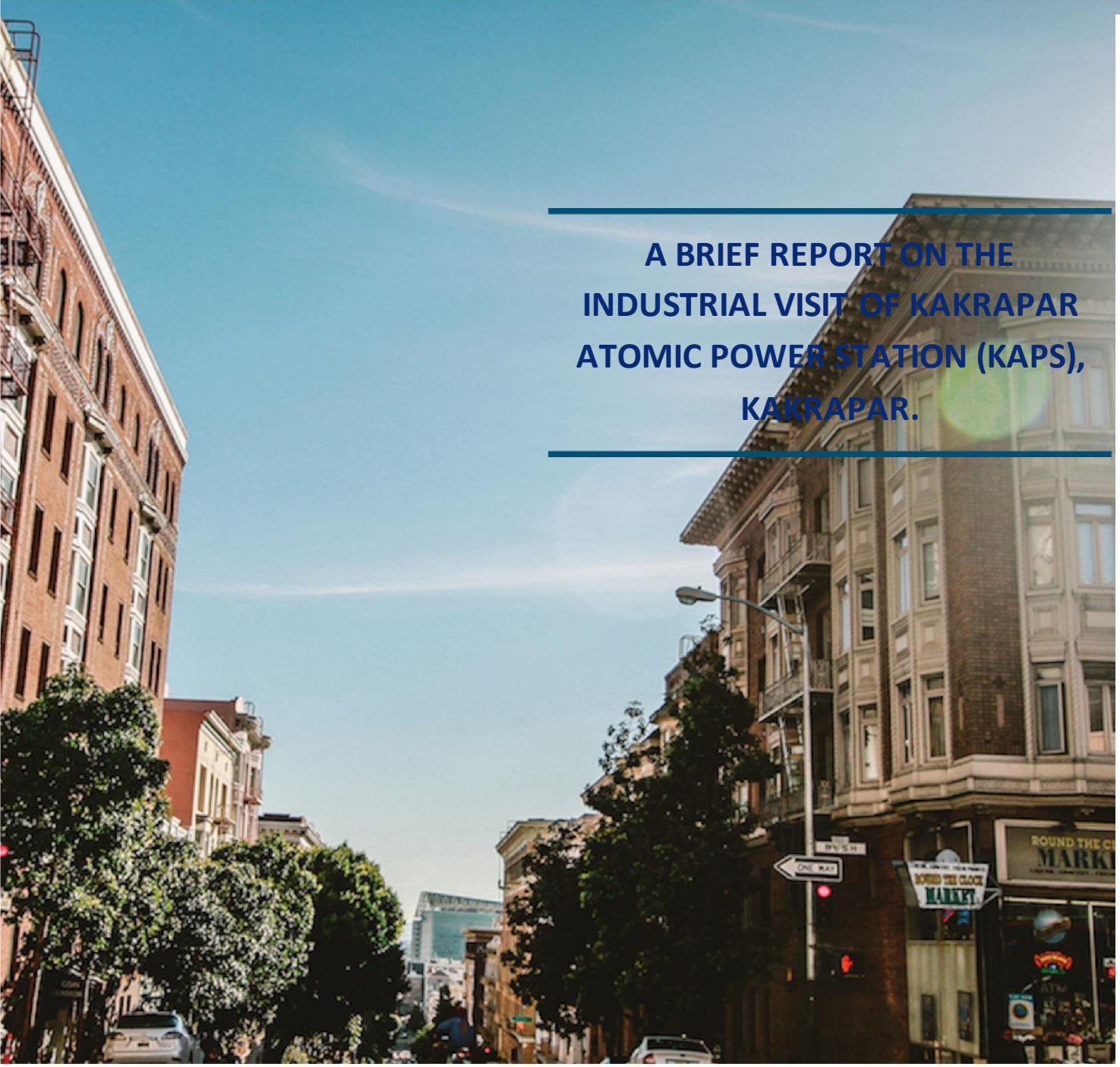
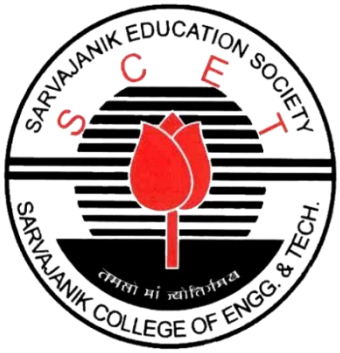


A BRIEF REPORT ON THE INDUSTRIAL VISIT OF KAKRAPAR ATOMIC POWER STATION (KAPS), KAKRAPAR.



