

FOR

DESIGN CONSULTANT (DC)

FOR

1,125 MW DORJILING HYDRO POWER PROJECT

**MONGAR BHUTAN** 



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### 1 Introduction

### 1.1 Background

The Dorjilung Hydropower Project is located on Kurichhu, 3 – 20 km upstream of the existing 60 MW Kurichhu Hydropower Plant. All the construction sites are located in the Mongar Dzongkhag except that some part of the reservoir fetch stretches in Lhuentse Dzongkhag. The dam site is located about 7 km downstream of Autsho town and the underground powerhouse is near the confluence of Kurichhu and Shongarchhu. The entire components of the Project are located on the right bank of Kurichhu.

The DPR 2015 has been updated in 2023-2024 with support from the World Bank with the objective to align it to the standards of the Bhutanese Guidelines for Development of Hydropower Projects 2018 (approved post DPR 2015) and to reflect international best practices and standards.

#### 1.2 Project Description and Location

The main components of the Project are the headworks, the water ways and the powerhouse complex. In addition, the Project includes the electromechanical equipment, the hydraulic steel structures and the power evacuation arrangement.

#### 1.2.1 Head works components

# Concrete Gravity Dam and Spillway

The project consists of a concrete gravity dam of maximum height of 139.5 m from the deepest foundation level and a crest length of 241 m with FRL at 850 m and is located at about 1.0 km upstream of Rewan village. For the construction of the concrete gravity dam, Kurichhu will be diverted through two diversion tunnels (DT) having length of 930 m and 821 m along the left bank to handle the discharge of 2,671 m3/s. The sluice spillway located in the dam body is designed to safely discharge a design flood of 16,225 m3/s downstream of dam and check flood of 20,123 m3/s. The spillway with its crest at El 795 m has six sluices with radial gates of 9 m x 15.1 m size whereas the auxiliary spillway with crest at El 844.5 m has one opening of 5.0 m x 4.0 m size. The energy dissipation arrangement envisaged is of trajectory bucket type with plunge pool.

### Intake Structure & Feeder Tunnels

The intake structure with invert level at El 821.0 m with the objective to divert 451 m3/s design discharge to water conductor system is proposed to be located on the right bank of Kurichhu about 50 m upstream of the proposed diversion dam. Intake structure will be followed by two 8 m diameter horseshoe-shaped feeder tunnels which combine to form the HRT.

#### **Diversion Tunnel**

During the construction period for river diversion, two numbers of 11 m diameter circular shaped diversion tunnels are proposed on the left bank with a view to divert flood of about 2,671 m3/s to facilitate the construction activities at the dam site. Diversion Tunnel, DT-2 located on the valley side is the shortest one with length of 821 m and the Diversion Tunnel, DT-1 located farthest from the valley is longest with length of 930 m. The inlet invert level is proposed at El 775 m and outlet invert is proposed at El 766 m for both the diversion tunnels.



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### Upstream Cofferdam

About 30 m high upstream cofferdam of rock fill provided with pre-cast concrete on its downstream face having top at El 803.5 m is proposed at about 178 m upstream of the dam axis. The top width of the cofferdam is about 153 m.

### Downstream Cofferdam

About 15.0 m high rock fill type downstream cofferdam is proposed to be located at about 345 m downstream of the dam axis with a view to minimize the seepage in the dam site during construction period.

#### **Head Race Tunnel** 1.2.2

A single-tunnel concrete lined 11.0 m diameter circular Head Race Tunnel (HRT) with total length of 14,974 m is provided to convey a design discharge of 451 m3/sec.

#### **Powerhouse Complex** 1.2.3

The powerhouse complex of the project includes 26 m diameter and 135 m high open to sky surge shaft with top located at El 910 m and bottom at El 775 m; butterfly valve chamber; three 5.5 m diameter steel lined pressure shafts of PS-1 & PS-3 (332.8 m) and PS-2 (313.50 m). Each pressure shaft bifurcates into unit penstock of 3.8 m diameter of 41.5 m and 33.0 m lengths. An underground powerhouse with an installed capacity of 1,125 MW (6 units of 187.5 MW each) measuring 210 m (L) x 23 m (W) x 60.5 m (H), a transformer cavern of 190 m (L) x 16.4m (W) x 31.25m (H) dimension located in the right bank hill of the Kurichhu near confluence of Kurichhu and Shongarchhu. The tail race tunnel discharges water back to Kurichhu through two 350 m and 360 m long tail race tunnel with tail race outfall at El 541 m.

#### **Electromechanical Equipment** 1.2.4

The powerhouse shall house six vertical shaft Francis type turbines having rated output of 191.4 MW under a weighted average net head of 276 m at 300 rpm synchronous speed. Each turbine shall be provided with spherical type main inlet valve. Three number penstock valve of butterfly type would be provided at the beginning of the pressure shaft downstream of surge shaft for the maintenance of main inlet valves and meeting the emergency conditions. The generators shall be synchronous and of the vertical shaft type of 187.5 MW rated power at 0.9 power factor and 50 Hz frequency. The generators shall have a speed of 300 rpm and generator voltage of 13.8 kV. Each generating unit will be provided with 10% continuous overload capacity.

The following mechanical and electrical auxiliary equipment would be provided:

- One number 225T/40T/10T EOT crane in the powerhouse cavern, 10 T EOT crane for GIS and 85T/40T EOT crane for penstock valve for installation and maintenance of the heavy equipment
- Cooling water system for generators and generator step up transformers •
- Drainage and dewatering systems •
- Ventilation and air conditioning system •
- Fire protection system •
- Compressed air system •
- Unit auxiliary and station auxiliary supply system





- D.C supply system
- Control and monitoring system
- Protection system, etc.
- E-flow turbine

The generation voltage of 13.8 kV is proposed to be stepped up to 1400 kV through 80 MVA, 13.8/400kV single phase transformers. Nineteen (19) numbers single phase transformers (including one spare) would be installed in the transformer cavern. Considering transport limitations, choice has been made for single phase transformers. The low voltage terminals of the transformers would be connected with the generator terminals through 13.8 kV isolated phase bus ducts laid in the inter-connecting tunnels between the two caverns. 400 kV terminals of the transformers would be connected to 420 kV Gas Insulated Bus Ducts (GIB) with 420 kV GIS located on the floor above the transformers in the transformer cavern. The outgoing feeders from 420 kV GIS shall be connected to 400 kV pothead yard through 400kV XLPE cables.

# 1.2.5 Hydraulic Steel Structures (HSS)

The following hydro-mechanical equipment have been provided in the project.

