INDUSTRIAL VISIT REPORT

UPPER SINDH HYDROELECTRIC POWER GENERATION PROJECT (USHP-II), KANGAN

Organizing Department: Department of Electrical Engineering, Institute of Technology (IoT) Zakura Campus, University of Kashmir

Destination: Upper Sindh Hydroelectric Power Project Stage-II (105 MW), Kangan, District Ganderbal, J&K
Date of Visit: November 5, 2026
Participating Batches: B.Tech Electrical Engineering — 3rd, 5th, and 7th Semesters
Faculty Coordinators & Staff:

- Dr. Ubaid Qureshi (Faculty Coordinator & Head Lead)
- Mr. Malik Younis Ahmed (Faculty Member)
- Mr. G.M. Gudoo (Faculty Member)
- Dr. Gazala Rashid (Faculty Member)
- Technical Support Team: Departmental Laboratory Assistants and Technical Staff

1. EXECUTIVE SUMMARY & OBJECTIVES

An extensive, high-level educational industrial visit was successfully conducted on 5th November 2026 to the Upper Sindh Hydroelectric Power Generation Project Stage-II (USHP-II) situated at Kangan, District Ganderbal, Jammu & Kashmir. The visit was organized by the Department of Electrical Engineering, Institute of Technology (IoT) Zakura Campus, University of Kashmir, for undergraduate engineering students belonging to the 3rd, 5th, and 7th semesters.

The core objective of this industrial exposure was to bridge the theoretical concepts of power generation, electrical machinery, high-voltage engineering, switchgear, and control systems taught in academic curricula with real-world, industrial-scale implementations. Supervised by faculty members Dr. Ubaid Qureshi (Coordinator), Mr. Malik Younis Ahmed, Mr. G.M. Gudoo, and Dr. Gazala Rashid, alongside experienced laboratory technical staff, the students gained first-hand insights into the working of a 105 MW grid-connected hydro power facility operated under the aegis of the Jammu and Kashmir State Power Development Corporation (JKSPDC).

Key Educational Objectives:

- Understanding the complete energy conversion process from hydraulic kinetic/potential energy to electrical power.
- Analyzing the constructional, operational, and mechanical aspects of 35 MW Vertical Shaft Francis Turbines (BHEL make).
- Inspecting synchronous generators (stator windings, rotor pole arrangements, brushless excitation, cooling, and bearing assemblies).
- Studying the layout and function of heavy-duty power transformers (Generator Step-Up Transformers, Station Auxiliary Transformers, and Instrument Transformers).

- Examining high-voltage outdoor switchyard equipment, including SF6 circuit breakers, isolators, busbars, and lightning arresters.
- Familiarizing with SCADA systems, electro-hydraulic governing systems, panel metering, and digital protection relays inside the central control room.

2. PROJECT OVERVIEW: UPPER SINDH HYDROELECTRIC PROJECT STAGE-II (USHP-II)

The Upper Sindh Hydroelectric Project Stage-II is a major run-of-the-river power generation plant located approximately 40 km northeast of Srinagar in the Ganderbal district. It utilizes the water discharge from two main natural sources: Sindh Nallah and Wangath Nallah (tributaries of the River Jhelum), operating under a nominal head of approximately 220 to 231.68 meters.

Total Installed Capacity	105 MW (3 Units x 35 MW each)
Owner / Operator	Jammu and Kashmir State Power Development Corporation (JKSPDC)
Water Sources	Sindh Nallah (Designed Discharge: 1384 Cusecs) & Wangath Nallah (416 Cusecs)
Net Hydraulic Head	231.45 M to 231.68 M (approx. 759 ft)
Turbine Type	Vertical Shaft Francis Reaction Turbines (BHEL)
Generator Type	3-Phase Vertical Synchronous Alternator (BHEL)
Rated Speed	600 RPM (Runaway Speed: 1175 RPM)
Generation Voltage	11 kV (3-Phase, 50 Hz)
Transmission Voltage	132 kV (Stepped up via Main Generator Transformers)
Annual Energy Generation	Approximately 448 – 535 Million Units (kWh)

3. CHRONOLOGY OF THE VISIT & PHOTOGRAPHIC DOCUMENTATION

The industrial delegation departed from the IoT Zakura Campus in Srinagar early on the morning of November 5, 2026, arriving at the USHP-II Power House complex in Kangan. Upon arrival, the engineering team was received by the Executive Engineer and Resident Technical Officers of JKSPDC.

Before entering the operational areas, a mandatory safety and operational brief was conducted by the plant engineers alongside Dr. Ubaid Qureshi. Students were divided into structured batches across 3rd, 5th, and 7th semesters to ensure interactive and focused learning. Faculty members Mr. Malik Younis Ahmed, Mr. G.M. Gudoo, and Dr. Gazala Rashid accompanied the respective groups through the multi-tier powerhouse levels, civil intake channels, machine hall, transformer yard, and control station.



Figure 1: Initial safety and technical orientation delivered by faculty coordinator Dr. Ubaid Qureshi alongside other faculty members to 3rd, 5th, and 7th semester students outside the 132 kV switchyard area.



