**SANIMA MIDDLE TAMOR HYDROPOWER LIMITED**
Shankha Park, Dhumbarahi, Kathmandu, Nepal

# MIDDLE TAMOR HYDROPOWER PROJECT
# (73 MW)

# CONSTRUCTION COMPLETION REPORT

**(April 2023)**

Sanima Hydro and Engineering (P.) Ltd.
Shank Park, Dhumbarahi, G.P.O. Box. 19737 Kathmandu
Phone No.: +977 1 4372828 / 4373030, Fax: +977 1 4015799
Email: engineering@sanimahydro.com
Web: www.sanimaengineering.com

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| amsl | above mean sea level |
| BoQ | Bill of Quantities |
| COD | Commercial Operation Date |
| CWTW | Chongqing Water and Turbine Work Co. Pvt. Ltd. |
| Dia, | Diameter |
| D/s | Downstream |
| DoED | Department of Electricity Development |
| EIA | Environmental Impact Assessment |
| Eli, | Elevation |
| EM | Electromechanical |
| FDC | Flow Duration Curve |
| FSR | Feasibility Study Report |
| GoN | Government of Nepal |
| GWh | Giga Watt hour |
| HEP | Hydroelectric Project |
| HM | Hydromechanical |
| HRT | Head Race Tunnel |
| HW | Head Works |
| IEE | Initial Environmental Examination |
| IPC | Interim Payment Certificate |
| INPS | Integrated Nepal Power System |
| km | Kilometers |
| kN | Kilo Newton |
| kV | Kilo Volt |
| m | Meter |
| MOEWRI | Ministry of Energy, Water Resources and Irrigation |
| MW | Mega Watt |
| MWh | Mega Watt hour |
| NEA | Nepal Electricity Authority |
| NPR | Nepalese Rupees |
| PH | Powerhouse |
| PPA | Power Purchase Agreement |
| RCC | Reinforced Cement Concrete |
| RCOD | Required Commercial Operation Date |
| RoR | Run of River |
| Rpm | Revolution per minute |
| S.N. | Serial Number |
| SEIA | Supplementary Environmental Impact Assessment |
| SHEPL | Sanima Hydro and Engineering (P.) Ltd. |
| SMTHL | Sanima Middle Tamor Hydropower Ltd. |
| SPV | Special Purpose Vehicle |
| TL | Transmission Line |
| ToR | Terms of Reference |
| TSE | Tamor Sanima Energy Pvt. Ltd. |
| U/s | Upstream |
| USD | United States Dollars |
| VAT | Value Added Tax |

# 1 INTRODUCTION

## 1.1 BACKGROUND OF THE PROJECT

The Middle Tamor Hydropower Project (MTHP) is a run-of-river (RoR) project with an installed capacity of 73 MW. The headworks (HW) of the project are located in Phungling Municipality and Phaktanglung Rural Municipality, and the Powerhouse (PH) is situated in Mikwakhola Rural Municipality on the right bank of the Tamor River in the Taplejung district. The boundary coordinates of the project are 870 40' 01" E to 870 42' 40" E and 270 23' 29" N to 270 25' 19" N. The nearest black-topped approach road to the project site is at Bahanande, on the Mechi Highway (233 km from Charali in Jhapa), 7 km south of the district headquarters Phungling Bazar. From Phungling, the project Powerhouse (Thumba village) and Headworks (Mitlung village) sites are accessible via separate earthen roads, 15 km and 17 km long respectively.

Sanima Middle Tamor Hydropower Ltd. (SMTHL) was established as a Special Purpose Vehicle (SPV) Company to implement and operate the Middle Tamor Hydropower Project. The Generation License of the Project was initially obtained for 54 MW on June 5, 2017. Subsequently, the design was revised, and a generation license for the revised capacity of 73 MW was obtained on December 10, 2018.

During the construction phase, SMTHL oversaw the construction works of the Project through four major individual contract packages with various international and national contractors. The Main Civil, Hydro-Mechanical, Electro-Mechanical, and Transmission Line Contractors were involved in the construction process. Apart from these major contracts, pre-construction and preparatory works have been executed by SMTHL including the construction of access roads, upgrading existing roads, slope protection works, construction of bridges, land acquisition, and other necessary arrangements.

The construction of the Middle Tamor Hydropower Project (MTHP) 73 MW was completed on Chaitra 30, 2080 (April 12, 2024). The power evacuated from MTHP was successfully connected to the national grid of Nepal on this very date. Currently, the Nepal Electricity Authority (NEA) is carrying out the reliability run of the Project and the Commercial Operation Date (COD) shall be assigned after the completion of the reliability run. The nearest possible COD of the Project is scheduled for Baisakh 23, 2081 (May 05, 2024). The construction progress of the Project till its completion is detailed in this report. Currently, a few finishing and river training works are being carried out at the Project site.

## 1.2 TECHNICAL SPECIFICATION

The project's installed capacity is 73 MW, with a design discharge of 73.71 $m^3/s$, corresponding to 42.71% exceedance flow. The catchment area of the Project is 2,002 $km^2$, and the gross head is 132 m. The weir, 50 m long, has a crest level of 887 m above mean sea level (amsl). The maximum height of the weir crest from its original ground level is 10.5 m. It diverts the required flow to the Intake. The Intake has 6 openings to withdraw the design discharge. The flow from the Intake is conveyed to the gravel trap and then to the underground settling basin via a concrete-cased approach pipe of 281.52 m length. The three-chambered 100 m long underground settling basin, designed with 90% trap efficiency, passes the clean water into the headrace tunnel.

The headrace tunnel, approximately 3,367 m long and lined with concrete and shotcrete, carries the design discharge to the penstock. The proposed penstock starts with a diameter of 4.5 m until a branching length of about 264.66 m. After that, four penstock pipes with internal diameters ranging from 2.25 m to 4.5 m supply water to the powerhouse. The Powerhouse, measuring 56.5 m in length and 26 m in width, has a tailwater level of 755 m amsl. Four units of vertical axis Francis turbines, each with a capacity of 18.25 MW, are set to generate the designed output of 73 MW. After power generation, the tailwater is discharged back to the Tamor River through a 75 m-long tailrace culvert. The generated electricity is supplied through an approximately 9 km long 220 kV double circuit transmission line to the Dhunge Sanghu substation of the Koshi Corridor, which is being constructed by the Nepal Electricity Authority (NEA). The estimated annual energy generation as per the PPA is 429.409 GWh.

The general layout of the project is depicted in Figure 1.

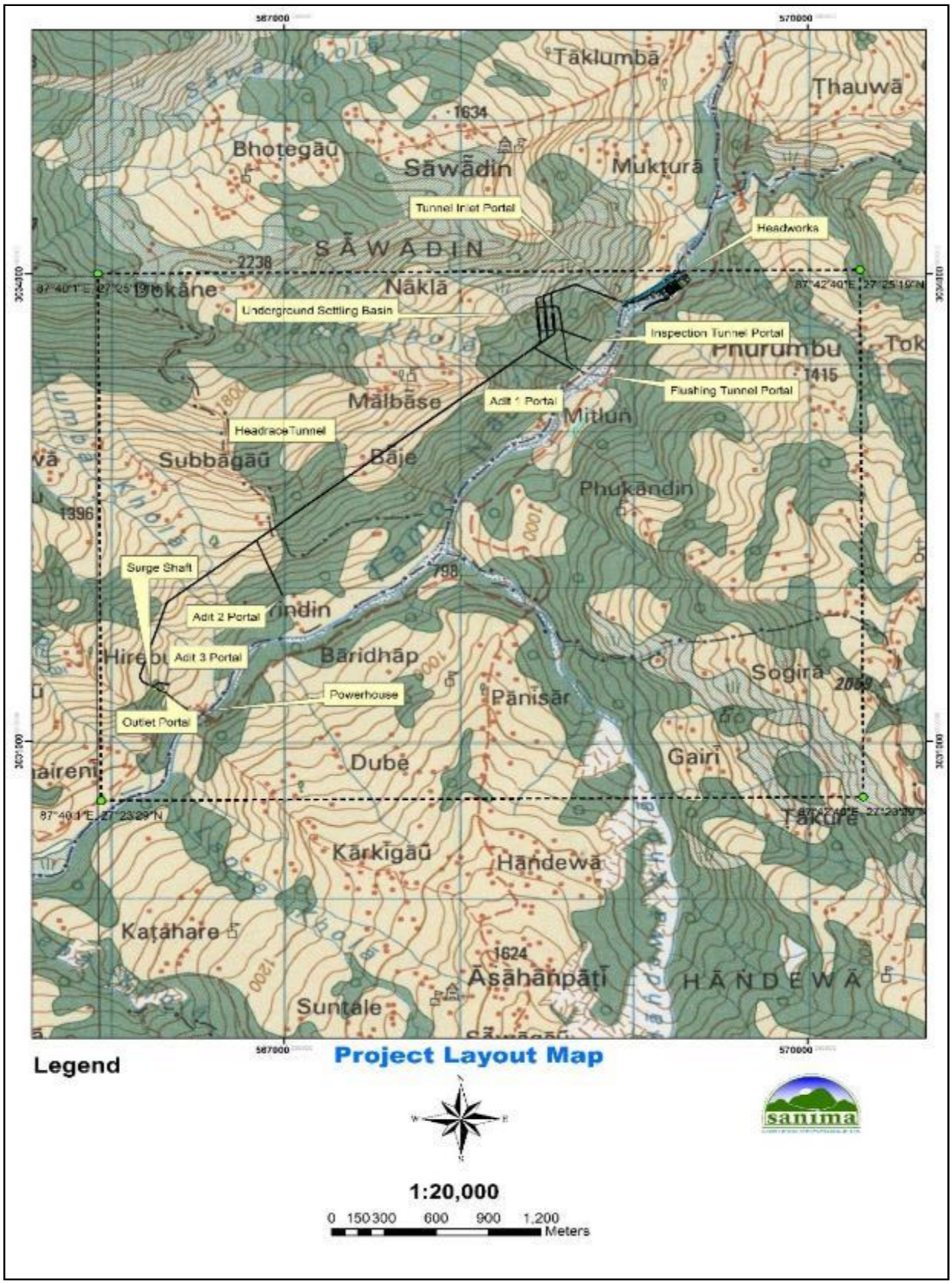


*Figure 1: General layout of the Project Structures*

## 1.3 PROJECT KEY INFORMATION

*Table 1: Project Key Information*

| **Project Key Data** | | | |
|---|---|---|---|
| Project Name | **Middle Tamor Hydropower Project** | | |
| Project Company Name | **Sanima Middle Tamor Hydropower Limited** | | |
| Installed Capacity | **73 MW** | Annual generation | **429.409 GWh** |
| Location | Taplejung, Nepal | Main Civil Contract Award | 12 April 2018 |
| Date of Generation license | 5 June 2017/10 Dec 2018 | Date of PPA signing | 10 Jan 2017/30 Nov 2018 |
| Revised Project Cost (estimated total) | NPR 13,330 Million | Total equity required (estimated) | NPR 3,332.5 Million |
| Total debt required (estimated) | NPR 9,997.5 Million | Commercial Operation Date | Amended to 05 May 2024 (Baisakh 23, 2081) |
| Lenders | NIBL – Lead, Nabil (Co-lead), Global IME (Co-lead), NMB, NCC, Laxmi, Nepal SBI, ADBL Banks | Consultant | Sanima Hydro and Engineering Pvt. Ltd. (SHE) |
| Main Civil Contractor | Zhejiang First Hydro and Power Construction Group Co. Pvt. Ltd., Zhejiang, China | Hydro-Mechanical Contractor | Machhapuchhre Metal and Machinery Works Pvt. Ltd., Pokhara, Nepal |
| Electro-Mechanical Contractor | Chongqing Water and Turbine Work Co. Pvt. Ltd. (CWTW), Chongqing, China | Transmission Line Contractor | Cosmic Electrical Engineering Associates Pvt. Ltd., Kathmandu, Nepal |
| Project Input(s) (Resources, Feedstock) | The Project has a design discharge of 73.71$m^3$/s with an installed generating capacity of 73 MW. | | |
| Project Output(s) | 429.409 GWh per year will be supplied to the Nepal electricity network, as per the Power Purchase Agreement (PPA) with the Nepal Electricity Authority (NEA) | | |

## 1.4 SALIENT FEATURES OF THE PROJECT

*Table 2: Detailed Salient Features of the Project as per Generation License*

| | |
|---|---|
| **Location:** | Phungling Municipality, Phaktanglung Rural Municipality, and Mikwa Khola Rural Municipality, Taplejung District, Koshi Province of Nepal |
| Purpose of Project: | To supply renewable energy for domestic use by connecting to the national grid |
| | |
| **Hydrology:** | |
| Catchment Area | 2,002.32 $km^2$ |
| Average Flow | 126.69 $m^3/s$ (minimum monthly flow 19.55 $m^3/s$) |
| Design Flow | 73.71 $m^3/s$ (42.71% exceedance flow) |
| 90% Exceedance flow | 17.98 $m^3/s$ |
| Design Flood ($Q_{100}$) | 2,791 $m^3/s$ |
| | |
| **Diversion Dam:** | |
| Type | Concrete gravity dam |
| Slope | Ogee-profile |
| Crest Elevation | 887 m above MSL |
| Max. Flood Level (100 years return) | 895.4 m above MSL |
| Crest Length | 50 m |
| Maximum height | 10.5 m (from the Original ground level) |
| | |
| **Spillway/Undersluice:** | |
| Type | Submerged with overflow spillway (2@ 5 m x 5 m) |
| Invert Elevation | 874.50 m above MSL |
| Size (B x H) | 5.0 m x 5.0 m |
| | |
| **Intake:** | |
| Type | Submerged |
| Number of Orifices | 6 |
| Sill Elevation of Orifice | 881 m above MSL |
| Top Elevation of Orifice | 885 m above MSL |
| Size (B x H ) | 4.75 m x 4.0 m (each) |
| | |
| **Gravel Trap:** | |
| Type | Rectangular, RCC (Continuous) |
| Particle size to be settled | 5 mm-100 mm |
| Number of Chambers | 3 |
| Width (each) | 12.00 m |
| Height | 11.85 m |
| Length | 15.00 m |
| | |
| **Approach Pipe** | |
| Type | Concrete-encased steel pipe |
| Number | 1 |
| Diameter | 4.5 m |

| | |
|---|---|
| Total Length (Up to Inlet Portal) | 281.52 m and 20 m inside the tunnel including Bell-mouth |
| Longitudinal slope | 1:1000 (V: H) |
| | |
| **Underground Settling Basin:** | |
| Type | Conventional flushing |
| Number of bay | 3 |
| Approach Tunnel length | 360.244 m (average) |
| Transition length | 35 m |
| Dimension ( L x B ) | 100 m x 13 m (each) |
| Particle Trap efficiency | 90% (*for sediment particles equal to or larger than 0.2 mm*) |
| Longitudinal slope | 1:50 |
| Length from transition up to outlet gate | 22.75 m |
| Length from gate to vertical drop | 30.26 m |
| Converging tunnel length from drop to main tunnel (Average of three) | 109.622 m |
| | |
| **Inspection Tunnel:** | |
| | Inspection Tunnel (common stretch): |
| Length | 131.758 m |
| Excavation Diameter | 4.9 m |
| | Inspection Tunnel 1 (to SB inlet): |
| Length | 145.963 m (excluding common stretch) |
| Excavation Diameter | 4.9 m |
| | Inspection Tunnel 2 (to SB outlet): |
| Length | 289.524 m (excluding common stretch) |
| Excavation Diameter | 4.9 m |
| | |
| **Adit-1 (near Nakla Kholsi):** | |
| Length | 301.562 m |
| Excavation Diameter | 4.9 m |
| | |
| **Sediment flushing tunnel:** | |
| Number | 6 |
| Length from inlet to common tunnel | 28.72 m (each) |
| Size(B X H) | 2.4 m x 2.4 m |
| Length of the common tunnel up to the portal | 327.89 m |
| The slope of the tunnel | 1:50 |
| Size (B x H) | 2.4 m x 2.9 m |
| Length of culvert from portal to outlet | 52.778 m |
| The slope of the culvert | 1:50 |
| Size of the culvert (B X H) | 2 m x 2.5 m |
| Total Sediment flushing length | 409.388 m |
| | |
| **Headrace Tunnel:** | |
| Length (Excluding settling basin) | 3,367 m (up to outlet portal) |
| Dimensions | Inverted U shape 6.5 m (Excavation Diameter) |