# Dam Complex

- Four numbers fixed wheel gates with downstream sealing at inlet of each diversion tunnel of size 4.5 m (w) x 11.0 m (h).
- Six numbers top sealing sluice type radial gates of size 9.0 m (w) x15.1 m (h) as main spillway with hydraulic hoists.
- One number fixed wheel type vertical lift gate of size 5.0 m (w)  $\times$  5.5 m (h) as auxiliary spillway with hydraulic hoist gate.
- One set of fixed wheel type stoplogs of size 9.0 m (w) × 18.2 m (h) for main spillways in the dam with electrical operated Gantry Crane.
- Each of the two intake structures with 4 trash-rack bays of 4.6 m (clear opening) with trash rack cleaning machine.
- Two numbers bulkhead gate (maintenance gate) of size 6.8 m (w) × 8.0 m (h) for Intake with rope drum hoist.
- Two numbers service gate of size 6.8 m (w) × 8.0 m (h) for intake with hydraulic hoists.
- Two numbers hinge type gates of size 2.2 m (w) × 2.2 m (h) for HRT Adit-1 and Adit-6 have been provided for inspection and future use.

# Powerhouse Complex

- Three numbers gate of size 4.5 m (w) × 4.5 m (h) for surge shaft with rope drum hoist.
- Two numbers gates each of size 8.0 m (w)  $\times$  6.7 m (h) for tail race tunnel with hydraulic hoists
- Six numbers of draft tube gate of size 4.7 m (W) x 4.4 m (h) with gantry crane

The HSS with a large number of embedded parts, gates and hoists are mainly located in the power intake, the low-level and mid-level outlets of the dam, and diversion tunnels.



## 1.2.6 Power Evacuation

It is proposed to have 2xD/C 400 kV ACSR Moose of twin configuration, extending from Dorjilung to Durungri pooling station (PS). The power aggregated at Durungri PS will subsequently be transmitted to India via a 1xD/C 400 kV ACSR Moose of Quad configuration. This arrangement establishes a radial connection between Dorjilung HPP and the larger national grid. To support the four circuits from Dorjilung HPP to Durungri PS, two tower routes are necessary till Durungri PS where power will be pooled and evacuated to India via 1xD/C Quad 400 kV line. As a contingency, 1xD/C 400 kV twin moose line is also proposed to evacuate Dorjilung power from Durungri to Phuntshothang, where power will be pooled and evacuated to India via 1xD/C 400 kV twin moose line, which will be part of the Nyera-Amari ATS.

# 1.2.7 Environmental and Social Impacts

As a result of the gorge setting for the Project, the Project reservoir will inundate about 360 acres of land (~145.68 ha) and shall result in displacement of one household due to its creation. Use of the Kurichhu River, on which the project is being constructed, is limited, as most local villages are located well above the river and depend on small tributary streams and springs for most of their water needs, so water use conflicts will be minimal. The Kurichhu River is a glacier-fed, turbid and high velocity river that provides aquatic habitat for fish and other aquatic species (invertebrates and planktons). An environmental flow (E-Flow) release of 6 m3/s will form part of the mitigation for aquatic biodiversity impacts to ensure continuous supply of water to the 16 km long diversion reach during the dry season.

The environmental and social components of the Project will be delivered in accordance with the applicable laws and regulations of Bhutan and the World Bank ESF ESS 1 through 8, and 10, as well as applicable safeguards of other co-funders. The impacts of the Project can be managed through a robust Environmental and Social Management Plan (ESMP), the framework of which along with issue/subject specific Environmental and Social Protection Plans (ESPP), a Land Acquisition and Livelihood Restoration Plan (LALRP), Biodiversity Management Plan (BMP), Cultural Heritage Management Plan (CHMP), Labour Management Procedure (LMP - to address peak workforce of 6,300 workers) and Gender, SEA/SH and Vulnerability Action Plan (GSVAP) are included as annexes (Supporting Plans) to the ESIA along with the Environmental and Social Commitment Plan (ESCP).

Additional supplemental studies, as per the World Bank's requirement are in progress for the Study of Opportunities for Net Gain of Terrestrial Biodiversity Features, including No Net Loss for Aquatic Biodiversity. A High-Resolution Environmental Flow Assessment has been completed along with E-flow Management Plan (EFMP).

The ESIA covers all aspects of project built-up area including access roads, construction power line, muck disposal sites, Contractor construction facilities and main project components of Dam, Diversion Tunnel, Head Race Tunnel including 6 Adits, Surge Shaft, Powerhouse and Tail Race Tunnel, among others.

### 1.2.8 Access to the Site

The Kingdom of Bhutan can be reached by air from Bangkok, Thailand; Dhaka, Bangladesh; Kathmandu, Nepal; Singapore and the Indian cities of New Delhi, Kolkata, Mumbai, Bagdogra and



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Guwahati. Bhutan can also be accessed by land through roads from India from several entry points. The project area is spread in two Dzongkhags of Mongar and Lhuentse in Eastern Bhutan, with almost all the project components falling under former except that the reservoir pounding enter in the later Dzongkhag. There is domestic air service on certain days from Paro International Airport to Yongphula Airport under Trashigang Dzongkhag. The road distance from Yongphula Airport to the project sites (Powerhouse at Kurizampa and Intake at Rewan) is approximately 150 km. The lateral East-West highway from the capital city, Thimphu to the project site is about 480 km. Of the many alternative routes available for accessing the project sites by roads, the Nganglam to Gyelpozhing route is the shortest for the project with the distance of about 98 km (Nganglam border to powerhouse site) and 126 km till the dam site. The nearest rail head for the project is at Pathsala, Assam, India located at about 38 km from Nganglam border town.

The dam site is located just below the Mongar-Lhuentse highway while the underground powerhouse is located on the right bank of Kurichhu near Kurizampa. The Headrace Tunnel (HRT) and its construction adits aligned along the right bank of Kurichhu can be accessed by farm roads connecting Thridangbi to Banjar and Ganglapong villages.

# 1.3 Duties and Responsibilities of Key Entities

The following key entities will be involved in the implementation of 1,125 MW Dorjilung Hydropower Project and the roles and responsibilities of each entity are defined in the table below:

- Employer
- Panal of Experts (POEs)
- Design Consultant (DC)
- Contractor
- Owner's Engineer (OE)

Entity	Key Responsibilities
Employer	Ensure all parties engaged to investigate, design, construct, commission, and operate the project are suitably qualified and have their roles, powers, and responsibilities properly defined. Comply with all regulatory requirements, including any requirements specified in conditions attached to consents issued by regulators and the World Bank. Provide the necessary funding to achieve the required quantity and quality of inputs in a timely manner. Make regular payments to the other parties, according to contractual provisions and progress of the works. Process variation orders in consultation with the OE.
Design Consultant (DC)	Endorsement of available DPR data along with sizing and adequacy check Finalize contract packages to optimize resources and timeline of projects Preparation of complete bidding documents as per contact packages and assist in contract award in close coordination with Employer Detail Engineering and Design of Civil and Hydro Mechanical Works; Review and approval of detailed designs and drawings of the E&M works in consultation with Employer;