SARVAJANIK COLLEGE OF ENGINEERING & TECHNOLOGY, SURAT

Date: 21st September 2023

Electrical Engineering Department

Brief and Aim about site

On the day of September 21st 2023, 3 faculty members and 53 students of Electrical Engineering Department visited Kakrapar Nuclear Power Plant situated in Kakrapar village in the state of Gujarat.

The main aim of the visit was to show and explain the working, designing and material science of the power station to students as well as to create awareness of components used in plant to students and also their relevance to their field

KAPS currently operates three Pressurized Heavy Water Reactors (PHWR), the first of which (Unit-1) began commercial operations on 6 May 1993. Unit-2 followed two years later in September 1995. The third reactor, the IPHWR-700 is the first indigenously built reactor in the country which attained criticality on 30th June 2023; there is construction going on to install another IPHWR-700 reactor, raising the tally to four reactors.

Unit	Type	Gross MW	Construction start	Operation start
Kakrapar 1	**IPHWR-220**	**220**	**1 December 1984**	**6 May 1993**
Kakrapar 2	**IPHWR-220**	**220**	**1 April 1985**	**1 September 1995**
Kakrapar 3	**IPHWR-700**	**700**	**22 November 2010**	**30 June 2023**
Kakrapar 4	**IPHWR-700**	**700**	**22 November 2010**	**March 2024 (planned)**

The construction costs originally were estimated to be 3.8252 billion Rupees, the plant was finally finished at a price of 13.35 billion Rupees.

COMPONENTS IN ATOMIC POWER STATION, KAKRAPAR

Fuel Element: -

To start with fuel used in reactor, India uses Uranium-235 as its primary Fuel Bundle, Uranium is first drawn into cylindrical roll of calculated diameter and length, and in the end stacked together as shown below.

In India these bundles are arranged, designed and assembled at BARC, Trombay. IPHWR uses 19 bundled or 37 bundled fuel based on power requirement. PHWR fuel is manufactured from natural uranium dioxide. The raw material for the production of PHWR fuel is Magnesium Di-Uranate (MDU) or Uranium Ore Concentrate (UOC). MDU concentrate is obtained from the uranium mine and mill at Jaduguda, Jharkhand.

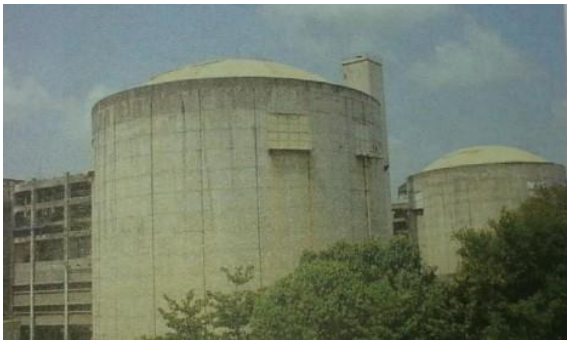
Reactor Building/Containment Building: -

At Kakrapar NPP, there is an allotment of separate confinement cover for every reactor to avoid leaking of radioactive gases or ejection of radioactive material during an explosion. One proud technological advantage for engineers at KAPS was maintaining low atmospheric pressure than the outside environment, so that even if the walls of cover do breaks or cracks, the outside air will rush inside reactor rather than its vice-versa. A gas-tight shell or other enclosure around a nuclear reactor to confine fission products that otherwise might be released to the atmosphere in the event of an accident. Such enclosures are usually dome-shaped and made of steel-reinforced concrete. The color of building is painted Light blue to blend the structure with sky when viewed from long distance.

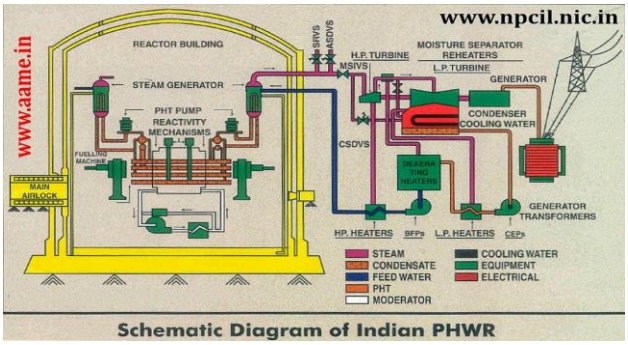
⬆
Unit I and II with IIIrd

unit under construction

Students were also explained about the different layer padding used in nuclear power stations around India, since the Chernobyl and Three Mile Island incidents, engineers at BARC designed and used it first at CIRUS reactor and then this technology was provided and shared with all power plants to use on active or under construction reactor.



