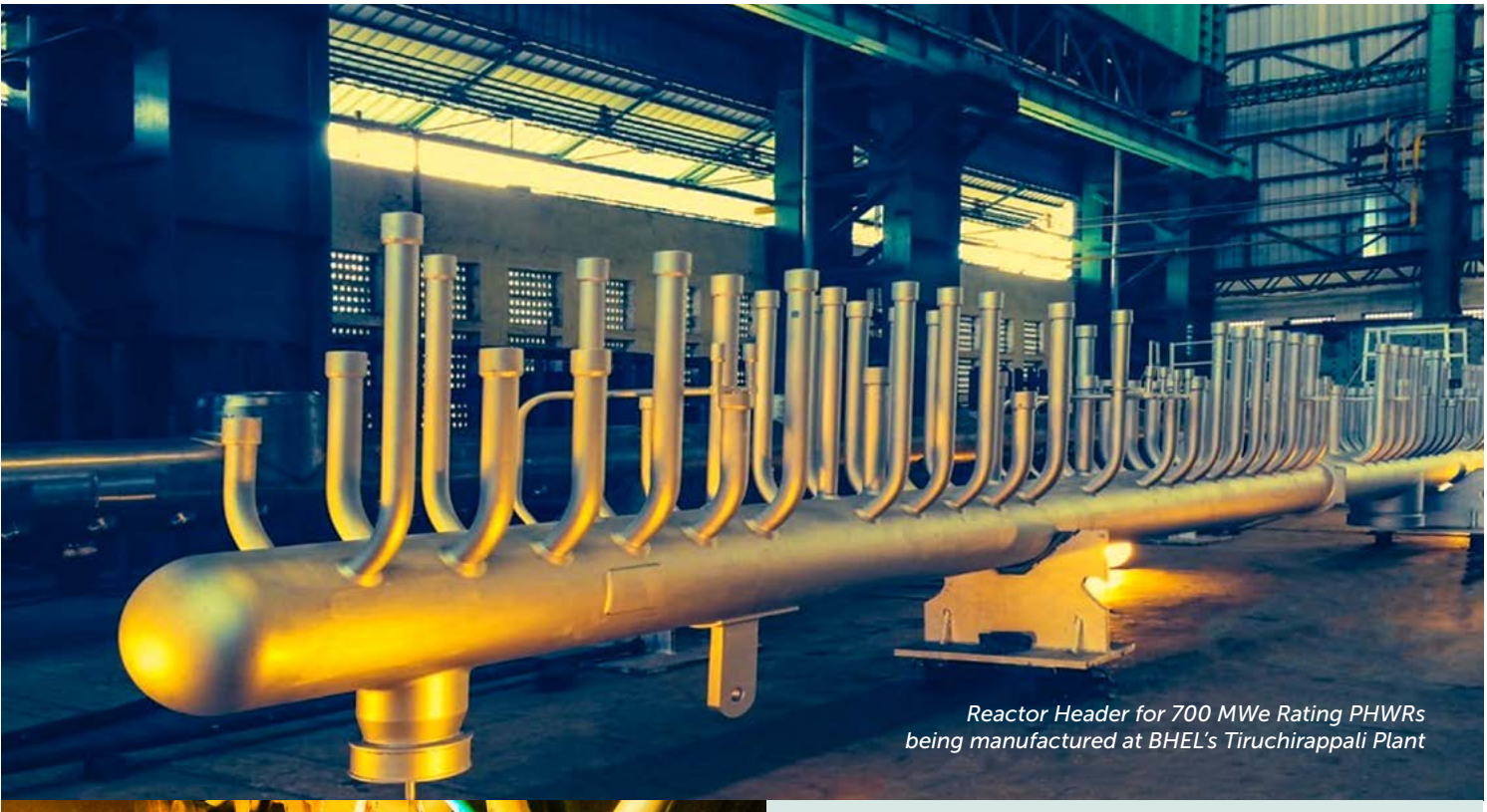
Products & Services

Primary side

- Steam Generators - 220 MWe, 540 MWe and 700 MWe
- Reactor Headers
- Heavy Water Heat Exchangers
- Pressure Vessels, Heat Exchangers and SGs for research
- Motors for Reactor Coolant Pumps for 220 MWe and 500 MWe
- Replacement Heat Exchangers
- Inner Vessel, Thermal Baffle for Prototype Fast Breeder Reactor (PFBR)
- Hair Pin Heat Exchangers for 220 MWe
- End-shields for 220 MWe
- Control Centre Instrumentation Package
- Piping & Valves
- Installation of Primary Side Equipment

Secondary side

- Steam Turbines and Auxiliaries -220 MWe, 500 MWe, 540 MWe and 700 MWe
- Generators and Auxiliaries -220 MWe, 500 MWe, 540 MWe and 700 MWe
- Motors for Cooling Water Pumps
- Condensing and feed heating equipment
- Boiler Feed Pumps
- Control & Instrumentation
- Deaerators
- Piping and Valves