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	Prepare and issue the construction design memo/notes, and drawings well in advance and interact with the Employer and OE; and
	Coordinate with the Employer and OE to ensure that any changes required during construction meet the design criteria and do not impair the safety of the structure. As appropriate, assist the Employer and OE in reviewing those Contractor submittals that have design relevance and that the proposed materials and methodologies are consistent with the design intent.
	The Employer shall appoint "Engineer" and "Engineer's Representative" who shall carry out the duties assigned to the Engineer and Engineer's Representative as per the FIDIC Conditions of Contract for Construction and the Owner's Engineer shall assist Employer in the implementation, monitoring and supervision of construction works;
	Provide the Employer with contract management support, ensuring effective administrative links between the Employer and Contractor(s);
	Develop and operate a quantitative and qualitative project performance monitoring system (PPMS) in consultation with the Employer to monitor and evaluate the performance of the project in relation to its goals, purposes and outputs;
	Ensure that the construction work is carried out in accordance with the contract design and specifications, typically with a team including full-time specialists;
Owner's Engineer OE)	Review and recommend to the Employer for approval of the Contractor's Quality Assurance Plan and monitor its effectiveness throughout construction, including the review of the Contractor's test records for compliance with the specifications and the design assumptions and additional tests or inspections as needed;
	Review and recommend to the Employer for the approval of the Contractor's method statements and work programmes before construction as required in the technical specifications for all important elements of the project and check for any non-compliant methods, equipment, or materials to be corrected before work commencement;
	Assist in review of Contractor(s) claims and variations in a timely manner and advise the Employer accordingly;
	Coordinate with the Design Consultant to resolve any design changes that may be dictated by changed conditions or findings during construction;
	Assist the Employer in cost optimisation with innovative design changes; and



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	Preparation of a comprehensive final completion report of the construction contract packages.	
	Provide all required resources for delivering quality construction works in a timely manner;	
Contractor	Submit method statements before construction to demonstrate an understanding of the design as required in the specifications for all important elements of the project subject to the approval or review by the OE; and	
	Employ qualified staff with full understanding of the design and experiences of similar type of projects to detect when variations to specified procedures are necessary (for example, foundation treatment, material selection and placement, filter manufacture and testing, or concrete manufacture and testing).	
PoE	Review and provide expert advice and recommendations on the critical design aspects and construction issues during the implementation of the project.	

### 1.4 General Scope of Services

The Design Consultant (DC) shall serve as design and engineering consultant including preparation of bidding documents and assist in contract award services for implementation of 1,125 MW Dorjilung Hydropower Project. The services provided by the DC shall conform to the international best practices and standards. The DC shall carry out all activities through a team consisting of engineers and relevant professionals, as required. The DC shall provide its services through combination of home and field deployments. The DC shall coordinate with the Employer for expeditious and timely delivery of services and ensure site adaptation of designs, as required.

The requirements of services from the DC defined in this ToR are not exclusive, exhaustive or limited. The DC shall be required to provide services not envisaged or specifically mentioned therein, but are otherwise required for completion of the project.

The general scope of services shall be, but not limited to, the following:

- i) Review and update of existing design criteria, memos and notes for the project;
- ii) Review and update geotechnical reports including Geological Baseline Report (GBR) incorporating tests data from the additional investigations;
- iii) Finalize contract packaging philosophy;
- iv) Preparation of bidding documents and assist in contract award services;
- v) Assist employer in the complete package wise bidding process till award including preparation of prequalification criteria;
- vi) Preparation of master document list (MDCL) with target dates and submission of documents as per target dates;
- vii) Prepare all design and engineering notes/memos, drawings and specifications required for the construction of the projects well in advance including the E-flow generating units on the Dam toe;





- viii) Review of detailed engineering documents, drawings and design memos/notes for E&M works including the E&M equipment for E-flow generating units;
- ix) Review and recommend any changes or modifications as per site conditions;
- x) Detail Design Engineering for Civil and H&M works including the E-flow generating units; and
- xi) Participate in project coordination/review meetings with Contractor(s), equipment manufacturers/ suppliers and vendors, as and when required.

### 2 Scope of Services

The scope of the services shall be, but not limited to, the following:

#### 2.1 Preparation of Bidding Documents and Contract Award Services

The Project will have the following four to five main Works contract packages:

### i) Civil and H&M works (3 to 4 packages)

Construction of the headworks structures including feeder tunnel, construction headrace tunnel, pressure tunnels, pressure shaft, surge tank and penstock protection valve chamber including all construction adits, construction of the underground powerhouse, underground transformer cavern, pothead yard and tailrace tunnel including all excavation and concrete works. Further including design, supply and installation of hydromechanical equipment for the whole project components.

#### ii) Electromechanical Work

Design, supply and Installation of turbine & generators and related main control equipment, design and supply of electrical auxiliary and general equipment for powerhouse and general electrical and control equipment for the headworks, design and supply of mechanical auxiliary equipment for powerhouse and headworks (HVAC, drainage equipment, etc.).

The DC shall propose the contract packaging philosophy to optimize resources and timeline of projects.

#### 2.1.1 Prequalification

The DC shall prepare the prequalification documents for each contract package, based on the World Bank "Document for Initial Selection of Applicants for the Request for Proposals". The DC shall ensure that these documents conform to the applicable laws within Bhutan and the procurement guidelines of the World Bank and other financing agencies. It shall be made clear that the procurement process shall be quality and price based. It shall be ensured that the qualification requirements for applicants are carefully defined, are appropriate for the Project and should lead to a competitive short list of prospective bidders.

The DC shall assist the Employer in pre-qualification announcement, issue of addendum/corrigendum, and clarifications to the applicants' queries.

The DC shall, jointly with the Employer, evaluate requests for prequalification based on the evaluation criteria and submit the evaluation report.



#### 2.1.2 Tendering Stage

The DC shall prepare the Bidding Documents incorporating all the information required as per the World Bank standards. Tender documents shall include all information required, in particular and without limitation, interface management requirements, Employer's requirements, GBR, Schedules of Baselines, Bills of Quantities, detailed specifications, bid drawings and reference information.

The Bid Documents for Civil and H&M Works shall be prepared in the context of FIDIC "Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer" First Edition 1999 (Red Book) while the Bid Document for Electro-Mechanical Work shall be prepared in accordance with the FIDIC "Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Plant, and for Building Works, designed by the Contractor" First Edition 1999 (Yellow Book).

