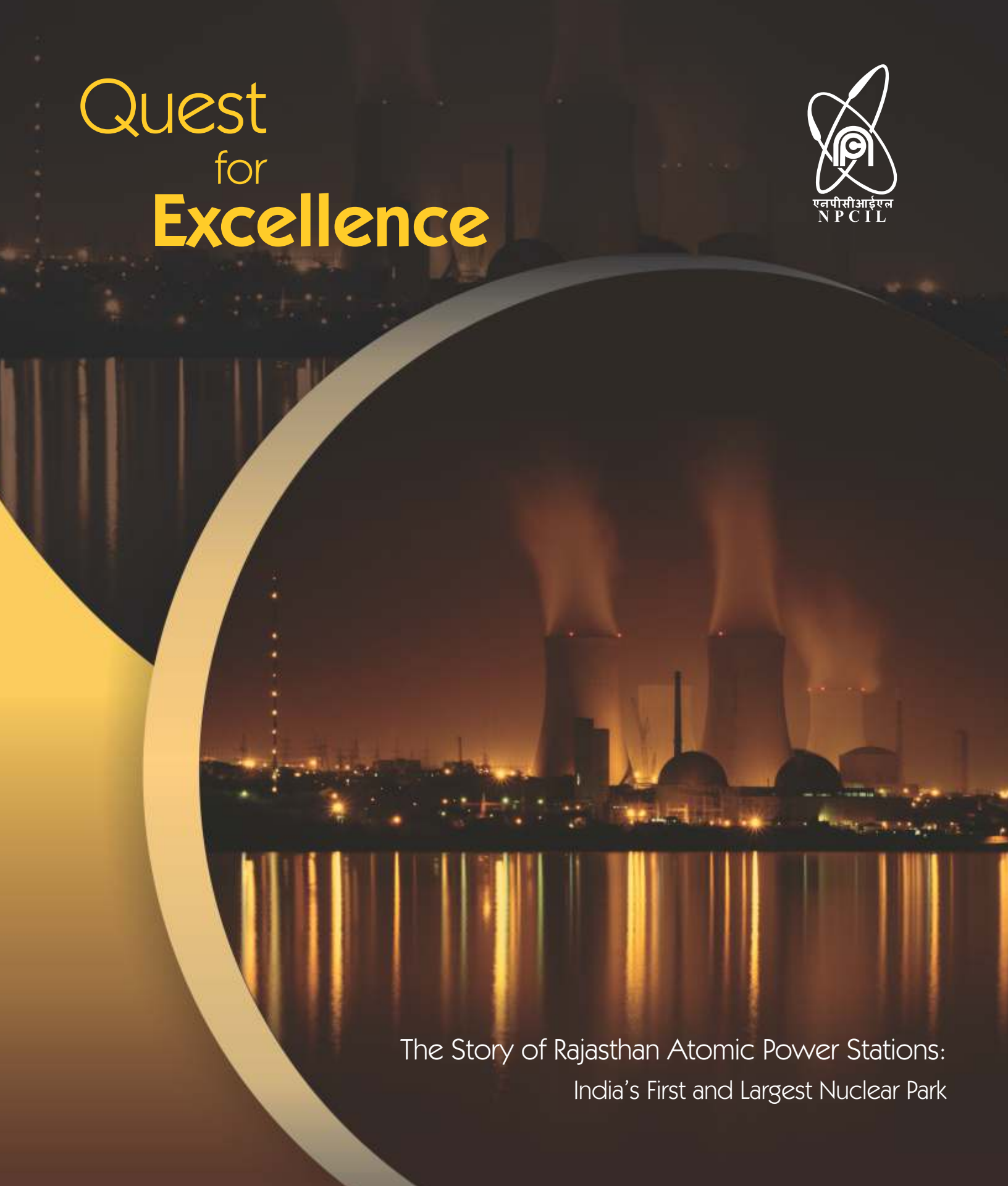
Quest for **Excellence**

एनपीसीआईएल
NPCIL



The Story of Rajasthan Atomic Power Stations:
India's First and Largest Nuclear Park

Rajasthan Atomic Power Stations

Home to India's First and the latest PHWRs

- Rajasthan Atomic Power Station site has the rare distinction of hosting India's very first as well as the latest PHWRs
- RAPS-1: India's maiden PHWR
- RAPS-5: Second-longest continuous run in the world - 765 days, thereby also making it the first nuclear power reactor unit in Asia to reach this lofty milestone
- Rawatbhata Rajasthan Site (RR Site) India's first and largest nuclear park

Vibrant Rajasthan

The vitality and vibrancy of Rajasthan is reflected in its every facet. The profusely colourful festivals, intricate art and lush culture of the land attract visitors from the four corners of the world, while its opulent history is evident in its royal palaces, forts and monuments. In Rajasthan, the past continues to live on in its current traditions and myriad expressions. And while it cherishes its legacy so intensely, this colourful western state has an equal stake in modernity.