| | |
|---|---|
| Support System | Concrete lining and shotcrete |
| | |
| **Surge Shaft:** | |
| Type | Vertical, Underground circular section/ dome type |
| Height | 79.93 m |
| Diameter | 16.00 m (Excavation) |
| | |
| **Ventilation tunnel for Surge shaft:** | |
| Length | 199.75 m |
| Size(B X H) | 3.5 m X 3.75 m |
| Slope | 1 in 8.69 |
| | |
| **Penstock:** | |
| Length | 264.66 m inclined length of 4.50 m diameter including Bell-mouth up to branching |
| | After branching, |
| | 11.54 m of 4.5 m diameter including transition |
| | 11.25 m of 3.9 m diameter including transition |
| | 11.47 m of 3.18 m diameter including transition |
| | 153.12m of 2.25 m diameter including transition |
| | 452.04 (Total Length) |
| Thickness | 18 mm to 36 mm thickness |
| Grade | E-350 (IS 2062 or Equivalent) |
| | |
| **Power Facilities:** | |
| Powerhouse Type | Semi-surface |
| Dimensions ( L x B ) | 56.5 m x 26 m |
| Gross Head | 132 m (887.0 m – 755.0 m above MSL) |
| Net Head | 115.59 m |
| Installed capacity | 73 MW (4 x 18.25 MW) |
| Dry energy | 64.90 GWh |
| Wet energy | 364.27 GWh |
| Annual Net Energy Output | 429.409 GWh |
| | |
| **Tailrace Culvert:** | |
| Type | RCC, rectangular culvert (double-chambered) |
| Length | 75.00 m |
| Height | 5.00 m |
| Width | 4.75 m each |
| Longitudinal slope | 1:500 (V: H) |
| Maximum Tail water level | 755.00 m amsl |
| | |
| **Transmission Facilities:** | |
| Transmission line length | 9 km |
| Voltage level | 220 kV, Double circuit |

## 1.5 PROJECT KEY DATES

The key dates for the project details are listed in the table below:

Survey License to SHEPL: 2nd Falgun 2064 (14 Feb 2008)

EIA approval: 10th Baisakh 2070 (23 Apr 2013)

| | |
|---|---|
| SEIA approval for 73MW | : 6th Kartik 2075 (23 Oct 2018) |
| Grid Connection Agreement | : 25thFalgun 2071 (09 Mar 2015) |
| Generation license received | : 22nd Jestha 2074 (05 Jun 2017) |
| Power Purchase Agreement for 54 MW (PPA) | : 26th Poush 2073 (10 Jan 2017) |
| Power Purchase Agreement (PPA) for additional 20.9 MW | : 14th Mangsir 2075 (30 Nov 2018) |
| Generation License received for 73 MW | : 24th Mangsir 2075 (10 Dec 2018) |
| Financial Closure | : 27th Magh 2075 (10 Feb 2019) |
| Main Civil Contract | : 29th Chaitra 2074 (12 Apr 2018) |
| Hydro-mechanical Contract | : 26th Ashad 2076 (11 July 2019) |
| ToR Approval for 220 kV TL Project | : 1st Bhadra, 2076 (18 Aug 2019) |
| Electro-mechanical Contract | : 7th Poush 2076 (23 Dec 2019) |
| Transmission Line Contract | : 25th Jestha, 2076 (07 June 2020) |
| IEE Approval for 220 kV TL Project | : 29th Aashad 2078 (13 July 2021) |
| Construction License received for 220 kV TL | : 19 Ashoj 2078 (05 October 2021) |
| Required Commercial Operation Date | : 26 Bhadra 2080 (11 September 2023) |
| Revised Required Commercial Operation Date | **:** 15 Falgun 2080 (27 February 2024) |
| Commercial Operation Date (COD) | : Proposed on 23 Baisakh 2081 (05 May 2024) |

## 1.6 MAJOR CONTRACT PACKAGES

Five different contract packages were prepared for the Project's implementation. Among them, Package I was awarded to Zhejiang First Hydro & Power Construction Group Co., Pvt. Ltd. of Hangzhou, Zhejiang, China, for Main Civil Works Construction on April 12, 2018. Package II was awarded to Machhapuchhre Metal and Machinery Works Pvt. Ltd. for Hydro-mechanical and Penstock on July 11, 2019. Package III was awarded to Chongqing Water and Turbine Work Co. Pvt. Ltd., China, on December 23, 2019. Package IV was awarded to Cosmic Electrical Engineering Associates Pvt. Ltd., Nepal, on June 7, 2020. Lastly, Package V was awarded to Bavari Construction Pvt. Ltd. for preconstruction and preparatory works. The construction works assigned for each of these Contract packages have already been completed and are in the final stage of handover to the Employer.

# 2 PROGRESS UPDATE

The Engineer, Sanima Hydro and Engineering Private Limited (SHEPL) oversaw the construction progress across Main Civil Works, Hydro-Mechanical Works, Electro-Mechanical Works, And Transmission Line Works at the Project site. Further, the Engineer shall look after the operation and maintenance of the Project throughout its operation period. The construction progress achieved by the Project till its completion is described below.

## 2.1 PRE-CONSTRUCTION WORKS

### 2.1.1 ACCESS ROAD

A fully functional earthen access road, approximately 20 km in length, has been constructed from the Mechi Highway junction (located at Bahanande) leading to the construction site. The majority of the access road sections have been built by the Project, which also involved upgrading existing village roads. These enhancements included necessary filling using riverbed material, the construction of side drains, as well as the addition of gabion and masonry wall structures. The access road consists of two river crossings: one at the Powerhouse location and another at the Headworks location. Additionally, the road passes over a significant dry stream (Hangdewa Khola), which sometimes results in road blockages during heavy monsoon rainfall. Furthermore, a few other dry streams require regular maintenance during the monsoon flood period. An additional road route from Mitlung to Thumba, along with the installation of an additional Bailey bridge at Budidaha, is fully operational, with occasional maintenance efforts. This road serves as the major access route between the Headworks and the Powerhouse of the Project and will be utilized throughout the operation period. The management remains fully cautious and prepared for any potential disruptions that may occur on the access roads.


*Figure 2: Access Road Network at the site*

### 2.1.2 CAMP FACILITIES

The construction of camp facilities in both the Headworks area (Simle Camp) and the Powerhouse area (Lorindin Camp) has been completed, following the final phase plan. In Simle Camp, eight buildings have been constructed, and in Lorindin Camp, four buildings have been completed. Additionally, an Army Camp and Bunker at Sisne, situated near the Headworks, is operational, with regular maintenance and cleaning being carried out. However, no major maintenance work has been required thus far.

*Figure 3: Construction of new residential camp building at the powerhouse*

### 2.1.3 CONSTRUCTION POWERLINE

Nepal Electricity Authority (NEA) Substation (S/S) located at Phungling (Hiti) in Taplejung, which is connected to the national grid, has been the primary power source supplying the necessary energy for the Project's construction. This power is delivered via a dedicated line originating from the nearby Hiti S/S, making it the most convenient source for the Project area.

The power requirements for the Project's construction, taking into account the load demands at the headworks, Adit-1, and the powerhouse, have been estimated at approximately 1.7 MVA. To transmit this power, a 17 km long 33 kV construction power line (currently operating at 11 kV) has been constructed, extending from the Hiti substation to both the powerhouse area and the headworks area. This construction power line has been operational since Mangsir 13, 2075, and was maintained with minor interventions as needed. Currently, the Project is utilizing self-generated electricity as per the requirement.

## 2.2 MAIN CIVIL WORKS

The Contract for the Main Civil Works was awarded to Zhejiang First Hydro and Power Construction Group Co. Ltd., China (referred to as 1st Hydro), on April 12, 2018. The construction of the main civil works commenced in March 2019, following the acquisition of the generation license and the successful financial closure achieved in February 2019.

The Main Civil Contractor completed all the construction works of the headworks and underground work fronts in February 2024, and the Powerhouse region by the first week of March 2024. The wet testing of these work fronts was carried out independently as per the testing manual recommended by the Engineer, SHEPL. The construction works for each front were approved by the Employer after successful wet testing of the structure as per the specifications outlined in the Main Civil Works Contract and to the satisfaction of the Engineer.

At present, the Main Civil Contractor is carrying out the finishing works at the Powerhouse and Valve house region along with the final installation of guard rails and safety railings. Additional river training works are also being carried out on each riverside to protect the structures from potential monsoon floods. The Main Civil Contractor shall remain at the construction site for the Defect Notification period (12 months from the handover of the Project from the Contractor to the Employer) before their demobilization.

The construction progress achieved to date in each of the structures is detailed in the subsequent headings.

### 2.2.1 HEADWORKS

The Main Civil Contractor carried out concreting works at the headworks fronts through several Nepali sub-contractors. The construction of the weir, stilling basin, and the downstream floodwall has been completed in June 2023. Additionally, the construction of the undersluice and the intake, two of the most crucial hydraulic structures of the project, were completed in February 2023, along with the construction of a fish ladder.

Furthermore, the completion of construction of the Intake canal was achieved in March 2023 with the gravel trap being completed in July 2023. In addition, the construction of the upstream (u/s) floodwall has also been completed. Most notably, the first water filling test at the upstream section of the weir was carried out successfully on August 01, 2023, and the excess water was allowed through the weir crest. Through this test, the structural stability of the weir, undersluice, intake, and upstream right floodwall was verified during the high flood of monsoon.

Additionally, the construction of the conveyance tank was completed as of November 2024. The concreting works of the approach pipe, which was the last remaining structure of the headworks, were also completed by the first week of February. The concreting works of this structure were carried out after the completion of all concrete works of the approach tunnels and settling basins. The wet testing of the headworks structures was officially commenced on February 14, 2024, in the joint presence of members from the Employer, Engineer, Main Civil Contractor, and Hydro-mechanical Contractor. The water was passed through an intake canal, and gravel trap and flushed back to the river via gravel gravel-flushing culvert. The subsequent water filling tests are described in each sub-heading.

Moreover, the construction of the headworks control building was also completed by mid-February and handed over to the EM Contractor for the installation of EM equipment.

A detailed breakdown of the construction work areas is provided below.

*Figure 4: Aerial view of Headworks from the downstream during wet testing (February 2024)*

#### 2.2.1.1 INTAKE AND GRAVEL TRAP

The construction of the intake structure as well as the gravel trap has been completed as of July 2023, with approximately 8,178 $m^3$ of concrete poured in the intake region and approximately 4,808.93 $m^3$ of concrete poured in the gravel trap. The construction of the intake canal was successfully finalized in March 2023, with the pouring of approximately 2,704.64 $m^3$ of concrete within the intake canal region. The water filling test was conducted in these structures on February 14, 2024, up to the sill elevation of the gravel trap. The water was flushed back to the river via gravel flushing culvert and downstream stilling basin of the undersluice.

The water filling test was again carried out on February 26, 2024, when the water was flushed and allowed to pass through the approach tunnels, settling basins bay, and flushed back to the river via. flushing tunnel and flushing culvert. A third test was conducted where the water filling was conducted up to the weir crest i.e. 887.00 amsl, allowing the gravel trap, intake canal, and conveyance tank to be filled. The settling basin intake gates were shut down and the approach tunnels were allowed to be completely pressurized. The water was kept for 24 hours to monitor the potential leakages and then flushed through the flushing tunnel.

#### 2.2.1.2 WEIR AND STILLING BASIN

The construction of the stilling basin was completed in May 2022, and the completion of main body of the weir, in June 2022. Particularly, a considerable volume of concrete was poured into these structures: approximately 17,342 $m^3$ for the weir, 10,848 $m^3$ for the stilling basin, and 2,096 $m^3$ for the upstream slab and cutoff. In total, a significant 30,086 $m^3$ of concrete was used for the construction of the weir and stilling basin section.

The curtain grouting works at the upstream slab of the weir and undersluice bed have already been completed. Additionally, a small portion of the left bank floodwall, situated over the crest of the weir, has also been completed by February 1$^{st}$ week. With the plugging of the weir openings being completed, the water filling test of the headworks region was successfully conducted on August 01, 2023, by shutting down all six intake gates and both the radial gates of the undersluice.

After the official commencement of the west testing of the Project, the water filling test upstream of the weir has been carried out several times. The radial gates of the undersluice were shut down, and the intake gates were opened partially. At this time, the water level upstream gradually rose and eventually passed from the weir crest. The stage (gauge) was set at different locations of the weir upstream section to monitor the water level continuously. The flow over the weir crest and the water retention at the stilling basin were monitored along with the seepage from both sides of the river. The hydraulic and structural performance of the weir and stilling basin were observed satisfactory. The final river training works at the downstream right bank are being carried out.

#### 2.2.1.3 UNDERSLUICE

The construction of the undersluice has been completed as of February 2023, along with the construction of the fish ladder. Throughout the construction process, approximately 19,327 $m^3$ of concrete has been poured into the undersluice portion.

The undersluice structure was continuously monitored for potential settlement during the water-filling test. The structural resilience of the structure was monitored several times during the water filling test for over a month and was observed to be satisfactory. Further, the water seepage from the radial gates during closed conditions was monitored during the wet testing and was found to be within the tolerable limit. The overall performance of the undersluice region was found to be satisfactory as per the Contract's specification.

#### 2.2.1.4 CONVEYANCE TANK

The construction of the conveyance tank has been accomplished as of June 2023. Approximately 8,022 $m^3$ of concrete has been poured into the conveyance tank region. The water filling test of the conveyance tank was officially commenced on February 26, 2024, whereas the structure was filled up to the weir crest level on February 28. There were no significant leakages or settlements observed during 24 hours of water retention. The structure was found satisfactory to the Contract's specification.

### 2.2.1.5 APPROACH PIPE

The concrete works at the approach pipe section, situated outside the inlet portal have already been completed as of June 2023 up to the bend, whilst the construction of the approach pipe was completed by the 1st week of February 2024. The concrete encasing was carried out simultaneously with the laying of approach pipes by the HM Contractor. The final concreting works were carried out once all the concrete lining works of the settling basins and approach tunnels were completed. Throughout the length of 282 meters of the approach pipe, approximately 5,532 $m^3$ of concrete has been poured.