The DC shall incorporate all the requirements from the following reports while preparing the bidding documents:

- i) DPR update 2024;
- ii) ESIA update 2024;
- iii) World Bank Dam Safety Documents; and
- iv) Recommendations of PoE.
- v) DPR 2015 (to be referred if required)

DC shall ensure that the qualification requirements are carefully defined for main and sub-contractors, are appropriate for the Project and should lead to a competitive tendering process. The interfaces between the contract packages shall be carefully specified and ensure that there is no gap or overlap in the services/facilities including design continuity.

#### 2.1.3 Pre-bid Stage and Pre-bid Meeting

Assist the Employer in reviewing the queries received from the prospective bidders and prepare replies to the queries in accordance with the provision of the Bidding Documents. Participate in the pre-bid meetings with the bidders and advise and provide clarifications on any queries.

#### 2.1.4 Bid Evaluation Stage

The DC shall assist Employer to evaluate bids, prepare a bid evaluation report and conduct technical clarification meetings for resolution of any technical issues and aspects of the Bidding Documents, bidders' offers and contract negotiation meeting. In such evaluation, the DC shall carefully confirm that bidders' submissions in their technical proposal including, any alternative suggested by bidder, site organization, mobilization schedule, method statement, construction schedule, safety plan, and EMP, etc. have been prepared in consistent with each other and meet requirements set forth in applicable laws and regulations, specifications and other parts of the bidding documents.



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#### 2.2 Design, Engineering and Drawing Services

- i) Review the overall layout of the project including requirement of any additional investigations such as geotechnical, physical model studies, etc. necessary for the project;
- ii) DC shall be responsible for updating the DPR drawings (Civil, H&M and E&M) as per the requirements of works;
- iii) Review of basic design (Design Criteria and Specifications, etc.) for Civil, E&M and H&M Works, site technical inspection, if necessary, design interfacing between Civil, H&M and E&M works;
- iv) Development of Design Basis Report for Civil, H&M and E&M works including development and submission of drawing List (Master Drawing List) along with schedule of submission and E-flow generating units. After approval, the Design Basis Reports along with the approved Schedule of Release of Construction Drawings, DC shall proceed with Detailed designs of components;
- v) Design Basis Report and Optimization for the detailed design of each component will be established by the DC right at the beginning of the work. These shall comprise of design requirements, assumptions and standards to be used in the design. These optimization and Design Basis Report shall be detailed enough to serve as basis for the design of the Project;
- vi) Conduct Transient/Surge Analysis for Civil and H&M Designs;
- vii) Detail Design Engineering for Civil and H&M works including CFD/Numerical modelling and suggest cost optimization measures;
- viii) Review and recommend for approval the detailed designs, drawings and specifications for all the E&M work submitted by the Contractor;
- ix) During detailed design and engineering, the DC may propose to modify or change the design of the Civil and H&M Works of the Project as described in the "DPR Update 2024" for technoeconomic reasons and time effectiveness provided always that the design of the Project shall be in accordance with the DPR parameters, International best practice and standards and shall meet Employer's requirements for the performance of the Works as warranted under the Contract. Such changes should be brought out in a detailed Design Memo to establish the proposal which is to be executed on specific approval of the Employer. Such changes shall not entitle the DC to additional cost, whatsoever, other than the Contract Price;
- x) Additional technical data and information related to the Project and available with the Employer and required for the Works shall be furnished to the DC without charge and the Employer may without obligation give such assistance or obtaining of any additional data and information as may reasonably requested by the DC. Further, all information of the E&M contract package received from the various suppliers such as dimensions, loads, arrangements, cables, ducts, pipes, etc. will be made available to the DC for interface engineering and establishing reference co-ordinates and alignments of each individual structure for the preparation of construction drawings;
- xi) Physical hydraulic model tests and studies shall be carried out through an entity approved by the Employer. The model studies will be mainly required for head works including the energy





dissipator and reservoir sedimentation, TRT etc. The DC shall witness and work closely with the model testing entity through the Employer in carrying out model studies;

- xii) DC to note that Green Building Design Concept shall be used for the project;
- xiii) DC shall be responsible for review of all the study report and suitable incorporation of the outcomes from the study in their design and drawings;
- xiv) DC shall witness performance testing, evaluate test reports and provide independent assessment as requested by the Employer; and
- xv) The DC shall be deemed to have scrutinized the Employer's/Employer's representative/ OE/ POE requirements and shall be responsible to comply with the same.

The detailed scopes under Design and Engineering shall be, but not limited to, the following:

#### 2.2.1 Preparatory Work

- i) Review and update designs and drawings of the DPR Update 2024 for approval by the Employer and prepare tender level drawings;
- ii) Prepare specifications and Bill of Quantities;
- iii) Review and update geological and geotechnical reports including Geological Baseline Report (GBR) incorporating tests data from the additional investigations if available;
- iv) Prepare the designs and drawings for dumping yards according to the DPR Update 2024 and ESIA Update 2024; and
- v) Prepare and submit complete bidding documents for Civil, E&M and H&M works for approval by the Employer.

#### 2.2.2 Additional Investigations and Tests

- i) Review available geological and geotechnical reports including GBR and Geotechnical Data Report (GDR) and propose additional investigations, deemed necessary, for detailed design;
- ii) Conduct numerical and physical hydraulic model tests and accordingly perform the design and engineering services. The model studies shall be carried out with relevant IS and International standards/practices
- iii) Review available topographical survey information and propose additional survey if deemed necessary; and
- iv) Prepare and submit reports for review/approval of the Employer.





#### 2.2.3 Basic and Detailed Design

- i) Preparation of basic design will be part of the detailed planning, and will include general arrangement drawings for all the project components (Civil including structural, E-flow generating units, H&M and E&M works);
- ii) The DC shall prepare and submit Engineering studies, design and analysis, design calculations, etc., carried out against each civil structure in the form of "Design Report" along with construction drawings for approval of Employer;
- iii) The DC shall comply with the followings in the preparation of Design Reports, wherever applicable:
  - use accredited/validated software and the same shall be indicated; and
  - submit printout and softcopies of all pages as appeared in output of the computer program without disturbing the output as generated by the program. DC shall also submit all the Input files used for analysis and design.
- iv) Numerical hydraulic modelling/CFD of head works of the projects including spillway inlet (and discharge coefficients), intake structure and tail race outlet shall be carried with the commercial software's having capability for analysis related to Hydraulic Engineering and water management which has advance techniques for handling free water surface, to be agreed with the Employer, to optimize the design and for ensuring its hydraulic design requirements and incorporating same in detailed engineering.
- v) Physical hydraulic model tests and studies shall be carried out through an entity approved by the Employer. The model studies will be mainly required for head works (large scale) including the entire spillway, plunge pool and reservoir sedimentation while a smaller scale for one chute to study the inlet coefficient and aerators. The DC shall work closely with the model testing entity through the Employer in carrying out model studies and results obtained from model studies shall be utilized for the detail design and drawings of the said components.
- vi) Review and update (if any) the following Dam Safety Documents in line with the framework available in DPR Update 2024:
  - Instrumentation Plan
  - Operation and Maintenance Plan (O&MP)
  - Emergency Preparedness Plan
- vii) Prepare Construction Supervision and Quality Assurance Plan (CSQAP) in line with Terms of Reference available in DPR Update 2024;
- viii) Review available data with respect to river sediments (concentration, petrographic, and grain size for suspended particles) for establishment of design criteria;
- ix) Undertake detailed design and study to optimize the transformer cavern (possible relocation of GIS and pre-consolidation of the cavern crown) and carry out 3D FEM Numerical Modelling of Powerhouse and Transformer Cavern;
- x) Conduct slope stability analysis and design of Dam Left Bank due to the presence of colluvial material deposit;