- 285 MVA Generator Transformers
- 220 kV Generator Breakers
- Switchyards
- EPC solution for entire Turbine Island



Reactor Header for 700 MWe Rating PHWRs being manufactured at BHEL's Tiruchirappali Plant

Tube sheet cladding for Steam Generator

BHEL is executing the contract for establishing Turbine Island on EPC basis for 6 units of 700 MWe Pressurised Heavy Water Reactors

Tube to Tubesheet Welding for Nluclear Steam Generators

Facilities/ Capabilities

Clean Room Facilities

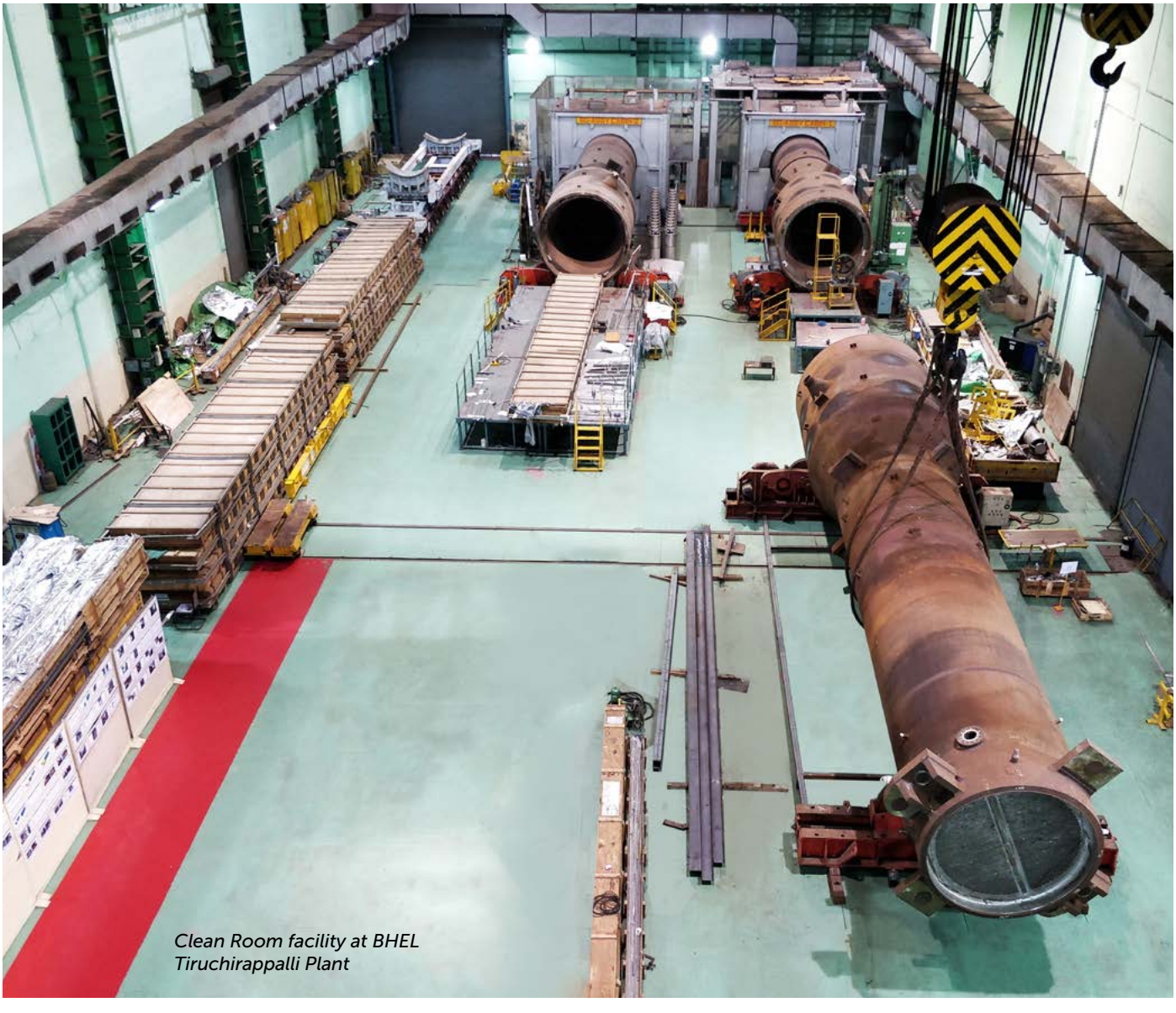
- A cumulative area of 5200 sq. m. of clean room infrastructure present in Tiruchirappalli, Bengaluru and Bhopal units of BHEL to support production of Nuclear equipments & products
- Clean room of various classes are available viz. ISO Class 6/ Class 7/ Class 8
- Clean room sizes vary from 80 sq. m. to 2070 sq. m.
- Operating temperatures : 20±2 °C to 25±2 °C