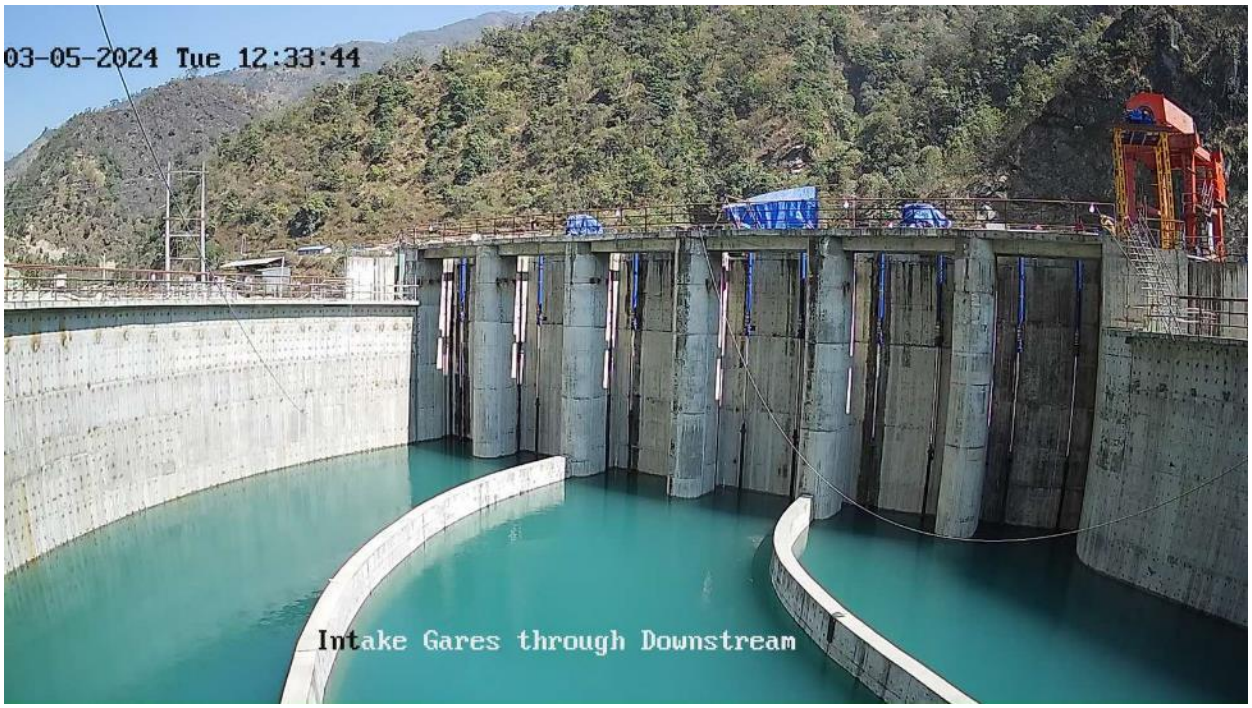


*Figure 5: A view of the gravel trap and intake canal from downstream during water-filling test*


*Figure 6: A view of the conveyance tank and gravel trap during the water filling test (February 2024)*


*Figure 7: A view of water flowing over the weir crest during testing (February 2024)*

*Figure 8: An aerial view of the headworks region during the wet test (February 2024)*

*Figure 9: An aerial top view of headwork during wet test*

*Figure 10: An aerial view of the Approach pipes*

### 2.2.2 UNDERGROUNDS WORKS

The tunnel excavation faced significant challenges due to the outbreak of COVID-19, which led to difficulty in the transportation of construction materials, a shortage of explosives, and the deployment of government security agencies. The departure of Chinese workers from Nepal due to the pandemic prompted the Main Civil Contractor to continue the excavation of the Headrace Tunnel (HRT) and surge shaft through Nepali sub-contractors while implementing strict health and safety measures. The excavation and rock support work at the settling basin sites were also carried out by a Nepali subcontractor to mitigate the impact of the evacuation of Chinese workers and the COVID-19 pandemic, although the resulting delay was inevitable.

Despite these challenging circumstances, the breakthrough of the Headrace Tunnel (HRT) was achieved on July 15, 2022. Additionally, the concrete lining works for the 80-meter-deep surge shaft was accomplished in July 2022 whereas the HRT lining was completed in November 2023. The shotcrete works of the HRT were completed in December 2023 along with the concrete lining works for the flushing tunnel network. Further, the full concrete lining works for the Settling Basin bays, approach pipes, and Settling Basin outlet platform were completed in December 2023.

Presently, a few manpower and resources are working on the finishing works of the adit tunnel and inspection tunnel. These outer tunnels remain as the access/inspection tunnel to the main waterways and have no significant impact on the water flow. The vertical sections of the underground works i.e. inlet and outlet gate shafts and flushing gate shafts were completed in the second week of February 2024. The details of construction progress at each front are mentioned in this report.

Regardless of the disruptions caused by the pandemic and occasional rock-over breaks in the caverns, leading to extensive and time-consuming repair and maintenance, the overall construction works of the underground fronts were completed by the second week of February 2024. The water filling test of the settling basin bay was successfully conducted on March 01, 2024. Further, the water filling of the HRT commenced on March 07, 2024, and was accomplished on March 15, 2024. Till the completion of the Project, approximately 6,626 meters of underground network was excavated.

**APPROACH/INLET PORTAL**

The excavation of the approach tunnel (247.055 m) was completed in January 2020. The final lining shotcrete and rock bolt installation have already been carried out in all three sections of Approach Tunnels.

**1. APPROACH TUNNEL 01/02/03**

The total length of Approach Tunnel 01 is 186.33 meters, which includes a 35-meter inlet transition zone 01. The excavation of Approach Tunnel 01 was completed on February 11, 2020, covering a distance of 151.26 meters. The length of approach tunnel 02 is 148.17 m including 35 m long inlet transition zone 02. The excavation of approach tunnel 02 has been completed on February 24, 2020. The length of approach tunnel 02 is 166.50 m including 35 m long inlet transition zone 02. The excavation of approach tunnel 03 has been completed on February 24, 2020.

To ensure structural stability, final support measures have already been implemented in all sections of the approach tunnels. This involved the installation of 50-75 mm thick shotcrete (sprayed concrete) and the placement of rock bolts. Additionally, the excavation of the inlet transition zone 01/02/03 was completed along with the concrete works. To provide the necessary structural integrity, a final layer of steel-reinforced shotcrete, 150 mm thick, has been applied along with 200-250 mm thick concrete lining at the invert and walls of the tunnel.

**2. SETTLING BASIN BAY 01/02/03**

The length of all three settling basin bays is 100 meters long, which includes a 35-meter-long inlet transition zone and a 15-meter-long outlet transition zone. The dimensions of the settling basin are 13.5 meters in width and 17.5 meters in height with a total excavation volume of approximately 29,669.13 $m^3$. The excavation of settling basin bay 01 was completed in February 2023. The excavation of settling basin bay 02 has been completed as of May 2023 and the excavation of settling basin bay 03 has already been completed as of November 2023. Most notably, the concrete lining works of all three settling basin bays were completed in December 2023 including inlet transition, main bay (hoppers, pier, and walls), and outlet transition zone.

*Figure 11: A view of SB 01 after the completion of concreting works (January 2024)*


*Figure 12: A view of Settling Basin 01 from the outlet platform during the water filling test (March 2024)*

*Figure 13: A view of SB 02 (February 2024)*


*Figure 14: A view of SB 02 during the water filling test (March 2024)*

*Figure 15: A view of SB 03 (February 2024)*


*Figure 16: A view of SB 03 during the water filling test (March 2024)*

The first water filling in the approach tunnel and settling basin was conducted on February 26, 2024, where the water was flushed through the settling basin flushing the tunnel back to the river. The second water filling test was conducted on March 01, 2024, when the water was filled in all three settling basin bays up to the outlet sill elevation i.e. 880.00 amsl. The water retention was conducted over 24 24-hour periods. Minor leakages were observed from the inlet portal region treated with the micro-fine cement grouting. The leakages were significantly reduced in the second water-filling test. After the successful water filling of the settling basin and the completion of bulkhead gate installation, the water filling test of HRT commenced on March 07, 2024.

## 3. CONNECTING TUNNELS FROM THE SETTLING BASIN TO HRT

*Figure 17: Full lining concrete at connecting tunnel junction*

Three connecting tunnels connect each settling basin bays at the outlet transition region to the head race tunnel. All three tunnels meet at the 0+000 chainage of the HRT at the junction point of the HRT with the Adit tunnel. The concreting works on this front have also been completed as of October 2023. With this, completion in one of the most challenging work fronts at the head race tunnel region has been achieved.

**Connecting tunnel-01**

The full concrete lining works at connecting tunnel 01 from the end of the outlet transition zone of SB-01 to the connecting tunnel junction point have been completed.

**Connecting tunnel-02**

The full concrete lining works at connecting tunnel 02 from the end of the outlet transition zone of SB-03 to the connecting tunnel junction point have been completed.

**Connecting tunnel-03**

The full concrete lining works at connecting tunnel 03 from the end of the outlet transition zone of SB-03 to the connecting tunnel junction point have been completed.

## 4. HEADRACE TUNNEL (HRT)

The headrace tunnel, which spans a length of 3,369 meters, features an excavation size of 6.5 meters by 6.5 meters. It serves as a connecting passage that links the Connecting tunnels with the penstock pipe at the outlet region.

A significant milestone was achieved with the breakthrough of the headrace tunnel on July 15, 2022, occurring at a chainage of 1+545.37 meters from the tunnel's starting point.

### 7.1 Excavation works

About 1,545.37 m was excavated from Adit-01 in the Headrace Tunnel section up to the breakthrough point whereas about 1,824.59 m was excavated from the outlet site.

| Total length (m) | Excavated from Adit 01 (m) | Excavated from Outlet (m) | Total Excavation (m) | Completion % |
|---|---|---|---|---|
| 3,370 | 1,545.37 | 1,824.59 | 3,370 | 100% |

### 4.2 Concreting works

The invert concreting works as well as wall concrete lining works up to the spring line at the Headrace Tunnel (HRT) were completed, covering the entire section, including the connecting tunnel to the Surge shaft and the connecting tunnels leading to each settling basin bay.

The full lining works for the HRT have been completed as of November 2023, throughout the HRT, marking significant progress in the HRT work front. In addition, the final shotcrete works have been completed throughout the length of the HRT as of December 2023. The final inspection and cleaning works of HRT have been completed along with the grouting works in February 2024.

Further, the construction of the bulkhead gate region (the junction of the adit tunnel and HRT) was completed on March 1st week. The completion of concrete works at the junction region and the installation of the bulkhead gate marked the overall completion of HRT.

After the successful water filling of the settling basin and the completion of bulkhead gate installation, the water filling test of HRT commenced on March 07, 2024. The HRT water filling test was completed within a week and was completed by March 15, 2024. During the water retention period at the HRT, there were no significant leakages observed. The water level was continuously monitored from the pressure gauge installed at the Penstock Protection Valve (PPV) region and the seepages were found under tolerable limits. However, there were no visible leakages seen in the nearby Kholsi and water outlets. The overall construction and hydraulic performance of the headrace tunnel were found to be satisfactory through the wet test.

*Table 3: HRT construction details*

| Particulars | Total length (m) | Length of concreting works (m) | Completion % |
|---|---|---|---|
| Invert concrete | 3,300.00 | 3,300.00 | 100% |
| Wall lining | 2,700.00 | 2,700.00 | 100% |
| Full lining | 625.00 | 625.00 | 100% |

*Figure 18: A section of HRT with concrete full lining from the outlet region*

*Figure 19: A completed section of concrete lining works at the rock trap*

## 5. SETTLING BASIN: INLET/OUTLET GATE SHAFT

The Settling Basin consists of 3 inlet gate shafts at the junction of each approach tunnel with respective settling basins and 3 outlet gate shafts at the junction of each connecting tunnel with the settling basins. The gate shafts open, on the top, at the invert of the inspection tunnel, and the bottom, towards the crown of transition sections of each settling basin. Each gate shaft consists of one gate for control of water at the settling basin along with a complete set of hoisting systems and control mechanisms.

The Main Civil Contractor completed the concrete lining works for SB 03 inlet gate shaft has already been completed in December 2023 whereas the concrete works for the inlet gates for SB 01, and SB 02 were completed in February 2024. The Hydro-mechanical Contractor commenced the gate installation and overall hoisting mechanism in these three inlet gate shafts and completed the gate installation in March 2024.

The construction of outlet gate shafts, which are relatively short in length, was completed in February 2024. The gates installation at these outlet gates regions was also completed in March 2024.

*Table 4: Details of excavation and concreting at inlet/outlet gate shafts of settling basin*

| S.N | Particulars | Excavation | | | Concrete works | | |
|---|---|---|---|---|---|---|---|
| | | Total depth (m) | Completed (m) | Completed (%) | Total depth (m) | Completed (m) | Completed (%) |
| 1 | SB Inlet Gate 01 | 15.8 | 15.8 | 100% | 26.8 | 26.8 | 100% |
| 2 | SB Inlet Gate 02 | 15.8 | 15.8 | 100% | 26.8 | 26.8 | 100% |
| 3 | SB Inlet Gate 03 | 15.8 | 15.8 | 100% | 26.8 | 26.8 | 100% |
| 4 | SB Outlet Gate 01 | 3.5 | 3.5 | 100% | 3.5 | 3.5 | 100% |
| 5 | SB Outlet Gate 02 | 3.5 | 3.5 | 100% | 3.5 | 3.5 | 100% |
| 6 | SB Outlet Gate 03 | 3.5 | 3.5 | 100% | 3.5 | 3.5 | 100% |
| | **Total** | **57.9** | **57.9** | **100%** | **90.9** | **90.9** | **100%** |

*Figure 20: A view of settling basin inlet gate 03 (view from settling basin) (February 2024)*

## 6. SEDIMENT FLUSHING TUNNEL

The excavation of 475 meters 475-meter-long sediment flushing tunnel has already been completed as of February 2023. The concrete lining works at the main flushing tunnel section along with its branches have been completed as of December 2023. The full concreting works were completed throughout the flushing tunnel network in December 2023 along with the full concrete lining works throughout the entire flushing tunnel network. The flushing tunnel was tested on February 26 when the water through the settling basin was flushing through the flushing tunnel back to the river. There were no leakage or seepages seen during the overall testing period. The overall hydraulic performance of the flushing tunnel and flushing culvert was found satisfactory.

*Figure 21: A view of the full concrete lining at the flushing tunnel*

*Table 5: Details of concreting works at the flushing tunnel*

| S. N | Particulars | Total (m) | Invert Lining | | Full Lining | |
|---|---|---|---|---|---|---|
| | | | Completed (m) | Remaining (m) | Completed (m) | Remaining (m) |
| 1 | Main flushing tunnel (2.4m x 2.9m) | 316.0 | 316.0 | 0.0 | 316.0 | 0.0 |
| 2 | Flushing branch 1 (2.4m x 2.4m) | 30.8 | 30.8 | 0.0 | 30.8 | 0.0 |
| 3 | Flushing branch 2 (2.4m x 2.4m) | 28.7 | 28.7 | 0.0 | 28.7 | 0.0 |
| 4 | Flushing branch 3 (2.4m x 2.4m) | 30.8 | 30.8 | 0.0 | 30.8 | 0.0 |
| 5 | Flushing branch 4 (2.4m x 2.4m) | 28.7 | 28.7 | 0.0 | 28.7 | 0.0 |
| 6 | Flushing branch 5 (2.4m x 2.4m) | 35.6 | 35.6 | 0.0 | 35.6 | 0.0 |
| | **Total** | **470.6** | **470.6** | **0.0** | **470.6** | **0.0** |
| | | | **100%** | | **100%** | |

## 7. FLUSHING GATE SHAFT

A large network of flushing tunnels and shafts works as a structure to divert the sediments trapped in each settling basin back to the river. Five flushing gate shafts which are each about 25 meters high open from the inspection tunnel to the flushing tunnel that lies below the settling basin level. Each gate shaft will consist of an operating and hoisting platform at the inspection tunnel and gates at the settling basin outlet region. During flushing, the gates will open and the sediments shall flush from the flushing tunnel network location below the settling basin level, all the way to the flushing culver which opens back to the river near the HRT adit portal region.

