

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT NO. 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**INTERNATIONAL COMPETITIVE BIDDING (ICB)
[Single Stage Two Envelope Bidding Procedure]**

**VOLUME 1 of 5
Bidding Procedures**

January 2026

Invitation for Bids No.: GKHEP/ICB-082/83/EPC-1
Employer: Remit Hydro Limited Nepal
Country:

Remit Hydro Limited
Ghunsa Khola Hydroelectric Project
Citizen Investment Trust Building, New Baneshwor
Kathmandu
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PREFACE

This volume is part of the Tender Documents for Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under EPC contract. The complete set of Tender Documents consists of the following volumes.

Volume 1	Bidding Procedures Section I - Instructions to Bidders (ITB) Section II - Bid Data Sheet (BDS) Section III - Evaluation and Qualification Criteria (EQC) Section IV - Bidding Forms (BDF) Section V - Eligible Countries
Volume 2	EMPLOYER'S REQUIREMENTS Section I – Scope of Works Section II – General Technical Requirements Section III – Standard Technical Requirements Section IV – Particular Technical Requirements Section V – Activity Schedule (ACS)
Volume 3	Conditions of Contract Section I - General Conditions of Contract (GCC) Section II - Special Conditions of Contract (SCC) Section III - Annexures Section IV - Contract Forms (COF)
Volume 4	Basic Project Report Part A: General Information 1 – Introduction 2 – Key Features of the project 3 – Power and Energy Studies 4 – Salient Features of Employer's Concept Design Part B: Project Description 5 – Topographic Survey and mapping 6 – Hydrology and Meteorology 7 – Sedimentology 8 – Geology and Geotechnics 9 – Seismicity
Volume 5	Employer's Concept Drawings

Invitation for Bids

Remit Hydro Limited

New Baneshwor, Kathmandu, Nepal

Invitation for Bids for the **Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project (77.5 MW) Under Engineering, Procurement and Construction (EPC) Contract.**

Contract Identification No: **GKHEP/ICB-082/83/EPC-1**

First Date of publication: 6th January 2026

1. Remit Hydro Limited has allocated funds towards the cost of Ghunsa Khola Hydroelectric Project and intends to apply a part of the funds to cover eligible payments under the Contract for the **Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project Under Engineering, Procurement and Construction (EPC) Contract.**
2. Bidding is open to all eligible Bidders as per Volume I Section V of bidding document.
3. **Remit Hydro Limited** invites electronic bids from eligible bidders for the construction of **Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project located in Phaktanglung Rural Municipality of Taplejung District** through EPC mode under **International Competitive Bidding – Single Stage Two Envelope Bidding procedures.**

Only eligible bidders with the following key qualifications should participate in this bidding:

- Minimum Average Annual Construction Turnover of the best 3 years within the last 10 years: **United States Dollar (US\$) 18.20 Million** (In Words: United States Dollar Eighteen Million Two Hundred Thousand Only).
 - Minimum Work experience of similar size and nature: at least one (1) EPC or Design and Built (DB) or Turnkey contract within the last Ten (10) years prior to the applications submission deadline, with a value of at least or equivalent to **US\$ 20.80 Million** (In words United States Dollar Twenty Million Eight Hundred Thousands Only) that have been successfully or are substantially completed and that are similar to the proposed works.
 - Concept paper for Understanding of the Project and Proposed Design.
4. The foreign bidders are required to **mandatorily** make Joint Venture (JV) with Nepalese firms.
 5. Under the Single Stage-Two Envelope Procedure, Bidders are required to submit the Technical Bid and the Price Bid, as per the provision of ITB 21 of the Bidding Document.
 6. Eligible Bidders may obtain further information and inspect the Bidding Documents at the office of Remit Hydro Limited, New Baneshwor, Kathmandu Nepal, Telephone: 01-4581780, email: procurement@remithydro.org.np or may visit PPMO e-GP system www.bolpatra.gov.np/egp.

Bidder submitting their bid electronically shall download the bidding documents for e-submission from PPMO's e-GP system www.bolpatra.gov.np/egp. Bidders, submitting their bid electronically, should deposit the cost of bidding document in the Project's **Rajaswa** (Revenue) account as specified below. The applicant has to bear the bank charges for the deposit or transfer of fees. The cost of Bid document fees is **NRs. 20,000.00 or US\$ 140.**

Information to deposit the cost of bidding document in Bank:

Name of the Bank: Laxmi Sunrise Bank Limited

Name of Office : Remit Hydro Limited

Office Account no.: 1621512304011219

Swift Code: LXBLNPKA

7. Pre-bid meeting shall be held at **Office of Remit Hydro Limited, 4th floor of CIT Building New Baneshwor, Kathmandu** on **29th January 2026, 11: 00 hour Nepalese Standard Time (NST)**.
8. Electronic bids must be submitted through PPMO's e-GP system www.bolpatra.gov.np/egp on or before **12: 00 hour NST on 23 February 2026**. Bids received after this deadline will be rejected.
9. The bids will be opened in the presence of Bidders' Authorized representatives who choose to attend at **14: 00 hour NST on 23 February 2026** at the office of Remit Hydro Limited, New Baneshwor, Kathmandu Nepal.
10. Bids must be valid for a period of **One Hundred Twenty (120) days** after the date of bid opening and must be accompanied by scanned copy of the bid security in pdf format amounting to a minimum of **Nepalese Rupees 200 Million (In Words: Nepalese Rupees Two Hundred Million only) or USD 1.40 Million (In words: United Stated Dollar One Million Four Hundred Thoudsands Only)**, which shall be valid for **30 days** beyond the validity period of the bid.
11. If the last date of purchasing and /or submission falls on a government holiday, then the next working day shall be considered as the last date. In such case the validity period of the bid security shall remain the same as specified for the original last date of bid submission.
12. Any addendum on the Bid shall be published in the PPMO's e-GP system www.bolpatra.gov.np/egp.
13. Remit Hydro Limited reserves the right to reject or accept any or all Bids partly or fully and to annul the bidding process and reject all bids without assigning any reason whatsoever.

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(Under EPC Contract)**

**VOLUME 1 of 5
BIDDING PROCEDURES**

**SECTION I
INSTRUCTIONS TO BIDDERS**

SECTION I: INSTRUCTIONS TO BIDDERS

This section specifies the procedures to be followed by Bidders in the preparation and submission of their Bids. Information is also provided on the submission, opening, and evaluation of bids and on the award of Contract.

