Pabna University of Science and Technology

Report On

Industrial Training/Attachment At BSCL &
Karnaphuli 230 MW (BPDB) Hydropower Plant
Course Title: Industrial Training/Attachment
Course Code: EEE-4100

SUBMITTED BY	SUBMITTED TO
Md. Kornel Ahmed Rahul Roll: 200219 Session: 2019-2020 4th Year 1st Semester Department of EEE Pabna University of Science and Technology	Dr. Dilip Kumar Sarker Professor Department of EEE Pabna University of Science and Technology

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Acknowledgement

I am really grateful to Almighty Allah for providing me the opportunity to complete the day 1 of my industrial training in the Satellite Secondary Ground Station, Betbunia, Rangamati successfully on 14^{th} May 2025. The government-owned Bangladesh Satellite Company Limited (BSCL) carried out this training because it is the official owner of the BS-1 satellite. And day 2 of my industrial training at the Karnaphuli Hydropower Station, situated on the Karnaphuli River in Kaptai, Rangamati, Bangladesh, on 15^{th} May 2025. Organized by our academic department, this visit offered an immersive learning opportunity at Bangladesh's only hydroelectric facility, which generates approximately 5% of the nation's electricity with a 230 MW capacity I am grateful for the experience and knowledge gained from my supervisor, Dr. Dilip Kumar Sarker, Professor of the Department of Electrical and Electronic Engineering, for supervising my attachment and supporting my learning process.

I would also like to thank "Sadman Al Farabi" an Assistant Manager (Assistant AR Engineer) of Bangladesh Satellite Company Limited (BSCL), for his continuous support and guidance during my industrial attachment. I am also grateful to all the staff of BSCL for their time and support.

Also, I would like to offer my sincerest gratitude to Mr. Mohammad Ahsan Habib Chowdhury, Assistant Engineer, Karnaphuli Hydroelectric Station, Biubo, Kaptai, Rangamati for his invaluable guidance, continuous support, and visionary direction throughout my industrial attachment. His advice and encouragement have greatly contributed to the successful fulfillment of my job. I also thank all the members of BPDB staff for their precious time, cooperation, and support throughout my attachment.

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Day 1: Satellite Secondary Ground Station, Betbuniya, Rangamati

1. Introduction

Industrial attachment is an important component of the engineering course that fills the gap between theory and industry practice. This report outlines the activities and learning experiences during my industrial attachment at the Bangladesh Satellite Company Limited (BSCL) on the BS-1 satellite system. The attachment gave me practical experience and exposure to satellite communication systems, operation, and maintenance.

Figure 1: Industrial training team on 14th May 2024 at Satellite Secondary Ground Station, Betbuniya, Rangamati.

2. About BSCL (Bangladesh Satellite Company Limited)

BSCL was established with the mission to operate and maintain Bangladesh's first geostationary satellite, the Bangladesh Satellite-1 (BS-1), launched in 2018. The organization is responsible for the satellite's Trouble-free operation, offering communication and broadcasting services to Bangladesh and other regions of the globe.

2.1 About Satellite Secondary Ground Station, Betbuniya, Rangamati

In Bangladesh's Rangamati district, the Secondary Satellite Ground Station at Betbuniya has played a crucial role in the country's telecommunications network. Bangladesh became a member of the International Telecommunication Union (ITU) on September 5, 1973. This membership was part of the country's efforts to integrate into the global telecommunication community following its independence in 1971. The decision to join the ITU was a strategic move by the government to modernize the nation's communication infrastructure and participate in international discussions on telecommunication policies and standards. Bangabandhu Sheikh Mujibur Rahman formally inaugurated it on June 14, 1975.

In the past, this facility has helped with international communications by offering telephony, data transmission, fax, and telex services to 11 nations, including Singapore, Japan, and Saudi Arabia. Betbuniya was extensively upgraded to serve as a backup ground station after Bangabandhu-1, Bangladesh's first satellite, was successfully launched in 2018. It now provides satellite control and monitoring capabilities in addition to the main station in Gazipur. In partnership with global organizations like Spectra Engineering Limited and Thales Alenia Space, this upgrade was finished, highlighting Bangladesh's progress in digital communications and space technology.