Rajasthan Atomic Power Station site is situated on the right bank of the "Rana Pratap Sagar" lake, formed between two dams - the Gandhi Sagar Dam downstream and the Rana Pratap Sagar Dam upstream of the Chambal River. The area around the station is sparsely populated. The nearest city, Kota, is 64 kilometers away. The Rawatbhata Rajasthan Site (RR Site) is a modern monument of scientific progress and technological achievements. The sprawling nuclear power plant site has the rare distinction of hosting India's very first as well as the latest pressurised heavy water reactors (PHWRs). Indeed, the RAPS site is home to eight PHWRs, of which two are under construction.

The Take-off

The Seeding of an Idea

The long struggle for independence had just come to an end and a young nation was born in 1947. And while everyone was rejoicing in the afterglow of this victory, some had set their sight on the future of India. Among these visionaries was Dr. Homi J. Bhabha, a prodigious talent, who had a clear vision and an innovative plan for meeting India's long-term energy needs. In fact, the idea had been brewing in his maverick mind even before the nation's independence.

Bhabha could see deep into the future - when India's modest energy resources would not be quite enough to serve the burgeoning needs of the nation, especially in the long term. He could, however, see a ray of hope in nuclear power. India, with its vast thorium reserves, was sitting pretty on a cornucopia of energy that could be unlocked with a right kind of technology. But first, he had to begin with uranium.

India could start with natural uranium and eventually, after a few decades, utilize thorium in a big way - this was the essence of his vision in a nutshell. Born of his vision was India's three-stage nuclear power programme – the first stage of which was to be a series of pressurized heavy water reactors (PHWRs). And this was when Rajasthan Atomic Power Station (RAPS-1), India's maiden PHWR plant, was born – ***conceptually.***

The Journey of Indian PHWRs

At a glance

Rajasthan Atomic Power Stations, Rawatbhata, Kota, Rajasthan

Unit	Reactor Type	Capacity(MW)	Date of Commercial Operation
1	Pressurised Heavy Water Reactor(PHWR)	100	December 16,1973
2	Pressurised Heavy Water Reactor(PHWR)	200	April 1,1981
3	Pressurised Heavy Water Reactor(PHWR)	220	June 1, 2000
4	Pressurised Heavy Water Reactor(PHWR)	220	December 23, 2000
5	Pressurised Heavy Water Reactor(PHWR)	220	February 4, 2010
6	Pressurised Heavy Water Reactor(PHWR)	220	March 31, 2010
7	Pressurised Heavy Water Reactor(PHWR)	700	Under Construction
8	Pressurised Heavy Water Reactor(PHWR)	700	Under Construction

RAPS - The Harbinger of Indian PHWRs

The Rawatbhata Rajasthan Site (RR Site), the nation's largest nuclear power plant site (8 reactors), heralded the era of pressurized heavy water reactors (PHWRs) in India with the commissioning of the first PHWR unit, Rajasthan Atomic Power Station unit-1 (RAPS-1), in 1973. Although RAPS-1 was India's first PHWR unit, it was not the first nuclear power reactor in India to generate grid power. That distinction goes to the Tarapur Atomic Power Station units–1&2 (TAPS-1&2), which were established four years earlier, in 1969. However, the Tarapur units were boiling water reactors (BWRs).

Bhabha wanted India to gain initial experience in the field of nuclear power generation. Thus, to set the ball rolling, the first two Tarapur units, BWRs, were setup on turnkey basis by General Electric (GE), USA, with a clear vision to then quickly move on to PHWRs – the stuff that was to constitute the first stage of India's three-stage nuclear power programme.




The Evolution of Indian PHWRs

The 220-MW RAPS-1, commissioned in December 1973, acted as a technology demonstrator for the PHWR technology. RAPS-1 was a CANDU PHWR reactor that was set up at the RR Site in association with Atomic Energy of Canada Limited (AECL). It still was essentially an imported technology, with the Indian side manufacturing part of the fuel, while also participating in the design and construction of the plant. After India conducted the Pokhran-I testing in 1974, the Canadians left, leaving India to face a technology denial regime that was to continue for over three decades. Indian scientists and engineers took this formidable challenge in the right earnest and commissioned RAPS-2 in 1981 with indigenous efforts.

Meanwhile, India was working relentlessly to achieve indigenasation of PHWRs. This was reflected in the first two Madras reactors (MAPS-1&2, 2 x 220MW PHWRs) that were commissioned in 1984 and 1986, respectively, in Tamil Nadu. The quest for further progressive improvements and innovations in all facets of PHWR technology and project implementation yielded the 'standardisation' of Indian PHWRs in the 1980s, represented by two 220-MW PHWRs at Narora in Uttar Pradesh. This was then followed by a 'consolidation' phase in the 1990s, which was achieved in Kakrapar units-1&2 (KAPS-1&2, 220-MW PHWRs).

