

NUCLEAR POWER CORPORATION OF INDIA LIMITED



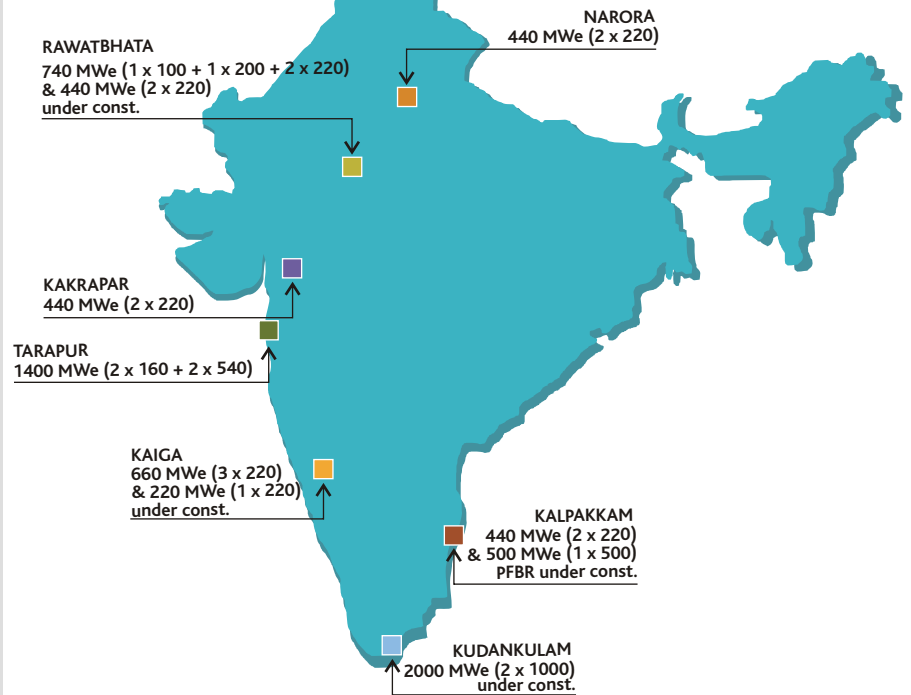
Nuclear Company with  
**Alive Technology**  
for Small & Medium Reactors

# NPCIL

Nuclear Power Corporation of India Limited (NPCIL), a company of the Government of India, is the key driving force for a comprehensive development of the nuclear power programme in India. It is responsible for providing end-to-end solutions for nuclear power production via the operation of 17 small and medium size reactors which dot the map of India.



## NUCLEAR POWER PLANTS IN OPERATION & UNDER CONSTRUCTION



## ATTAINING COMMERCIAL MATURITY

- ➔ US\$ 3 BILLION AUTHORIZED CAPITAL
- ➔ US\$ 6 BILLION ASSETS
- ➔ US\$ 5 BILLION PROJECTS UNDER EXECUTION
- ➔ WELL TRAINED MANPOWER OF ABOUT 12,000 PROFESSIONALS

Nuclear **Power**  
Conglomerate of India

# PROVIDING INTEGRATED SOLUTIONS

Considering the close interface that exists between various functions and the smooth transition demanded in the entire chain of nuclear power production and management, NPCIL provides end-to-end solutions. The Company, with its spectacular multi-faceted performance has set a unique paradigm with distinct advantages in the nuclear power business.

The domain of NPCIL encompasses the functions of selecting site, creating design and undertaking construction of the entire nuclear power project. On completion of the project, NPCIL is responsible for its operation and maintenance. It is also responsible for nuclear waste management, the decommissioning of reactors, renovation and plant life extension and overall ageing management.



## MANY COMPANIES IN ONE





# Scrutiny, Efficiency & Efficacy

## PROJECT MANAGEMENT

### REDUCED GESTATION PERIOD

Confronted by unique situations and overcoming the challenges over a span of more than 4 decades, NPCIL has rich experience of project management. To further enhance efficiency and effectiveness in this sphere, modern practices and IT-based project management tools have been incorporated. Consequently, our project managers are able to scrutinize every facet of the project. From the first pour of concrete to the attainment of criticality, NPCIL has achieved a gestation period of less than 5 years.