Machining

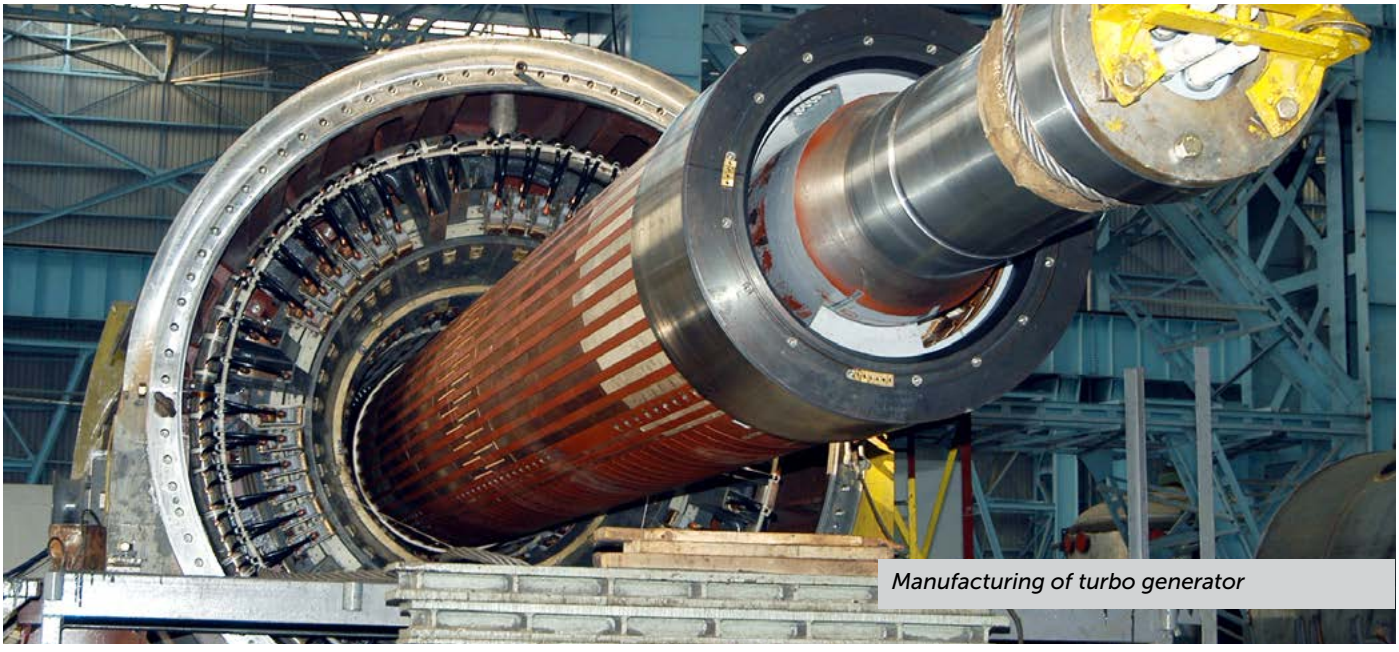
Manufacturing facilities at BHEL have a wide variety of state-of-the-art precision machining setups which include various CNC equipment viz. CNC Horizontal/ Vertical Boring Machines, CNC Multi-axis Mutli-spindle Machines, Milling, Grinding, Tube finnng Machines, etc. We, at our works also have Modern Blade Shop for Advanced Class Steam Turbine Blades.