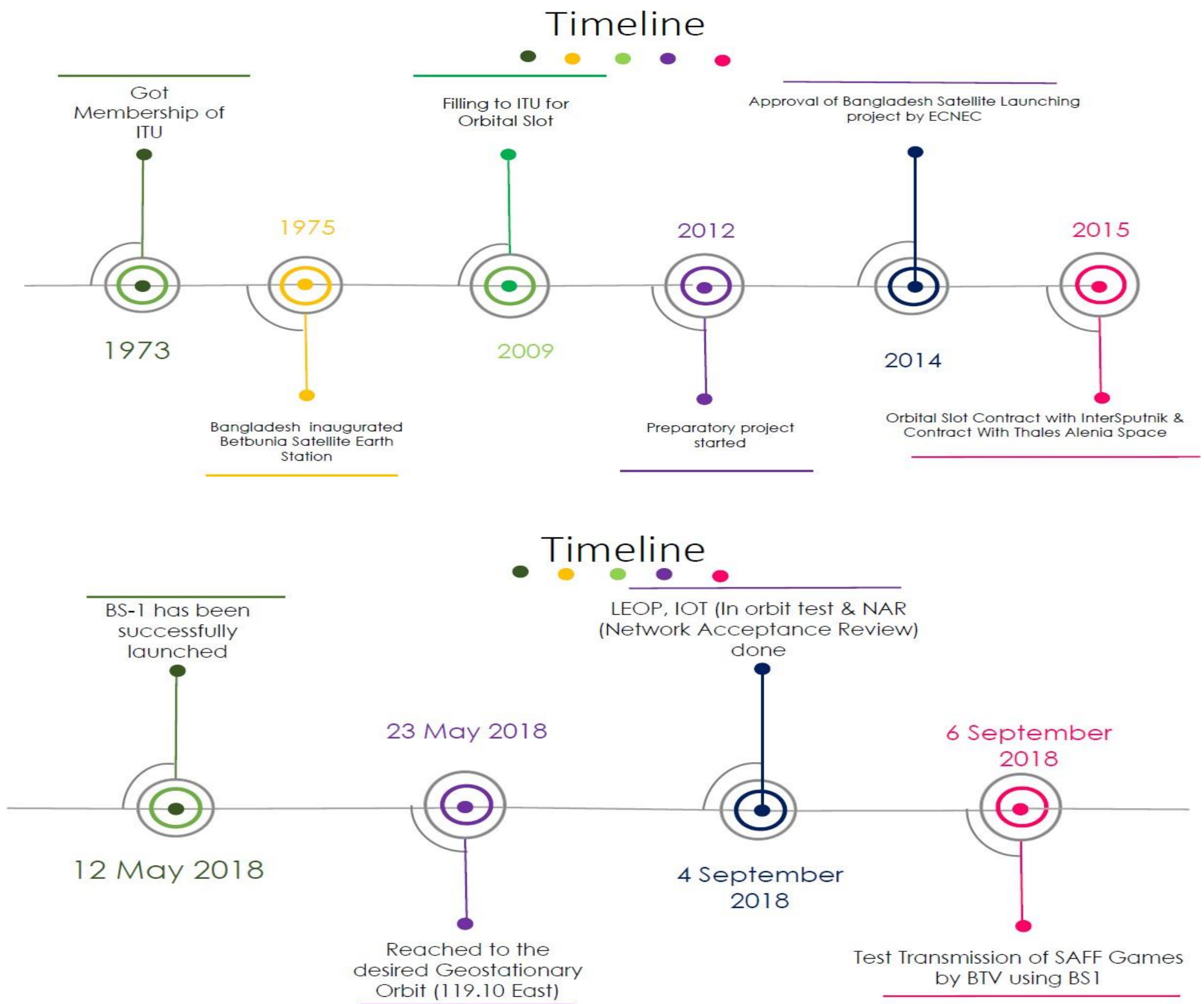

Figure 2: Black Diagram of Timeline of Bangladesh Satellite Company Limited (BSCL).

3. BSCL's Mission & Vision

3.1 Mission:

To ensure uninterrupted satellite-based communication services, augmenting national connectivity, and supplementing the country's communication infrastructure.

3.2 Vision:

To enhance global connectivity and become a leading satellite communication service provider in South Asia.

4. Bangladesh Satellite-1 (BS-1) Overview

4.1 Technical Information:

Satellite Name	: Bangladesh Satellite-1 (BS-1)
Type of Satellite (Position)	: Geostationary Satellite
Type of Satellite (Function)	: Communication and Broadcasting
Owner of Satellite	: Government of the People's Republic of Bangladesh
Operator of Satellite	: Bangladesh Satellite Company Limited (BSCL)
Orbital Slot	: 119.1° East longitude
Frequency Bands	: C Band and Ku Band
Number of Transponders	: 40 (14 C Band and 26 Ku Band)
Capacity of Satellite	: Total capacity of 1600 MHz, with each transponder offering 36 MHz
Solar Array	: 3 panels per wing
Satellite Fuel	: Hydrazine, Nitrous Oxide, and Hydrogen Peroxide
Mission Life	: Over 15 years
Launch Date	: May 12, 2018, at 2:14 AM (Bangladesh Time, GMT+6)
Ground Stations	: 1. Primary Ground Station: Gazipur, Bangladesh 2. Secondary Ground Station: Betbunia, Rangamati, Bangladesh