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SECTION I: INSTRUCTIONS TO BIDDERS

A. GENERAL	
1. Scope of Bid	1.1 In connection with the Invitation for Bids indicated in the Bid Data Sheet (BDS), the Employer, as indicated in the BDS, issues this Bidding Document for the procurement of Works as specified in Section VI (Works Requirements). The name, identification, and number of Contracts of the International Competitive Bidding (ICB) are provided in the BDS. 1.2 Throughout this Bidding Document: (a) the term “in writing” means communicated in written form, delivered against receipt and received through e-GP system or email or fax or courier; (b) except where the context requires otherwise, words indicating the singular also include the plural and words indicating the plural also include the singular; and (c) “day” means calendar day. 1.3 Multiple Contract shall be applicable and shall be grouped as specified in the BDS.
2. Source of Funds	2.1 GoN Funded: In accordance with its annual program and budget, approved by the GoN, the implementing agency indicated in the BDS plans to apply a portion of the allocated budget to eligible payments under the contract(s) for which this Bidding Document is issued. Or Public Entities' own Resource Funded: In accordance with its annual program and budget, approved by the public entity, the implementing agency indicated in the BDS plans to apply a portion of the allocated budget to eligible payments under the contract(s) for which this Bidding Document is issued. Or DP Funded: The GoN has applied for or received financing (hereinafter called “funds”) from the Development Partner (hereinafter called “the DP”) indicated in the BDS toward the cost of the project named in the BDS. The GoN intends to apply a portion of the funds to eligible payments under the contract(s) for which this Bidding Document is issued.

	2.2 DP Funded: Payment by the DP will be made only at the request of the GoN and upon approval by the DP in accordance with the terms and conditions of the financing agreement between the GoN and the DP (hereinafter called the “Loan/Grant Agreement”), and will be subject in all respects to the terms and conditions of that Loan/Grant Agreement. No party other than the GoN shall derive any rights from the Loan Agreement or have any claim to the funds.
3. Fraud and Corruption	3.1 Procuring Entities as well as Bidders, suppliers and contractors and their sub-contractors shall adhere to the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this: (a) the Employer adopts, for the purposes of this provision, the terms as defined below: (i) “corrupt practice” means the offering, giving, receiving, or soliciting, directly or indirectly, anything of value to influence improperly the actions of another party; (ii) “fraudulent practice” means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation; (iii) “coercive practice” means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party; (iv) “collusive practice” means an arrangement between two or more parties designed to achieve an improper purpose, including influencing improperly the actions of another party. v) “obstructive practice” means (a) deliberately destroying, falsifying, altering, or concealing of evidence material to an investigation; (b) making false statements to investigators in order to materially impede an investigation; (c) failing to comply with requests to provide information, documents, or records in connection with an investigation; (d) threatening, harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or (e) materially impeding GoN/DP’s contractual rights of audit or access to information; and vi) “integrity violation” is any act which violates Anticorruption Policy, including (i) to (v) above and the following: abuse, conflict of interest, violations of GoN/DP sanctions, retaliation against whistleblowers or witnesses, and other violations of

	Anticorruption Policy, including failure to adhere to the highest ethical standard. (b) the Employer will reject a proposal for award if it determines that the Bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations in competing for the contract; (c) DP will cancel the portion of the financing allocated to a contract if it determines at any time that representative(s) of the GoN or of a beneficiary of DP-financing engaged in corrupt, fraudulent, collusive, or coercive practices or other integrity violations during the procurement or the execution of that contract, without the GoN having taken timely and appropriate action satisfactory to DP to remedy the situation. (d) DP will impose remedial actions on a firm or an individual, at any time, in accordance with DP's Anticorruption Policy and related Guidelines (as amended from time to time), including declaring ineligible, either indefinitely or for a stated period of time, to participate in DP-financed, -administered, or -supported activities or to benefit from an DP-financed, -administered, or -supported contract, financially or otherwise, if it at any time determines that the firm or individual has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices or other integrity violations; and (e) The Contractor shall permit the GoN/DP to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by the GoN/DP, if so required by the GoN/DP. 3.2 The Bidder shall not carry out or cause to carry out the following acts with an intention to influence the implementation of the procurement process or the procurement agreement : (a) give or propose improper inducement directly or indirectly, (b) distortion or misrepresentation of facts, (c) engaging in corrupt or fraudulent practice or involving in such act, (d) interference in participation of other competing bidders, (e) coercion or threatening directly or indirectly to cause harm to the person or the property of any person to be involved in the procurement proceedings, (f) collusive practice among bidders before or after submission of bids for distribution of works among bidders or fixing artificial/uncompetitive bid price with an intention to deprive the Employer the benefit of open competitive bid price,

	(g) Contacting the Employer with an intention to influence the Employer with regards to the bids or interference of any kind in examination and evaluation of the bids during the period from the time of opening of the bids until the notification of award of contract. 3.3 PPMO, on the recommendation of the Procuring Entity may blacklist a Bidder for a period of one (1) to three (3) years for its conduct including on the following grounds and seriousness of the act committed by the bidder: (a) if convicted by a court of law in a criminal offence which disqualifies the Bidder from participating in the contract, (b) if it is established that the contract agreement signed by the Bidder was based on false or misrepresentation of Bidder's qualification information, (c) if it at any time determines that the firm has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for, or in executing, a GoN/DP-financed contract. (d) if the Successful Bidder fails to sign the Contract. 3.4 A bidder declared blacklisted and ineligible by the GoN, Public Procurement Monitoring Office (PPMO) and/or the DP in case of DP funded project, may be ineligible to bid for a contract during the period of time determined by the GoN, PPMO and/or the DP. 3.5 In case of a natural person or firm/institution/company which is already declared blacklisted and ineligible by the GoN, any other new or existing firm/institution/company owned partially or fully by such Natural person or Owner or Board of director of blacklisted firm/institution/company; shall not be eligible bidder. 3.6 Furthermore, Bidders shall be aware of the provisions of GCC (GCC 33.4 and 79.2(f))
4. Eligible Bidders	4.1 A Bidder may be a natural person, private entity, or government owned entity subject to ITB 4.5 or any combination of them in the form of a Joint Venture (JV) under an existing agreement, or with the intent to constitute a legally-enforceable joint venture. In the case of a JV: (a) all partners shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms. Maximum number of JV and other provision for JV shall be as per specified in the BDS. The qualification requirement of the parties to the JV shall be as specified in Section III: Evaluation and qualification Criteria, and