Figure 2: Faculty members and electrical engineering students attending the outdoor technical session adjacent to the grid switchyard towers.

4. DETAILED TECHNICAL FINDINGS & COMPONENT ANALYSIS



Figure 3: Students and faculty gathered inside the main machine hall of USHP-II Kangan, observing the vertical generator bays and heavy overhead gantry crane infrastructure.

4.1 Civil Works & Water Conductor System

The students began by examining the hydraulic conveyance systems that bring water from the catchment to the turbines:

- **Headworks & Diversion Structures:** Water is impounded and diverted from Sindh and Wangath streams through concrete and masonry structures equipped with silt exclusion gates.
- **Water Conductors & Tunnels:** A combination of open channels (7.24 km), cut-and-cover conduits (6.02 km), and concrete-lined pressure tunnels (2.94 km) convey water to the storage/forebay structure.
- **Balancing Reservoir & Forebay:** Serves as a surge and storage basin to regulate sudden load fluctuations and prevent water hammer effects.
- **Penstocks:** Two high-pressure steel penstocks (diameters 3.0 m and 2.25 m, length ~955–1000 m) direct water under high pressure down into the turbine scroll casings inside the underground/semi-underground machine hall.

4.2 Hydro Turbines (Francis Vertical Shaft)

Inside the deep powerhouse pit, students observed the 3 x 35 MW Francis Reaction Turbines manufactured by Bharat Heavy Electricals Limited (BHEL). Being reaction turbines, the water enters under high static pressure and transfers energy to the runner as its pressure and velocity decrease.

- **Spiral (Scroll) Casing:** A cast steel spiral conduit surrounding the runner that evenly distributes water around the entire circumference of the guide vanes while maintaining uniform velocity.
- **Stay Ring & Stay Vanes:** Heavy structural steel vanes that support the mechanical weight of the upper powerhouse structures and direct water toward the moveable guide vanes.
- **Guide Vanes (Wicket Gates):** A set of 24 movable aerofoil-shaped vanes controlled by hydraulic servo-motors and governor links. By altering the angle of these vanes, the flow rate of water is precisely regulated to control power output and generator frequency (50 Hz).
- **Runner:** High-grade stainless steel (13% Cr, 4% Ni alloy) cast runner with fixed curved blades. High-velocity water strikes the blades radially and exits axially, transferring shaft torque to the main vertical shaft.
- **Draft Tube:** An elbow-shaped diverging pipe connected below the runner exit. It converts the remaining kinetic energy of tail water into pressure head, improving overall turbine efficiency.



Figure 4: Detailed view inside the turbine pit showing the BHEL 35 MW Francis turbine spiral (scroll) casing, regulating ring mechanism, hydraulic actuator piping, and lubrication feed lines.



Figure 5: Hydraulic oil pressure manifolds, governor actuation lines, and turbine auxiliary piping arrangement inspected inside the lower turbine pit gallery.



Figure 6:Mr. Malik Younis Ahmed conducting an interactive floor session with students on turbine speed governing and regulating ring mechanisms.



Figure 7: Technical discussion near the unit hydraulic cooling and lubricating oil circulation loops serving the turbine guide bearings.



Figure 8: Close-up inspection of the vertical turbine shaft assembly, shaft sealing box, and main bearing support bracket from the servicing platform.

4.3 Synchronous Generators (Stators and Rotors)

Directly coupled to the vertical turbine shaft above the turbine pit is the 3-phase Synchronous Generator. The plant staff provided an in-depth walkthrough of the generator constructional details:

Rated Electrical Output	35,000 kW (35 MW) Active Power / 38,888 kVA Apparent Power at 0.8 Power Factor (Lagging)
Stator Voltage & Current	11,000 V (11 kV) Line-to-Line; Stator Current ~2,041 A
Stator Core & Winding	High-permeability laminated silicon steel core with radial ventilating ducts. Winding is 3-phase, star-connected, with Class F insulation.
Rotor Structure	Salient Pole Rotor with 10 laminated steel field poles mounted on a forged steel spider wheel. Rated speed N = 120f / P = (120 x 50) / 10 = 600 RPM.
Excitation System	Static Brushless DC Excitation System. Rotor Field Voltage ~159 V DC, Field Current ~810 A DC.
Bearings & Oil System	Heavy-duty Thrust Bearing to take vertical load (water thrust + rotor weight), with upper and lower guide bearings. Lubrication via dual redundant AC motor oil pumps (60 HP) and automatic DC backup pumps.



Figure 9: Dismounted salient-pole rotor wheel and vertical generator shaft positioned on the erection bay floor, showing field windings, pole shoes, and collector ring mounting shaft.



Figure 10: Top-down perspective into an open generator pit displaying the laminated silicon steel stator core slots, 3-phase star-connected stator end-windings, and radial cooling ducts.



Figure 11: Upper/Lower bearing bracket structure engineered to support combined vertical hydraulic thrust forces and rotor assembly deadweight.