4.2 Bangladesh Satellite-1 (BS-1) Position

Longitude	: 119.1°E
Perigee Altitude	: 35,789.3 km
Apogee Altitude	: 35,798.5 km

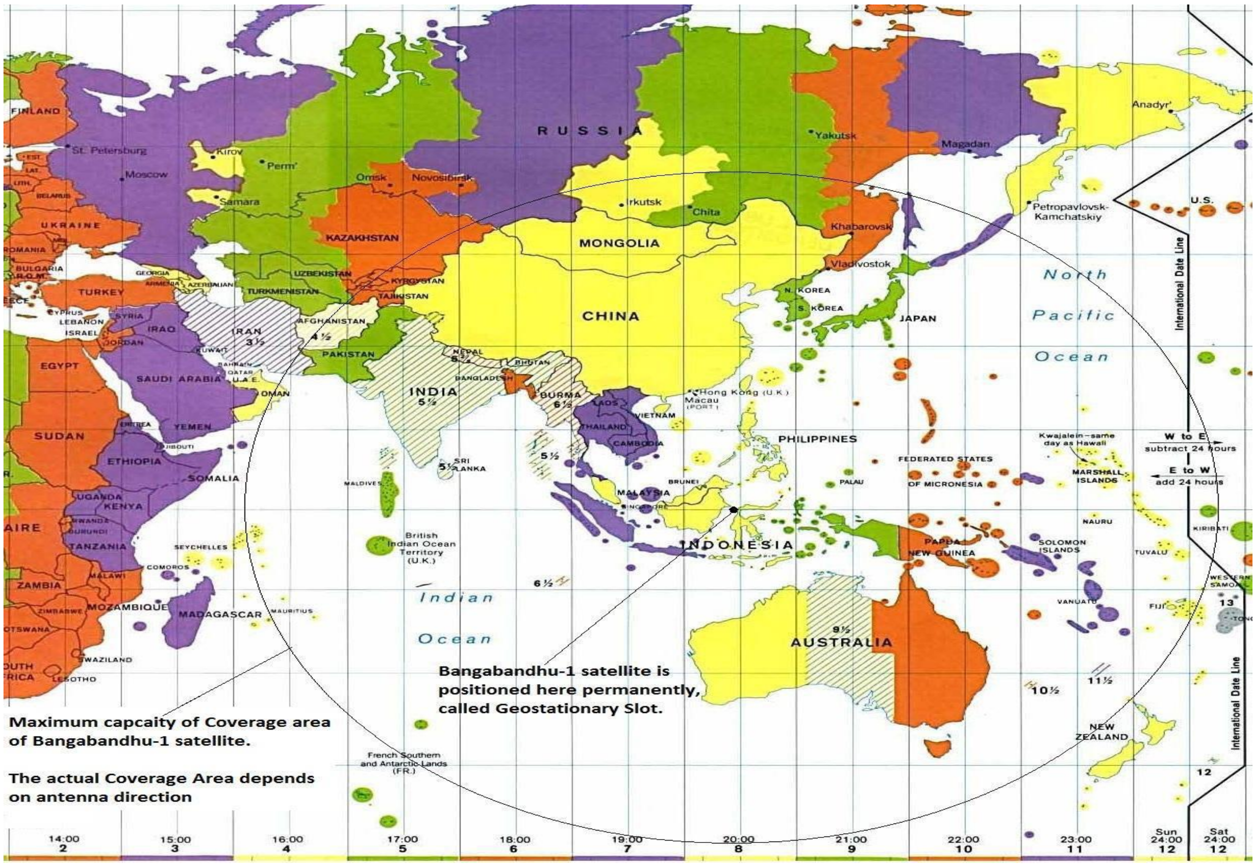

Figure 3: Position of BS-1 In world Map 2D view.