Fabrication

- Special materials fabrication such as P-91, low alloy steels, stainless steel, alloy 800, titanium, etc.



Clean Room facility at BHEL Tiruchirappalli Plant



Manufacturing of turbo generator

- CNC Incremental Pipe Bending Machine for dia. up to 1200 mm absorption, assimilation & system integration

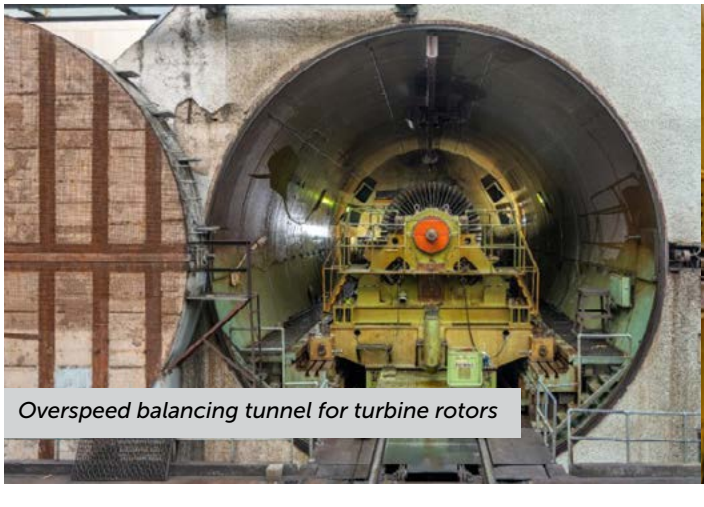
Welding Capability

Welding Research Institute (WRI) - leading institute in India for welding research with advanced welding processes and technologies at Tiruchirappalli, Tamil Nadu

- Welding - SMAW, MIG, TIG, SAW processes
- Thin Section / Pipe Section welding
- Welding Manipulator capacity up to 15 ton
- Welding Overlay facility
- 2 MW Nd-Yag Laser for Welding & Cutting
- Experienced and Certified Welders

Testing Capabilities

- Non-Destructive Testing:
  - 360 degree Panoramic X-ray
  - Digital X - Ray
  - DP, MPI, Ultrasound Testing
- CNC 3-D Coordinate Measuring Machine
- Chemical Analysis & Mechanical Testing
- Laser based gauge Checking Device
- Electrical Insulation Testing Laboratory
- Electronics Laboratory
- Overspeed Balancing Tunnel for Turbine Rotors up to 1000 MW unit size
- UHV Lab (750 kV) & Vapour Phase Plant for Transformers
- NABL Accredited labs