	(b) the JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during Contract execution.
	4.2 A Bidder, and all parties constituting the Bidder, shall have the nationality of an eligible country, in accordance with Section V (Eligible Countries). A Bidder shall be deemed to have the nationality of a country if the Bidder is a citizen or is constituted, or incorporated, and operates in conformity with the provisions of the laws of that country. This criterion shall also apply to the determination of the nationality of proposed sub-contractors or suppliers for any part of the Contract including related services.
	4.3 A Bidder shall not have a conflict of interest. A Bidder found to have a conflict of interest shall be disqualified. A Bidder may be considered to be in a conflict of interest with one or more parties in this bidding process, if any of, including but not limited to, the following apply: (a) they have controlling shareholders in common; or (b) they receive or have received any direct or indirect subsidy from any of them; or (c) they have the same legal representative for purposes of this bid; or (d) they have a relationship with each other, directly or through common third parties, that puts them in a position to have access to material information about or improperly influence the Bid of another Bidder, or influence the decisions of the Employer regarding this bidding process; or (e) a Bidder participates in more than one bid in this bidding process either individually or as a partner in a joint venture. This will result in the disqualification of all Bids in which it is involved. However, subject to any finding of a conflict of interest in terms of ITB 4.3 (a)-(d) above, this does not limit the participation of the same subcontractor in more than one bid; or (f) a Bidder or any of its affiliated entity, participated as a consultant in the preparation of the technical specifications or employer's requirements of the works that are the subject of the Bid; or (g) a Bidder was affiliated with a firm or entity that has been hired (or is proposed to be hired) by the Employer as Engineer for the Contract.
	4.4 A firm that is under a declaration of ineligibility by the GoN in

	accordance with ITB 3, at the date of the deadline for bid submission or thereafter, shall be disqualified. A firm shall not be eligible to participate in any procurement activities under an DP-financed, -administered, or - supported project while under temporary suspension or debarment by DP pursuant to the DP's Anticorruption Policy (see ITB 3), whether such debarment was directly imposed by the DP, or enforced by other DPs pursuant to the Agreement for Mutual Enforcement of Debarment Decisions. A bid from a temporary suspended or debarred firm will be rejected. The list of debarred firm is available at the electronic address specified in the BDS. 4.5 Enterprises owned by Government shall be eligible only if they can establish that they are legally and financially autonomous and operate under commercial law, and that they are not a dependent agency of the GoN. 4.6 Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer, as the Employer shall reasonably request. 4.7 Firms shall be excluded in any of the cases, if (a) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, Nepal prohibits any import of goods or Contracting of works or services from that country or any payments to persons or entities in that country. Where Nepal prohibits payments to a particular firm or for particular goods by such an act of compliance, that firm may be excluded; (b) DP Funded: as a matter of law or official regulation, Nepal prohibits commercial relations with that country, provided that the DP is satisfied that such exclusion does not preclude effective competition for the supply of goods or related services required; (c) DP Funded: a firm sanctioned or temporarily suspended by the DP in relation to their guidelines or appropriate provisions on preventing and combating fraud and corruption in projects financed by them. 4.8 In case a prequalification process has been conducted prior to the bidding process, this bidding is open only to prequalified Bidders.
5. Eligible Materials, Equipment and Services	5.1 The materials, equipment and services to be supplied under the Contract shall have their origin in any source countries as defined in accordance with Section V (Eligible Countries) and all expenditures under the Contract will be limited to such materials, equipment, and services. At the Employer's request, Bidders may be required to provide evidence of the origin of

	materials, equipment and services.
	5.2 For purposes of ITB 5.1 above, “origin” means the place where the materials and equipment are mined, grown, produced or manufactured, and from which the services are provided. Materials and equipment are produced when, through manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that differs substantially in its basic characteristics or in purpose or utility from its components.
B. Contents of Bidding Documents	
6. Sections of Bidding Document	6.1 1 The Bidding Document consist of Parts I, II, and III, which include all the Sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8. PART I Bidding Procedures Section I Instructions to Bidders (ITB) Section II Bid Data Sheet (BDS) Section III Evaluation and Qualification Criteria (EQC) Section IV Bidding Forms (BDF) Section V Eligible Countries PART II Requirements Section VI Employer’s Requirement (ERQ) Section VII Activity Schedule (ACS) PART III Conditions of Contract and Contract Forms Section VIII General Conditions of Contract (GCC) Section IX Special Conditions of Contract (SCC) Section X Contract Forms (COF)
	6.2 The Invitation for Bids issued by the Employer is not part of the Bidding Document.
	6.3 The Employer is not responsible for the completeness of the Bidding Document and their Addenda, if they were not obtained directly from the source stated by the Employer in the Invitation for Bids.
	6.4 The Bidder is expected to examine all instructions, forms, terms, and specifications in the Bidding Document and to furnish with its bid all information and documentation as is required by the Bidding Documents. Failure to furnish all information or documentation required by the Bidding Document may result in the rejection of the bid.
7. Clarification of Bidding Document, Site Visit, Pre-Bid Meeting	7.1 A prospective Bidder requiring any clarification of the Bidding Document shall contact the Employer in writing at the Employer’s address indicated in BDS or raise any question or curiosity during the pre-bid meeting if provided for in accordance with ITB 7.4. The Employer will respond in writing

	to any request for clarification, provided that such request is received within the period as mentioned in ITB 7.5. The Employer shall forward copies of its response to all Bidders who have acquired the Bidding Document in accordance with ITB 6.3, including a description of the inquiry but without identifying its source. Should the Employer deem it necessary to amend the Bidding Document as a result of a request for clarification, it shall do so following the procedure under ITB 8 and ITB 22.2. 7.2 The Bidder is advised to visit and examine the Site of Works and its surroundings and obtain for itself, on its own risk and responsibility, all information that may be necessary for preparing the bid and entering into a Contract for construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense. 7.3 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the Bidder, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection. 7.4 The Bidder's designated representative is invited to attend a pre-bid meeting, if provided for in the BDS. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage. 7.5 The Bidder is requested, to submit any questions in writing, to reach the Employer as mentioned in BDS. 7.6 Minutes of the pre-bid meeting, including the text of the questions raised, without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Bidders who have acquired the Bidding Document in accordance with ITB 6.3. Any modification to the Bidding Document that may become necessary as a result of the pre-bid meeting shall be made by the Employer exclusively through the issue of an addendum pursuant to ITB 8 and not through the minutes of the pre-bid meeting. 7.7 Non-attendance at the pre-bid meeting will not be a cause for disqualification of a Bidder.
	8.1 At any time prior to the deadline for submission of bids, the Employer may amend the Bidding Document by issuing