5. Operations and Functions of BS-1

5.1 Block Diagram of Satellite Communication

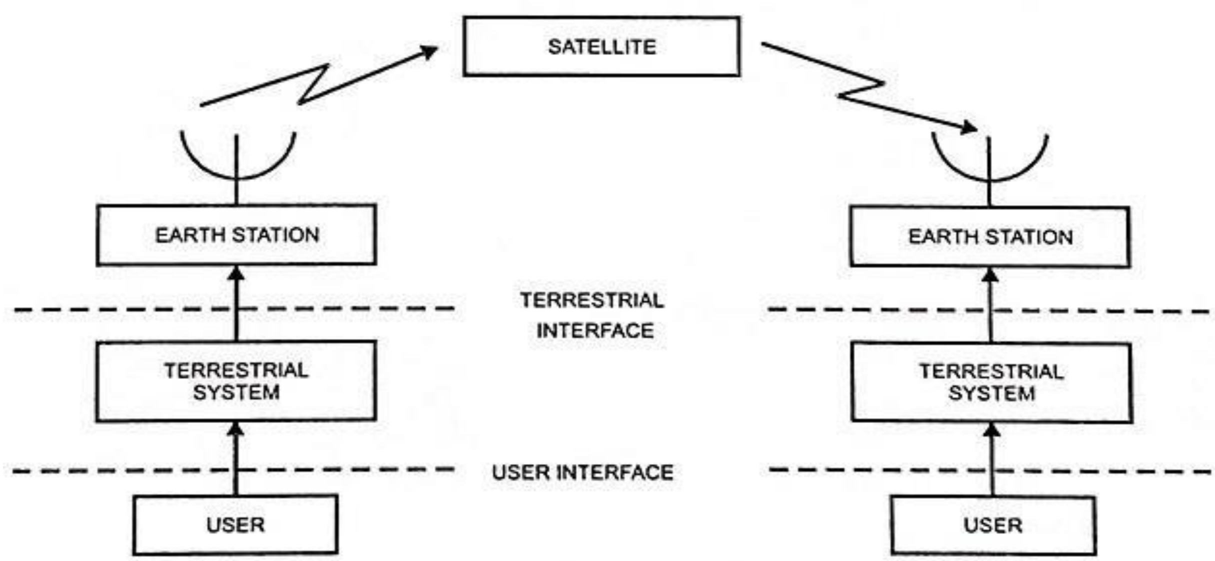

Figure 4: Block Diagram of Satellite Communication

6. Major components and design parameter of BSCL

6.1 Antenna:

The antenna system is a critical component for satellite communication, enabling high-frequency uplink and downlink transmissions with geostationary satellites like Bangladesh Satellite-1.

- **Type & Size:**
  - Large parabolic reflector antenna (typically C-band or Ku-band).
  - Diameter: Around 9m and 9.3m for Ku-band and C-band respectively (for high-gain, narrow beamwidth).
- **Functions:**
  - Uplink: Transmits signals to satellites (e.g., 6 GHz in C-band, 14 GHz in Ku-band).
  - Downlink: Receives signals from satellites (e.g., 4 GHz in C-band, 12 GHz in Ku-band).
  - Precision Tracking: Uses azimuth-elevation (AZ-EL) motors to follow satellite movement.
- **Key Components:**
  - **Feed Horn:** Captures/transmits signals to/from the reflector.
  - **Low-Noise Block Downconverter (LNB):** Amplifies weak downlink signals.
  - **High-Power Amplifier (HPA):** Boosts uplink signals (e.g., klystron or TWTA).
  - **Antenna Control Unit (ACU):** Automates tracking using satellite ephemeris data.
  - **Waveguide & RF Components:** Guides microwave signals between the feed horn and transceiver with minimal loss.

Figure 5: Physical View of antenna at Satellite Secondary Ground Station, Betbuniya, Rangamati.

6.2 Electro-Mechanical Equipment's:

6.2.1 Generator:

Figure 6: Generator and control panel of a generator

Two diesel generators are deployed as the primary backup power source to ensure 100% power redundancy. The 1+1 redundancy configuration ensures reliable power by using Generator-1 as the primary backup and Generator-2 as a standby, which activates if the first fails. An Automatic Transfer Switch (ATS) transfers the load within 10–30 seconds of a grid failure. Optional parallel operation allows both generators to share the load during prolonged outages. The generator control panel is the "brain" of the backup power system, ensuring reliable operation during grid failures. it performs the following key functions such as Automatic Start/Stop Control, Power Monitoring & Protection, Engine Monitoring & Safety etc.

6.2.2 Transformer:

Figure 7: Transformer

Two transformers are installed to ensure uninterrupted power supply and system reliability. The system primary transformer handling the regular load and a secondary transformer as a backup, ensuring zero downtime during maintenance or faults also Parallel operation allows load sharing. This setup supports maintenance without shutdown crucial for 24/7 satellite operations like TV broadcasting and military communications. It also provides fault protection, with automatic switchover in case of overheating or short circuits, preventing damage to sensitive equipment. Additionally, the configuration allows scalability, accommodating future expansion with added antennas, servers, or cooling systems.

6.2.3 Control Panel of Substation:

Figure 8: Control Panel System

Here we see the three control panels. 1st 2 control panels for 2 transformer and last one for UPS. At a time only one control panel works. Sometimes 1st 2 panel works together. But the third one only works when rest two is turn off.

6.2.4 Fire Extinguishing System:

The fire pump room is a vital part of a building's fire protection system, equipped with jockey pumps, main fire pumps, and a network of red-painted pipes and valves that deliver high-pressure water during fire emergencies. The red color coding follows fire safety standards. Typically part of a wet-pipe sprinkler system, it ensures immediate response through components like pressure gauges, gate valves, and automatic controllers

Figure 9: Fire Extinguishing System.

6.2.5 UPS System:

Figure 10: UPS System

The UPS system is a critical component in satellite ground stations that provides instant backup power during grid failures, ensuring uninterrupted operations. The key function of UPS system is: Bridging Power Gaps, Voltage Stabilization, Backup for Critical Loads.

6.2.6 Cooling System:

A cooling system in a satellite ground station is essential for maintaining optimal operating temperatures of critical electronic equipment such as transmitters, receivers, servers, and power systems. These systems generate significant heat during continuous operation, especially in 24/7 facilities.

Figure 11: Cooling System

6.2.7 Protection devices:

Protection is essential to keep equipment and personnel safe from any kind of damage caused by an electrical unbalance or fault condition. We cover the objectives of power system protection, different protection devices and schemes to provide complete safety to an electrical power system.