- xi) Conduct reservoir rim stability analysis and stabilization measures for potential landslides and recommend additional investigations if necessary;
- xii) Conduct mix design and tests for Roller Compacted Concrete;
- xiii) Preparation of design criteria, memos, notes and Specifications of all Civil and H&M works and submission to the Employer for review/approval;
- xiv) Based on the finalized project layout and design of the project, the transient analysis of the project shall be carried out using appropriate software "SIMSEN" or to be agreed with the Employer. The transient analysis shall be carried out for checking the reliability of water conductor system of project and also support the E&M requirements which is related to the transient analysis;
- xv) Preparation of detailed design and drawings for the Civil and H&M Works in compliance with Bhutanese guidelines and international best practices & standards (with special attention to: anchorage system for gate supports of dam spillway, foundation treatment in river bed, cofferdam imperviousness, fault treatment in HRT, weak zones treatment in Powerhouse, spillway chute concrete and reinforcement, and spillway gates size);
- xvi) Review 3D dynamic FEM analysis carried out during DPR Update 2024 for the dam and update if necessary;
- xvii) Conduct thermal analysis for dam concreting and optimization of dam section;
- xviii) Conduct detail dynamic analysis and design of the powerhouse machine foundation and associated structures using appropriate software;
- xix) Develop 3D models of Civil, H&M and E&M work for visualization and integration;
- xx) Review and prepare all instrumentation planning and design including drawings and specifications required during the construction and operation phase of the project;
- xxi) Monitor the progress of Civil and H&M Works to verify the suitability of the design during construction, and to make or initiate modifications as may be required;
- xxii) DC shall also prepare Schedule of Release of Construction Drawings along with "Design Basis Report and Optimization" for various Civil and H&M works and submit it to Employer for approval. The schedule shall be reviewed and resubmitted whenever required to be updated, matching with the construction schedule of the Project. Drawings shall be submitted without delay in line with the approved Schedule;
- xxiii) DC shall also finalize the format of the drawings in consultation with Employer;
- xxiv) Prepare manuals required for the operation and maintenance of the Civil and H&M Works, including a Manual for the initial filling-up of the Reservoir and Water Conductor System as part of the commissioning;
- xxv)Review and approve the detailed designs, drawings and specifications for all the E&M Works submitted by the Contractor(s);





- xxvi) Identify the gap, inaccuracy and inadequacy of design and engineering done by the E&M Contractor(s) and provide appropriate measures for its correction;
- xxvii) Prepare and submit Construction Drawings marked as "Good for Construction" and such additional design reports as may be required including the manuals as above; and
- xxviii) Maintain the records of any change in approved designs and drawings during the implementation at site and shall certify and resubmit in 'As-built Drawings'.

#### 2.2.4 As-Built Drawings

i) Preparation and submission of As-built Drawings for Civil and H&M packages to the Employer for approval.

#### 2.3 Field Visits

The DC, during the execution of the consultancy services, shall visit the project sites and contractor's facility as and when required and requested by the Employer. The number of experts and discipline including the duration of the site visit will be decided in consultation with the Employer as per site requirements.

The first site visit shall be immediately after the award of the consultancy service to assess the suitability of the locations of each project components for finalizing optimization of components as per the framework of DPR. while the subsequent visits shall be communicated by Employer as and when required.

#### 2.4 Interface Between Stakeholders

- i) Interface management between different packages during the design and engineering and ensure that there is no gap or overlap in the services/facilities including design continuity; and
- ii) Co-ordination with Employer, consultant(s) and Contractor(s) to ensure smooth interfacing of work activities.

#### 2.5 Additional Work

If in the opinion of Employer, it is necessary to carry out any additional works in addition to the Services, the DC, with written orders of Employer, shall carry out such additional works and costs of same shall be paid by the Employer on production of documentary evidence by the DC as per actual based on the agreed person-day rate under the variation order issued by Employer.

### 3 Project Management Structure

The Team Leader of the DC shall report directly to the Person appointed by the Employer. For multidisciplinary functions, the DC shall work closely with the different formations of DHPP as provided below:

- Engineering and Design Division for Civil works;
- EM & HM Division for H&M and E&M works;
- Contracts and Procurement Division for Contractual aspects; and



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• Technical Support Section for Schedules, plans and coordination aspects.

The DC shall set-up an office in Thimphu initially until award of main packages and later at the project site, for smooth coordination and delivery of services on time. The Consultant shall be responsible, and shall include costs, for all other facilities required for his staff including air transportation, accommodation, per diem, and costs for visa and work permits for the duration of the assignment.

### 4 Schedule

The duration for the implementation of 1,225 MW DHPP is as given in the table below and the duration of the consultancy services for the DC will be the same as the duration of the project; however, in the event that the projects are delayed for reasons not attributable to the DC, DC shall remain under obligation to extend the duration of consulting services, as may be required, to complete the projects. The Master Schedule for the Project is attached as Annexure.

The construction duration for DHPP is as under:

SN	Particulars	Duration (months)
1	Preparatory works	18
2	Project Construction	60

### 5 Reporting

### 5.1 Deliverables

The DC shall submit the following detailed reports in an electronic copy for the project including editable version such as excel design sheets, AutoCAD files, shape files and word documents. Further, all the documents shall be uploaded in cloud data storage (data management system) for easy access and documentation. All the reports and subsequent comments/suggestions of the Employer shall be documented, incorporated and submitted to Employer:

- i) Inception Report summarizing the DC's state of mobilization, DC's obligations, methodology for undertaking the assignment, frequency of reporting, schedule of designs and drawings and framework for site meetings, list of software to be used for the work and record keeping. This Report shall be submitted within 1 month from date of Letter of Award;
- ii) **Design Reports and Drawings** consisting of all design criteria/memos including engineering calculations, analysis, drawings, method statement, reports, references, etc. prepared by the DC and review reports on the designs, drawings and specifications submitted by the E&M Contractor during the execution of its duties under this Contract shall be submitted to Employer as per the Milestones in Section 6;
- iii) As-Built Drawings incorporating all the changes during implementation stages for Civil and H&M Works shall be prepared and submitted to the Employer after incorporating any comments by the Employer; and





- iv) Other Deliverables and Review of following reports/document:
  - Construction monitoring, inspections, Testing and commissioning procedures and reports;
  - Monthly Progress Report;
  - Reports and reviews for site visits;
  - Presentations for Management whenever required;
  - Design Safety Reports on Dams; and
  - O&M Manual for Civil works including initial water filling.