8. Amendment of Bidding Document	addendum.
	8.2 Any addendum issued shall be part of the Bidding Document and shall be communicated in writing to all who have obtained the Bidding Document from the Employer in accordance with ITB 6.3.
	8.3 To give prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may, at its discretion, extend the deadline for the submission of Bids, pursuant to ITB 22.2
C. Preparation of Bids	
9. Cost of Bidding	9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.
10. Language of Bid	10.1 The Bid, as well as all correspondence and documents relating to the bid exchanged by the Bidder and the Employer, shall be written in the language specified in the BDS. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified in the BDS, in which case, for purposes of interpretation of the Bid, such translation shall govern.
11. Documents Comprising the Bid	The Bid shall comprise the Technical Bid containing the documents listed in ITB 11.2 and the Price Bid containing the documents listed in ITB 11.3. 11.2 The Technical Bid shall comprise the following: (a) Letter of Technical Bid; (b) Bid Security in accordance with ITB 19; (c) alternative Technical Bid, at Bidder's option and if permissible, in accordance with ITB 13; (d) written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 20.2; (e) documentary evidence in accordance with ITB 17, establishing the Bidder's qualifications to perform the contract; (f) Technical Proposal in accordance with ITB 16; (g) Bids submitted by a Joint Venture shall include a copy of the Joint Venture Agreement entered into by all partners. Alternatively, a Letter of Intent to execute a Joint Venture Agreement in the event of a successful Bid shall be signed by all partners and submitted with the Bid, together with a copy of

	the proposed agreement. The Joint Venture agreement, or letter of intent to enter into a Joint Venture including a draft agreement shall indicate at least the parts of the Works to be executed by the respective partners; and (h) any other required documents, which is not against the provision of Procurement Act/ Regulation /Directives and Standard Bidding Document issued by PPMO as specified in the BDS. 11.3 The Price Bid shall comprise the following: (a) Letter of Price Bid; (b) Priced Activity Schedule, in accordance with ITB 12 and ITB 14, or as stipulated in the BDS; (c) alternative price Bids, at Bidder's option and if permissible, in accordance with ITB 13; (d) Any other document required in the BDS. 11.4 The Bidder is solely responsible for the authenticity of the submitted documents. 11.5 The Technical Bid shall not include any financial information related to the Price Bid. A Technical Bid containing such material or financial information shall be declared non-responsive.
12. Letter of Bid and Schedules	12.1 The Letters of Technical Bid and Price Bid, Schedules, and all documents listed under ITB 11, shall be prepared using the relevant forms in Section IV (Bidding Forms) and in Section VII (Priced Activity Schedule). The forms must be completed without any alterations to the text, and no substitutes shall be accepted. All blank spaces shall be filled in with the information requested.
13. Alternative Bids	13.1 Unless otherwise specified in the BDS, alternative bids shall not be considered. 13.2 When alternative times for completion are explicitly invited, a statement to that effect will be included in the BDS, as will the method of evaluating different times for completion. 13.3 When specified in the BDS, Bidders are permitted to submit alternative technical solutions for specified parts of the Works. Such parts will be identified in the BDS and described in Section VI (Employer's Requirements). The method for their evaluation will be stipulated in Section III (Evaluation and Qualification Criteria).
	14.1 The prices and discounts quoted by the Bidder in the Letter of Price Bid and in the Schedules shall conform to the

14. Bid Prices and Discounts	requirements specified below.
	14.2 The Bidder shall submit a bid for the whole of the works described in ITB 1.1 by filling in price as Lump sum price in Section VII (Priced Activity Schedule).
	14.3 The price to be quoted in the Letter of Price Bid shall be the total price of the Bid, excluding any discounts offered.
	14.4 Unconditional discounts, if any, and the methodology for their application shall be quoted in the Letter of Price Bid, in accordance with ITB 12.1.
	14.5 If so indicated in ITB 1.3, bids are invited for individual Contracts or for any combination of Contracts (packages). Bidders wishing to offer any price reduction for the award of more than one Contract shall specify in their bid the price reductions applicable to each package, or alternatively, to individual Contracts within the package. Price reductions or discounts shall be submitted in accordance with ITB 14.4, provided the Bids for all Contracts are submitted and opened at the same time.
	14.6 The price quoted by the Bidder shall be fixed which means that the price is not subject to adjustment.
	14.7 The bidder is subject to local taxes such as VAT, social charges or income taxes on nonresident international personnel, and also duties, fees, levies on amounts payable by the employer under the Contract. All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date Thirty (30) days prior to the deadline for submission of bids, shall be included in the rates and prices and the total bid price submitted by the Bidder.
15. Currency of Bid and Payment	15.1 The prices shall be quoted by the bidder entirely in Nepali currency; if not otherwise specified in the BDS.
16. Documents Comprising the Technical Proposal	16.1 The Bidder shall furnish a Technical Proposal including a statement of work methods, equipment, personnel, schedule and any other information as stipulated in Section IV (Bidding Forms), in sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion time.
17. Documents Establishing the Qualifications of the Bidder	17.1 To establish its qualifications to perform the Contract in accordance with Section III (Evaluation and Qualification Criteria) the Bidder shall provide the information requested in the corresponding information sheets included in Section IV (Bidding Forms).

18. Period of Validity of Bids	18.1 Bids shall remain valid for the period specified in the BDS after the bid submission deadline date prescribed by the Employer. A bid valid for a shorter period shall be rejected by the Employer as nonresponsive.
	18.2 In exceptional circumstances, prior to the expiration of the bid validity period, the Employer may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing. If a bid security is requested in accordance with ITB 19, it shall also be extended Thirty (30) days beyond the deadline of the extended validity period. A Bidder may refuse the request without forfeiting its bid security. A Bidder granting the request shall not be required or permitted to modify its Bid and to include any additional conditions against the provisions specified in Bid Documents.
19. Bid Security	19.1 The Bidder shall furnish as part of its bid, in original form, a bid security as specified in the BDS. In case of e-submission of bid, the Bidder shall upload scanned copy of Bid security letter at the time of electronic submission of the bid. The Bidder accepts that the scanned copy of the Bid security shall, for all purposes, be equal to the original. The details of original Bid Security and the scanned copy submitted with e-bid should be the same otherwise the bid shall be non-responsive.
	19.2 The bid security shall be, at the Bidder's option, in any of the following forms: (a) an unconditional bank guarantee from Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law or; (b) a cash deposit voucher in the Employer's Account as specified in BDS. In the case of a bank guarantee, the bid security shall be submitted either using the Bid Security Form included in Section IV (Bidding Forms) or in another Form acceptable to the employer. The form must include the complete name of the Bidder. The bid security shall be valid for minimum Thirty (30) days beyond the original validity period of the bid, or beyond any period of extension if requested under ITB 18.2.
	19.3 The bid security issued by any foreign Bank outside Nepal must be counter guaranteed by Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law in Nepal.
	19.4 Any bid not accompanied by an enforceable and substantially compliant bid security shall be rejected by the Employer as