The successful breakthrough of all five flushing gate shafts was achieved and the concreting works in all 5 flushing tunnel shafts were completed in February 2024. Out of a total 122.2 meters stretch of 5 vertical gate shafts, the concreting works for the entire length have already been completed marking 100% construction completion in this front.

| S.N. | Particulars | Total depth (m) | Concrete works depth (m) | Remaining (m) | Completed (%) | Status |
|---|---|---|---|---|---|---|
| 1 | Flushing Shaft 01 'A' | 24.7 | 24.7 | 0.0 | 100% | Completed |
| 2 | Flushing Shaft 01 'B' | 25.2 | 25.2 | 0.0 | 100% | Completed |
| 3 | Flushing Shaft 02 'A' | 24.1 | 24.1 | 0.0 | 100% | Completed |
| 4 | Flushing Shaft 02 'B' | 24.5 | 24.5 | 0.0 | 100% | Completed |
| 5 | Flushing Shaft 03 | 23.7 | 23.7 | 0.0 | 100% | Completed |
| | **Total** | **122.2** | **122.2** | **0.0** | **100%** | |

*Figure 2-18: View of the flushing gate shaft from the top (February 2024)*

## 8. SURGE SHAFT

The Project consists of an almost 80-meter-high vertical tunnel with a design diameter of 16.4 meters. It is one of the most crucial hydraulic structures of the Project which required high skill and precision for the construction. The excavation of the shaft was completed as of June 2022 along with the application of temporary rock supports. Further, the concreting works for the shaft were finalized as of January 31, 2023, along its depth of approximately 80 meters. In addition, the full concrete lining works for the connecting tunnel that links the Headrace Tunnel (HRT) to the Surge shaft has also been completed as of July 2023.

## 9. VENTILATION TUNNEL

The excavation of a ventilation tunnel of 199.7 m has been completed in March 2020. The ventilation tunnel opens at the crown level of the surge shaft and is located about 80 meters above the HRT invert at the point. About 50-75 mm thick shotcrete and rock bolts have been installed in all sections of the ventilation tunnel as supports. The steel ribs have been installed as per site conditions. This tunnel is very crucial for the overall operation of the underground surge shaft and will act as an access tunnel to monitor the level of water at the Surge Shaft and future maintenance region. \

*Figure 22: A view of full lining concrete at the connecting tunnel of Surge Shaft (November 2023)*

### 2.2.3 POWERHOUSE AND PENSTOCK ALIGNMENT

The construction of the powerhouse, penstock, and tailrace region was completed in December 2024 whereas the construction of the Valve house was completed in March 2024. To carry out excavation and concreting works at the Powerhouse area, the Main Civil Contractor, 1st Hydro, employed Nepali workers through a Nepali sub-contractor company. In addition, the construction of the block, anchor block, switchyard region, and tailrace pond had been completed already. Currently, the Contractor is carrying out the final aesthetic works in the powerhouse region like interior painting, furnishing, and flooring works.

#### 2.2.3.1 PENSTOCK, ANCHOR BLOCKS AND SADDLE SUPPORT

The concreting works in the manifold region, including the necessary backfilling, were completed in September 2023 along with the penstock slope stabilization works using geo-synthetic composite on the inclined section of the penstock. The concrete works at the saddle support and the penstock foundation at this inclined section were completed along with the penstock installation works inside the HRT. Further, the construction of anchor block 01 (located at the outlet of HRT) was completed in December 2023.

In addition, the concreting works for the Penstock Protection valve (PPV) house located just outside of the HRT outlet, was completed in February. The PPV, one of the most crucial parts of the Project and one of the most challenging equipment to transport was delivered to the Project site in January 2024. The complete installation of the PPV at the valve house was completed in the first week of March.

Regarding the wet test, the water-filling test of HRT commenced on March 07 with the PPV at a shutdown position. Following that, the water was passed through the penstock via. PPV on March 16 and the performance of the PPV and other associated civil structures were found to be exceptional.

#### 2.2.3.2 POWERHOUSE AND CONTROL BAY

The construction of the main powerhouse building, as well as the ground floor of the auxiliary powerhouse building (control bay), was completed in December 2024. The main powerhouse building and the ground floor of the control building were prioritized first to allow the Electro-mechanical contractor to install their EM equipment.

A significant volume of concrete, approximately 11,495 $m^3$, has been poured in the powerhouse and control bay building, till the completion of the structure. Further, the truss erection works and roof installation on the first floor of the control building have also been completed. Currently, the Contractor is carrying out the flooring and finishing works at the powerhouse main building which includes, tiles installation, painting in the inner walls of the powerhouse, guard rails installation, poly-urethane (PU) flooring, and gabion retaining walls on the periphery of the powerhouse region.

#### 2.2.3.3 VALVE HOUSE

The valve house, which houses the penstock protection valve (PPV), is located just outside the HRT outlet portal. This structure is another crucial civil structure of the Project which consists of the PPV, along with an electric overhead traveling (EOT) crane of 100-ton capacity, control panels, etc. The construction of the valve house building was completed in January 2024. In addition to these, the hydraulic performance of PPV was also tested and found to be satisfactory.

#### 2.2.3.4 TAILRACE CHAMBER, TAILRACE FLOODWALL, AND TAILRACE CULVERT

The tailrace section of the project comprises the tailrace chamber, tailrace culvert, and tailrace floodwall. The construction of the tailrace floodwall was completed in February 2021, providing an important component for managing floodwater. The construction of the tailrace chamber and tailrace culvert has been completed as of November 2022. Approximately 3,374 $m^3$ of concrete has been poured in the tailrace section.

#### 2.2.3.5 SWITCHYARD

The Main Civil Works Contractor completed the civil works for the switchyard region along with the backfilling works, construction of retaining walls, and transformer foundation. In addition, the Electro-Mechanical Contractor completed all the erection and connection works of various electro-mechanical equipment and cables at the switchyard region. The installation of tower parts and other accessories of the switchyard was completed in December 2023. Further, the necessary drain and cable trench have already been constructed. The EM Contractor successfully carried out the dry test of all associated EM works on January 23, 2024, and the result was found to be satisfactory.

*Table 6: Progress of concreting at Powerhouse and tailrace culvert*

| Structure | Total concrete volume ($m^3$) | Completed Volume ($m^3$) | % Complete |
|---|---|---|---|
| Powerhouse and control bay | 11,552.61 | 11,552.61 | 100% |
| Tailrace chamber, culvert & floodwall | 3,374.37 | 3,374.37 | 100% |
| Penstock, anchor block and Manifold block | 9,776.56 | 9,776.56 | 100% |

The overall civil construction works of the headworks, underground fronts, and powerhouse region were completed on April 12, 2024. A few remaining finishing/furnishing works are being carried out by the Contractor along with additional river training works are also being done. The wet tests conducted in civil structures showed exceptional results. There were no significant leakages or seepages observed while a few minor leakages observed were found to be under tolerable limit as per the contractual specifications. The overall hydraulic performance of the civil structures was found to be satisfactory without any noticeable concern.

*Figure 23: Aerial view of switchyard region, powerhouse, AP-01 tower, and penstock alignment*


*Figure 24: An interior view of the Powerhouse main building*

*Figure 25: A view of the switchyard*

*Figure 26: A view of the valve house during the installation of PPV (February 2024)*

*Figure 27: Control bay during inauguration day (April 12, 2024)*

*Figure 28: An interior view of the Powerhouse showing all four generating units (March 2024)*

*Figure 29: A view of penstock and anchor block (March 2024)*

## 2.3 HYDRO-MECHANICAL WORKS

The Hydro-mechanical (HM) works contract was awarded to Machhapuchhre Metal and Machinery Works (P) Ltd, and these works commenced in August 2019, starting from the headworks of the construction area. The hydro-mechanical works including fabrication, installation, and testing of various HM components were carried out simultaneously with the civil construction works. The major work incorporated the fabrication, installation, and testing of pipe components and gate components. The major pipes included approach pipes, penstock pipes including 3 bifurcations, and 3 transition pipes. More than 50 gates needed to be manufactured and installed which included 2 radial gates, 6 intake gates, 6 settling basin inlet/outlet gates, 5/5 flushing gates and stop logs, 5/5 bed load sluice gates and stop logs, 2 tailrace gates, and the major bulkhead gate at the Adit junction along with their hoisting mechanism.

The testing of the radial gates was conducted during the first water-filling test of the headworks on August 01, 2024. The radial gates were completely shut, and the water level could rise and flow over the weir crest. The leakages from the radial gates were monitored and were found to be within tolerable limits.

The official testing of the gates commenced on February 14, 2024, when the intake gates, radial gates, trash passage gates, bed load sluice gates, and gravel flushing gates were tested simultaneously under various water levels. The tests of the settling basin inlet gates and flushing tunnel gates were carried out on February 26 and February 28. The overall performance of the gates was found to be satisfactory without any significant issues.

One of the most crucial aspects of the HM works, the bulkhead gate located at the adit tunnel junction, was installed in the last week of February. Once the final assembly and tests were carried out, the water filling of the HRT began on March 07, 2024. There were no leakages observed from the bulkhead gate region and the pressure release valve installed at various sections of the underground tunnel network performed satisfactorily.

The water was allowed to pass from the penstock region, after the required water retention test at HRT. On March 16, 2024, the water filling at the penstock was carried out via—the bypass valve of PPV. The water filling was conducted when all four Main Inlet Valves (MIV) were in closed condition. The water was retained at the penstock pipes for over 24 hours' period and the leakages were checked. There were no significant issues and the overall fabrication of the entire penstock pipes network was found satisfactory.

A summary of various works carried out by the HM contractor at the Middle Tamor Hydropower Project from the commencement till work completion is detailed in respective headings.

### 2.3.1 STEEL LINING

The steel lining works have been completed at all associated work fronts. The steel lining works were carried out at the sill region and pier region of the Intake, an upstream base slab of the undersluice throughout the slope, bed load sluice region, gravel flushing gate section, and flushing tunnel region. The overall work quality of the steel lining works is satisfactory and there have been no significant damages to the steel lining works despite the structure enduring over 3 years of flood.

### 2.3.2 HM WORKS AT GATES AND STOP LOGS

The erection of gates and stop log frames at the different locations of the settling basin (settling basin inlet gates, outlet gates, and flushing gates) have been completed simultaneously with the Civil Contractor work schedule. The required gates and associated hoisting mechanisms were installed before the wet testing. The overall performance of the gates and the hoisting mechanism in various work fronts were tested independently. There were no significant mechanical failures or leakages observed in any gates. The overall workmanship of the HM Contractor was thus verified to be satisfactory.

*Table 7: Detail of work progress of gates and stop logs*

| S.N. | Description | Nos. | Work status | | | | Remarks |
|---|---|---|---|---|---|---|---|
| | | | 1st Stage Embedded Parts | 2nd stage embedded parts | Main Body | | |
| | | | | | Fabrication | Erection | |
| | **Gates** | | | | | | |
| 1 | Undersluice Gates | 2 | All Complete | All Complete | All Complete | All Complete | No leakages No mechanical failure |
| 2 | Intake Gates | 6 | All Complete | All Complete | All Complete | All Complete | |
| 3 | Bedload sluice gates | 5 | All Complete | All Complete | All Complete | All Complete | |
| 4 | Fish Passage Gate | 1 | All Complete | All Complete | All Complete | All Complete | |
| 5 | Trash Passage Gate | 1 | All Complete | All Complete | All Complete | All Complete | |
| 6 | Gravel Flushing Gates | 3 | All Complete | All Complete | All Complete | All Complete | |
| 7 | Setting Basin Inlet gates | 3 | All Complete | All Complete | All Complete | All Complete | |
| 8 | Setting Basin Outlet gates | 3 | All Complete | All Complete | All Complete | All Complete | |
| 9 | Settling Basin Flushing Gates | 5 | All Complete | All Complete | All Complete | All Complete | |
| 10 | Adit Bulk Head Gates | 1 | All Complete | All Complete | All Complete | All Complete | |
| 11 | Draft Tube Gates | 2 | All Complete | All Complete | All Complete | All Complete | |
| 12 | Tail race gates | 2 | All Complete | All Complete | All Complete | All Complete | |
| | **Total no. of gates** | **34** | | | | | |
| | **Stop logs** | | | | | | |
| 1 | Undersluice Stop logs | 1 | All Complete | All Complete | All Complete | Ongoing | No leakages No mechanical failure |
| 2 | Bedload sluice Stop logs | 5 | All Complete | All Complete | All Complete | All Complete | |
| 3 | Trash Passage Stop logs | 1 | All Complete | All Complete | All Complete | All Complete | |
| 4 | Gravel Flushing Stop logs | 3 | All Complete | All Complete | All Complete | All Complete | |
| 5 | Settling Basin Flushing Stop logs | 5 | All Complete | All Complete | All Complete | All Complete | |
| 6 | Settling Basin Flushing Outlet Stoplogs | 1 | All Complete | All Complete | All Complete | All Complete | |
| | **Total no. of stop logs** | **16** | | | | | |
| | **Total number of gates and stop logs** | **50** | | | | | |

*Figure 30: A view of inlet gates before the water filling test (February 2024)*

*Figure 31: Hoisting powerpack to lift the radial gates at Undersluice*

*Figure 32: During the installation of the Inlet gate at SB 01 along with its hoisting mechanism (Feb 2024)*

*Figure 33: Mechanical hoisting (double screw spindle) system of flushing stop log*

*Figure 34: A view of undersluice during the closing procedure (March 2024)*

### 2.3.3 TRASH RACKS

*Table 8: Detail of work progress of trash rack*

| S.N. | Description | Work status | | Remarks |
|---|---|---|---|---|
| | | Embedded Parts | Main Body | |
| 1 | Intake Trash rack | All complete | All complete | |
| 2 | Bedload sluice Trash rack | All complete | All complete | |
| 3 | Conveyance Tank Trash rack | All complete | All complete | |
| 4 | Settling Basin outlet Trash rack | All complete | All complete | . |

*Figure 35:Erection of fine trash rack at Conveyance tank region*

### 2.3.4 STEEL PIPES AND OTHERS

**HEADRACE STRAIGHT PIPELINE**

Internal Diameter: 4.5 m
Thickness: 16 mm

*Table 9: Detail of work progress of Headrace Pipe*

| S.N. | Particulars | | Number of pipes | Length of each shell (m) | Total Length of section (m) | No. of pipes installed | Progress in meters | Progress % | Status |
|---|---|---|---|---|---|---|---|---|---|
| | Diameter (m) | Thickness (mm) | | | | | | | |
| 1 | 4.5 | 16 mm pipe | 88 | 2.5 | 220 | **88** | **220** | 100% | Outside Approach |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 4.5 | 16 mm pipe (Cut Piece-01) | 1 | 1.16 | 1.16 | **1** | **1.16** | 100% | Tunnel (All Complete) |
| 3 | 4.5 | 16 mm pipe (Cut Piece-02) | 1 | 1.2 | 1.2 | **1** | **1.2** | 100% | |
| 4 | 4.5 | 16 mm pipe | 11 | 2.5 | 27.5 | **11** | **27.5** | 0% | Inside Approach Tunnel |
| 5 | 4.5 | 16 mm pipe (Cut Piece-03) | 1 | 1.2 | 1.2 | **1** | **1.2** | 0% | Inside Approach Tunnel |
| | | Total | | | | | **251.06** | | |

Overall, the erection of 88 numbers of pipes along with the required cut pieces has been completed along with welding and testing works.