4.4 Types of Transformers at USHP-II Kangan

Transformers play a vital role in voltage transformation, station power distribution, and protection. Students studied four primary categories of transformers installed at the station:

- **1. Generator Step-Up Transformers (GT):** Step up generation voltage from 11 kV to 132 kV for efficient long-distance transmission. 3-Phase, Delta/Wye (Dyn11) connected oil-immersed transformers with ONAF cooling. Equipped with Buchholz Relay, PRV, WTI, OTI, conservator tank, and dehydrating breather.
- **2. Station Auxiliary Transformers (SAT):** Step down voltage from 11 kV (or incoming 132 kV grid) to 415 V AC 3-phase for station internal loads (oil pressure pumps, cooling water pumps, crane operations, control supplies).
- **3. Unit Auxiliary Transformers (UAT):** Tapped directly from the 11 kV generator bus duct to supply unit-specific auxiliaries during running conditions.
- **4. Instrument Transformers (CTs & PTs):** Includes Current Transformers (CTs) for stepping down high currents (2000A to 1A/5A) for protection relays and Potential Transformers (PTs) for stepping down voltages (11kV / 110V and 132kV / 110V).



Figure 12: Electrical engineering faculty and students examining the outdoor transformer yard containing generator step-up transformers, station auxiliary transformers, and high-voltage bushings.

4.5 High-Voltage Switchgear, Substation & Station Auxiliary Boards

The station utilizes indoor Low Voltage (LT) switchgear lineups and outdoor 132 kV switchyards for internal power management and grid interconnection:

- **SF6 Circuit Breakers:** High-speed breakers utilizing SF6 gas as the arc quenching medium, capable of interrupting high short-circuit fault currents safely.
- **Air-Break Isolators & Earth Switches:** Off-load mechanical switching devices used to isolate transmission lines and transformers during maintenance.
- **Lightning Arresters (Surge Arresters):** Zinc-oxide (ZnO) gapless surge arresters installed at line entry points to divert high-voltage lightning and switching surges to ground.
- **LT Switchgear & Station Auxiliary Boards:** Indoor 415 V Station Service Boards (SSB), Air Circuit Breakers (ACBs), Tie-Breaker Panels, and Diesel Generator Incomer panels for supplying critical power station auxiliaries.



Figure 13: Overview of the indoor Low Voltage (LT) switchgear room and Station Service Board panel gallery at USHP-II Kangan.



Figure 14: Faculty explaining protection relay integration, incoming feeder breakers, and bus section operations to students.



Figure 15: Detailed walkthrough of Station Service Board-2, Tie-Breaker panels, and emergency DG incomer switchgear panels.



Figure 16: Interactive session inside the LT switchgear room focusing on auxiliary transformer feeder protection and local/remote switching modes.

4.6 Central Control Room, Unit Control Boards & SCADA Automation

The tour concluded in the Central Control Room (CCR) and local Unit Control Board (UCB) bays, representing the intelligence hub of the power plant:

- **Unit Control Boards (UCB):** Stand-alone control cubicles located on the machine hall floor housing micro-processor controllers, numerical relays, digital mimic indicators, and synchronization controls.
- **SCADA Consoles:** Computerized mimic displays rendering real-time metrics of water head, valve openings, MW/MVAR outputs, bearing temperatures, and bus voltages.
- **Electro-Hydraulic Governor Controls:** Automated systems maintaining generator speed at exactly 600 RPM by dynamically modulating turbine guide vane openings in response to grid frequency fluctuations.
- **Automatic Voltage Regulator (AVR):** Regulates generator terminal voltage by adjusting excitation field current.
- **Annunciator & Protection Relay Panels:** Numerical micro-processor-based relays providing differential protection, overcurrent, earth fault, distance protection, and reverse power protection.



Figure 17: Demonstration at Unit Control Board II (UCB II) inside the machine hall, displaying digital parameters, SCADA interface screens, and generator protection relay panels.

5. ACADEMIC IMPACT & STUDENT LEARNING OUTCOMES

The visit provided immense practical value tailored across different semester levels:

- **3rd Semester Students:** Gained foundational understanding of basic electrical machines, magnetic circuits, mechanical-to-electrical energy conversion, and transformer working principles.

- **5th Semester Students:** Correlated coursework in Electrical Machines-II and Power Transmission & Distribution with actual stator/rotor construction, synchronous generation, grid coupling, and transformer cooling setups.
- **7th Semester Students:** Experienced advanced applications in Power System Protection, Switchgear, SCADA/Automation, and Hydro Power Engineering, aiding their final-year research projects and career readiness.

6. ACKNOWLEDGMENTS & CONCLUSION

The Department of Electrical Engineering, Institute of Technology Zakura Campus, University of Kashmir, extends its sincere gratitude to the senior management and technical personnel of the Jammu & Kashmir State Power Development Corporation (JKSPDC) at USHP-II Kangan for granting permission and delivering thorough technical guidance.

Special recognition is extended to Dr. Ubaid Qureshi (Faculty Coordinator) for meticulously planning and coordinating the visit, as well as faculty members Mr. Malik Younis Ahmed, Mr. G.M. Gudoo, and Dr. Gazala Rashid for guiding the students through technical discussions. The assistance of the departmental laboratory staff was instrumental in making the visit safe, organized, and intellectually rewarding.

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Date: November 5, 2026