### OPENING VISTAS

At the threshold of a nuclear power renaissance, many countries in the world today are empowered with electricity generated by tapping the energy cocooned in the nucleus of an atom. Approximately 16% of the entire energy mix across the world comprises nuclear power. More and more nations are integrating nuclear power in their energy mix. Nuclear power, as a power generation technology, could prove to be the new-age answer to energy security for many more countries and revitalize their economies. An environment-friendly option, nuclear power lessens dependence on fossil fuels and produces negligible carbon emissions.



### ON THE FAST TRACK

- INTRODUCTION OF MEGA PACKAGES
- OPEN TOP CONSTRUCTION
- MULTI-FRONT JOB & PARALLEL WORKING
- INCREASED MECHANIZATION
- PARALLEL CIVIL & MECHANICAL ERECTION
- ROUND-THE-CLOCK CONSTRUCTION WORK
- USE OF PROJECT MANAGEMENT TOOLS



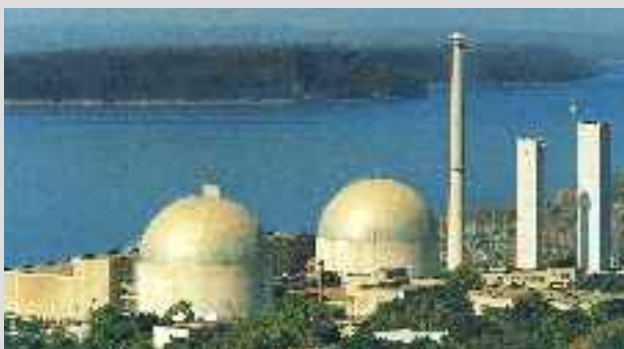
## SMALL & MEDIUM SIZE PHWRs

Bearing the stamp of Indian ingenuity in nearly all its processes, NPCIL has great confidence in its intrinsic capabilities. At this juncture, India is looking forward to sharing its small and medium size PHWR technology and partnering with nations nurturing the nascent idea of establishing nuclear power base within their country.

NPCIL's 220MWe and 540MWe Pressurised Heavy Water Reactors (PHWRs) known as small and medium size reactors, could prove to be the optimal power solution for countries where medium size electricity grids are in operation, and are keen on expanding their power base.

Having adopted the PHWR technology as early as 1973, at Rajasthan Atomic Power Station-1, NPCIL has worked over it for more than 3 decades and has consequently amassed great technological maturity vis-à-vis PHWRs. India, with its highly evolved small size PHWR technology, design and infrastructure, is in a position to provide all of it to countries keen on expanding their small conventional power grids by aligning with nuclear energy.

Prospective countries, by making relatively low investments and setting up limited infrastructure, with NPCIL's support will leap into the arena of power generation via nuclear energy.