*Figure 36: Approach pipes encasing (March 2024)*

## HEADRACE BENDS

Internal Diameter: 4.5 m
Thickness: 16 mm

*Table 10: Detail of work progress of Headrace Bends*

| S.N. | Particulars | | Number of pipes | Length of each shell (m) | Total Length of section (m) | No. of pipes installed | Progress in meters | Progress % | Status |
|---|---|---|---|---|---|---|---|---|---|
| | Diameter (m) | Thickness (mm) | | | | | | | |
| 1 | 4.5 | 16 mm pipe (Bend-01) | 3 | | | **3** | | 100% | Outside Approach Tunnel (All Complete) |
| 2 | 4.5 | 16 mm pipe (Bend-02) | 3 | | | **3** | | 100% | |
| **3 | 4.5 | 16 mm pipe (Bend-03) | 9 | | | **9** | | 100% | All Complete |

*Figure 37: Installation of head race bend at the approach pipe section (December 2024)*

**PENSTOCK PIPES**

Internal Diameter: 4.5 m
Thickness: 16 mm to 36 mm

The Hydro-mechanical (HM) Contractor has made significant progress in the erection of penstock pipes with various thicknesses at the penstock alignment. Here's a breakdown of the completed pipe installations:

A. Manifold Section
- All associated pipes have been erected and encased with concrete (manifold block)

B. Penstock pipes in the inclined Section
- 36mm Thickness: 6 bend pipes (Completed)
- 32mm Thickness: 6 pipes (Completed)
- 30mm Thickness: 7 pipes (Completed)

- 28mm Thickness: 8 pipes (Completed)
- 25mm Thickness: 9 pipes plus one cut piece (Completed)
- 22mm Thickness: 6 pipes (Completed)
- 20mm Thickness: 11 pipes (Completed)
- 18mm Thickness: 4 pipes (Completed)
- 16mm Thickness: 6 pipes (Completed)

C. Penstock pipes inside HRT

- 16mm Thickness: 38 pipes plus 1 cut piece (Completed)
- 16mm Thickness bend: 2 pipes (Completed)

In total, the HM Contractor has successfully erected all penstock pipes covering a range of thicknesses from 36mm down to 16mm at the inclined section of the Penstock. The HM Contractor completed the installation of the transition pipe (bell mouth) at the HRT outlet region on August 24, 2023. The bell mouth acts as a transition of the waterway from an Inverted-D to a circular shape. The installation of penstock pipes located inside HRT was already completed in October 2023.

*Table 11: Detail of work progress of Penstock Pipes and other pipes at the penstock alignment*

| S.N. | Particulars | | Number of pipes | Length of each shell (m) | Total Length of section (m) | No. of pipes installed | Progress in meters | Progress % |
|---|---|---|---|---|---|---|---|---|
| | Diameter (m) | Thickness (mm) | | | | | | |
| **A** | **Penstock inside tunnel** | | | | | | | |
| 1 | 4.5 | 16 mm pipe | 38 | 2.5 | 95 | **38** | **95** | 100% |
| 2 | 4.5 | 16 mm pipe (Bend) | 2 | | | **2** | **0** | 100% |
| 3 | 4.5 | 16 mm pipe (Cut Piece) | 1 | 2.2 | 2.2 | **1** | **2.2** | 100% |
| **Sub-Total (A)** | | | **41** | | | | | |
| **B** | **Anchor block 01** | | | | | | | |
| 1 | 4.5 | 16 mm pipe (Bend) | 6 | | | **0** | | 0% |
| 2 | 4.5 | 18 mm pipe | 4 | 2.5 | 10 | **4** | **10** | 100% |
| 3 | 4.5 | 20 mm pipe | 11 | 2.5 | 27.5 | **11** | **27.5** | 100% |
| 4 | 4.5 | Expansion Joint (20 mm) | 1 | 1.7 | 1.7 | **1** | **1.7** | 100% |
| 5 | 4.5 | 22 mm pipe | 6 | 2.5 | 15 | **6** | **15** | 100% |
| 6 | 4.5 | Cutpiece | 1 | 1.25 | 1.25 | **1** | **1.25** | 100% |
| | | 25 mm pipe | 9 | 2.5 | 22.5 | **9** | **22.5** | 100% |
| 7 | 4.5 | 28 mm pipe | 8 | 2.5 | 20 | **8** | **20** | 100% |
| 8 | 4.5 | 30 mm pipe | 7 | 2.5 | 17.5 | **7** | **17.5** | 100% |
| 9 | 4.5 | 32 mm pipe | 6 | 2.5 | 15 | **6** | **15** | 100% |
| 10 | 4.5 | 36 mm pipe (Bend) | 6 | | | **6** | | 100% |
| **Sub-Total (B)** | | | **65** | | | | | |
| **Total** | | | **106** | | **227.65** | **106** | **227.65** | **100%** |

**REDUCERS**

Internal Diameter: 2.25 m to 2.00 m
Thickness: 20 mm
The erection of all 4 unit's reducers has been completed at the site along with the erection of the branch pipe.

**BRANCH PIPES**

Internal Diameter: 3.90 m to 2.25 m
Thickness: 20 mm to 32 mm

*Table 12: Detail of work progress of Branch Pipes*

| S.N. | Particulars | | Number of pipes | Length of each shell (m) | Total Length of section (m) | No. of pipes installed | Progress in meters | Progress % | Status |
|---|---|---|---|---|---|---|---|---|---|
| | Diameter (m) | Thickness (mm) | | | | | | | |
| 1 | 3.9 | 30 mm pipe | 1 | 2.5 | 2.5 | **1** | **2.5** | 100% | |
| | | 30 mm cut piece | 1 | 2.47 | 2.47 | **1** | **2.47** | 100% | |
| 2 | 3.18 | 25 mm pipe | 1 | 2.5 | 2.5 | **1** | **2.5** | 100% | |
| | | 25 mm cut piece | 1 | 1.76 | 1.76 | **1** | **1.76** | 100% | |
| 3 | 2.25 | 20 mm pipe | 16 | 2.5 | 40 | **16** | **40** | 100% | |
| 4 | 2.00 | 20 mm pipe | 22 | 2.5 | 53.18 | **22** | **53.18** | 100% | |
| 5 | 2.25 to 2.00 | 20 mm (Reducer) | 4 | | | **4** | | 100% | |
| 6 | 2.25 | 20 mm (Bend-1) | 3 | | | **3** | | 100% | |
| 7 | 2.25 | 20 mm (Bend-2) | 3 | | | **3** | | 100% | |
| 8 | 2.25 | 20 mm (Bend-3) | 4 | | | **4** | | 100% | |
| 9 | 2.25 | 20 mm (Bend-4) | 7 | | | **7** | | 100% | |
| Total | | | 63 | | | | | | |

The erection of all associated branch pipes of the penstock manifold has been completed on all 4 units.

**BRANCH BENDS**

Internal Diameter: 2.25 m
Thickness: 20 mm
The erection of branch bends on all has been completed.

**BIFURCATIONS**

*Table 13: Description of Bifurcation*

| Unit | Inlet Diameter (m) | Outlet Diameter 1 (m) | Outlet Diameter 2 (m) | Thickness (mm) |
|---|---|---|---|---|
| 1 | 4.50 | 3.90 | 2.25 | 36 |
| 2 | 3.90 | 3.18 | 2.25 | 30 |
| 3 | 3.18 | 2.25 | 2.25 | 25 |

The erection of all three units of bifurcation has been completed.

### 2.3.5 DIFFUSER

Plate thickness: 12 mm
Estimated Weight of each unit: 25.79 Tons
The erection of all four unit diffusers has been completed on all the units at the powerhouse location.

### 2.3.6 ADDITIONAL WORKS

In addition to the previously mentioned progress, a significant advancement has been made by adding flushing pipes at the weir section. Each flushing pipe unit has a length of 15.76 meters, and there are a total of 2 units of these flushing pipes. Both the fabrication and erection of these flushing pipes have been completed along with its cover plate (2 pieces). Similarly, a pipe of diameter 4.0 m and length 10.9m has been fabricated, erected, and welded at the Adit Junction. As a comprehensive summary, the hydro-mechanical works of the project have been completed as of April 2024 while a few remaining fitting works are being carried out.

*Figure 38: Erection of penstock pipes (November 2024)*

*Figure 39: A view of penstock pipes from the switchyard region (February 2024)*

## 2.4 ELECTRO-MECHANICAL WORKS

The Electro-Mechanical (EM) works for the MTHP were carried out by Chongqing Water Turbine Works Co. Ltd. (CWTW) from China. Their responsibilities span the entire electro-mechanical aspect, encompassing the design, fabrication, assembly, supply, and installation of all relevant components from the end of the penstock to the pickup gantry of the switchyard accommodating four units of vertical Francis turbine with all corresponding generating units, control and protection systems, battery backups, internal power consumption transformers, power transformers, excitation transformers, SCADA and communication system as per NEA's grid code requirements, the overhead crane, butterfly valves for each unit feeding penstock.

The mobilization of manpower and resources for installation works of Electro-mechanical equipment commenced officially on February 09, 2021. The setup work for the camp and warehouse was completed and the delivery of the equipment and their installation began promptly. Due to COVID-19's impact, the EM Contractor, being a Chinese company, encountered challenges in mobilizing their national workers at the site. To address this, they engaged a Nepali subcontractor, JADE, who smoothly carried out installation works for various parts. The project team overcame these hurdles by mobilizing its project manager and technical experts, mostly mechanical and electrical engineers later and expediting the installation works at the construction site.

CWTW completed all associated fabrication works in November 2023 which incorporated the design, fabrication, and testing of vital equipment like generator sets, runners, shafts, relay, control system, PPV, etc. Regarding the delivery of the EM equipment, more than 90% of the equipment was delivered before November 2023 consisting of turbine parts, generator components, control panels, cables, Electric Overhead Travel (EOT) cranes and accessories, switchyard equipment, etc. The 13$^{th}$ shipment consisting of crucial components like the Positive Pressure Ventilation (PPV) valve and communication system was delivered to the Project site in January 2024, marking the complete delivery of EM equipment at the Project's site.

Regarding the tests, the dry tests of all four generating units comprising generators, turbines, relay panels, control systems, excitation system, and switchyard equipment were carried out in the last week of January 2024, by the EM Contractor. The result of the dry test was found to be satisfactory thereby achieving a crucial milestone for Project's success.

The PPVs were installed at the end of February and successfully tested in the first week of March 2024. Once the official manpower of the EM Contractor came from China, the wet testing of the EM equipment commenced on March 18, 2024. The no-load spinning tests for all four units were commenced from March 18 till the end of the month. The load tests of each unit were conducted separately at different load conditions and the load rejection for all units was successfully carried out on April 20, 2024, at 6.5 MW each (total generation = 26 MW). The full load rejection will be carried out in the upcoming wet season when the plant will be operating at full capacity i.e. 73 MW.

The grid connection of the Project was successfully carried out on April 11, 2024 (Chaitra 29, 2080), with the NEA's substation located at Dhunge-Sanghu, and the back feed for the test was received on the same day. The official inauguration of the Project was conducted on April 12, 2024 (Chaitra 30, 2080), in the joint presence of the Managing Director of Nepal Electricity Authority, Mr. Kulman Ghising, and celebrated Nepali actor duo, Mr. Madan Krishna Shrestha and Mr. Hari Bansha Acharya. The inauguration was marked by the successful commissioning of Unit 01 and Unit 03 generating units. Unit 04 was commissioned on April 16, 2024 (Baisakh 04, 2081) whereas Unit 02 was commissioned on April 19, 2024 (Baisakh 7, 2081).

With the successful commissioning of all four units, the reliability run of the Project began on April 20, 2024 (Baisakh 8, 2081) and will run for 15 days. With this, the Commercial Operation Date of the Project is set for May 05, 2024 (Baisakh 23, 2024).

### 2.4.1 MANUFACTURING WORKS

The manufacturing works for the Electro-Mechanical equipment were completed at various factories in China in November 2023. The turbine sets, including spare runners, and the generators were delivered at the beginning and their installation was completed earlier.

The list of major Electro-mechanical components is listed below,

- **Turbine** - All complete
- **Generator** - All complete
- **Governor** - All complete
- **Excitation system** - All complete
- **Switchyard equipment including transformer and steel structures** - All complete
- **PPV valve** - All complete
- **MIV valve** - All complete
- **Control panels** - All complete
- **Control and protection system** - All complete
- **Cables** - All complete

### 2.4.2 INSTALLATION WORKS

The Electro-Mechanical installation works were carried out simultaneously with the Civil construction works. The installation of embedded parts and pipes for the turbine and generator was carried out concurrently with the civil work, serving as the foundation for further EM activities. Additionally, the EOT crane installation, commissioning, and load testing, a crucial Electro-Mechanical milestone, were successfully carried out in 2022. The final assembly of turbines and generators was completed in November 2023 and the dry tests of these equipment were carried out in January 2024.

#### 2.4.2.1 EOT CRANE INSTALLATION

Upon the completion of roofing work in Bay 1, the electrical commissioning of the crane was conducted. The crane's functionality was thoroughly tested as it was driven from Bay 1 to Bay 5 at different speed levels, with a careful check of safety measures and connections. An essential step in validating the EOT (Electric Overhead Travel) crane's capabilities involved a successful load test, where a 66-ton dummy load was lifted to verify the crane's load capacity.

#### 2.4.2.2 UNIT 01/ 02/ 03/ 04

The installation of the vital components of the turbine and generator in all four units was completed along with the final assembly of the bottom ring, guide vane, head cover, lower guide bearing, and upper bracket in November 2023. The assembly of the split stator and rotor for the generator was fully accomplished. Ensuring the integrity of the electrical components, the high voltage testing of the installed stator coils and rotor was successfully carried out independently. The summary of works carried out is mentioned below,

- Installation of thrust and upper guide bearing of the upper bracket
- Installation of lower guide-bearing bush
- Coupling of runner and rotor shaft
- Run-out and alignment check of shaft
- Pressure test of upper bracket bearing oil cooler
- Installation of the water distribution system
- Accessories mounting work
- No load spinning of the turbine
- Load spinning of the turbine at various loading conditions (25%, 50%, 75%, 100%, and full load rejection)
- Commissioning of the unit

The dates of dry and wet testing conducted in each generating unit are shown in the table below,

| S.N. | Generating units (→)<br>Particulars (↓) | Unit 01 | Unit 02 | Unit 03 | Unit 04 |
|---|---|---|---|---|---|
| 1 | Completion of Assembly | November 1st week | December end | November end | December 1st week |
| 2 | Dry tests | Started from January 23, 2024 to January 30, 2024 | | | |
| 3 | No load spinning (Heat run test) | Started from March 18, 2024 to March 30, 2024 | | | |
| 4 | Load spinning (@25%, @50%, @75%, @100%) | April 11, 2024 (Chaitra 29, 2080) | April 19, 2024 (Baisakh 07, 2081) | April 12, 2024 (Chaitra 30, 2080) | April 16, 2024 (Baisakh 04, 2081) |
| 5 | Load rejection test at partial load (i.e. 6.5 MW each) | April 20, 2024 (Baisakh 08, 2081) | | | |
| 6 | Load rejection at full load | Targeted for the wet season | | | |
| 7 | Trial run (Reliability Run) | Commenced from April 20, 2024 (Baisakh 08, 2081) | | | |
| 8 | Target Commercial Operation Date (COD) | May 05, 2024 (Baisakh 23, 2081) | | | |

*Figure 40: Installation of temperature and resistance measuring sensors at Thurst bearing*