#### 5.2 Reporting Procedure

- One month after the date of "Letter of Award", the DC shall submit to the Employer a Work Programme showing the details of design and engineering services including preparation of bidding documents and contract award services to be carried out to complete the implementation of DHPP. This Work Programme shall be aligned to the Master Work Programme of the project to ensure that design and drawings (approved) are available minimum 1 (one) month in advance of the start of the construction activity;
- ii) The Work Programme shall show major activities such as but not limited to submission of bidding documents, design reports, hydraulic model study, drawings, etc. indicating the methodology for phase-wise submission as per the Milestones and Deliverables of the ToR. The detailed design criteria/memo for the project components shall be submitted to the Employer for approval 3 (three) months in advance of the start of the construction activity. The drawing and relevant standard for the aforesaid component of Works shall be based on the approved criteria and submitted at least two months prior to the start of the construction activity;
- iii) The number of copies of the Reports and other Documents to be submitted to the Employer by the DC is specified as below:
  - a) Design criteria/design basis/design memo, Drawings of Civil and H&M works for information/comments shall be submitted in soft copies (both editable and non-editable format);
  - Beview reports with comments/recommendation for approval of the designs, drawings and specifications submitted by the E&M and H&M Contractor(s) shall be submitted in soft copies;
  - c) Drawings for the Construction of Civil and H&M Works and interfacing components shall be submitted in soft copies (both AutoCAD and PDF);
  - d) O&M manuals and any other documents shall be submitted in set of 2 (two) hard copies along with the soft copy; and
  - e) Monthly reports shall be submitted in soft copy.
- iv) The DC shall successively submit the design and drawings for comments (if any) of the Employer in accordance with the agreed schedule. The Employer shall give comments on all designs and drawings within 30 days of the date of receipt;
- v) In case the Employer has any comments on such documents, technical discussions shall, if required, be held thereafter without delay to finalize the Drawings;





- vi) In case comments of the Employer have not been communicated within the stipulated 30 days then the DC shall notify the Employer immediately and if the Employer does not comment within next 15 days the DC shall proceed ahead with the Works considering that the Employer has reviewed the designs and drawings and has no comments to offer;
- vii) The DC shall review the designs, memos, design notes, specifications and drawings of E&M package and accordingly consult with Employer, for approval by DC within 14 calendar days of the date of receipt of the same;
- viii) The DC may make minor alterations to designs during the course of construction as may be necessary or expedient, under prior intimation to the Employer. If errors, omissions, ambiguities, inconsistencies inadequacies or other defects are found in the design and drawings submitted by the DC, these documents and the Works shall be corrected at the DC's cost notwithstanding any consent or approval thereof by the Employer;
- ix) In case the Employer requests amendment of an approved report/design/redesign or revoke such approval and such request by the Employer is as per site requirement for proper completion and functioning of the Works, the DC shall without any cost to the Employer, redesign/revise/revoke the same;
- x) The DC shall inform the Employer about the software to be used for analysis and design for endorsement; and
- xi) The final drawings/documents to be submitted but not limited to are as below:
  - A) Civil and H&M Works
    - i) Design criteria
    - ii) Design memo
    - iii) Detailed Specifications
    - iv) General arrangement and layout drawings of each component and its related structures.
    - v) Report on Hydraulic Model Studies
    - vi) Detailed Design Calculations (Hydraulic and Structural)
    - vii) Excavation Drawings
    - viii) Concrete outline drawings
    - ix) Reinforcement drawings
    - x) Structural steel and fabrication drawings
    - xi) Foundation treatment drawings
    - xii) Lift drawings
    - xiii) Assembly drawings.
    - xiv)Instrumentation drawings
    - xv) Reservoir Rim Treatment Drawings
    - xvi)As-built Drawings
    - xvii) Manuals

### B) Electro-Mechanical Works



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- i) Design Review Reports of all the E&M works including designs and drawings submitted by the Contractor(s); and
- ii) General arrangement and interface drawings.

Note: All the documents, reports, software files (input & output), drawings, etc. shall be the property of the Employer and no data shall be used for other purposes by the DC without the consent of the Employer.

#### 6 Milestones

S.N.	Report / Document	Deadline	
1	Milestone 1	1 month from the Letter of Award	
2	Milestone 2	3 months from the Letter of Award	
3	Milestone 3	6 months from the Letter of Award	
4	Milestone 4	The DC shall submit the schedule for the	
5	Milestone 5	- The DC shall submit the schedule for the	
6	Milestone 6	Schodulo	
7	Milestone 7	Schedule	

### 6.1 Milestone 1

- i) Site Visit
- ii) Inception Report
- iii) Work Programme

### 6.2 Milestone 2

- i) Design Basis Report for each component;
- ii) Master Drawing List (MDL);
- iii) Review and update design criteria and notes for the project;
- i) Review and update geotechnical reports including GBR and GDR;
- ii) Submission of finalized pre-qualification documents; and
- iii) Submission of finalized bidding documents of Civil and H&M Packages.

# 6.3 Milestone 3

- i) Submission of finalized bidding documents of EM packages;
- ii) Submission of detailed design and study on optimization of the transformer cavern (possible relocation of GIS and pre-consolidation of the cavern crown);
- iii) Furnishing of all inputs needed for the award of Physical and Numerical Hydraulic model test(s); and
- iv) Issue of construction drawings (portals, excavation & support drawings, and concrete & reinforcement details) related to all adits including pre-grouting tunnels in the Powerhouse and Diversion Tunnels.

### 6.4 Milestone 4

i) Submission of slope stability analysis report of dam left abutment;





- ii) Submission of Roller Compacted Concrete mix design and test reports;
- iii) Submission of slope stability analysis and stabilization measures for landslide on right bank upstream of dam site; and
- iv) Finalization of basic design and layout of the Project.

# 6.5 Milestone 5

- i) Issue of construction drawings for upstream and downstream coffer dams;
- ii) Issue of construction drawings related to excavation and support details of Dam/Headworks, HRT, Surge Shaft, Pressure Shaft, BVC, powerhouse complex, pothead yard and TRT;
- iii) Submission of Thermal Analysis report; and
- iv) Submission of Physical and Numerical Hydraulic model test(s) reports.