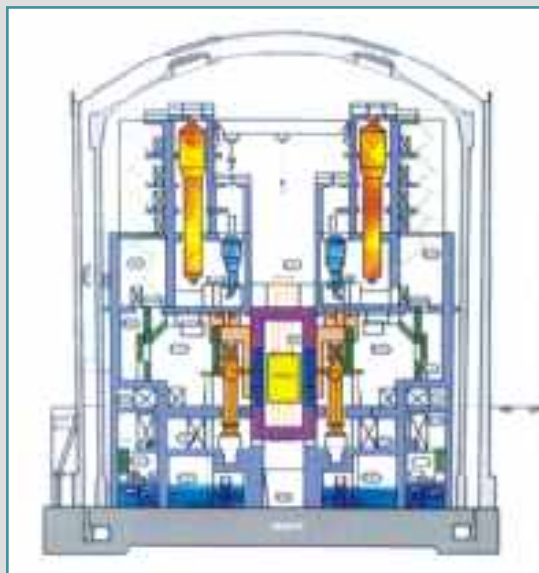
### ACCRUING BENEFITS

- CAPITAL COST SAVING
- SAFE PERFORMANCE
- UNIT ENERGY COST SAVING

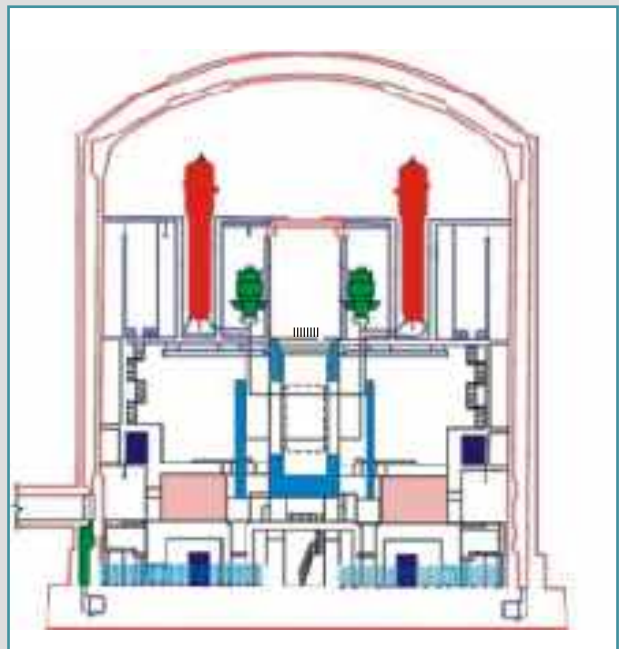
# SALIENT FEATURES OF PHWRs

NPCIL - the vibrant Nuclear company  
which designs, constructs & operates proven  
**Small (220 MWe) and  
Medium (540 MWe) Reactors**