*Figure 41: Rotor and stator coupling in  unit 01*

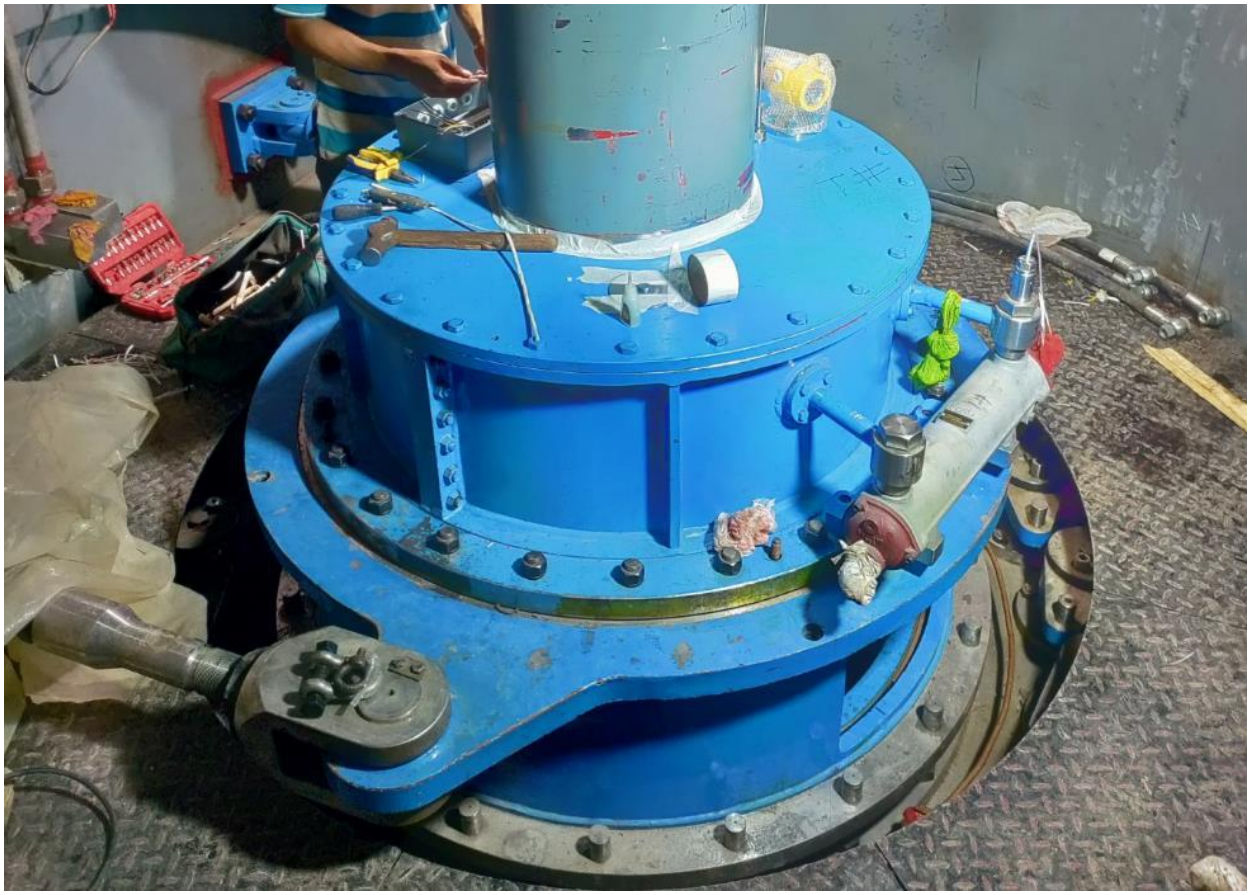

*Figure 42: Final installation of water guide mechanism along with monitoring sensors*

*Figure 43: Brazing and lacing work of stator coils*

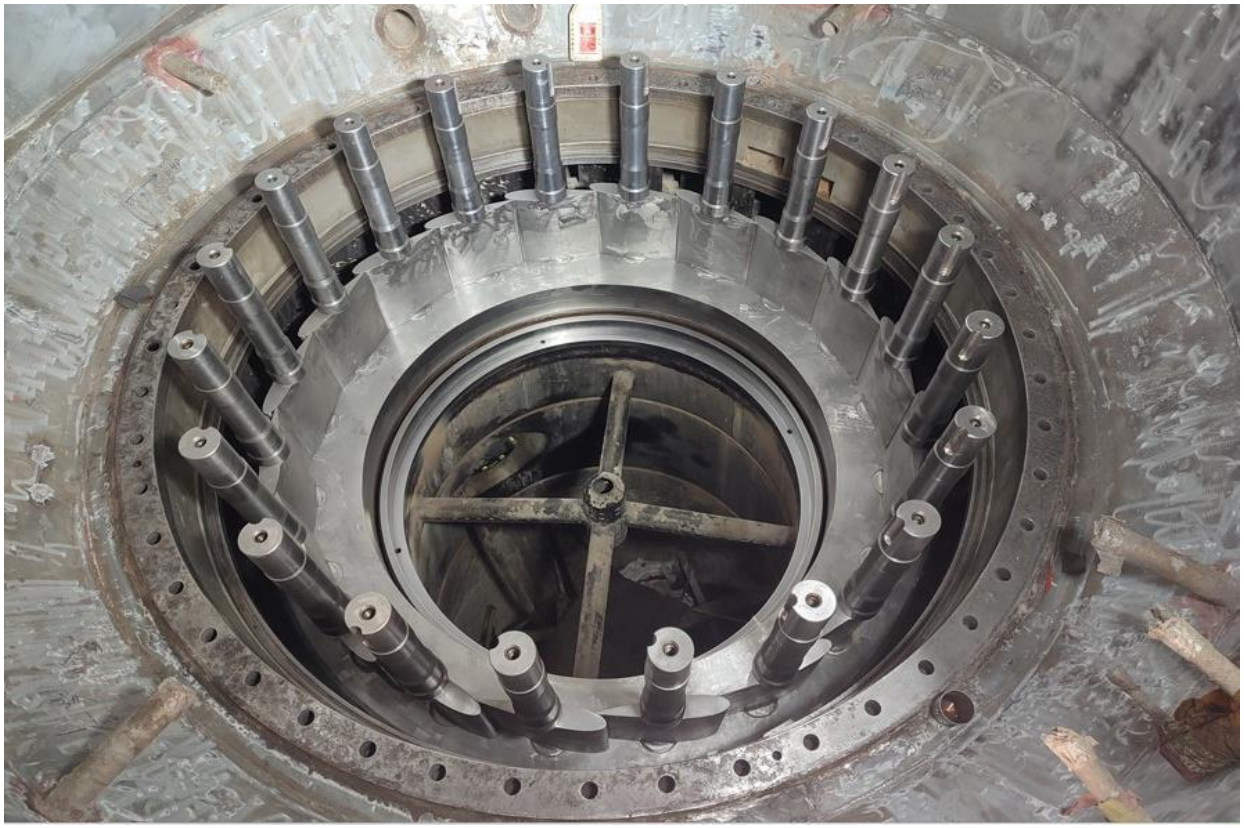

*Figure 44: Final assembly of bottom ring and guide vane*

*Figure 45: Excitation system installation*

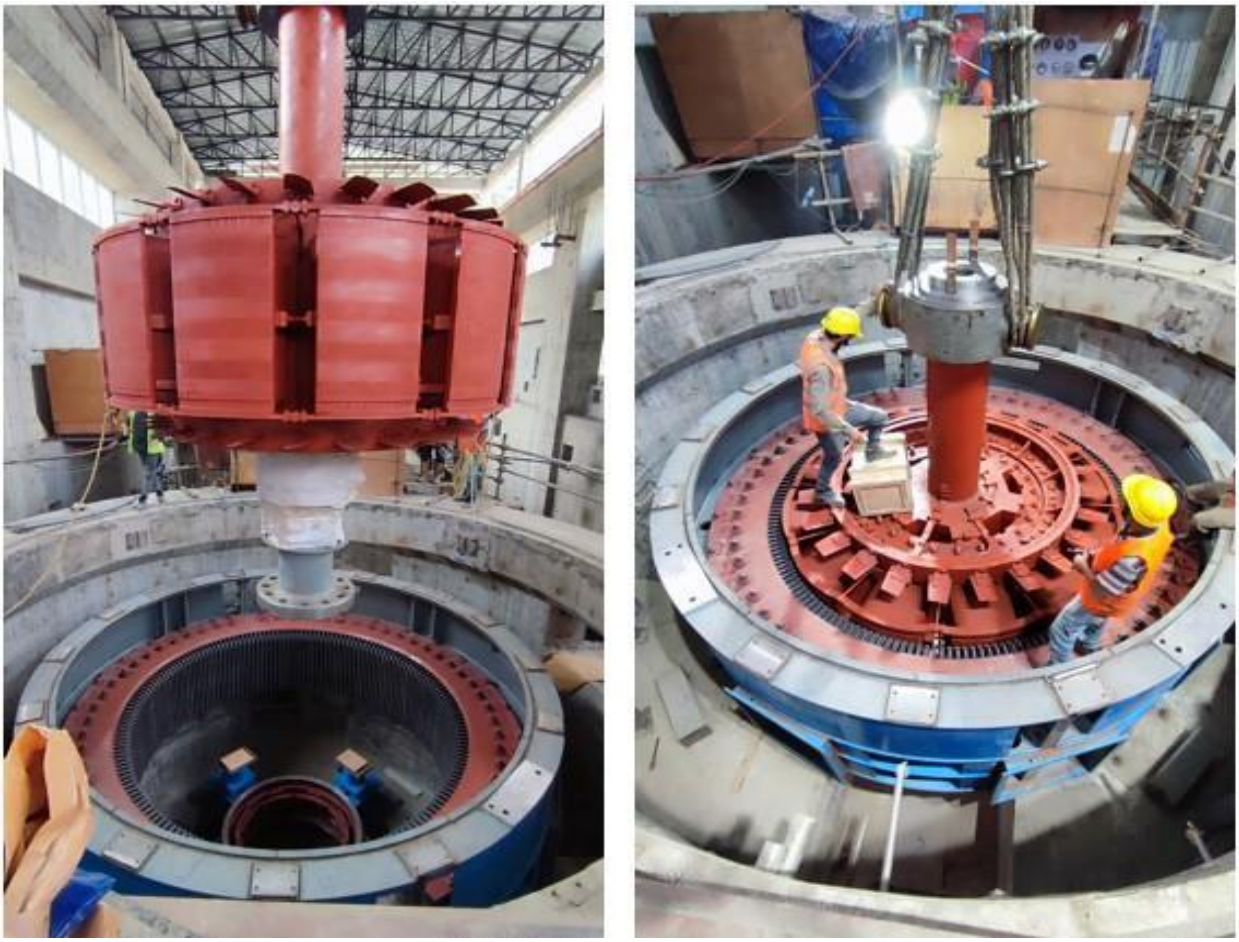

*Figure 46: Rotor lowering in Unit 3*

*Figure 47: Assembly of the runner with the main shaft*

*Figure 48: Rotor lowering of unit 04*

*Figure 49: Final installation of turbine guide bearing and water regulating mechanism*

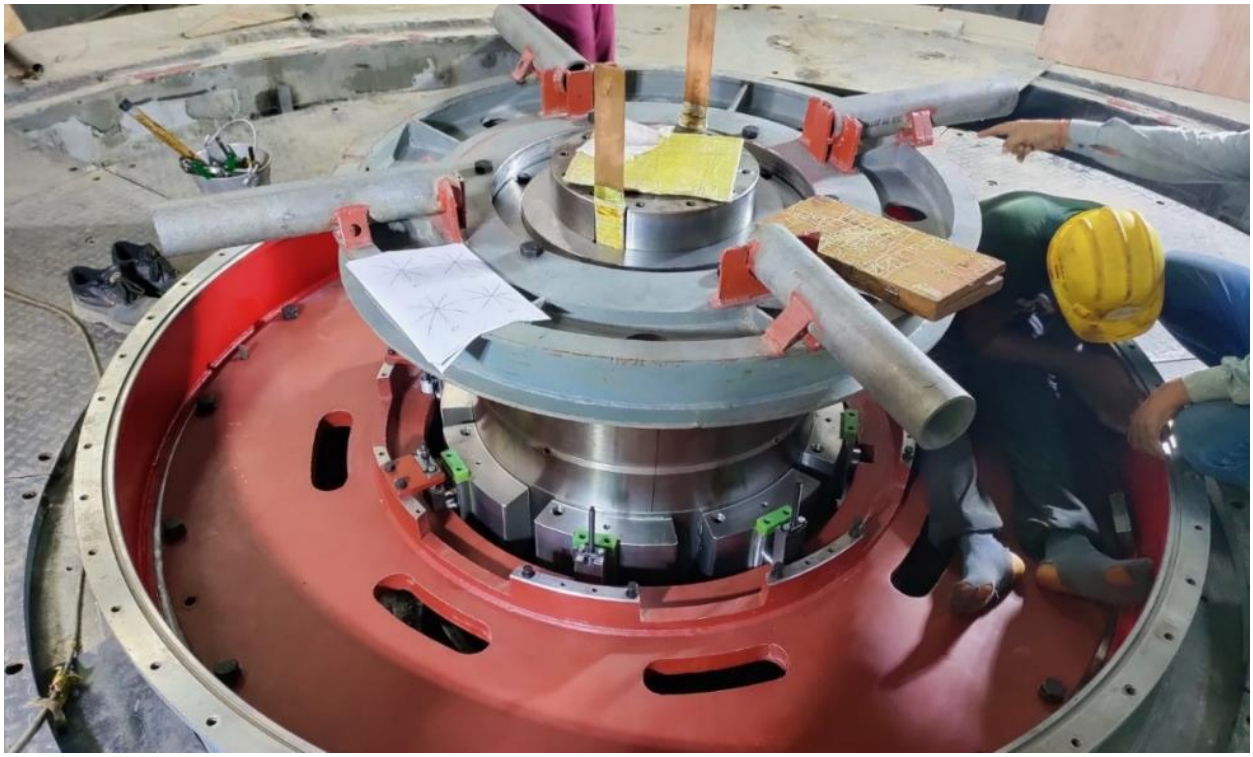

*Figure 50: Run-out check of shaft*

*Figure 51: Final assembly of water regulating mechanism*

### 2.4.2.3 MAIN INLET VALVE

The installation of all 4 units of the Main Inlet Valve has been completed in December 2023. Further, the assembly of bypass valves from Unit 1 to Unit 4 has been completed. The wet testing of the MIV was conducted on March 16, 2024, when all four units of MIV were shut down and the water was retained in the penstock. No leakages or mechanical failures were noticed in either of the MIVs and the overall performance was found to be satisfactory. A few photographs of the work progress are shown below:

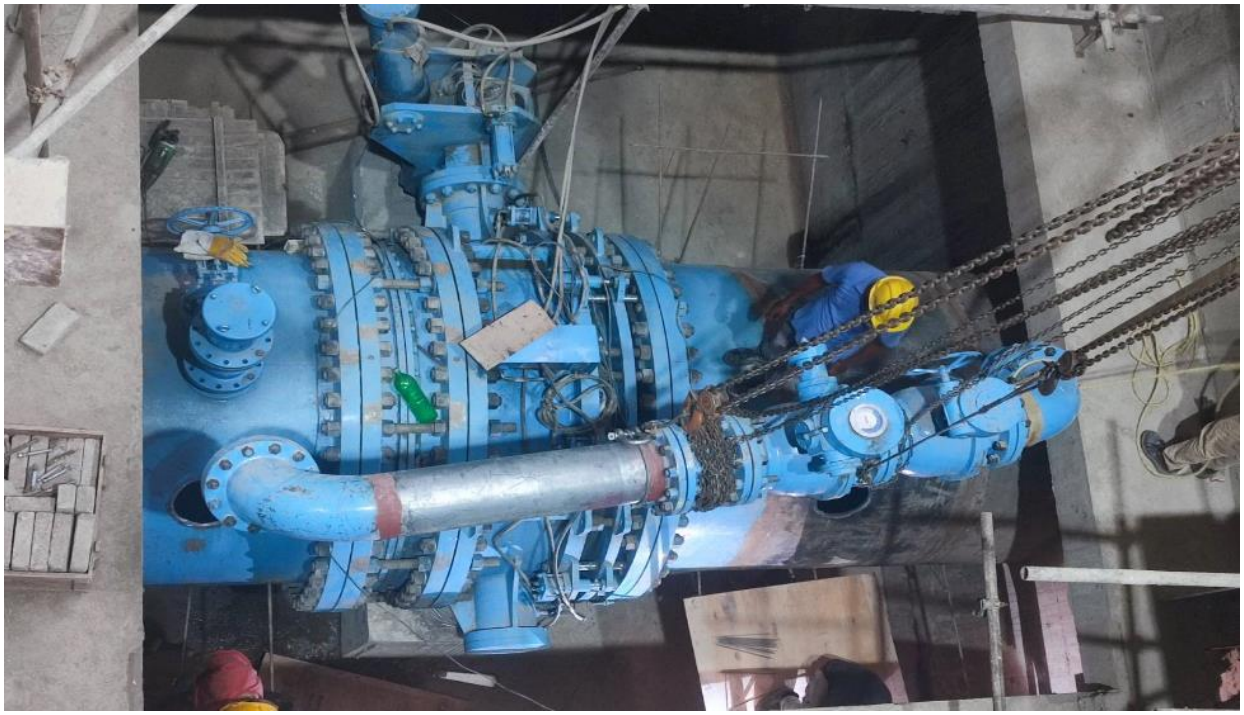

*Figure 52: Unit 02 bypass valve assembly and erection*

*Figure 53: Unit 01 bypass valve work*

### 2.4.2.4 CONTROL ROOM

The installation of all the embedded parts, pipes, ventilation fans, control panels, cable support bracket, and auxiliary transformer of the control room has been completed along with the laying, dressing, and termination work of power and control cables. A few photographs of the work's progress are shown below.

