

# **Industrial Visit to Sabarigiri Hydro Electric Project**

## **Learnings**

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### **1. Plant Capacity and Rating Details**

➤ The total plant capacity is 340 MW, with six generating units.

- ◆ G1 – 55 MW
- ◆ G2 – 55 MW
- ◆ G3 – 55 MW
- ◆ G4 – 60 MW\*
- ◆ G5 – 55 MW
- ◆ G6 – 60 MW

\* G4 is a Chinese-made unit, and due to vibration issues, it is currently operated at 18 MW.

- The water intake for the project is from the Pamba–Azhutha–Kakki reservoir system (Anathode–Kakki Dam).
- Water is conveyed from the reservoir through a single headrace tunnel.
- The headrace tunnel trifurcates into three main penstocks.
- At the powerhouse, each of the three penstocks bifurcates, forming a total of six penstocks.
- These six penstocks supply water to six generating units in the powerhouse.

### **2. Feeder Details**

➤ The power station is connected through six 220 kV feeders:

- ◆ Theni Feeder (Industrial)
- ◆ Three Edamon Feeder
- ◆ Pallom Feeder
- ◆ Ambalamugal Feeder

➤ 66 kV feeders:

- ◆ Kochu pamba-Triveni

The 66 kV transmission line is stepped down to 11 kV through transformers, and the power is distributed to nearby areas such as **Kakkad, Colony, and Kakki**.

### **3. Salient Features of the Machine**

- vertical-axis hydro turbine–generator sets.
- Each unit is designed for high-head operation
- The weight of the turbine and generator is supported by a collar bearing
- The machines are equipped with efficient hydraulic turbines
- modern control and protection systems
- Oil and water-cooling systems are employed to maintain operating temperature.
- 12-Pole Machine with Double Lap Winding.
- The machine operates at a synchronous speed of 500 rpm.
- Pelton Wheel Turbine with 21 Buckets.
- Needle Mechanism for Controlling Water Flow:
  - The needle controls the water flow to the turbine, its position is sensed by an Linear Variable Differential Transformer (LVDT)(110mV) and the signal is converted into a 4–20 mA analog signal for transmission to the control system.
- Brake jet:
  - A brake jet system is used to quickly slow down and safely stop the turbine after load rejection, preventing overspeed and protecting the equipment.
- Jack System
  - ◆ Used to lift the turbine–generator shaft during start-up and shutdown
  - ◆ High-pressure oil is supplied to the jacking pads to raise the shaft slightly
  - ◆ Reduces load on thrust bearings when the unit is stationary
  - ◆ Helps in proper alignment and maintenance of rotating parts
  - ◆ Prevents damage to thrust bearings during long shutdown periods
- Brake System
  - ◆ Used to stop the turbine–generator unit safely
  - ◆ Operates during normal shutdown and emergency conditions
  - ◆ Air pressure is used to apply the braking mechanism
  - ◆ Works along with a brake jet (in impulse turbines) or a mechanical brake
  - ◆ Prevents overspeed and mechanical damage after load rejection
  - ◆ Applied only when the speed reduces below 125 rpm

- Oil Pumping Unit & LGB Vapour Exhaust System
  - ◆ 110 V DC oil pumping unit supplies lubricating oil to turbine and generator bearings
  - ◆ Maintains required oil pressure during start, operation, and shutdown
  - ◆ Ensures smooth and safe bearing operation
  - ◆ LGB vapour exhaust system removes oil vapours from the lower guide bearing area
  - ◆ Prevents oil fume accumulation.
  
- Pole strainer

A pole strainer is installed at the water intake of a hydro electric plant to prevent debris and unwanted materials from entering the turbine, thereby protecting the equipment and ensuring smooth operation.
  
- Sensors
  - ◆ A **vibration sensor** measures machine body vibration in the X and Y directions, and the vibration limit is typically set at 1 mm to monitor and protect the equipment.
  - ◆ A **Hall effect sensor** is used to measure turbine speed by detecting rotational pulses, and the speed signal is fed to the governor, which controls the water flow to maintain the required speed
  
- Main Inlet Valve (MIV)

The Main Inlet Valve (MIV) is used to control and completely shut off water flow to the turbine for safe operation, shutdown, and maintenance of the hydro electric unit, while its bypass valve is used to equalize water pressure across the MIV before opening, ensuring smooth and safe valve operation.
  
- Neutral grounding transformer

A neutral grounding transformer with 1 ohm resistance is used to limit earth fault current by grounding the system neutral through a resistor, thereby protecting equipment and improving system safety.

#### **4. SCADA-Based Control, Automation, and Monitoring System**

- **PLC (Programmable Logic Controller)**
  - ◆ Used for automatic control of plant operations
  - ◆ Receives signals from sensors (speed, pressure, temperature, level, etc.)
  - ◆ Processes these signals using pre-programmed logic

- ◆ Sends control commands to actuators like guide vane motors, valves, breakers, and pumps
- ◆ Provides interlocking and protection to prevent unsafe operations
- ◆ Communicates with SCADA / Control Room for monitoring and remote control

➤ **Local Control Panel:**

- ◆ Used to start and stop the turbine and generator locally
- ◆ Shows important values like speed, voltage, temperature, and oil pressure
- ◆ Helps control guide vanes, inlet valve, brake jet, and oil system
- ◆ Gives alarm or trips the unit if any problem occurs
- ◆ Connected to the control room for monitoring and operation Ensures safe operation using interlocks

**Reserve shutdown** is a safety feature in a hydro electric plant used to stop the turbine–generator unit automatically in case the normal shutdown system fails, ensuring protection of the equipment and safe operation.

**Spinning reserve** is the extra generating capacity that is already running and synchronized with the grid, but not fully loaded, and can immediately increase output to meet sudden increases in demand or to cover generation loss.

## **5. Features**

- The Sabarigiri Hydro Electric Project (SHEP) is the second largest hydroelectric project in Kerala(340 MW).
- The Sabarigiri Hydro Electric Project has the largest design net head in Kerala, at approximately 714.76 metres, making it one of the highest head hydroelectric projects in the state.
- Utilizes water from Pampa–Anathode and Kakki reservoirs
- The water discharged through the tailrace from the Sabarigiri Power Plant is collected in the Moozhiyar reservoir and is subsequently utilized for power generation at the Kakkad Power House (25 MW).
- There is a **Auxiliary pumping system** at Kochu Pamba. The Kochu Pamba pumped storage scheme is equipped with four pumps of 350 HP each. The system operates with an energy conversion ratio of 1:8, wherein one unit of electrical energy is utilized to pump water back to the upper reservoir, and the same stored water subsequently generates approximately eight units of electrical energy during power generation. In this scheme, a high head difference is utilized to generate power

efficiently by converting the potential energy of water into mechanical and subsequently electrical energy.