- **Instrument Transformer:** Voltage and Current measurements give feedback on whether a system is healthy or not. Voltage transformers and current transformers measure these basic parameters. The current transformer has two jobs to do. Firstly, it steps down the current to such levels that it can be easily handled by the relay current coil. Secondly, it isolates the relay circuitry from the high voltage of the high voltage system.

- **Relay:** Relays are operated by measuring the voltage and current values and converting them into digital and/or analog signals, which in turn isolate the circuits by opening the faulty circuits. Most often, the relays serve two objectives, alarm and trip, once the abnormality is noticed.

- **Circuit Breaker:** The circuit breakers, which are used to isolate the faulty circuits, can carry these fault currents until the fault currents are cleared.
- **Lighting Arrester**: This is the specialized protection device that is much helpful to manage the current flow and arrests the unwanted flow in the circuit. As a result, all these protection devices are the best protection agent to the circuit.
- **Fuse:** Fuse is one of the vital things that are useful as protection devices. It protects the current from overcurrent through its metal strip which is to liquefy the current when the flow is high.

6.3 Building Drawing Power System of Secondary Satellite Ground Station;

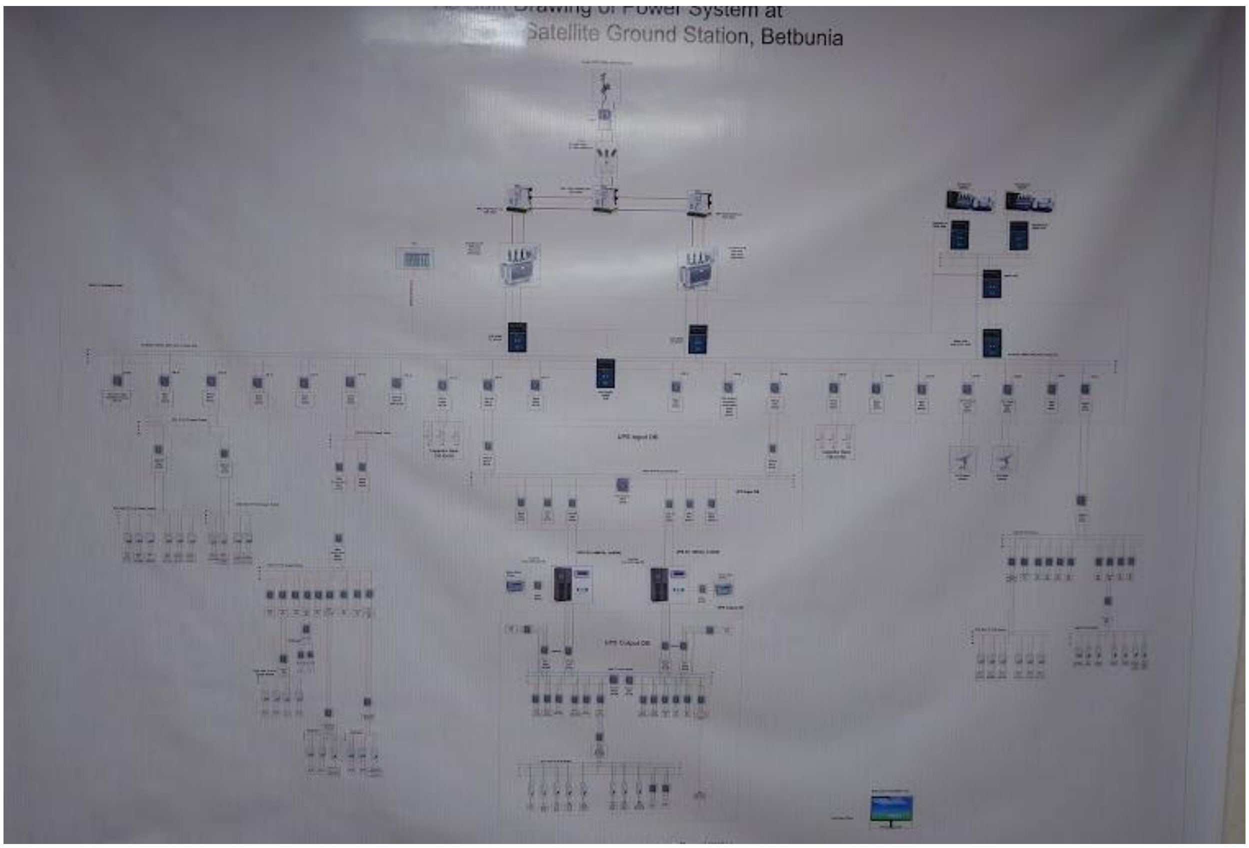

Figure 12: Power System Design of Secondary Satellite Ground Station

7. Application of Bangladesh Satellite-1 (BS-1)

7.1 Video Broadcasting & Distribution:

- C-band service of multiplexed digital television, radio and associated data services to medium-sized antennas anywhere in the Satellite’s footprint.