	nonresponsive. In case of e- Submission, if the scanned copy of an acceptable Bid Security letter is not uploaded with the electronic Bid then Bid shall be rejected.
	19.5 The bid security of unsuccessful Bidders shall be returned within Three (3) days, once the successful Bidder's furnishing of the required performance security and signing of the Contract Agreement pursuant to ITB 40.1 and 41.1
	19.6 The bid security shall be forfeited if: (a) a Bidder requests for withdrawal or modification of its bid, except as provided in ITB 18.2: (i) during the period of bid validity specified by the Bidder on the Letter of Technical Bid and Price Bid, in case of electronic submission; (ii) from the period twenty-four hours prior to bid submission deadline up to the period of bid validity specified by the Bidder on the Letter of Technical Bid and Price Bid, in case of hard copy submission. (b) a Bidder changes the prices or substance of the bid while providing information pursuant to clause 27.1; (c) a Bidder involves in fraud and corruption pursuant to clause 3.1; (d) the successful Bidder fails to: (i) furnish a performance security in accordance with ITB 40.1; (ii) sign the Contract in accordance with ITB 41.1; or (iii) accept the correction of arithmetical errors pursuant to clause 33.1
	19.7 The Bid Security of a Joint Venture shall be in the name of the Joint Venture that submits the bid. If the Joint Venture has not been legally constituted at the time of bidding, the Bid Security shall be in the names of all future partners as named in the letter of intent mentioned in ITB 4.1.
20. Format and Signing of Bid	20.1 The Bidder shall prepare the Technical Bid and the Price Bid comprising the Bid as described in ITB 11 Alternative bids, if permitted in accordance with ITB 13, shall be prepared as "ALTERNATIVE". The Bidder shall submit his bid electronically in PDF or web forms files as specified in ITB Clause 21.1(a).
	20.2 The bid shall be attached with the signed authorization letter by an authorized person or persons duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as specified in the BDS and shall be attached to the bid. The name and position held by each person signing the

	authorization must be typed or printed below the signature.
	20.3 Any amendments such as interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the bid.
D. Submission and Opening of Bids	
21. Submission of Bid	21.1 Bid submission procedure (a) Bidders submitting the Bids shall follow the electronic bid submission procedure specified in this clause. - The bidder is required to register in the e-GP system https://www.bolpatra.gov.np/egp following the procedure specified in e-GP guideline. - Interested bidders may either purchase the bidding document from the Employer's office as specified in the Invitation for Bid (IFB) or bidders may download the IFB and bidding document from e-GP system. - The registered bidders need to maintain their profile data each time required during preparation of bids. - In order to submit their bids, the cost of the bidding document can be deposited as specified in IFB. In addition, electronic scanned copy (.pdf format) of the bank deposit voucher/cash receipt should also be submitted along with the technical bid. - The bidder can prepare their technical and price bids using data and documents maintained in bidder's profile and forms/format provided in bidding document by Employer. The bidder may submit bids as a single entity or as a joint venture. The bidder submitting bid in joint venture shall have to upload joint venture agreement along with partner(s) Bolpatra ID provided during bidder's registration. - Bidders (all partners in case of JV) should update their profile data and documents required during preparation and submission of their technical bids. - In case of bid submission in JV, the consent of the partners shall be obtained through the confirmation link sent to the registered email address and the partners shall have to acknowledge their confirmation. - After providing all the details and documents, two separate bid response documents i.e technical bids and price bids will be generated from the system. Bidders are advised to download and verify the response documents prior to bid submission. - For verifying the authentic user, the system will send one-time password (OTP) in the registered e-mail address of the bidder. System will validate the OTP and allow bidder to submit their bid.

	x. Electronically submitted bids can be modified and/or withdrawn through system. The bidder may modify their bids multiple times online within bid submission date and time specified in e-GP system. Once a Bid is withdrawn, bidder won't be able to submit another bid response for the same bid. xi. The Bidder / Bid shall meet the following requirements and conditions for e-submission of bids; aa) The e-submitted bids must be readable through open standards interfaces. Unreadable and or partially submitted bid files shall be considered incomplete and rejected for further bid evaluation. bb) In addition to electronically submitted PDF files/web forms, the Bidder shall be required to submit original bid security letter/ documents and clarifications as specified in ITB Clause 27. If a bidder does not submit the original Bid security letter and requested documents and or clarifications within the specified time limit then the bid shall not be considered for further evaluation. cc) If major discrepancy is found between the electronically submitted PDF bid files and the documents/ clarifications provided by the Bidder as per ITB Clause 27, then the bid shall not be considered for further evaluation. dd) The facility for submission of bid electronically through e-submission is to promote transparency, non-discrimination, equality of access, and open competition in the bidding process. The Bidders are fully responsible to use the e- submission facility properly in e-GP portal of PPMO- http://www.bolpatra.gov.np as per specified procedures and in no case the Employer shall be held liable for Bidder's inability to use this facility. ee) When a bidder submits electronic bid through the PPMO e-GP portal, it is assumed that the bidder has prepared the bid by studying and examining the complete set of the Bidding documents including specifications, drawings and conditions of contract. ff) Bidders who submit electronic bid should deposit the bidding document fee as specified in IFB and upload the scan copy (in pdf format) of the deposit voucher at the time of bid submission. The deposited amount shall be verified by the Employer during the bid evaluation process. The submitted Bid shall be non-responsive and shall not be evaluated if the cost for bidding document is not deposited as specified in the IFB. The required forms and documents shall be part of technical bids.

No.	Document	Requirement	Remarks
1.	Letter of Technical Bid	Mandatory	PDF
2.	Bid Security/Bank Guarantee	Mandatory	PDF
3.	Company registration Certificate	Mandatory	PDF
4.	VAT registration Certificate	Mandatory for domestic bidders	PDF
5.	Business Registration Certificate	Mandatory	PDF
6.	Tax Clearance Certificate/Tax return submission evidence/evidence of time extension	Mandatory (for domestic bidders)	PDF
7.	Power of Attorney of Bid signatory	Mandatory	PDF
8.	Bank Voucher for cost of bid document	Mandatory	PDF
9.	Joint venture agreement	Mandatory in case of JV Bids Only	PDF
10.	Qualification Documents	Mandatory	Using profile data (financial details, contract details etc.) and Technical Proposal
11.	Additional documents; specified in ITB 11.2 (h)	If applicable	PDF

The required forms and documents shall be part of price bids.