The next ten PHWRs set up in the country, including four Rajasthan units (RAPS-3, 4, 5 and 6), advanced the state-of-the-art further, reaching the 'commercialisation' phase in the decade of 2000-2010, denoting a fully mature PHWR programme in the country, belonging to the first stage of India's three-stage nuclear power programme.

In the meanwhile, the Indian PHWR design has undergone scaling-up in two phases: first, from 220-MW to 540-MW (the 540-MW Tarapur PHWR units-3&4) and then from 540-MW to 700-MW PHWRs. The last two reactor units at the RR site, RAPP-7&8, are of 700-MW, state-of-the-art scaled-up design with several further improvements, especially safety enhancements. Another two indigenous PHWRs of 700-MW capacity that are also currently under construction in the country are the Kakrapar units 3 and 4 (KAPP-3&4). There are also several more indigenous 700-MW PHWRs coming up at various locations across the country.

The RR Site, home to 8 PHWRs , thus has another feather in its cap – that of being India's first 'nuclear park'.

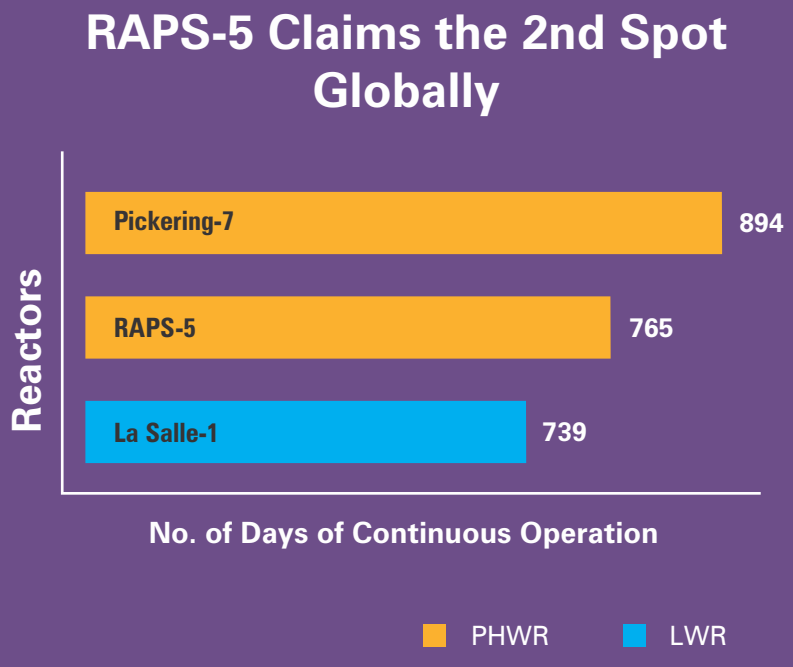
Operational Excellence

RAPS-5 Clocks World's Second-longest Continuous Operation - 765 Days

On Sep 6, 2014, RAPS-5 reached a trailblazing performance milestone by operating nonstop for 765 days at a single stretch, thereby becoming the 'second' nuclear power reactor in the world and 'first' in Asia to achieve this stellar feat. Earlier, when it crossed 739 days of continuous operation on August 11, 2014, it claimed the second place in the world for longest continuous operation by a nuclear power reactor unit by displacing the previous second-place holder in the world – unit-1 of the La Salle Power County Nuclear Generating Station at Illinois in the U.S., which had held this position since 2006.

By virtue of this stellar achievement, RAPS-5 has also surpassed the earlier record for longest continuous operation by an Indian nuclear power reactor held since 2011 by Tarapur Atomic Power Station unit-2 (TAPS-2).

The fact that RAPS-5 stands among the top nuclear power reactors globally for such long continuous run proves the country's technological maturity in nuclear power plant operation with the highest levels of safety.



- Operating Performance: Since the commencement of commercial operation, a total of 105,556 million units generated from all the 6 units of RAPS, till July 2014
- During the year 2012-13 and 2013-14, the capacity and availability factor of all the five units of RAPS 2-6 were above 90% and 85%, respectively

Major Feats

The OSART Mission to RAPS-3&4 – A First for an Indian NPP

India's nuclear power programme is robust, mature and on-course. A proud and historic moment for Rawatbhata Rajasthan Site was when the RAPS-3&4 became the first (and till date, the only) nuclear power station in India to undergo an Operational Safety Review Team (OSART) review. The IAEA-led OSART, consisting of international experts, visited the station from October 29–November 14, 2012. The expert mission conducted an independent and comprehensive safety review of the station. After this highly successful mission, an OSART follow-up visit – an epilogue to the original 2012 mission – was organised for the station in February 2014.