- The users of this service are likely to be broadcasters distributing their content services to intermediaries like cable TV network operators, or re-broadcasters like DTH Operators in other countries.

7.2 Direct to Home (DTH):

- Ku-band service consisting of multiplexed digital television, radio and associated data direct to very small antennas.
- Operators in the respective countries will package the content at their broadcast centre(s) and transmit them to the Bangladesh Ground Station or another earth station facility for uplink to the Satellite.

7.2.1 Broadcast service at-a-glance:

- **Teleport facility**
  - ✓ It's Provided 42 TV channels
  - ✓ It's Provided 02 Radio Channels.
  - ✓ It's Provided 01 DTH operator.
- **Two Modality**
  - ✓ MCPC (multiple Channel per carrier).
  - ✓ SCPC (Single Channel per carrier).

7.3 VSAT Private Networks:

- The Network shall support private networks consisting of voice, data, video and Internet services, to banks, corporate offices, etc. with medium-sized antennas.
- The service will be delivered using Ku-Band in the Bangladesh and the IndiaPlus coverage regions and also using C-Band beams.
- Typically, the customers will be Satellite Service Providers offering end-to-end services for the user groups.

7.3.1 VSAT service at-a-glance:

- **Island project**
  - ✓ Implemented in 2022.
  - ✓ 112 VSAT at 31 islands
  - ✓ Covered - Primary & High schools, Union health Center, Union Parishad, Police station, Forest office.
  - ✓ Operated using South Asia Satellite

- **RIC project**
  - ✓ On going.
  - ✓ Target – 115 ; Implemented – 70
  - ✓ Covered - Primary & High schools, Community Clinics, Union Parishad, Army camps
  - ✓ Operated using Bangladesh Satellite – 1

- **Disaster Recovery**

- ✓ During Flood at Sylhet region in June 2022, BSCL deployed VSAT at 45 sites to restore emergency communication among Govt. offices & Army camps to co-ordinate relief distribution
- ✓ During Cyclone MOCHA in May 2023, BSCL helped Army to restore 5 sites in Coxsbazar for emergency communication

7.4 ATM booth Network via Satellite

Satellite-based ATM networks enable secure, real-time financial transactions in remote and underserved areas where terrestrial internet/mobile networks are unreliable or unavailable.

8. Conclusion

The industrial attachment at BSCL was a worthwhile experience that provided enlightening exposure to satellite communication systems. The attachment allowed me to witness the operation of Bangladesh's first satellite, BS-1, and its significant role in the country's communication infrastructure. The attachment was a rewarding experience, bridging the gap between theory and practice.

A secondary satellite ground station acts as a crucial backup to maintain uninterrupted communication if the primary station fails. It ensures redundancy and reliability during outages caused by power failures or natural disasters, supports load balancing during peak operations, and plays a key role in disaster recovery for critical services like defense and broadcasting. It can also offer extended satellite coverage or serve backup frequencies. To be effective, it must have geographical separation from the primary site, support automated handover, and feature matching infrastructure—including antenna capacity, power backup, and security systems.

Day 2: Karnaphuli Hydropower Station, Kaptai, Rangamati.

1. Introduction

Industrial attachment plays a vital role in the education of undergraduate engineering students by linking academic knowledge with real-world experience. It allows students to gain practical skills, better understand industrial operations, and become familiar with professional work settings. Students enhance technical proficiency, develop professional communication, and forge valuable industry networks through such attachment. The experience bolsters résumés, fosters confidence, and prepares students for future careers by engaging them in operational systems and industry-standard practices.

Figure 13: Industrial Attachment at Karnaphuli Hydropower Station, 15th May 2025

I am delighted to share that I, along with my fellow trainees, completed a two-day industrial attachment at the Kaptai Hydropower Plant, situated on the Karnaphuli River in Kaptai, Rangamati, Bangladesh, on May 14-15, 2025. Organized by our academic department, this visit offered an immersive learning opportunity at Bangladesh's only hydroelectric facility, which generates approximately 5% of the nation's electricity with a 230 MW capacity. The plant, operational since 1962, features an earth-fill embankment dam that created Kaptai Lake, the largest artificial lake in Bangladesh.

During the attachment, we gained comprehensive insights into the plant's operations, including the functionality of its five turbine-generator units, spillway systems, penstocks, and control mechanisms. Technical personnel provided detailed explanations of maintenance schedules, load management strategies, and the rule curve-based water level regulation (mean 8.14 m), critical for optimizing power output. We also learned about the plant's environmental and social impacts, such as ecosystem changes and the displacement of Indigenous communities during the dam's construction in the late 1950s.

The hands-on experience included observing real-time monitoring of power generation, safety protocols, and data logging processes. Interactions with engineers and operators enriched our understanding of the plant's role under the Bangladesh Power Development Board (BPDB) and its challenges, such as reduced capacity utilization (13-26%) due to climatic factors. This attachment not only reinforced our academic knowledge but also highlighted the importance of sustainable engineering practices.