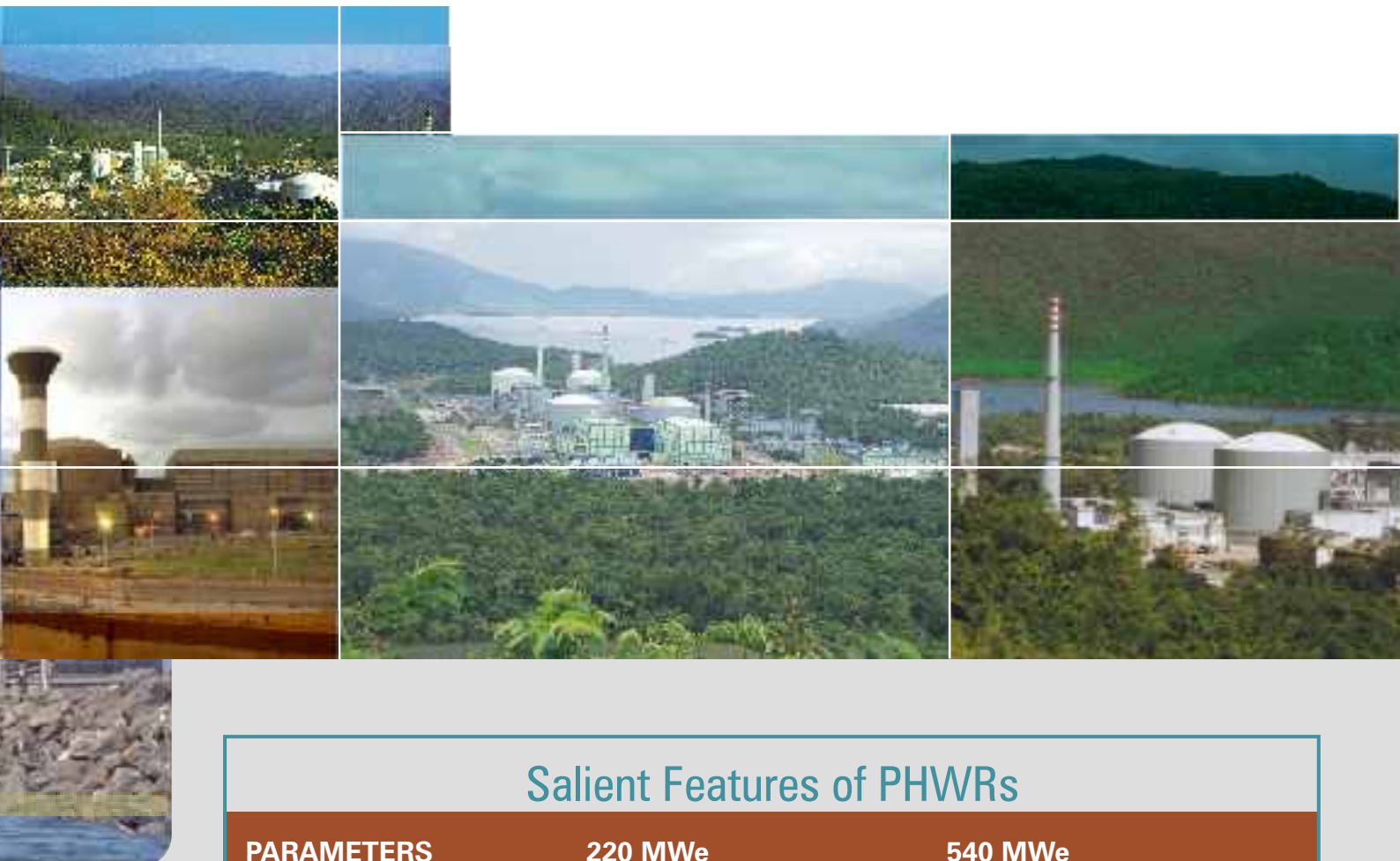
220 MWe PHWR



540 MWe PHWR



- SEISMICALLY QUALIFIED SAFETY RELATED STRUCTURES
- DOUBLE CONTAINMENT WITH PRIMARY CONTAINMENT PRE-STRESSED
- REDUNDANCY, DIVERSITY AND DEFENSE-IN-DEPTH APPROACH IN SYSTEM DESIGN
- DISTRIBUTED MICRO-PROCESSOR BASED CONTROL AND COMPUTERIZED OPERATOR INFORMATION SYSTEM



## Salient Features of PHWRs

PARAMETERS	220 MWe	540 MWe
Rated Output Electrical	220 MWe	540 MWe
Rated Output Thermal	756 MWt	1734 MWt
Fuel	Natural UO <sub>2</sub> , 19 element bundle, 495 mm long	Natural UO <sub>2</sub> , 37 element bundle, 495 mm long
Moderator and reflector	Heavy Water	Heavy Water
Coolant	Heavy Water	Heavy Water
Type	Horizontal Pressure Tube	Horizontal Pressure Tube
Pressure Tubes	306, 82.5 mm ID, Zirconium-2.5% niobium alloy	392, 103.4 mm ID, Zirconium-2.5% niobium alloy
Primary Coolant Total Flow	3528 kg/s	7814 kg/s
Pressure (outlet header)	87 kg/sq. cm	100 kg/sq. cm
Channel Inlet temperature	249°C	260°C
Channel Outlet temperature	293°C	304°C
Shutdown System -1	14 Mechanical rods, Cadmium Sandwich in SS	28 Mechanical rods, Cadmium Sandwich in SS
Shutdown System-2	Lithium pentaborate solution column in tubes	Liquid poison-GdNO <sub>3</sub> injection in moderator
Steam Generators	4 steam generators with inverted U tubes & integral steam drum (mushroom shaped)	4 steam generators with inverted U tubes & integral steam drum (mushroom shaped)
Containment	Double Containment	Double Containment

# PARTNERING WITH INDIAN INDUSTRY

The Indian industry has been closely involved with all facets of Nuclear power plants such as civil, mechanical, reactor components & processes, electrical, control and instrumentation and has eventually gained valuable skill-set and maturity in this regard. Today, the Indian industry is capable of taking up all works related to small and medium size nuclear power plants.



Micro-Processor based Control Systems



Robotic Equipment



Intricate Mechanisms



Delicate & Large Equipment



Precision & Heavy Equipment



Large & Heavy Equipment

## AN INTERNATIONAL MANDATE

- RIGOROUS IMPLEMENTATION OF DEFENSE-IN-DEPTH LEADING TO MULTIPLE BARRIERS, REDUNDANCY, INDEPENDENCE AND FAIL-SAFE DESIGN
- ADOPTION OF DESIGNS WITH INTERNATIONAL CODES AND STANDARDS
- STRINGENT QUALITY ASSURANCE MEASURES
- APPROVED OPERATING PROCEDURES
- REGULAR IN-SERVICE INSPECTIONS
- REGULAR MAINTENANCE OF SAFETY SYSTEMS

## IN-SERVICE INSPECTION TOOLS



## STRONG R&D SUPPORT

NPCIL's capabilities in design, engineering & construction of nuclear power plants are backed by its extensive in-house Research & Development facilities supported by Bhabha Atomic Research Centre (BARC). The perseverance of Indian nuclear scientists in innovation and the resilience of engineers in execution, has resulted in an array of design, manufacture and construction processes.

# Extensive Research & Development



Electronic System Development



BARCIS



FM Snout Level Control Experiment



Special Orbital Cutting Machine

# FROM STRENGTH TO STRENGTH

## The Cutting Edge

### HIGH AVAILABILITY FACTOR

NPCIL's Kaiga-2 nuclear power reactor established a new bench mark in operational efficiency by recording continuous operation for 529 days between August 2006 and January 2008. A very high availability factor over the entire life span, the hallmark of operational efficiency of a nuclear power reactor, sets apart NPCIL's nuclear power reactors.