Old Containment Buildings



Schematic Diagram of Indian PHWR

Calandria in reactor is the heart of the plant. It is a horizontal cylindrical shaped equipment which contains 306 horizontal tubes it contains uranium as fuel in tubes and also, heavy water as moderator and coolant.

Calandria installed in Unit III

Cooling Towers: -

Students were given brief explanation of water management at plant, the main aim of employees at plant is to reuse water without limiting its quality. The vapor cloud which is used water is very less than that of processed, Kakrapar consumes its water from river and a reservoir very near to plant. Students were showed:

1. *Induced Draft Cooling Tower:* The steam coming from reactor is sent here, the aim of this tower is to create direct contact with steam and cool air to condense it, the

fans above the tower forces the vapor to remain in area, very little steam escapes it.

2. *Natural Draft Cooling tower: T*he steam coming from IDCT is passed to these towers: NDCT, this structure too has a fan to attempt to cool off final steam to water, after this the steam finally exits the plant, this steam is very lightly radioactive, but not hazardous.

3. *Cooling/Air Filtering Tower:* In case of some minor leak or if very small amount of steam is to passed out the facility, then these long towers are used. Their main aim is to filter the radioactive steam through filter layers and pass it to outside environment. Their height is up to 100-150m, main reason is, the radioactive gas gets filtered while descending from such height as well as for cooling steam too.

Turbine Hall:

Second part of the power plant is turbine building. Turbine and generator are enclosed in turbine building. The steam which is generated in reactor is fed to the turbine in controlled environment. This steam rotates turbine at the speed of 3000 RPM which drives generator and the electricity is produced. The electricity which is generated by generator is distributed by 220 KV switch yard to various states which includes Gujarat, Maharashtra, Madhya Pradesh, Chhattisgarh, Goa, Dadra Nagar Haveli, Daman etc.

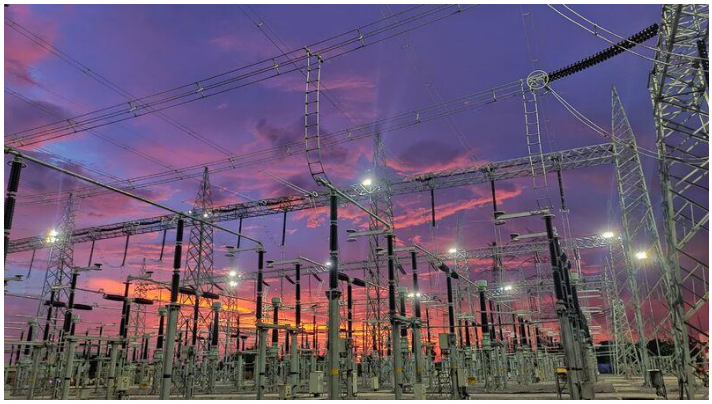
Control Room:

The control room inside Kakrapar is governed by licensed scientists. Each scientist has to undergo a simulation test series every 3 years
and after completing certain courses, a scientist can operate certain reactor operation. The scientists are themselves an engineer, being here after completing an year course at training center. The shape of room is in U-shape to enable operator to look at any data from any location.

Switch Yard:

220 KV switchyard is provided with one Main Bus and Main Cum Transfer Bus Scheme. This system enables import and export of electrical energy possible at the same time. The buses of switchyard of aluminum tube. Main bus is of 4 inch in diameter and Bay Bus is of 2 1/2-inch diameter. Breakers are of SF-6 type but installation of new vacuum type breakers is also under way especially in new units.

Gapless lightning arrester shields the switchyard from lightning by overhead earthing conductor with shielding angle 30 degrees. The switchyard has thirteen bays. Each bay contains isolators, current transformers, lightning arrestors, wave traps and capacitor voltage transformers (last two equipment's are for line bays only).



Station electric power is evacuated through seven number of 220 KV lines connecting to the Gujarat Electricity Board Grid Network, two lines to Haldavra (near-Bharuch), two to Vapi, two to Vav (near Surat) and one to Ukai Thermal Power Station (interconnected).

Through these lines power is transmitted in different directions and further shared by Western Region State of Gujarat, Maharashtra, Madhya Pradesh, Goa, Chhattisgarh, Daman & Diu and Dadra Nagar Haveli. The dedicated 220 KV line from Ukai provides power to station in case of grid failure.