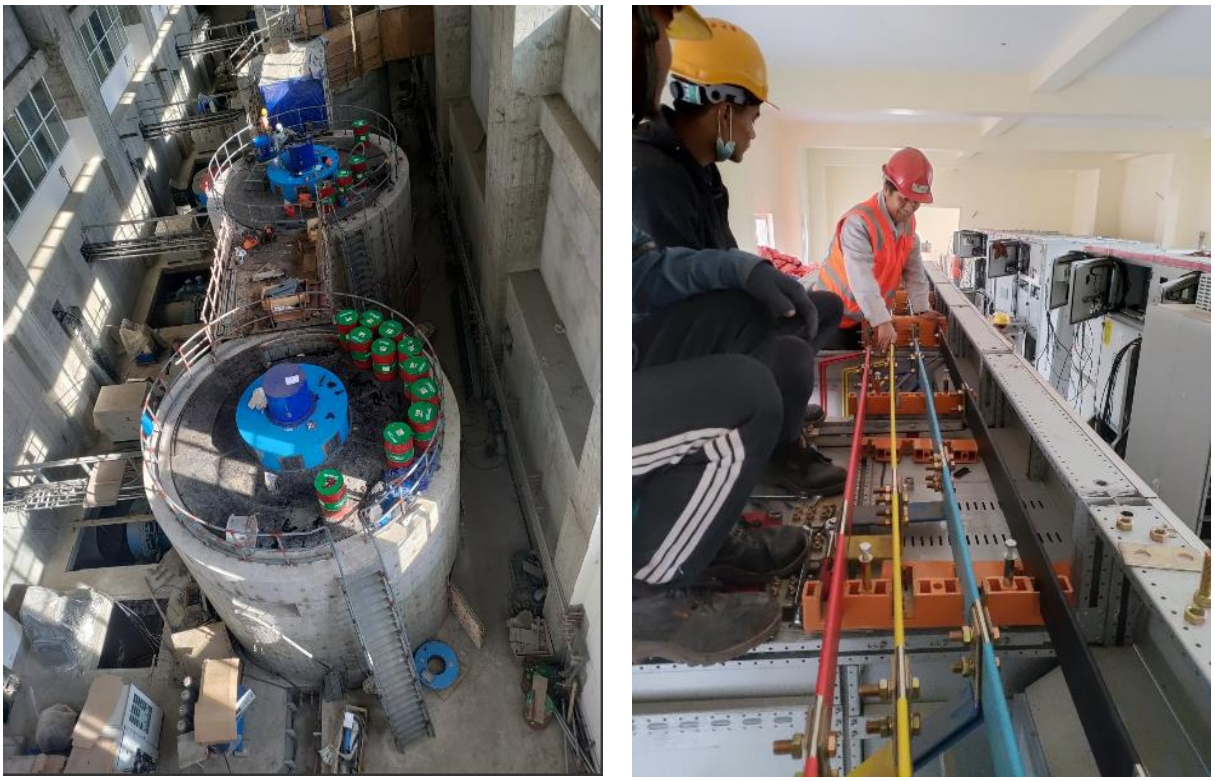

*Figure 54: Laying of power and control cables (left) and Busbar installation works (right)*

*Figure 55: Laying of power and control cables in 11kV switchgear room*

*Figure 56: Installation of relay panels and control systems at the Control bay (March 2024)*

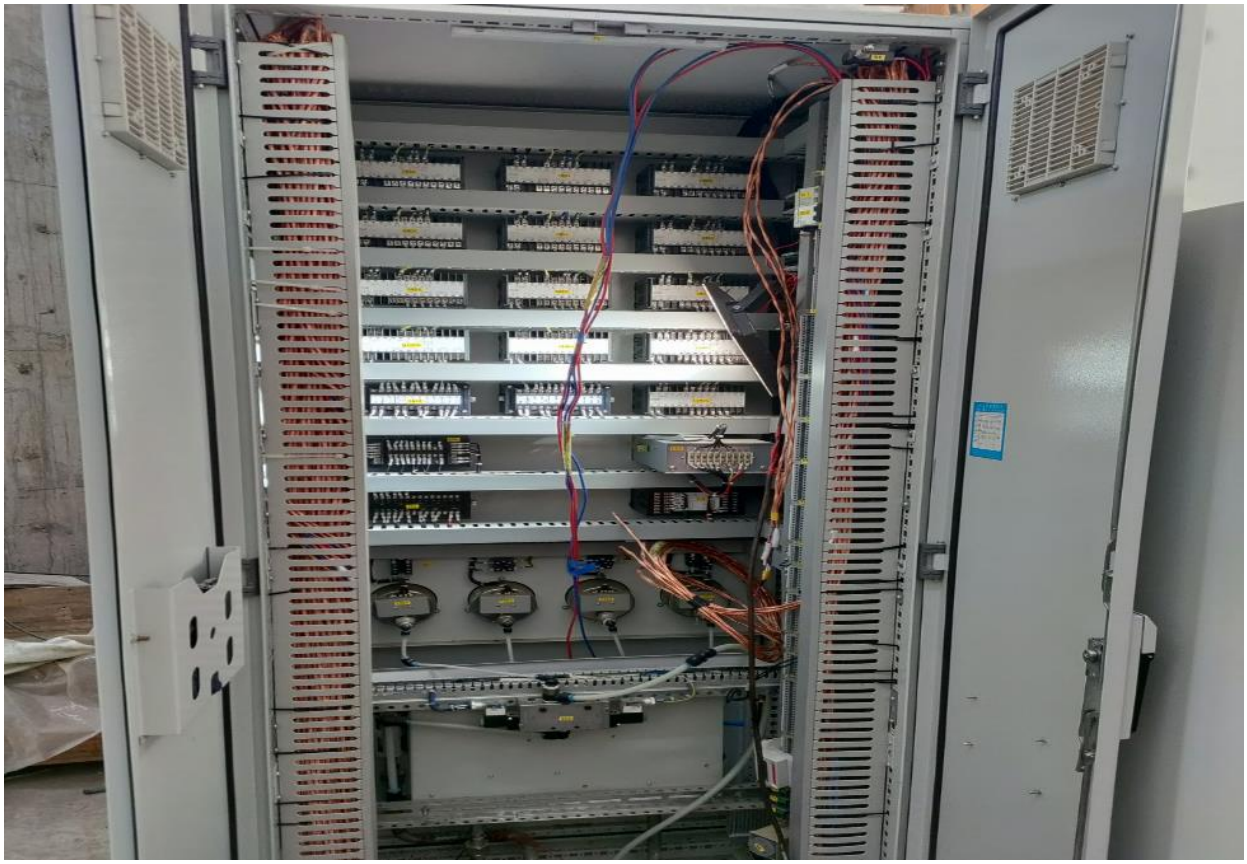

*Figure 57: Control cable termination works*

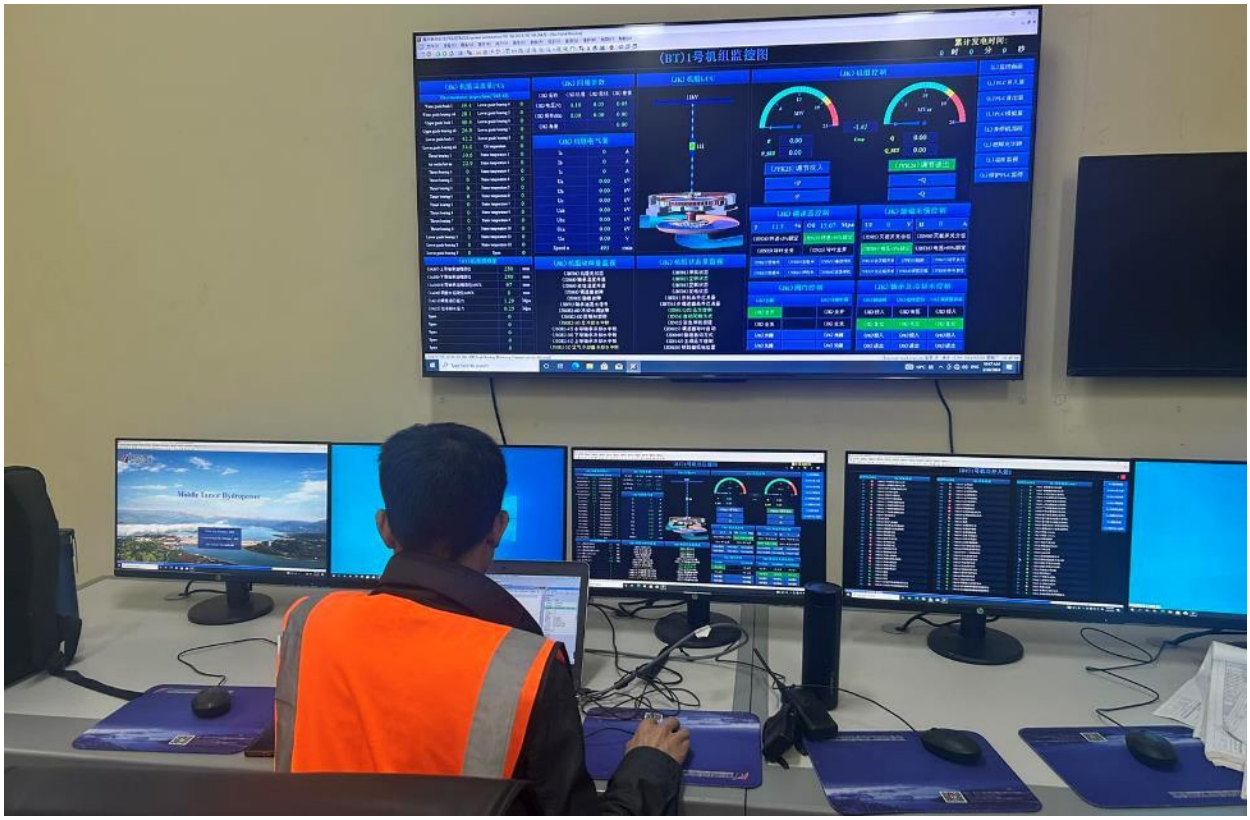

*Figure 58: SCADA system installed in the control building*

#### 2.4.2.5 SWITCHYARD AND VALVE HOUSE

Laying of earthing flats, embedded parts, and pipes in the switchyard as well as valve house simultaneously completed with the Main Civil works. Erection of the gantry tower and other equipment posts have also been completed in the switchyard. With the successful dry test of the EM equipment, the Project is ready to generate electricity. A few photographs of the work progress are shown below.

*Figure 59: A view of transformers at the switchyard region (February 2024)*

*Figure 60: Power transformer located at the switchyard region*

*Figure 61: PPV installation at the Valve House region*

## 2.5 TRANSMISSION LINE WORKS

The Contract for Transmission Line works was signed with Cosmic Electrical Engineering Associates Private Limited on June 07, 2020, for the comprehensive completion of a 9 km long, 220 kV D/C transmission line. This transmission line consists of 25 towers and originates from the switchyard of the Middle Tamor Hydropower Project, connecting with the interconnecting bay of the Dhunge-Sanghu sub-station of NEA located in Taplejung.

The check surveys, soil investigations, design, and procurement of tower components, were completed during the early stage of construction. Once the construction license was obtained, the process of land acquisition for all tower angle points (APs) began, followed by the construction of tower foundations, and the erection of towers.

The foundation concreting and stub erection were completed at all 25 locations. The tower erection was accomplished at 24 sites in October 2023 however, due to issues in the acquisition of land at AP17, the erection works were affected. The acquisition of land at AP 17 was done in December 2023 and the tower was erected in January 2024. The stringing work was completed from AP24 to AP18 and AP13 to AP01 in December 2023. Once the tower at AP17 was completed, the complete conductor stringing throughout the 9 km stretch was achieved on February 28, 2024.

As per the Connection agreement, power generated from the Middle Tamor Hydropower Project was initially planned to be evacuated at the Dhungesanghu substation. The 132 kV system at Dhungesanghu sub-station was scheduled for completion in January 2024, however, its upgradation had to be done to a 220 kV system, to allow the power evacuation from MTHP.

The 220 kV upgradation works of Dhungesanghu were not commenced and hence, it seemed impossible to connect the Middle Tamor Hydropower Project at the Dhungesanghu sub-station. This concern was raised during various meetings of the coordination committee with NEA, where it was proposed to establish a contingency arrangement until a 220 kV system is built at the Dhungesanghu substation. This alternative evacuation arrangement involved the stringing of a transmission line from the Dhungesanghu substation to the Basantapur substation and an interconnection bay at the Basantapur substation. This circuit will be operated at 220 kV and will be exclusively dedicated to the Middle Tamor Hydropower Project for power evacuation to the 220 kV bay at Basantapur sub-station.

Based on this arrangement, the stringing of this circuit and the construction of the bay were completed by the NEA on April 11, 2080 (Chaitra 29, 2080). The testing was successfully conducted and the back feed was provided to the Project via. Basantapur to Dhunge Sanghu and the switchyard of MTHP. For the power evacuation, the final tower (AP 24) of MTHP was connected to the second tower of the Dhunge Sanghu to Basantapur transmission line through a tower-to-tower (T to T) arrangement. With this, the successful grid connection of MTHP was established on April 11, 2024, and the official inauguration of the project was done on April 12, 2024.

After the successful wet testing of all four generating units, the reliability run of the Project began on April 20, 2024 (Baisakh 2081). Considering all of the above, the Commercial Operation Date (COD) of the Project is anticipated for May 05, 2024 (Baisakh 23, 2081).

The transmission line route map is shown in the figure below.


*Figure 62: Transmission line route map*

### 2.5.1 CONSTRUCTION WORKS

The contractor completed all associated construction works in all 25 tower locations in February 2024. This included acquisition of land, construction of tower foundations, erection of towers, Right of Way (RoW) clearance, stringing of transmission line, stringing of OPGW wire and connection at switchyard of the Middle Tamor Hydropower Project at one end and NEA's substation at another end. The overall transmission line is 9 km long and stretches along 25 tower locations.