En Masse Coolant Channel Replacement (EMCCR)

In the PHWRs of earlier design, the material used in the fabrication of the coolant tubes was Zircaloy-2, which was widely considered to be the best material available at that time. However, several years later, it was evident from worldwide experience that these earlier-design tubes had a lesser service life (10-12 years) due to an increased hydrogen pick-up in the contacting channels. In the En Masse Coolant Channel Replacement (EMCCR) operation at RAPS-2, all the 306 coolant tubes of RAPS-2 reactor were replaced. The new channels were made of Zirconium–2.5% Niobium. The task was completed using indigenously developed remote handling tools in a record time and at minimum man-rem expenditure. It is matter of great pride for the Indian nuclear industry that such a highly complex task of EMCCR had been undertaken for the first time in an Indian nuclear reactor and only the second time in the world. Based on the RAPS-2 expertise, similar EMCCR work has been also been accomplished at other PHWRs namely MAPS-1&2, NAPS-1&2 and KAPS-1.

En Masse Feeder Replacement (EMFR)

A study and assessment was carried out in-house to detect any thinning of feeder pipes in Indian PHWRs based on reports on Canadian reactors. As a proactive approach, replacement of all the feeder pipes in RAPS-2 along with MAPS-1, NAPS-1&2, and KAPS-1 was carried out in a phased manner. Replacement of the feeder pipes involved precision fabrication of pipes, matching the connections with the end-fittings and the reactor headers. Besides, given the different diameters, complex shapes of the feeders and narrow spacing between them, detailed procedures were worked out for precision welding and detailed rehearsals were carried out to confirm the routes of the pipes.

OPRD Leak Repair

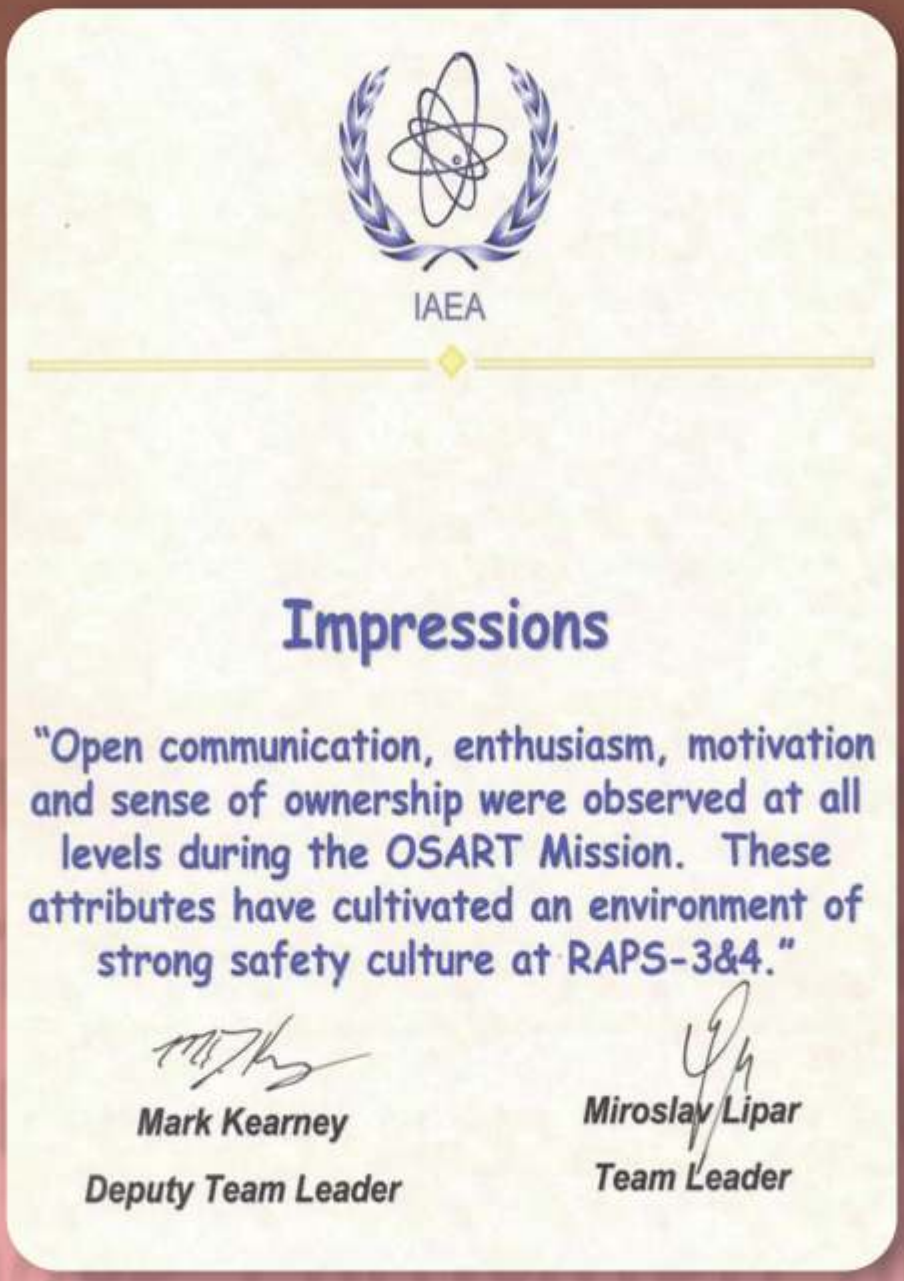
The Over Pressure Relief Device (OPRD) installed on the calandria of RAPS-1 had developed an external leak. The cause of the leak was identified to be the corrosion of the OPRD nickel gasket due to corrosive atmosphere. The challenging part was the location of the OPRD gasket, which was in an inaccessible area. This necessitated the development of specialized remote tools to carry out the repairs, and the entire leak repair work was successfully performed through a small 3.5-inch opening provided at the top of the calandria. The unique method used for leak rectification was termed RELIEF – an acronym for "Repair of Leak by Indium Embedding and Forming".