# 6.6 Milestone 6

- i) Issue of construction drawings related to Concrete and reinforcement details Dam/Headworks, HRT, Surge Shaft, Pressure Shaft, BVC, powerhouse complex, pothead yard and TRT;
- ii) Submission of review reports of EM and HM work packages; and
- iii) Issue of construction drawings related to the Dam and Powerhouse incorporating/integrating requirements of H&M and E&M structures.

# 6.7 Milestone 7

- i) Manuals required for the operation and maintenance of the Civil Works, including a Manual for the filling-up of the Reservoir and Water Conductor System.
- ii) Submission of design memo/report and As-Built Drawings.
- iii) Native files of all drawings, document & 3D model to be submitted to Owner as and when asked for and at the end of the project.

# 7 Terms of Payment

90% of Contract Price shall be paid as per the achievement of Milestone as foreseen in the TOR. Payment for each Milestone shall be as under:

- 5% of 90% Contract Price on achievement of Milestone 1
- 15% of 90% Contract Price on achievement of Milestone 2
- 15% of 90% Contract Price on achievement of Milestone 3
- 10% of 90% Contract Price on achievement of Milestone 4
- 25% of 90% Contract Price on achievement of Milestone 5
- 25% of 90% Contract Price on achievement of Milestone 6
- 5% of 90% Contract Price on achievement of Milestone 7

10% (Ten percent) of the Total Contract Price shall be released after the issuance of final completion certificate by the Client.

# 8 Key Experts

The DC shall provide design and engineering services in collaboration with the design team from Employer. While the number and expertise of experts from DC to be deployed are listed below, the DC





shall have the full range of experts required to provide completeness of services for the successful implementation of the project.

DC shall ensure the continuity of its identified and approved personnel for the entire duration of the execution of contract. In case of any unavoidable change of any deployed person, DC shall inform the Employer about the change well in advance and shall timely replenish the same with Employer's consent without affecting the quality, quantity or scope of work progress.

The duration for experts, either home or field, has not been stipulated since this is a **Lump Sum Contract**. The Bidder shall make its own estimate of the level of efforts required to complete this contract. The supporting staff and any other experts required for completion of this contract shall be arranged by the Consultant (successful Bidder) without additional cost to the Employer. The following Minimum Key Experts are Required:

SN	Key Experts (International)	No. of Experts
1	Hydropower Expert (Team Leader)	1
2	Engineering Geology Expert	1
3	Hydraulic Expert	1
4	Dam/Headwork Expert	1
5	Underground Structural Expert	1
6	Electro-Mechanical Expert	1
7	Hydro-Mechanical Expert	1
8	CAD Expert	1
9	Contract and Procurement Expert	1
	Total	9

The Hydropower Expert (Team Leader) or Engineering Geology Expert shall be stationed at the project site after the award of the main contracts. The other experts shall visit the project sites as and when required and requested by the Employer. The number of experts and discipline including the duration of the site visit will be decided in consultation with the Employer as per site requirements. The first site visit shall be immediately after the award of the consultancy service while the subsequent visits shall be communicated by Employer as and when required.

### 9 Qualification and Responsibility of Key Experts

The Key Experts of the DC shall have the qualifications as stipulated hereunder and perform the following activities:

### 9.1 Hydropower Expert (Team Leader)

The Hydropower Expert from DC shall meet the following qualification criteria:

- Minimum of Master's Degree with Bachelor's Degree in Civil/hydropower engineering;
- At least 15 years of experience in the design, supervision and monitoring of similar hydropower projects/contracts of at least 500 MW capacity;





- Minimum of 5 years' experience in project management at senior level in a similar kind of project/ contract of at least 500 MW capacity;
- Have worked as a Team Leader in at least one project of similar kind and scope.
- Experience of assistance of ICB tender and construction supervision for Hydropower Projects.

The Hydropower Expert's principal responsibilities include, but not be limited to the following summarized tasks:

- Responsible for coordination and overall activities of team members
- Represent the DC in all contractual activities and be the point of contact for the DHPP to communicate;
- Coordinate with a Person appointed by the Employer and ensure the provision of all services required to be provided by the DC on time;
- Plan design works with the team and supervise all the DCs' activities and outputs for the overall design works;
- Conduct site visits to assess the site conditions and performance in terms of implementation of works as and when required;
- Assist Employer in issuing Taking-Over Certificates to the Contractor;
- Prepare and submit the deliverables to the Director Technical, DHPP as per the ToR

### 9.2 Engineering Geology Expert

The Engineering Geology Expert shall have:

- A minimum of Master's Degree in Geology /Engineering geology
- Relevant professional experience of at least 15 years in hydropower projects of with at least 5 years in Himalayan Geology
- Experience in the geotechnical engineering, soil and rock mechanics in at least two hydropower projects of at least 500 MW capacity;
- Experience in RMR and GSI classification system.

The Engineering Geology Expert's responsibilities include, but not be limited to the following summarized tasks:

- Review of available data;
- Conduct site visits to assess the site conditions and performance in terms of implementation of civil works as and when required;
- Review and make recommendations for any subsequent investigations to make the data available for relevant design and engineering;
- Review rock mass characterization for all underground facilities;
- Identify and analyse potential risks of landslide, seepage and other hazards in reservoir, dam safety/monitoring/instrumentation and disaster risk assessment & management plan.
- Review and preparation of all instrumentation planning and design including specifications required during the construction and operation phase of the project as per the Dam Safety Documents;





- Monitor and analyse the reading of measuring devices/instruments, establish frequencies
  of reading and documentation of data;
- Provide relevant design data and information for detailed design and engineering of the project; and
- Recommend requirement for additional investigations, if any.

# 9.3 Hydraulic Expert

The Hydraulic Expert shall have:

- A minimum of Bachelor's Degree in Civil/Hydraulic/Hydropower Engineering;
- Relevant professional experience in the hydraulic designs of hydropower projects for at least 10 years;
- Experience in the hydraulic design of at least two hydropower projects of 500 MW capacity or more.

The Expert's work shall include, but not be limited to the following:

- Provide technical expertise by reviewing the available data and designing the project components in collaboration with other experts;
- Conduct site visits to assess the site conditions and performance in terms of implementation of civil works as and when required;
- Provide relevant design data and information to other designers for detailed design and engineering of the project;
- Provide relevant data and information for Physical and Numerical Model studies;

### 9.4 Dam/Head Works Expert

The Dam/Head Works Designer shall have:

- A minimum of Bachelor's Degree in Civil/Hydropower/Structural Engineering;
- Relevant professional experience in the design and construction of Dams and head works of hydropower projects for at least 10 years;
- Experience in the design of Dams and head works of at least two hydropower projects of 500 MW capacity or more.