Overspeed balancing tunnel for turbine rotors

UHV laboratory

Rajasthan Atomic Power Project (RAPP)
at Rawatbhata, Rajasthan, India, powered with BHEL sets

Engineering Capabilities

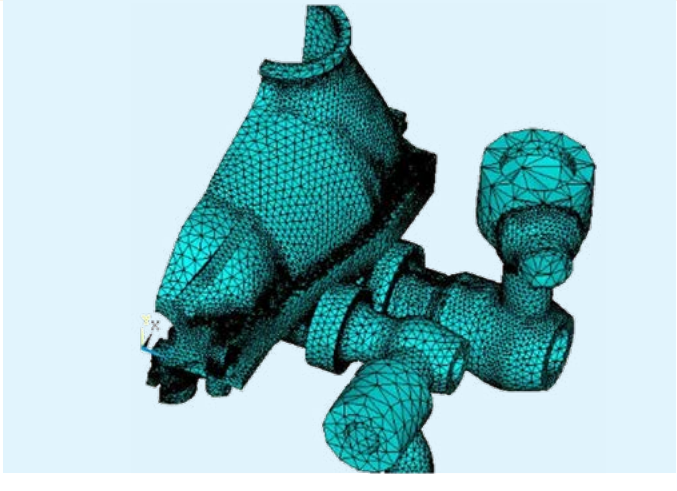
Providing Solutions on both Primary & Secondary side

Complementing its manufacturing prowess, BHEL has a strength of 9000 Engineers who have expertise in various domains including design of Nuclear Equipment.

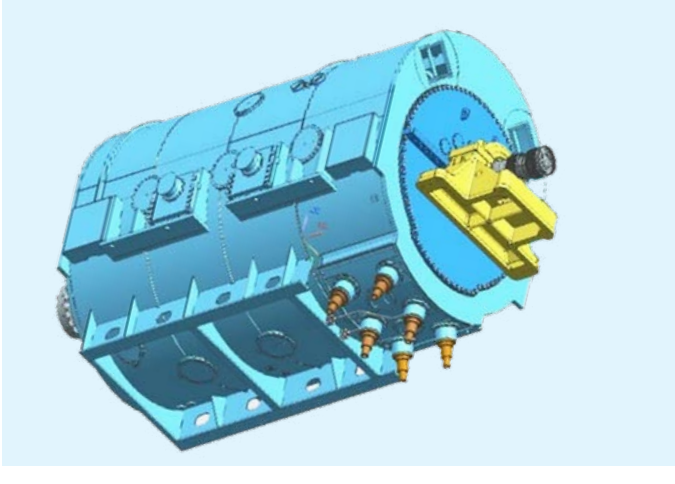
On the primary side BHEL designers have the capablity for design of equipment that makes up the Nuclear Steam Supply System. BHEL has been involved in the uprating of Nuclear Steam Generator from 540 MWe rating to 700 MWe rating for the Indian Nuclear Power Segment.

On the secondary side, BHEL has expertise in design & optimization of the secondary cycle and equipment viz. Turbine, Generator, Condensor, Moisture Separator Re-heater, HP & LP Heaters etc. which form part of the Turbine Island.

Along with the in-house technological development, as part of its growth strategy, BHEL has also been partnering with collaborators for indigenisation of technologies in Nuclear segment.