No.	Document	Requirement	Remarks
1.	Letter of Price Bid	Mandatory	PDF
2.	Completed Activity Schedule (ACS)	Mandatory	Online Forms

	3.	Additional Documents; specified in ITB 11.3 (d)	If applicable	PDF
	Note: a) Bidders (all partners in case of JV) should verify/update their profile documents as appropriate for the specific bid before submitting their bid electronically.			
22. Deadline for Submission of Bids	22.1 Bids must be submitted electronically no later than the date and time indicated in the BDS. The standard time for e-submission is Nepal Standard Time as set out in the server. The e-procurement system will accept the e-submission of bid from the date of publishing of notice and will automatically not allow the e-submission of bid after the deadline for submission of bid.			
	22.2 The Employer may, at its discretion, extend the deadline for the submission of bids by amending the Bidding Document in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.			
23. Late Bids	23.1 The e-procurement system will automatically not allow the e-submission of bid after the deadline for submission of bid..			
24. Withdrawal, and Modification of Bids	24.1 A Bidder may withdraw, or modify its bid- Technical or Price - after it has been submitted by e-submission. Once a Bid is withdrawn, bidder shall not be able to submit another bid for this bidding process. Procedures for withdrawal or modification of submitted bids are as follows: (a) Bidder may submit modification or withdrawal prior to the deadline prescribed for submission of bids through e-GP system by using the forms and instructions provided by the system.			
	24.2 Bids requested to be withdrawn in accordance with ITB 24.1 shall not be opened.			
	24.3 The following provisions apply for withdrawal or modification of the Bids: (i) No bids shall be withdrawn or modified in the interval between deadline for submission of bids and the expiration of the period of bid validity specified by the Bidder on the Letter of Technical Bid and Price Bid or any extension thereof.			
	24.4 Request for withdrawal or modifications through different medium shall not be considered.			
25. Bid Opening	25.1 The Employer shall open the Technical Bids in public at the address, on the date and time specified in the BDS in the			

	presence of Bidders` designated representatives who choose to attend.
	25.2 The Employer shall download the e-submitted Technical Bid. The e-GP system allows the Employer to download the e-submitted technical bid only after bid opening date and time after login simultaneously by at least two members of the Bid Opening Committee.
	25.3 Electronic Bids shall be opened one by one and read out. The e-submitted technical bids must be readable through open standards interfaces. Unreadable and or partially submitted bid files shall be considered incomplete.
	25.4 Only Technical Bids read out and recorded at bid opening shall be considered for evaluation. No bid shall be rejected at opening of Technical Bids.
	25.5 The Employer shall prepare a record of the opening of Technical Bids that shall include, as a minimum: the name of the Bidder and whether there is a withdrawal, or modification; and the presence or absence of a bid security. The Bidders` representatives who are present shall be requested to sign the record. The omission of a Bidder`s signature on the record shall not invalidate the contents and effect of the record.
	25.6 At the end of the evaluation of the Technical Bids, the Employer will invite bidders who have submitted substantially responsive Technical Bids and who have been determined as being qualified for award to attend the opening of the Price Bids. The date, time, and location of the opening of Price Bids will be advised in writing by the Employer. Bidders shall be given at least Seven (7) days` notice for the opening of Price Bids.
	25.7 The Employer will notify Bidders in writing who have been rejected on the grounds of their Technical Bids being substantially nonresponsive to the requirements of the Bidding Document.
	25.8 The Employer shall conduct the opening of Price Bids of all Bidders who submitted substantially responsive Technical Bids, in the presence of Bidders` representatives who choose to attend at the address, on the date, and time specified by the Employer. The Bidder`s representatives who are present shall be requested to sign a register evidencing their attendance.
	25.9 All envelopes containing Price Bids shall be opened one at a time and the following read out and recorded:

	a. the name of the Bidder; b. whether there is a modification; c. the Bid Prices, including any discounts and alternative offers; and d. any other details as the Employer may consider appropriate. Only Price Bids, discounts, modifications, and alternative offers read out and recorded during the opening of Price Bids shall be considered for evaluation. No Bid shall be rejected at the opening of Price Bids. 25.10 The Employer shall prepare a record of the opening of Price Bids that shall include, as a minimum, the name of the Bidder, the Bid Price (per lot if applicable), any discounts, modifications and alternative offers. The Bidders' representatives who are present shall be requested to sign the record. The omission of a Bidder's signature on the record shall not invalidate the contents and effect of the record.
E. Evaluation and Comparison of Bids	
26. Confidentiality	26.1 Information relating to the examination, evaluation, comparison, and post-qualification of bids and recommendation of Contract award, shall not be disclosed to Bidders or any other persons not officially concerned with such process until information on Contract award is communicated to all Bidders. 26.2 Any attempt by a Bidder to influence the Employer in the evaluation of the bids or Contract award decisions may result in the rejection of its bid. 26.3 Notwithstanding ITB 26.2, from the time of bid opening to the time of Contract award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it may do so in writing.
27. Clarification of Bids	27.1 To assist in the examination, evaluation, and comparison of the Technical and Price Bids, the Employer may, at its discretion, ask any Bidder for a clarification of its Bid. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing. No change in the substance of the Technical Bid or prices in the Price Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Price Bids, in accordance with ITB 33. Upon notification from the employer, the bidder shall also submit the original of documents

	comprising the Technical and Price Bid as per ITB 11.2 and ITB 11.3 for verification of submitted documents for acceptance of the e-submitted bid.
	27.2 If a Bidder does not provide clarifications of its Bid by the date and time set in the Employer's request for clarification, its Bid may be rejected.
28. Deviations, Reservations, and Omissions	28.1 During the evaluation of bids, the following definitions apply: (a) "Deviation" is a departure from the requirements specified in the Bidding Document; (b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Document; and (c) "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Document.
29. Examination of Technical Bid	29.1 The Employer shall examine the Technical Bid to confirm that all documents and technical documentation requested in ITB 11.2 have been provided, and to determine the completeness of each document submitted.
	29.2 The Employer shall confirm that the following documents and information have been provided in the Technical Bid. If any of these documents or information is missing, the offer shall be rejected. (a) Letter of Technical Bid; (b) written confirmation of authorization to commit the Bidder; (c) Bid Security; and (d) Technical Proposal in accordance with ITB 16
30. Determination of Responsiveness of Technical Bid	30.1 The Employer's determination of a Bid's responsiveness is to be based on the contents of the bid itself, as defined in ITB11.2.
	30.2 A substantially responsive Technical Bid is one that meets the requirements of the Bidding Document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that, (a) if accepted, would: (i) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or (ii) limit in any substantial way, inconsistent with the Bidding Document, the Employer's rights or the Bidder's obligations under the proposed Contract; or