The Expert's work shall include, but not be limited to the following:

- Provide technical expertise by reviewing the available data and designing the project components in collaboration with other experts;
- Review of measuring devices and investigations required to prepare final design computations and drawings, i.e. all work necessary to establish the detailed input data and design criteria. This will involve advising the Employer on laboratory and field equipment/instrumentations required, and drawing up a detailed programme of field testing/instrumentation and measurement to be carried out during construction;
- Prepare the dam foundation design for the control of bypass seepage and suggest design measures to minimize the seepage.
- Assess the slope stability at the dam abutment. contract





- Prepare the reservoir rim stability, sediment assessment and management plan.
- Review the construction material suitability for the dam construction.
- Conduct site visits to assess the site conditions and performance in terms of implementation of civil works as and when required;
- Provide relevant design data and information to other designers for detailed design and engineering of the project
- Provide relevant data and information for Physical and Numerical Model studies;
- Prepare and submit the monitoring program for the construction and operation phases on Dam safety aspects to determine if objectives and activities are appropriate in light of current and predicted project impacts. Recommend revisions and/or additional components as necessary.

#### 9.5 Underground Structural Expert

The Underground Structure Engineer shall have:

- A minimum of Bachelor's Degree in Civil/Geotechnical /Structural Engineering;
- Relevant professional experience in the design and construction of underground caverns, underground tunnels and shafts of hydropower projects for at least 10 years with 3 years of experience in Himalayan geology;
- Experience in the design of at least two hydropower projects of 500 MW capacity or more.

The Underground Structure Engineer's responsibilities include, but not be limited to the following summarized tasks:

- Review and check the geotechnical input data and the criteria for the design of project components. This includes the review of all available geotechnical and other reports and conclusions drawn therefrom, and a review of the construction programme from the geotechnical aspect;
- Review of measuring devices and investigations required to prepare final design computations and drawings, i.e. all work necessary to establish the detailed input data and design criteria. This will involve advising the Employer on laboratory and field equipment/instrumentations required, and drawing up a detailed programme of field testing and measurement to be carried out during construction;
- Review and prepare the optimized layout of the above structures based on the geological, hydrological and geotechnical studies.
- Carry out Design and engineering of waterways such as the intake, headrace tunnel, surge tank, pressure shafts and penstock in collaboration with other designers;
- Carry out structural Design and engineering of project components such as machine foundations, powerhouse, etc. in collaboration with other designers;
- Conduct site visits to assess the site conditions and performance in terms of implementation of civil works as and when required;
- Provide relevant design data and information to other designers for detailed design and engineering of the project



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- Prepare and design the installation and monitoring of all geotechnical instrumentations. Shall review readings of these instruments regularly and recommend remedial measures where required;
- Work closely with other designers and discharge of his responsibilities;

#### 9.6 Electro-Mechanical Expert

The Electro-Mechanical Engineer shall have:

- A minimum of Bachelor's Degree in Electrical or Mechanical Engineering or related area;
- Relevant professional experience in the design and preparation of design specifications of powerhouse electrical equipment at least 10 years.
- Experience of design of at least two hydropower projects of 500 MW capacity or more.

The Electro-Mechanical Engineer's responsibilities include, but not be limited to the following summarized tasks:

- Review and recommend for approval all documentation, design, notes/memos, drawings, quality assurance plans, test schedules, etc. prepared by E&M Contractor(s) for electrical systems and mechanical components;
- Review and recommend for approval the method statements, construction methodologies, construction plan, and quality plans and provide advice for modifications/revisions, if any, within the time frame to provide timely approvals to Contractor(s);
- Review the E&M package Contractor's designs of the automatic control system for the hydropower station ensuring that all operating requirements for the single or joint control and individual loading and unloading of units can be met by the specification, both for the manual system and the supervisory control and data acquisition (SCADA) equipment;
- Review the E&M package Contractor's designs and documents, making recommendations for changes or adjustments of the designs, drawings or specifications where necessary;
- Check the design of the electrical components and control equipment with regard to the methods of installation;
- Assist the Contractor to develop and coordinate detailed test procedures for factory acceptance test, unit test, both dry and wet commissioning and participate in the supervision of these tests;
- Review the detailed requirements and standards to be used in the circuit diagrams to be submitted by the E&M Contractor with their installation and the specifications of the equipment with regard to international and local standards;

### 9.7 Hydro-Mechanical Expert

Hydro-Mechanical Engineer shall have:

- A minimum of Bachelor's Degree in Mechanical Engineering;
- Relevant professional experience in the design and installation, testing and commissioning of Gates, Hoists and steel lining for hydropower projects for at least 10 years.
- Experience of design of at least two hydropower projects of 500 MW capacity or more





The Hydro-Mechanical Engineer's responsibilities include, but are not limited to the following summarized tasks:

- Review and check the input data and the criteria for the design of project components. This includes the review of all available information and other reports and conclusions drawn therefrom, and a review of the technology from the operational aspect;
- Review of specifications for H&M manufacturers;
- Review the optimized hydro-mechanical system for the project to operate remotely.
- Review the detailed Design and engineering of each H&M components designed by the H&M Contractor;
- Conduct site visits to assess the site conditions and performance in terms of interfacing of civil and H&M works as and when required;
- Provide relevant design data and information to other designers for detailed design and engineering of the project;
- Work closely with other designers and discharge his responsibilities;

# 9.8 CAD Expert

CAD Expert shall have:

- A minimum of Bachelor's Degree in Civil Engineering or relevant field;
- Relevant professional experience in the design and engineering and preparing models/drawings of Hydropower projects for at least 10 years. 8.9

The CAD Expert's responsibilities include, but not be limited to the following summarized tasks:

- Preparing the relevant construction-level drawings for the construction of the project;
- Preparing the relevant H&M and E&M interfacing drawings for H&M and E&M manufacturer;
- Incorporating the design outputs and comments from the Employer to the drawings;
- Maintain documents and record of drawing revisions for reference and information to the Employer.

### 9.9 Contract and Procurement Expert

The Contract and Procurement Expert shall have:

- Minimum of Master's degree Contracts Management or law or relevant field;
- Relevant professional experience in the preparation of condition of contract and award of contract for at least 15 years;
- Experience of preparation of conditions of contract in successfully completed atleast 2 numbers of hydropower projects of 500 MW capacity or more based on international contracts such as FIDIC or SPD of the World Bank or another MDB

The Contract and Procurement Expert's responsibilities include, but not be limited to the following summarized tasks:

• Preparation of prequalification document for each contract packages;





- Preparation of conditions of contract for Civil and H&M Works as per the FIDIC "Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer" First Edition 1999 (Red Book) or SPD of the World Bank or another MDB;
- Preparation of conditions of contract for E&M Works as per the FIDIC "Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Plant, and for Building Works, designed by the Contractor" First Edition 1999 (Yellow Book) or SPD of the World Bank or another MDB; and
- Support the Employer in managing the entire bid management process through selection and negotiation of each contract packages.