Safety - Our Highest Priority

- Safety accorded the highest priority in all phases
- Adoption of 'Defense-in-Depth' principle-Deployment of multiple barriers
- Diversity and Fail-safe design
- Redundancy (more than one system to act as back-up)
- Robust regulatory mechanism
- Operation by trained and licensed personnel

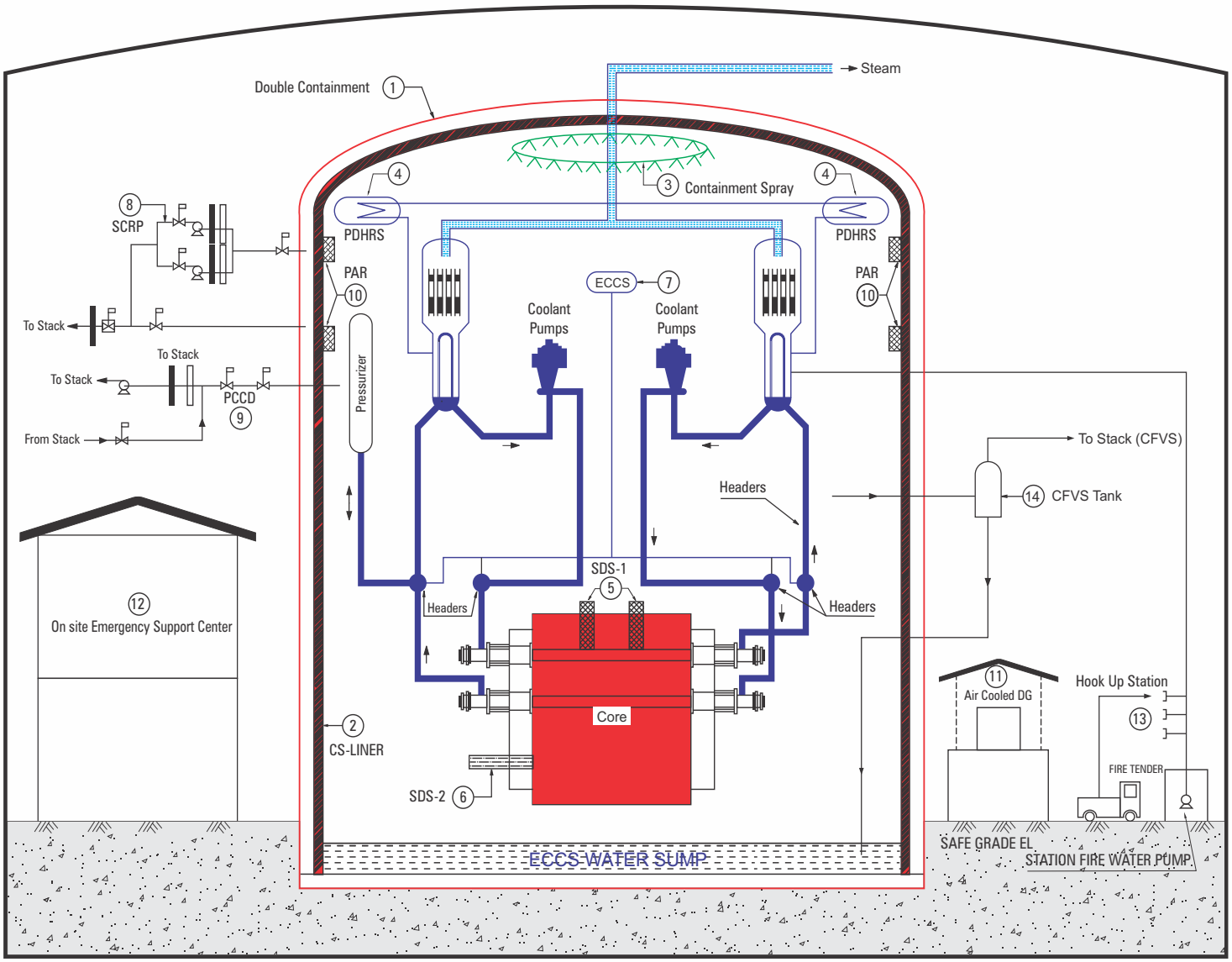
Impression by IAEA-led OSART

RAPS-3&4 is the first and only nuclear power station in India to undergo a comprehensive safety review and a follow-up visit by an IAEA-led Operational Safety Review Team (OSART). An unequivocal endorsement by the expert team members of the plant's safety culture has been a privilege and a unique honour for RAPS-3&4.



Robust Safety Paradigm

Safety Systems in a 700-MW Indian PHWR



Safety - Salient Features

1 Double Containment
2 Carbon Steel Liner
3 Containment Spray System
4 Passive Decay Heat Removal System
5 Shutdown System-1
6 Shutdown System-2
7 Emergency Core Cooling System
8 Secondary Containment Recirculation Purge System
9 Primary Containment Controlled Discharge
10 Passive Autocatalytic Recombiner
11 Air-cooled Diesel Generator
12 On-site Emergency Support Center
13 Hook-up Station
14 Containment Filtered Venting System

Alma Mater for Training

Inside view of RAPS-3 Simulator

Nuclear Training Centre (NTC)

Rajasthan Atomic Power Station site has been a cornerstone of nuclear training for PHWRs in India

The biggest asset of NPCIL is its current human capital and continual human resource development in induction, training, retraining, licensing qualification and skill development in all disciplines of nuclear power technology. And in this process, Nuclear Training Centres (NTCs) play instrumental role in providing vital professional training to nuclear professionals.

These NTCs are equipped with latest and structured documentation as well as training aids, including state-of-the-art full-scope reference plant simulators

- RAPS has the distinction of hosting India's first Nuclear Training Centre (NTC).
- RAPS site has India's largest Nuclear Training Centre infrastructure in the country, with an ISO-9001:2000 certified, well-established, fully equipped NTC with latest pedagogy, training infrastructures and, above all, a large pool of experienced faculty.
- The exhaustive capabilities of the full-scope plant simulators that make it possible to provide comprehensive training for PHWRs.
- Almost all nuclear professionals belonging to the first generation and the successive generations have been trained at the RAPS NTCs.