*Table 14: Summary of Transmission Line Works Progress*

| S.N. | Tower Works | Total | Completed | Units | Overall Progress till date | Status |
|---|---|---|---|---|---|---|
| **A** | **Overall Transmission Line Works** | | | | **95%** | In Progress |
| 1 | Land Acquisition Works | 25 | 25 | Nos. | 100% | Completed |
| 2 | Tower Foundation Works | 25 | 25 | Nos. | 100% | Completed |
| 3 | Erection of Towers | 25 | 25 | Nos. | 100% | Completed |
| 4 | Stringing Works | 9 | 9 | km | 100% | Completed |

*Figure 63: View of Conductor stringing from switchyard gantry to AP1*

*Figure 64: A view of stringing works*

*Figure 65: A view of the completion of the control bay at the Dhunge-sanghu substation (March 2024)*

*Figure 66: A view of the completion of the Basantapur substation (March 2024)*

*Figure 67: Tower-to-tower connection made at Dhunge-sangha substation (February 25, 2024)*

## 2.6 FINANCIAL PROGRESS TO DATE

The total revised cost of the Middle Tamor Hydropower Project is estimated as NPR 13,330,000,000 (In words - NPR Thirteen Billion Three Hundred Thirty Million only). Within this project cost, the equity portion amounts to NPR 3,332,500,000, while the debt is NPR 9,997,500,000. The promoter's equity share, representing 70% of the total equity (NPR 2,332,750,000), has been fully paid. Additionally, the public equity share, constituting 30% of the total equity or NPR 999,750,000, has also been completely paid, leading to the Company's listing on the Nepal Stock Exchange. The debt portion has been arranged through a consortium of 8 commercial banks, with Nepal Investment Mega Bank Ltd. leading the effort.

Regarding the Main Civil Works, out of the Contract amount, 95% has been disbursed to the Main Civil Contractor up to the present date against the raised Interim Payment Certificates (IPCs) to IPC 29 along with the expenditures made under contingencies. The Main Civil Contractor is in the process of issuing the IPC 30. After this, the Contractor shall issue a final fill incorporating all the remaining payment till the completion of the project, incorporating earlier rectification and previously held amount. In addition, there is a 5% retention amount held from each payment made to the Contractor against the IPCs. In addition to the retention amount, an additional Performance Guarantee (PG) equivalent to 10% of the Civil Contract is kept as additional security by the Employer. Both these payments shall be released to the Main Civil Contractor after the Defect Notification Period (DNP) of 1 year, provided no damages or significant issues occur in the civil structures.

Likewise, 89% of the Contract amount has been paid to the Hydro-Mechanical Contractor (up to IPC 9), covering the design and procurement segment. Regarding the procurement of steel pipes for the Project, the Employer directly purchased all the necessary steel plates. At present, the HM Contractor is in the process of issuing the final bill to the Employer whilst the official handover of works is in process. The overall performance of the HM works has been found satisfactory from the tests carried out at the site. In addition, similar to the Main Civil Contractor, the Employer has retained a 5% amount from each running bill along with a PG equivalent to 10% of the Contract amount as security for the performance of HM works. This shall be released after the DNP of 1 year.

In the context of Electro-Mechanical works, approximately 93% of the Contract amount out of the supply portion has been provided to the Electro-Mechanical Contractor. This amount covers the supply portion's bills for dispatch up to the 13th lot of EM equipment following their receipt on-site, along with an advance paid against the Advance Payment Guarantee (APG). The payment against the service portion of the EM works is yet to be paid to the Contractor. As performance security, 20% of the total Contract amount has been retained from the total payable amount of EM works as per the Contract. This 20% retained amount shall be released to the EM Contractor at the rate of 5% per year provided the EM works performance is found satisfactory.

Additionally, about 82% of the total Contract amount has been paid to the Transmission Line (TL) Contractor, encompassing bills up to IPC#10, which also incorporates all additional variations and advance payments. The Contractor has already submitted the final bill which is in the final stage of verification from the Engineer.

*Table 15: Financial Progress of Major Contract Packages Till Date*

| **Major Contract Packages** | **Expense till date (%)** | **Remaining Budget (%)** |
|---|---|---|
| Main Civil Works including contingencies | **95%** | 5% |
| Hydro-Mechanical Works | **89%** | 11% |
| Electro-Mechanical Works | **93%** | 7% |
| Transmission Line Works | **82%** | 18% |
| **Particulars** | **% Expense to date** | **% Remaining Budget** |
| Financial Progress of MTHP | **90%** | 10% |

The total financial expenditure of the overall Project to date is about **90%** of the total project cost of NPR. 13,330,000,000.

# 3 OCCUPATIONAL HEALTH SAFETY AND ENVIRONMENT (OHSE)

## 3.1 PRIMARY RISK PARAMETERS

The Engineer has carried out a detailed risk assessment of the Project and is consistently aware of the potential risk/hazard that may arise during the operation and maintenance phase of the Project. The Project lies on the Tamor River, and the headworks structures and powerhouse lie immediately on the right bank of the Tamor River. There is a moderate to high risk of flood as adequate flood protection structures have been constructed along with the gabion walls. Further, an automated flood warning system has been installed about 10 km upstream of the headworks. The Project's staff and operation team are notified approximately 1 hour before any potential flood event. Considering the Project's surroundings and geological condition, the project has a moderate risk in terms of natural perils like bushfires, landslides, and earthquakes. The use of explosives has been completed. The remaining explosive materials are safely stored in the Project's bunker which is under the protection of the Nepal Army residing at Sisne camp. Flammable solvents are not used in large quantities and so, the chances of explosion are low.

Nepal is located in the tectonically active Himalayan belt. Although most parts of Nepal are prone to earthquakes and their associated disasters, the project premises are located in the hilly and rocky belt in the eastern part of Nepal, Taplejung district. No major incident occurred during the past earthquake that occurred in 2072. Since the project is a run-off-river type, there is a provision for a diversion weir. The weir allows the excess flow during a flood to pass over the weir crest. There have been no significant storm events in the past. The location of the Powerhouse is on the right bank of Tamor River which is protected with adequate boulder lining and gabion protection. No major incident has given rise to the claim reported to date. Adequate protections have been utilized at the slope regions of the Project. Necessary bio-engineering is done to maintain slope stability.

## 3.2 SAFETY PROTOCOLS AT THE PROJECT

A comprehensive safety protocol has been developed and put into action at the Project site to mitigate various risks and hazards. The Employer takes the health and safety of all employees seriously, providing suitable and necessary Personal Protective Equipment (PPE) daily. A dedicated healthcare worker is permanently employed to ensure the well-being of employees, along with the establishment of a healthcare facility equipped with sufficient medicines and a first aid kit. Regular health screening is conducted by the Occupational Health, Safety, and Environment (OHSE) team, including temperature checks and general health assessments.

To prevent risks during underground work, Contractor safety personnel continually educate employees about potential hazards associated with drilling and blasting activities in the tunnel, emphasizing adherence to control measures. Periodic safety induction training and toolbox training are conducted for the workers of contractors and sub-contractors. Further, a foreman has been deputed to oversee the entry and exit of workers and other staff from each tunnel front. Fire extinguishers are strategically placed in high-temperature work areas, and oxygen levels and lighting are closely monitored in underground work zones.

The OSHE team regularly conducts safety drills at the Contractor's camp in the headworks and powerhouse, providing training on proper procedures during natural calamities or hazards. In addition, the Employer frequently conducts training on emergency evacuation during times of natural disasters. Toolbox talks are given to new batches of workers at the construction site, alongside essential safety training. Furthermore, the technical team members are advised to exercise caution when entering hazardous areas, and extra precautions are taken to ensure the safety of visitors. Following safe working practices remains a priority, aiming to minimize possible incidents effectively.

Considering potential future outbreaks of COVID-19 or similar pandemics, the project has implemented efficient mechanisms. These include maintaining sufficient stocks of essential construction materials, engaging new subcontractors, implementing strict health and safety protocols, and establishing isolation centers at the Project site. These collective efforts have been playing a crucial role in maintaining progress while prioritizing the safety and well-being of workers and staff, setting a positive example for managing construction projects in the face of unexpected challenges.

## 3.3 SECURITY PROVISIONS AT THE PROJECT

The employer has prioritized security measures to ensure the security and safety of the project facilities and personnel. Currently, camps and major project components are equipped with walls and fencing, and work is underway to extend fencing to additional structures like the powerhouse, switchyard, and PPV house. A qualified security team, outsourced from reputable security companies, is dedicated to maintaining a safe environment around the clock. This includes having a sufficient number of security guards stationed throughout the plant premises.

Furthermore, the plant also benefits from the proximity of two police posts - Siwa Police Post (Phaktanglung RM-3) and Dandagaun Police Post (Mikwakhola Rm-1), located near the Headworks and Powerhouse respectively, providing additional security coverage. Additionally, the District Police Office is situated approximately 1.5 hours away from our project location, further bolstering our security infrastructure.

## 3.4 OPERATION, MAINTENANCE AND INSPECTION

There is a daily/fortnightly/monthly/half-yearly and annual maintenance schedule for the Generators, Turbines, and other plant & equipment. The turbine runner, head cover, and bearings are checked regularly during operation as well during off-peak season. The vibration monitoring system has been placed to monitor any abnormal vibrations. The efficiency monitoring system is also in place to monitor any wear and tear of the turbine parts.

The trash racks are cleared regularly during the monsoon season and the emergency tail race gate is also checked periodically for readiness during emergencies. The water turbines are provided with Overspeed trip devices to trip the turbine over the normal design speed. The Penstock Protection Valve is placed immediately after the outlet portal to address emergencies in the penstock and Main inlet valve and hence acts as the shutdown device for water entering into the penstock and runner.

The protective devices provided for the generator are:

- Generator Differential Protection
- Over/Under voltage protection.
- Over/Under current protection.
- Earth fault protection.
- Over/Under Frequency protection.

The plant personnel are well trained and competent to carry out the routine inspection of the plant & equipment. Critical spares of the equipment are also available in the stores.

*Figure 68: Provisions of guard railings at the tall regions of the headworks region*

*Figure 69: Safety induction training provided to the Contractor's personnel*

*Figure 70: Use of safety belts*


*Figure 71: Awareness program to the project staff regarding fire hazards and extinguishers*

*Figure 72: Provisions of guard railings at the tall regions of the powerhouse*

*Figure 73: Provision of lightening arresters in the switchyard region*

# 4 CONCLUSION

In summary, the construction of the Middle Tamor Hydropower Project has been completed as of April 2024. The final concrete works by the Main Civil Contractor were completed in the first week of March 2024 whereas the final installation works by the Hydro-mechanical Contractor were completed by the middle of March. The construction works of the headworks and underground work fronts have been completed in February 2024, and the Powerhouse region in the first week of March 2024. The EM Contractor completed all the erection works of all four generating units in November and the switchyard construction and cabling works in December 2024. The dry test of the EM equipment was conducted successfully in the last week of January 2024 whilst the final assembly of PPV at the valve house region was completed in Mid of March 2024.

The wet testing of the headworks structures was officially commenced on February 14, 2024, in the joint presence of members from the Employer, Engineer, Main Civil Contractor, and Hydro-mechanical Contractor. The water filling in the HRT commenced from March 07 and the overall hydraulic and geological performance of the underground structures was tested for about 10 days. The wet testing of the penstock and powerhouse structures commenced on March 16 and was successfully carried out.

Regarding the EM works, the dry tests of all four generating units comprising generators, turbines, relay panels, control systems, excitation system, and switchyard equipment were commenced on January 23, 2024, by the EM Contractor. After the installation of the PPV and the arrival of the official manpower of the EM Contractor from China, the wet testing of the EM equipment commenced on March 18, 2024. The no-load spinning tests for all four units were commenced from March 18 till the end of the month. The load rejection for all units was successfully carried out on April 20, 2024, at a generation capacity of 26 MW. In the transmission line works, the foundation concreting and stub erection were completed at all 25 locations in 2023. The complete tower erection and stringing works were completed throughout the 9 km stretch on February 28, 2024.

Based on the power evacuation arrangement agreed with the NEA, the back-feed was provided to the Project via. Basantapur substation. The wet testing of all associated work fronts has been carried out successfully. The overall quality and performance of the structures have been tested as per the Contractual specification to the satisfaction of the Engineer and already approved by the Employer. The successful grid connection of MTHP was established on April 11, 2024, and the official inauguration of the project was done on April 12, 2024.

At present, each Contractor is in the process of raising the final IPC and the handover of the works from each of the Contractors to the Employer is underway. The remaining finishing works at the Powerhouse and Valve House region are being carried out. Additional river training works are also being carried out at the headworks region and on each riverside to protect the structures from potential monsoon floods.

*Table 16: Work progress summary chart*

| S.N. | Particulars | Construction Progress |
|---|---|---|
| **1** | **Main Civil Works including Contingency utilized** | **100%** |
| **2** | **Hydro-mechanical Works** | **100%** |
| **3** | **Electro-mechanical Works** | **100%** |
| **4** | **Transmission Line Works** | **100%** |
| **5** | **Infrastructure Development Works** | **100%** |
| | **Overall Construction Progress** | **100%** |

During the construction phase, the Project faced unexpected geological issues during the excavation of large caverns, limitations in cavern excavation due to frequent overbreaks requiring continuous repairs in challenging sections, and an extended tunnel excavation cycle, all of which affected the pace of work. In response to various challenges faced by the Project, the Employer provided additional support to the Contractors, including mobilizing extra equipment such as boomers, batching plants, grouting machines, robotic shotcrete machines, generators, trucks, excavators, loaders, concrete pumps, jackhammers, water pumps and rollers as well as addressing their cash flow issues. In addition, on the recommendation of the Engineer the Employer had to take over the actual construction works through third-party intervention to expedite the construction to meet the operation deadline. The management collaborated with various stakeholders, including the Engineer, Contractors, Subcontractors, Suppliers, Transporters, and government authorities at various levels to keep the construction environment smooth. The completion of the Project demonstrates the success of the proactive approaches made by the Project in achieving this great milestone.

The challenges posed by the global COVID-19 pandemic have had a significant impact on the construction timeline of the Middle Tamor Hydropower Project. Furthermore, the collapse of the Hewa Khola bridge linking Phidim and Hilihang along the Mechi Highway on June 18, 2023, led to a complete disruption of all vehicular movement for almost a month. This, in turn, halted the transportation of construction materials like rebars, cement, admixtures, and explosives as well as the movement of manpower for several weeks. During this period, the construction works at the site were being carried out using the construction materials that were stocked at the Project site, and only a limited quantity of materials was transported. alternative route. Unfortunately, the construction pace of the project was severely hindered during a critical phase of the Project. In addition to these, the supply of explosives to the project was disrupted due to India halting the supply. This disrupted the excavation works in critical areas such as settling basin benching, settling basin gate shafts, and flushing gate shafts for over two months. While the project managed to gradually arrange the required explosives through various alternative means in small quantities, the overall schedule for the excavation works was significantly delayed.

Recognizing the unforeseen disruptions caused by the COVID pandemic, the collapse of the Hewa bridge, the scarcity of explosives, extended treatment of geological overbreaks on the Settling Basins, and the transmission line from Dhunge Sanghu to Basantapur (being developed by the NEA) not being completed within the earlier RCOD which resulted in the contingency evacuation plan for power transmission of the Project, the RCOD was extended to mitigate the effects of the ongoing crisis. After the successful wet testing of all four generating units, the reliability run of the Project began on April 20, 2024 (Baisakh 2081). Considering all of the above, the Commercial Operation Date (COD) of the Project is anticipated for May 05, 2024 (Baisakh 23, 2081).

This report collectively demonstrates the significant progress achieved by the Middle Tamor Hydropower Project across multiple work fronts in the face of challenges and construction hurdles till the completion of the project. Despite the considerable challenges brought about by the pandemic, the construction of the Middle Tamor Hydropower Project was completed in April 2024. Although the original goals were impacted due to the pandemic and the extension of RCOD became unavoidable, the completion of the Project showcases the success achieved by the Project enduring the difficult times. The Project is optimistic about the successful power generation and commercial run of the Project during the operation and management stage.