Azadi ka amrit mahotsav

In the last seven and half decade since independence, the Indian nuclear field has certainly done its part in nation building. On one hand it rose to a considerable level from an incipient stage, while on the other hand it became one of the significant causes for development of industries in the nation.

As the nation commemorates the 75 years of Independence, it is worth knowing about the voyage of India's nuclear power programme, particularly the Pressurised Heavy Water Reactor technology.

Scientific India, a leading science magazine in the country, has published a story "India's Pressurized heavy-water reactor Voyage" on January 23, 2021. This article is placed on the following pages for your kind reading, please.

INDIA CELEBRATES 75 YEARS OF INDEPENDENCE

राष्ट्र की सेवा में परमाणु
एनपीसीआईएल
NPCIL
ATOMS IN THE SERVICE OF THE NATION
न्यूक्लियर पावर कॉर्पोरेशन ऑफ इंडिया लिमिटेड
Nuclear Power Corporation of India Limited

TECHNOLOGIES FOR
NEW INDIA@75
आज़ादी का अमृत महोत्सव

SCIENTIFIC INDIA

By the Scientist, for the People

India’s Pressurized heavy-water reactor Voyage

- J. Devaprakash Senior Manager , Kudankulam Nuclear Power Project looks after public awareness and press relations

2022-01-23 13:00:26

Credit: pixabay.com

Consider this situation: You are left alone in the mid-sea. You have neither experience in sea swimming nor any idea about the directions and conditions of the sea. Now you have to decide your own fate. And, you have three choices before you: One, give up and drown. Two, cry for help and wait till you get one or till you drown. Three, gather your senses, brave the plight, swim hard, and move on towards your destination. India chose the third option when it comes to nuclear power programme.

As the nation celebrates 75 years of India’s independence, this feature brings you the riveting story of India’s nuclear energy programme.

Birth of India’s nuclear era

The commencement of India’s nuclear programme coincided with the nation’s independence. It all started with the establishment of Tata Institute of Fundamental Research in 1945 by the revered scientist Homi Jehangir Bhabha. Like a house is made by laying brick over brick, Dr. Bhabha brought institutions after institutions to build the nuclear programme. While India’s Department of Atomic Energy came into function in the same year, the Atomic Energy Commission to frame polices for nuclear energy was setup in 1948. In 1954, he launched the Atomic Energy Establishment Trombay (later renamed as Bhabha Atomic Research Center) exclusively for the development of atomic energy technologies.

With modest experience from the research reactors but with lot of confidence and technological understanding, India began to construct Asia’s first commercial nuclear power plant at Tarapur, Maharashtra in 1955. When the two 160 MWe capacity Boiling Water Reactors (BWR) here began to generate electricity in 1969, India was in its very fledgling stage in nuclear power technology. As Tarapur was a turnkey project by the General Electric, USA the country had a little chance to savvy everything about developing a nuclear power reactor as the construction, commissioning and initial operation of the plant were by the GE. Since the concept and technology was new to the country, there was hardly any industry to develop components or spares for such a massive power unit.

While Tarapur project was in progress, India began to make another nuclear power plant project at Rajasthan’s Rawatbhata with a new technology, the Pressurised Heavy Water Reactor (PHWR). It was a well thought out move by Dr. Homi J. Bhabha in line with his vision to lead India towards energy security. By deploying PHWR that uses natural uranium as fuel, he reasoned, India can pave a technological way for utilising the abundant thorium reserves in our soil. India’s first Pressurised Heavy Water Reactor (100 MWe capacity) at Rawatbhata began the sustained nuclear fission in 1973. If the nuclear power project at Tarapur was for knowing about nuclear power generation, the Rajasthan nuclear project was the stepping stone for a long term nuclear power programme.

Around that time, to bolster up the national security India tested its first peaceful nuclear explosion. This has resulted in imposition of tough sanctions on India by US and other countries that had provided technological support to India. Due to this the Rajasthan project was badly affected.

Canada withdrew its support and the Rajasthan project was left in lurch, particularly when the unit 2 of Rajasthan Atomic Power Station which was under construction. And the country’s ambitious nuclear power programme was at the crossroads. Now, India had three choices: give up and wind up the project; or wait till the embargo is lifted and look for support again from abroad; or face the challenge and move on gallantly with indigenous efforts. India chose the third.

The breakthrough

Indian scientists and engineers went forward from where the Canadians left, commissioned the unit 2 of Rajasthan Atomic Power Station successfully and demonstrated the world that India was capable of building a nuclear power reactor. And the unit began to supply commercial electricity in 1981. With the conquest of

technological capabilities during the development of RAPS-2, India had set sail for a long-term nuclear power programme.