IAEA

Impressions

NTC, RAPS has excellent online "Training Management System" including excellent training facilities. NTC team is highly enthusiastic, motivated and willing to adopt new technologies for improvement. These attributes of training centre reflected in safety performance of station.

Team Leader *Miroslav Lipár*

Inclusive Growth

Corporate Social Responsibility (CSR)

For NPCIL, inclusive growth and well-being of the locals comes first. Indeed, the neighbouring communities are like extended families.

From sharing of information to making a meaningful difference in the lives of the people residing in the vicinity of its power plants, our participation with them is a genuine life-long relationship toward meeting their cherished dreams.

NPCIL contributes to community development and social welfare through a variety of programs like setting up educational infrastructure, distributing educational aids (books, computers, etc.), establishing drinking water supply, constructing toilets and bathrooms, setting up hospitals, building roads and setting up street lighting, organizing medical camps etc.

Also, the setting up of a nuclear power plant generates direct as well as indirect employment during the construction phase of the plant and also after it becomes operational, thus leading to inclusive growth across the social spectrum.

In Harmony with Nature

Environment Stewardship Programme (ESP)

With an absolute zeal to preserve the nature around Indian nuclear power plants, NPCIL has instituted a voluntary initiative "Environment Stewardship Programme". The programme, born in 2006, focuses on scientific studies on biodiversity, preservation of habitats, monitoring of migratory and resident birds, establishment of butterfly gardens as well as studies on wildlife within and around the exclusion zones of Indian nuclear power plant sites.

Rawatbhata Rajasthan Site is located on the eastern bank of Rana Pratap Sagar reservoir on Chambal river. The region is rich in forest cover and has abundant wildlife. The region supports a wide variety of wildlife. Here, over 220 species of birds are found, numerous butterflies thrive and a diverse flora flourishes. Large birds like Sarus Cranes and Painted Storks, and small birds like munias, babblers and kingfishers are part of Rawatbhata's bird diversity. Butterflies like Blue Pansy, Crimson Rose, Plain Tiger and Emigrants are very common here.