Accidents:

- 1998 KAPS-1 was switched off because of a leakage in the cooling loop for 66 days.
- 10 March 2004 the (at the time of) supply for the control rods were irreparably damaged during maintenance work. In response, poisons were added to the system and the reactor was shut off.
- On 22 August 2006 it was reported by village inhabitants the area around the power station had been penetrated. A search by the police did not result in any findings.

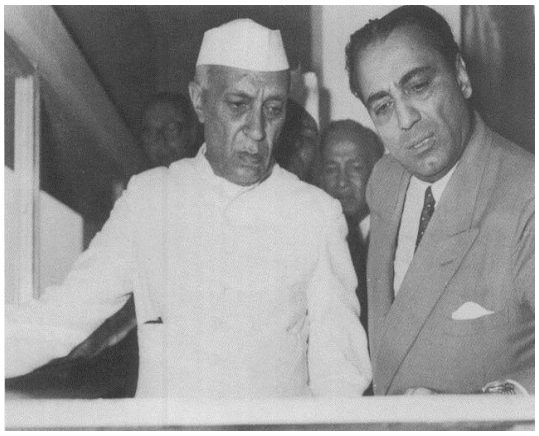
- On 11 March 2016, KAPS-1 automatically shut down due to a leak of heavy coolant water, leaving both reactors non-operational. The leak was plugged ten days later. Corrosion and cracks were found on the coolant channel and similar corrosion spots were found in KAPS-2 which had been non-operational since July 2015 after a coolant channel leak. KAPS-2 attained criticality on 17 September 2018 after a replacement of its coolant channels and feeder tubes. KAPS-1 became operational ahead of schedule on 19 May 2019.

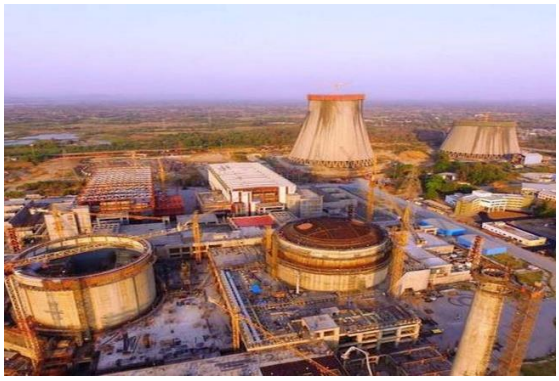
FATHER OF INDIAN NUCLEAR PROGRAM

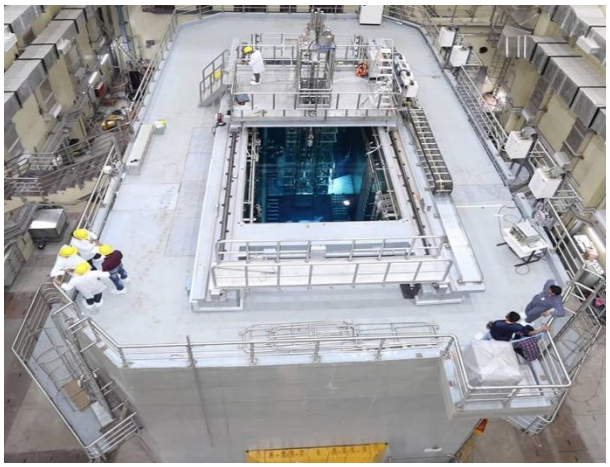
Dr. Homi Jehangir Bhabha


CISF
HANKRIEG


CISF







Faculty Members Accompanied During Industrial Visit:

1) Dr. Nilesh V. Shah, EED (Coordinator)
2) Prof. Sharad B. Patel, EED
3) Prof. Dimple Bhanabhagwanwala, EED

Report Compiled By:

Mr. Krishn Naik, BTech Sem-5 Electrical Engineering

Student Coordinator:

1) Mr. Ketul Desai, BTech Sem-5 Electrical Engineering
2) Mr. Tej Desai, BTech Sem-5 Electrical Engineering
3) Mr. Devansh Desai, B. E.--IV Electrical Engineering

Vote of Thanks:
Thanks to head of the electrical Engineering Department and Head of the Institute for granting permission of the Industrial Visit and extending all associated support. Special Thanks to Prof. Shabbir Ghadiali, T&P officer, SCET for getting permission of Industrial Visit at Atomic Power Station, Kakrapar.

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