In fact, with the experience gained from Rajasthan, the nation leapt on to next level in nuclear technology by designing, constructing and commissioning nuclear power reactors its own. It was easier said than done. The construction, commissioning and operation teams had to overcome numerous challenges, both foreseen and unforeseen, during every phase of developing the nuclear power reactors at Madras Atomic Power Station (MAPS), Kalpakkam. For instance, construction of undersea tunnel to draw sea water for cooling purposes posed a great challenge as it was first-of-its-kind in the country. Despite that, they hadn't given up but got better of after every challenge they faced and finally scripted a new history in nuclear technology.

Thus, India's first home-grown nuclear power reactors (two 220 MWe capacity units) came into existence at Kalpakkam in Tamilnadu near Chennai in mid 1980s. With MAPS, the country's nuclear voyage became unwavering and opened up new vistas in the nuclear field.

The steady progress

Just a few years after the MAPS reactors began to supply electricity, a dedicated institution named as Nuclear Power Corporation of India Limited (NPCIL) was formed in 1987 as a public sector enterprise under the department of atomic energy to take the nuclear power generation business forward. The new-sprung NPCIL began to work in full swing on building two more nuclear power reactors (similar to that of MAPS) on the banks of River Ganges at Narora in Uttar Pradesh and parallelly started planning for more reactors in the country. At Narora the standards for nuclear power reactors were set which became the base for the upcoming new reactors. The units, NAPS-1 and NAPS-2 began to operate since 1991 and 1992 respectively. Similar to NPCIL, the Department of Atomic Energy of India rolled out many dedicated institutions for specific tasks like Uranium Corporation of India Limited – for uranium mining and processing, Nuclear Fuel Complex – for fabricating nuclear fuels, Heavy Water Board – for producing heavy water for the PHWRs.

The programme went ahead and two more 220 MWe Pressurised Heavy Water Reactors were made in the country at Kakrapar in Gujarat. Barely within two years of NAPS launch, the first unit of Kakrapar became operational in 1993. KAPS-2 followed suit in 1995. In every new project, the Indian nuclear experts brought in improvements and innovations that made the home-grown technology stronger. The nuclear expansion programme enabled Indian industries to grow in line with the technological requirements and provided ample opportunities for fabrication and supply of nuclear components, spares, machineries and tools.

At Kakrapar, the Indian nuclear industry could integrate all facets of nuclear power technology and brought forth consolidation which became a touchstone for and future nuclear projects.

What's more? The country made great strides in the nuclear sector and brought several more nuclear power reactors into existence during 2000s. Two more units (RAPS-3 and RAPS 4) at Rawatbhata from where the PHWR voyage set out, and

two 220 MWe PHWRs at a new site in Karnataka (Kaiga Generating Station units 1 and 2) have come up in a rapid manner. These projects lead to commercialization phase of PHWRs in the country. And India excelled in nuclear technology, particularly in PHWRs.

The country made several feats in nuclear power generation and performance. With 559 reactor years of safe operation, the 22 Indian nuclear power plants with an installed capacity of 6780 MWe have supplied over 755995 million units of carbon-free electricity to the nation's grid as of 2021. Operating nuclear power plants safely at the same time reliably has been a hallmark of Indian nuclear sector. 16 nuclear power reactors have run continuously for more than a year in this five decade journey. Some of them have exhibited non-stop operation for more than one time. Thus, 37 times the Indian nuclear power plants have run non-stop for a year. Above all, the unit-1 of Kaiga Generating Station at Karnataka has set a world record in continuous operation which ran for 962 days (between 2016 and 2018) without any break.

The evolution: From 100 to 700

On one hand Indian nuclear experts were building more and more nuclear reactors of 220 MWe while on the other they were working on larger capacity nuclear power plants. And a design was developed for double the capacity of existing reactors. At Tarapur, India had set up two 540 MWe capacity PHWRs, a scaled-up version of 220 MWe, in mid 2000s.

Not settling with achievements, the Indian nuclear fraternity is already making another set of upgraded nuclear power reactors. Now, it is from 540 MWe to 700 MWe. India's first largest PHWR, the Kakrapar Atomic Power Project – 3 at Gujarat, achieved its first criticality (the start of sustained chain reaction) in July 2020 and was first synchronized with the grid on January 10, 2021. Besides, three more 700 MWe reactors are underway. And the government of India has accorded approval to launch ten 700 MWe PHWRs in fleet mode.

Since 1969, India's nuclear power journey has been continuing robustly for over five decades. It wasn't a smooth ride. But every hardship that was encountered made the country stronger. Throughout this enriching ride India has maintained a flawless safety record, brought forth several advancements and innovations in the field of nuclear electricity generation, and contributed in industrial growth. Particularly, from 100 MWe to 700 MWe India's PHWR voyage has now attained a monumental stage. And the country's nuclear journey is propelling ahead with more zeal.

https://scind.org/article/Indias-Pressurized-heavy-water-reactor-Voyage