Like in other NPCIL sites, a nature club was set up under ESP at Rawatbhata with the nature-loving employees as its members. The Gyps Nature Club, as it is named, actively participate in various activities from nature watch to public awareness campaigns, from butterfly surveys to bird studies and from habitat protection to habitat improvement. One of the notable works is the campaign against the use of Diclofenac (a drug) in animal husbandry, which was responsible for the sharp decline of Gyps Vultures. The volunteers of Gyps Nature Club are propagating the Government directive at grassroots level for the withdrawal of this killer drug, thus helping in conserving the vultures.








Awards & Accolades

The Environmental Management System (EMS) and Occupational Health and Safety Management System (OHSMS), as per ISO-14001: 2004 and IS-18001:2007

Consistent Performance Wins Laurels

- National Award for Meritorious Performance in Power Sector to RR Site by Ministry of Power in 2014
- RAPS-1&2 won NSCI Shrestha Suraksha Puraskar, silver Trophy (2nd Level award) for the year 2012 from National Safety Council at New Delhi, received in September 2013
- National Safety Council Industrial Safety Award-2012 Bronze Trophy to RAPS-3&4
- National Awards to RAPS-1&2 for Meritorious Performance in Power Sector in Recognition of Outstanding Performance during 2011-12 and 2012-13 from the Ministry of Power, Govt. of India
- Shrestha Suraksha Puraskar (Silver Trophy) for the year 2010 to RAPS-1&2 from National Safety Council of India (NSCI), Mumbai
- Rawatbhata Rajasthan Site Bagged the Gold Shield Award on March 22, 2012
- Appreciation Certificate to RAPS-1&2 from National Safety Council, Award-2009
- Safety Innovation Award –2009 to RAPS-1&2 from Institution of Engineers (India)
- Rajeev Gandhi National Quality Award-2007 for RAPS 1-4
- Golden Peacock Award consecutively for 3 years - 2001, 2002 and 2003 - to NTC, Rawatbhata Rajasthan Site

Rajiv Gandhi National Quality Award-2007

Golden Peacock Award-2003
to NTC, Rawatbhata Rajasthan Site

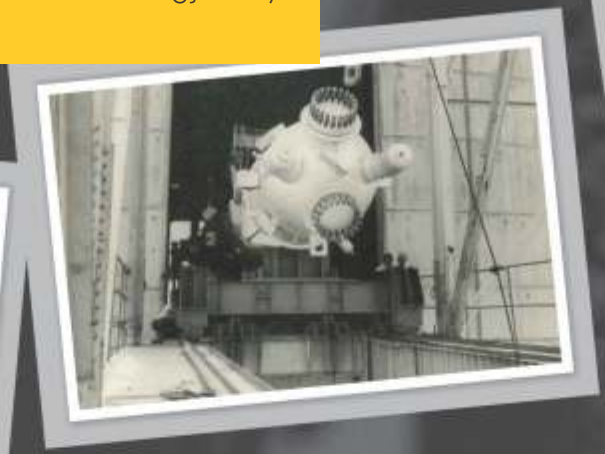
National Safety Council
Industrial Safety Award-2012
Bronze Trophy to RAPS-3&4

National Award for
Meritorious Performance in Power Sector to
Rawatbhata Rajasthan Site by Ministry of Power

Rawatbhata Rajasthan Site Bags Gold Shield Award in 2012

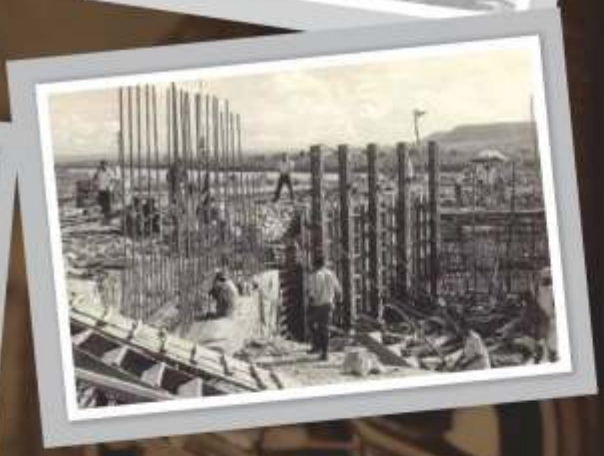
Then...