Turbine 3D Finite Element Analysis

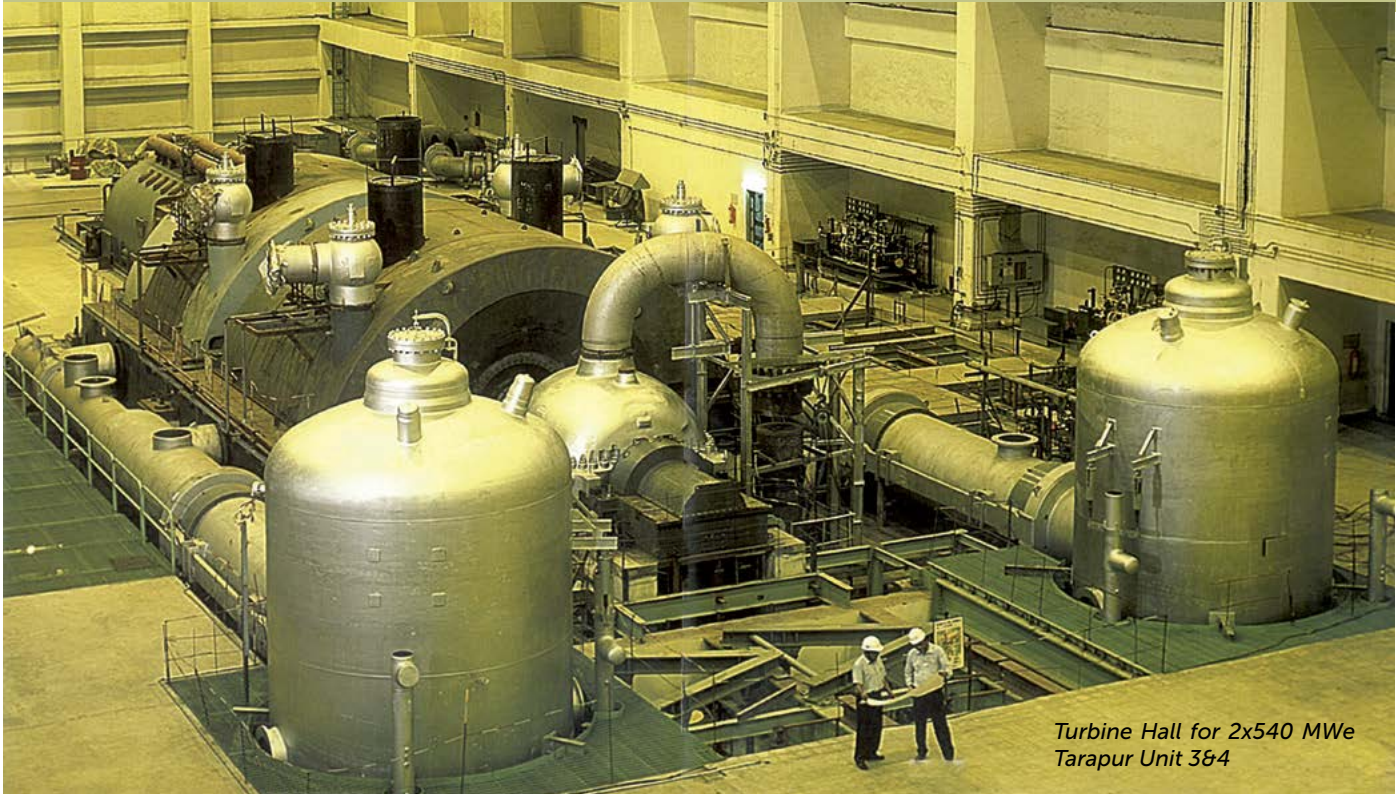


3D model of Generator

Main Control Room for Kakrapar Atomic Power Plant (KAPP) Unit 3&4, Gujarat, India

Advantage BHEL

- Leading engineering and manufacturing company in India, with extensive experience in development of infrastructure projects especially in power generation and energy technologies
- Five Decades of collaboration with Department of Atomic Energy in India - NPCIL, BARC, IGCAR, BHAVINI
- PAN India Presence - Strong Pre-Sales and After Sales support
- Vast infrastructure facilities including world class manufacturing capability
- Existing successful Technology Collaborations with Global OEMs



Turbine Hall for 2x540 MWe Tarapur Unit 3&4

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