This report aims to encapsulate our observations, technical learnings, and professional insights from the Kaptai Hydropower Plant visit, detailing the operational framework, system components, and key takeaways that will shape our future engineering endeavors.

2. About Kaptai Hydropower Plant, Rangamati, Bangladesh

The Karnafuli Hydroelectric Power Station, owned by the Bangladesh Power Development Board (BPDB), is located in Kaptai, Rangamati. It is the only hydroelectric power plant in Bangladesh, consisting of 5 generating units with a rated capacity of 230 MW and a maximum capacity of 242 MW. The units are as follows:

Unit 01: 40 MW (Max 46 MW), commissioned in 1962

Unit 02: 40 MW (Max 46 MW), commissioned in 1962

Unit 03: 50 MW, commissioned in 1982

Unit 04: 50 MW, commissioned in 1988

Unit 05: 50 MW, commissioned in 1988

This plant plays a vital role in supplying renewable energy to the national grid and supports regional power stability in southeastern Bangladesh.

Figure 14: Kaptai Hydropower Plant, Karnaphuli River in Kaptai, Rangamati, Bangladesh

The dam’s construction significantly altered local ecosystems, submerged vast agricultural lands, and displaced Indigenous communities, particularly the Chakma people, prompting ongoing discussions about its social and environmental impacts.

3. Mission & Vision of Kaptai Hydropower Plant

3.1 Mission: To maximize the resources of the Karnaphuli River while maintaining operational effectiveness, environmental responsibility, and community welfare in order to produce clean, dependable, and sustainable hydroelectric power for Bangladesh. With a 230 MW capacity, the Kaptai Hydropower

Plant, owned by the Bangladesh Power Development Board (BPDB), will provide approximately 5% of the nation's power supply and provide affordable electricity to meet demand.

3.2 Vision: To serve as an example of sustainable Hydropower production in Bangladesh, boosting energy security and advancing the country's objective of universal access to electricity. The facility aims to modernize operations while striking a balance between social justice and ecological preservation in the Rangamati region. With the projected 50 MW units, capacity might increase to 330 MW.

4. Objectives of Kaptai Hydropower Plant

- Generate clean, sustainable hydroelectric power to meet ~5% of Bangladesh's electricity demand.
- Optimize water resource management using the rule curve (mean 8.14 m) for efficient power production.
- Ensure a reliable and cost-effective electricity supply under the Bangladesh Power Development Board (BPDB) oversight.
- Maintain and upgrade infrastructure, including turbines, spillways, and control systems, for operational efficiency.
- Minimize environmental impact while preserving Kaptai Lake's ecosystem.
- Support national energy security and sustainable development goals.
- Explore capacity expansion (e.g., proposed 50 MW units) to enhance output.
- Promote community welfare and address social impacts on displaced Indigenous populations.