	(b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive bids.
	30.3 The Employer shall examine the technical aspects of the Bid submitted in accordance with ITB 16, Technical Proposal, in particular, to confirm that all requirements of Section VI (Works Requirements) have been met without any material deviation, reservation or omission.
	30.4 If a bid is not substantially responsive to the requirements of the Bidding Document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.
	30.5 The Employer evaluates the bid on the basis of the information in the electronically submitted bid files. If the Bidder cannot substantiate or provide evidence to establish the information provided in e-submitted bid through documents/clarifications as per ITB Clause 27.1, the bid shall not be considered for further evaluation.
	30.6 Bidder shall be Non- Responsiveness, if the Bid Document Fee is not deposited to the stated bank account or paid to the employer's office. In case of JV, bidder must deposit or pay the bid document fee in the name of JV or all JV Partners.
	30.7 In Case, a corruption case is being filed to Court against the Natural Person or Board of Director of the firm/institution /company or any partner of JV, such Natural Person or Board of Director of the firm/institution /company or any partner of JV such bidder's bid shall be excluded from the evaluation, if public entity receives instruction from Government of Nepal.
31. Nonconformities Errors, and Omissions	31.1 Provided that a bid is substantially responsive, the Employer may waive any non-conformities in the bid that do not constitute a material deviation, reservation, or omission.
	31.2 Provided that a Technical Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its bid.
	31.3 Provided that a Technical Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment

	shall be made using the methods indicated in Section III (Evaluation and Qualification Criteria). 31.4 If the monetary value of such non-conformities is found to be more than fifteen percent of the Bid Price of the bidder pursuant to ITB 31.3, such bid shall be considered nonresponsive and shall not be involved in evaluation.
32. Qualification of the Bidder	32.1 The Employer shall determine to its satisfaction during the evaluation of Technical Bids whether Bidders meet the qualifying criteria specified in Section III (Evaluation and Qualification Criteria). 32.2 The determination shall be based upon an examination of the documentary evidence of the Bidder's qualifications submitted by the Bidder, pursuant to ITB 17.1. 32.3 An affirmative determination shall be a prerequisite for the opening and evaluation of a Bidder's Price Bid. A negative determination shall result into the disqualification of the Bid, in which event the Employer shall return the unopened Price Bid to the Bidder.
33. Correction of Arithmetical Errors	33.1 During the evaluation of Price Bids, the Employer shall correct arithmetical errors on the following basis: (a) If there is a discrepancy between the bid price in the Summary of Activity Schedule and the bid amount in item(c) of the Letter of Price Bid, the bid price in the Summary of Activity Schedule will prevail and the bid amount in item(c) of the Letter of Price Bid will be corrected. (b) If there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a). 33.2 If the Bidder that submitted the lowest evaluated bid does not accept the correction of errors, its bid shall be disqualified and its bid security shall be forfeited.
34. Subcontractors	34.1 The Employer shall permit subcontracting for certain specialized works as indicated in Section III The sub-contractor shall meet the qualifications criteria as indicated in section III. Sub-contractors' qualification and experience will not be considered for evaluation of the Bidder. The Bidder on its own (without taking into account the qualification and experience of the sub-contractor) should meet the qualification criteria. If the qualification and experience shall not meet the qualifications criteria as indicated in section III, the proposed

	subcontractor shall be rejected but the responsibility to perform the scope of work shall be of the bidder itself. Bidders may propose subcontracting up to the percentage of total value of contracts or the volume of works as specified in the BDS.
35. Evaluation of Price Bids	35.1 The Employer shall evaluate Price Bid of each bid for which the Technical Bid has been determined to be substantially responsive. The Employer shall use the criteria and methodologies listed in this Clause. No other evaluation criteria or methodologies shall be permitted.
	35.2 To evaluate a Price Bid, the Employer shall consider the following: (a) the bid price, excluding Value Added Tax, Provisional Sums, and the provision, if any, for contingencies in the Summary Priced Activity Schedule, but including Day work items, where priced competitively; (b) price adjustment for correction of arithmetic errors in accordance with ITB 33.1; (c) price adjustment due to discounts offered in accordance with ITB 14.4; (d) adjustment for nonconformities in accordance with ITB 31.3; (e) application of all the evaluation factors indicated in Section III (Evaluation and Qualification Criteria); (f) the currency(ies) of the bid shall be converted into a single currency as specified in the BDS. (g) If applicable, bid price adjustment for a domestic preference as specified in the BDS.
	35.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in bid evaluation.
	35.4 If this Bidding Document allows Bidders to quote separate prices for different Contracts, and to award multiple Contracts to a single Bidder, the methodology to determine the lowest evaluated price of the Contract combinations, including any discounts offered in the Letter of Price Bid, is specified in Section III (Evaluation and Qualification Criteria).

	35.5 If the bid, which results in the lowest Evaluated Bid Price extremely low in the opinion of the Employer, the Employer may require the Bidder to produce detailed price analysis for any or all activities of the Priced Activity Schedule, to demonstrate the internal consistency of the price with the construction methods and schedule proposed. After evaluation of the price analysis, taking into consideration the schedule of estimated Contract payments, the Employer may require that the amount of the performance security be increased at the expense of the Bidder as mentioned in BDS to protect the Employer against financial loss in the event of default of the successful Bidder under the Contract or may consider the bid as non-responsive. 35.6 The total amount for the contract must be priced as Lump sum. 35.7 The Employer evaluates the bid on the basis of the information in the electronically submitted bid files. If the Bidder cannot substantiate or provide evidence to establish the information provided in e-submitted bid through documents/clarifications as per ITB Clause 27.1, the bid shall not be considered for further evaluation. 35.8 In Case, a corruption case is being filed to Court against the Natural Person or Board of Director of the firm/institution /company or any partner of JV, such Natural Person or Board of Director of the firm/institution /company or any partner of JV such bidder's bid shall be excluded from the evaluation, if public entity receives instruction from Government of Nepal.
36. Comparison of Bids	36.1 The Employer shall compare all substantially responsive bids in accordance with ITB 35.2 to determine the lowest evaluated bid.
37. Employer's Right to Accept Any Bid, and to Reject Any or All Bids	37.1 The Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all Bids at any time prior to contract award, without thereby incurring any liability to Bidders. In case of annulment, all Bids submitted and specifically, bid securities, shall be promptly returned to the Bidders.
F. Award of Contract	
38. Award Criteria	38.1 The Employer shall award the Contract to the Bidder whose offer has been determined to be the lowest evaluated bid as per ITB 35.2 and is substantially responsive to the Bidding Document, provided further that the Bidder is determined to be qualified to perform the Contract satisfactorily.