### MEETING STRINGENT REGULATORY REQUIREMENTS

Atomic Energy Regulatory Board (AERB), an independent body regulates safety aspects of all nuclear facilities in India.

### SAFETY FIRST

For safety in the design, construction and operation of nuclear power stations, NPCIL has adopted international standards. NPCIL is a member of World Association of Nuclear Operators (WANO), an organisation created to improve safety in every nuclear power plant in the world.

### PROFICIENCY ATTAINMENT

- A STRICT SCHEDULE OF OUTAGE FOR MAINTENANCE AND IN-SERVICE INSPECTION
- BIENNIAL SHUTDOWN FOR 18-20 DAYS FOR IN-SERVICE INSPECTION, CONTAINMENT TESTING AND SO ON
- REDUCED DOWN TIME FOR UNSCHEDULED OUTAGES
- REDUNDANT SYSTEMS: PREVENTIVE MAINTENANCE PERFORMED ON-POWER
- REACTOR BUILDING DESIGNED TO BE PARTLY ACCESSIBLE DURING REACTOR POWER OPERATION

**1970s**  
TECHNOLOGY  
DEMONSTRATION  
AECL  
RAPS 1&2

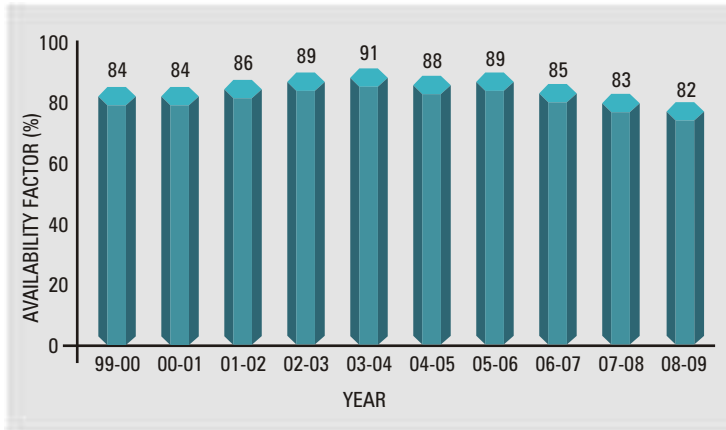
**1980s**  
INDIGENISATION  
MAPS 1&2

**1980s**  
STANDARDISATION  
NAPS 1&2

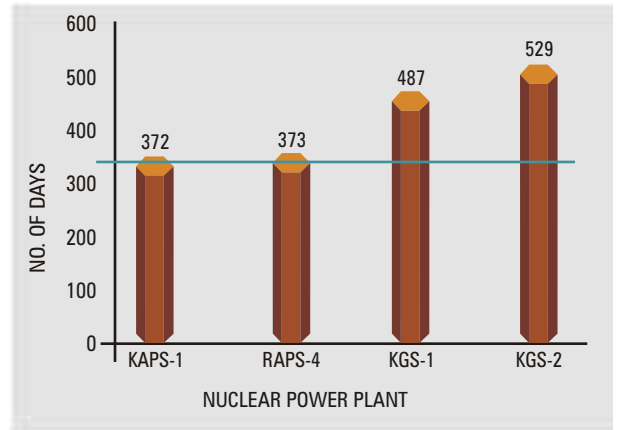
**220 MWe**



### AVAILABILITY FACTOR



### UNINTERRUPTED PLANT OPERATION



## INDIAN PRESSURISED HEAVY WATER REACTORS

**700 MWe**  
FUTURE PROJECTS

**1990s**  
CONSOLIDATION  
KAPS 1&2

KAIGA 1&2

RAPS 3&4

**2000s**  
COMMERCIALISATION

RAPP 5&6

KAIGA 3&4

TAPS 3&4

**540 MWe**





**Nuclear Power Corporation of India Limited**  
(A Government of India Enterprise)

REGISTERED OFFICE:  
16<sup>th</sup> Floor, Centre I, World Trade Centre  
Cuffe Parade, Colaba  
Mumbai - 400 005, India.

[www.npcil.nic.in](http://www.npcil.nic.in)