5. Block Diagram

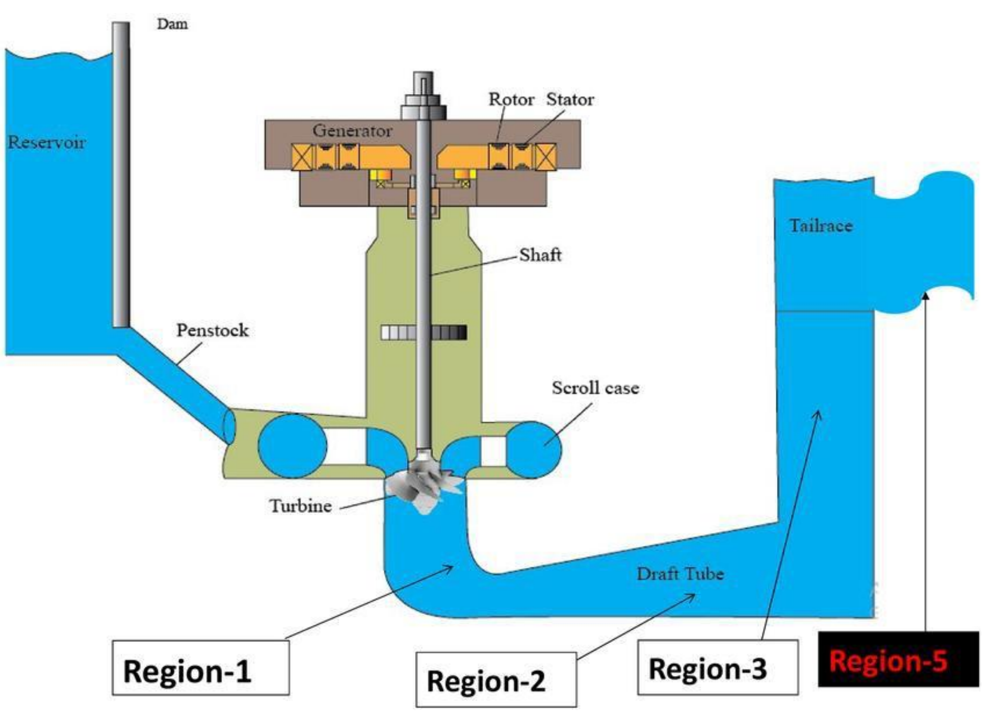

Figure 15: Block Diagram of Karnafuli Hydro Power Station

6. Main Dam:

Figure 16: Main Dam

The Kaptai Dam is an earthen embankment dam constructed on the Karnafuli River in Kaptai, Rangamati. It has a total length of 2,200 feet (670.6 meters) and a crest level of 118 feet (35.97 meters). The crest width is 25 feet (7.6 meters), while the base measures up to 1,500 feet wide and 150 feet high. The total volume of the dam is approximately 6,98,00,000 cubic feet (19,77,000 m^3).

7. Reservoir:

The Kaptai Dam creates Kaptai Lake, the largest artificial lake in Bangladesh. It has a catchment area of 4,250 square miles (11,000 km^2). At the full water level scale of 109 ft (33.23 m), the lake covers up to 300 square miles. The minimum water level is 66 ft (20.12 m). The reservoir has a total storage capacity of 52,51,000 acre-feet, supporting hydroelectric power generation and irrigation. The region receives an average annual rainfall of 98 inches, with maximum recorded rainfall of 110 inches in 1976 and minimum of 62 inches in 1972.

Figure 17: Kaptai Lake (Reservoir)

8. Generating Unit:

The Kaptai Hydroelectric Plant uses Francis Turbines. The plant has 5 turbine units with a total capacity of 230 MW, the largest unit generating 50 MW. Each turbine is connected to a synchronous generator that produces 3-phase AC electricity at 11 kV, which is then stepped up to 132 kV for transmission to the national power grid.

Figure 18: Three Generating Unit (Unit-1,2 & 3) and Generator Shaft

9. Electrical Control Panel:

This is an electrical control panel used in industrial settings, likely for managing power distribution or equipment operation. It features multiple sections with indicator lights (red and green) showing status (e.g., on/off), switches, and meters for monitoring voltage or current. Labels such as "Carbon Dust Collection Unit" and "Governor Oil Pump Unit" suggest it controls systems like dust collection and oil pumps, possibly in a power plant or manufacturing facility. The presence of safety warnings (e.g., "Bus Bar") indicates high-voltage hazards, requiring trained personnel for operation.

Figure 19: Electrical Control Panel

10. Transformer:

The transformer at the Karnafuli Hydropower Station plays a vital role in ensuring efficient power transmission. It steps up the generator output voltage from 11 kV to 132 kV for delivery to the national grid.

Figure 20: Transformer

This voltage conversion helps minimize energy loss during long-distance transmission. Additionally, the transformer provides electrical isolation and protection, shielding the generator from potential grid disturbances. The Karnafuli Hydropower Station is equipped with 9 single-phase transformers and 2 three-phase transformers to step up and supply electricity efficiently to the national grid. Additionally, the station

uses 3 single-phase transformers dedicated to drawing electricity for alternator excitation, which is essential for maintaining the magnetic field in the generators.

11. National Grid:

The Karnafuli Hydropower Station supplies electricity to the national grid through a structured process. Its 11 kV generator output is first stepped up to 132 kV using transformers for efficient long-distance transmission. Before connection, the power is synchronized with the grid's 50 Hz frequency and phase angle. The Power Grid Company of Bangladesh (PGCB) manages the dispatch to ensure a balance between supply and demand. Karnafuli plays a vital role by providing baseload and peak support, offering stable and flexible power, and balancing renewable sources like solar and wind by adjusting output as needed.

Figure 21: National Grid

Spillway

Figure 22: Spillway gate control using electric Motor

The spillway of the Kaptai Dam is a controlled type, designed to manage excess water from the reservoir. It has a length of 745 feet (227.13 m) with a crest elevation of 71.25 ft MSL (21.73 m). The spillway features 16 gates, supported by 15 piers each 7 feet wide. Each gate measures 40 ft × 37.75 ft and weighs 75 tons. The system has a maximum discharge capacity of 5,70,000 cubic feet per second (16,000 m^3/s), with a flow velocity of 9 ft/min. Gates can be lifted up to 37 ft, with a raising speed of 1.5 ft/min and a lowering speed of 2.0 ft/min, ensuring precise control during flood events or reservoir management.

12. Conclusion

The Karnaphuli Hydropower Plant is essential for Bangladesh to manage its water and energy resources. It lowers CO_2 emissions and the use of fossil fuels by generating 230 MW of clean electricity. In addition to protecting against flooding and supplying Chittagong with drinking water, the dam boosts local businesses through fishing, farming, tourism, and transportation on Kaptai Lake. Environmental effects, habitat loss, displacement, and power instability brought on by climate change are some of its difficulties, though. It could become a paradigm for integrated water-resource projects in Bangladesh if modernization and silt management are improved in the future.