When the three-stage Indian nuclear power programme was launched, the Indian industry was in a nascent stage, with very basic technology infrastructure available in the country. The country's PHWR technology has fully matured now. Over the years, with the growth of nuclear power, the Indian industry has also grown concurrently. With active cooperation of the nuclear power establishment, the Indian industry has been on an onward march and has made significant strides in technological achievements, infrastructure, competence and capabilities, as well as economy of scale. This success has not been easy. A series of formidable challenges were successfully met and difficulties overcome. The fruition of this long and dedicated endeavour has come in the form of the level of technological maturity reached by Indian industry partners. Presented here are some glimpses of this enthralling journey over the years.



...Now

Then...



...Now

Down the Memory Lane


NUCLEAR POWER CORPO
FOUNDATIO

Glimpses of 'Longest Continuous Run' Event of RAPS-5


Chairman,Atomic Energy Commis
and
Chairman & Managing Director,NP
compliment and congratulate all the em
Rawatbhata Rajasthan Site NPCIL fo
completion of 765 days of RA
(from 2nd August,2012 to 6th Septemb
and setting the second highest wo
continuous operation of a Nuclear Pow
Kailash Chandra Purohit
Chairman & Managing Director
Nuclear Power Corporation of India Limited


Rawatbhata Rajasthan Si
omes you
Year


Rawatbhata Rajasthan Site
Welcomes you
on
DAE Diamond Jubilee Year Celebration
&

Reflections...

The Hindu, New Delhi, 7 September 2014, Page: -

RAPS Unit-5 sets a record

T.S. Subramanian

A view of Rajasthan Atomic Power Station Unit-5 at Rawatbhata on Saturday. —PHOTO: S. SUBRAMANIUM

Business Standard, Mumbai, 13 August 2014, Page - 12

Rajasthan nuclear plant sets a record

BS REPORTER ■ Mumbai

Nuclear Power Corporation-run Rajasthan Atomic Power Station unit five on Monday set a world record for continuous operation for 740 days. The 220-mega... has generated 4,12... units (MUs) during... operation. It has g... 8,525 MUs since it... commercial opera... February 4, 2010.

Asian Age, Delhi 7/9/2014 P-3

RAJASTHAN N-PLANT SETS NEW RECORD

Rawatbhata (Rajasthan), Sept. 6: India's nuclear power programme on Saturday reached a new milestone after Unit 5 of the Rajasthan Atomic Power Staion become the second-longest running reactor in the world by being in operation for 765 days continuously. The Unit 5 of the Rajasthan Atomic Power Station...

indiatimes.com/07/09/2014

Unit 5 of RAPS now world's 2nd longest running nuclear reactor

Hindustan, Delhi 7/9/2014 P-9

रावतभाटा परमाणु बिजली घर ने बनाया रिकॉर्ड

2017 से शुरू होंगे दो नए बिजलीघर

Hindustan Times, Jaipur, 7 September 2014, Page: - 2

RAPS record-holding unit shut down for tests

RAPS UNIT 5 REACTOR HAD CLAIMED 2ND POSITION IN WORLD BY BREAKING THE RECORD OF 739 DAYS OF CONTINUOUS RUN

HT Correspondent

KOTA: Unit 5 of the Rajasthan Atomic Power Station (RAPS) in Rawatbhata, which created world record by generating power continuously for 765 days, was shut down on Saturday for routine maintenance and safety tests.

SK Sharma, site director of RAPS, told HT that the 220 MW-capacity unit 5 of RASP was shut down on Saturday night.

Vinod Kumar, director of Unit 5, RAPS said that some technical and safety tests were due for the unit, hence a bi-annual shutdown has taken place.

These tests are laid down as mandatory by the Atomic Energy Regulatory board. Kumar said that the unit would remain closed for 40 days, during which functional tests for the safety of the atomic reactor would be performed.

... is an indigenously-designed Pressurized Heavy Water Reactor (PHWR) which generated a total of 8,593 million units.

Kumar also said that the unit 5 of RAPS had claimed the 2nd position in the nuclear power reactors of the World in August by breaking the record of 739 days of continuous nuclear power generation.

Earlier the LaSalle-2 unit in USA was on the 2nd position.

RAPS also organised a celebratory ceremony at RAPS in which RK Sinha, chairman Atomic Energy Commission and ...

Zee News/07/09/2014

Unit 5 of RAPS becomes world's 2nd longest running reactor

Business Standard/07/09/2014

Trailblazing Performance of 765 Days of Continuous Run Yields Second Place for RAPS-5 Globally Golden Jubilee Celebrations of Dae Marked the Feat Achievements

Dainik Bhaskar/Kota/07/09/2014 P-3

परमाणु ऊर्जा आयोग के अध्यक्ष डॉ. सिन्हा ने रावतभाटा में कहा-

हम भरोसेमंद, इसलिए सब यूरेनियम देने को तैयार

NDTV/07/09/2014

Rajasthan Nuclear Plant Makes History, Runs Uninterrupted for Over 2 Years

Pallava Bagla

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