39. Letter of Intent to Award the Contract/Notification of Award	39.1 The Employer shall notify the concerned Bidder whose bid has been selected in accordance with ITB 38.1 within Seven (7) days of the selection of the bid, in writing that the Employer has intention to accept its bid and the information regarding the name, address and amount of selected bidder shall be given to all other bidders who submitted the bid. 39.2 If no bidder submits an application pursuant to ITB 42 within a period of Seven (7) days of the notice provided under ITB 39.1, the Employer shall, accept the bid selected in accordance with ITB 38.1 and Letter of Acceptance shall be communicated to the selected bidder prior to the expiration of period of Bid validity, to furnish the performance security and sign the contract within Fifteen (15) days. 39.3 At the same time, the Employer shall affix a public notice on the result of the award on its notice board and may make arrangements to post the notice into its website, if it has; and if it does not have, into the website of the Public Procurement Monitoring Office, identifying the bid and lot numbers and the following information: (i) name of each Bidder who submitted a Bid; (ii) bid prices as read out at Bid Opening; (iii) name and evaluated prices of each Bid; (iv) name of bidders whose bids were rejected and the reasons for their rejection; and (v) name of the winning Bidder, and the Price it offered, as well as the duration and summary scope of the Contract awarded. 39.4 In Case, a corruption case is being filed to Court against the Natural Person or Board of Director of the firm/institution /company or any partner of JV, such Natural Person or Board of Director of the firm/institution /company or any partner of JV such bidder's bid shall be rejected, if public entity receives instruction from Government of Nepal.
40. Performance Security and Line of Credit	40.1 Within Fifteen (15) days of the receipt of Letter of Acceptance from the Employer, the successful Bidder shall furnish the performance security in accordance with the Conditions of Contract, subject to ITB 35.5, as specified below from Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law using Sample Form for the Performance Security included in Section X (Contract Forms), or another form acceptable to the Employer. The performance security issued by any foreign Bank outside Nepal must be counter guaranteed by a Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law in Nepal. i) If bid price of the bidder selected for acceptance is up to 15 (fifteen) percent below the approved cost estimate (including Provisional Sum amount) the performance security amount

	shall be 5 (five) percent of the bid price. ii) For the bid price of the bidder selected for acceptance is more than 15 (fifteen) percent below of the cost estimate (including Provisional Sum amount), the performance security amount shall be determined as follows: Performance Security Amount = $[(0.85 \times \text{Cost Estimate} - \text{Bid Price}) \times 0.5] + 5\% \text{ of Bid Price}$. The Bid Price and Cost Estimate shall be exclusive of Value Added Tax. Within Fifteen (15) days of the receipt of Letter of Acceptance from the Employer, the successful Bidder shall furnish the Letter of Commitment for Bank's Undertaking for Line of Credit of the amount as specified in the BDS, using Sample Form for the Line of Credit included in Section X (Contract Forms) at the time of contract agreement. 40.2 Failure of the successful Bidder to submit the above-mentioned Performance Security and Line of Credit or to sign the Contract Agreement shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security. In that event the Employer may award the Contract to the next lowest evaluated Bidder whose offer is substantially responsive and is determined by the Employer to be qualified to perform the Contract satisfactorily. The process shall be repeated according to ITB 39.
41. Signing Contract	of 41.1 The Employer and the successful Bidder shall sign the Contract Agreement within the period as stated ITB 40.1. 41.2 At the same time, the Employer shall affix a public notice on the result of the award on its notice board and make arrangement for causing such notice to be affixed on the notice board also of the District Coordination Committee, District Administration Office, Provincial Treasury and Controller Office and District Treasury and Controller Office or publish in Employer's Web Site or PPMO Website. The Employer may make arrangements to post the notice into its website, if it has; and if it does not have, into the website of the Public Procurement Monitoring Office, identifying the bid and lot numbers and the following information: (i) the result of evaluation of bid; (ii) date of publication of notice inviting bids; (iii) name of newspaper; (iv) reference number of notice; (v) item of procurement; (vi) name and address of bidder making contract and (viii) contract price.

	41.3 Within Thirty (30) days from the date of issuance of notification pursuant to ITB 39.1 unsuccessful bidders may request in writing to the Employer for a debriefing seeking explanations on the grounds on which their bids were not selected. The Employer shall promptly respond in writing to any unsuccessful Bidder who, requests for debriefing. 41.4 If the bidder whose bid has been accepted fails to sign the contract as stated ITB 41.1, the Public Procurement Monitoring Office shall blacklist the bidder on recommendation of the Public Entity.
42. Complaint and Review	42.1 If a Bidder is dissatisfied with the Procurement proceedings or the decision made by the Employer in opening of the price bid or the intention to award the Contract, it may file an application to the Chief of the Public Entity within Seven (7) days of providing the notice under ITB 25.8 and ITB 39.1 by the Public Entity, for review of the proceedings stating the factual and legal grounds.
	42.2 Late application filed after the deadline pursuant to ITB 42.1 shall not be processed.
	42.3 The chief of Public Entity shall, within Five (5) days after receiving the application, give its decision with reasons, in writing pursuant to ITB 42.1: (a) whether to suspend the procurement proceeding and indicate the procedure to be adopted for further proceedings; or (b) to reject the application. The decision of the chief of Public Entity shall be final for the Bid amount up to the value as stated in 42.4.
	42.4 If the Bidder is not satisfied with the decision of the Public Entity in accordance with ITB 42.3, is not given within Five (5) days of receipt of application pursuant to ITB 42.1, it can, within Seven (7) days of receipt of such decision, file an application to the Review Committee of the GoN, stating the reason of its disagreement on the decision of the chief of Public Entity and furnishing the relevant documents, provided that its Bid amount is equal or more than Rupees Twenty Million (NRs. 20,000,000). The application may be sent by hand, by post, by courier, or by electronic media at the risk of the Bidder itself.
	42.5 Late application filed after the deadline pursuant to ITB 42.4 shall not be processed.
	42.6 Within Three (3) days of the receipt of application from the Bidder, pursuant to ITB 42.4, the Review Committee shall

	notify the concerning Public Entity to furnish its procurement proceedings, pursuant to ITB 42.3.
	42.7 Within Three (3) days of receipt of the notification pursuant to ITB 42.6, the Public Entity shall furnish the copy of the related documents to the Review Committee.
	42.8 The Review Committee, after inquiring from the Bidder and the Public Entity, if needed, shall give its decision within One (1) month of the receipt of the application filed by the Bidder, pursuant to ITB 42.4.
	42.9 The Bidder, filing application pursuant to ITB 42.4, shall have to furnish a cash amount or Bank guarantee from Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law equivalent to one percent (1%) of its quoted Bid amount with the validity period of at least Ninety (90) days from the date of the filing of application pursuant to ITB 42.4.
	42.10 If the claim made by the Bidder pursuant to ITB 42.4 is justified, the Review Committee shall have to return the security deposit to the applicant, pursuant to ITB 42.9, within Seven (7) days of such decision made. 42.11 If the claim made by the Bidder pursuant to ITB 42.4 is rejected by the Review Committee, the security deposit submitted by the Bidder pursuant to ITB 42.9 shall be forfeited.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 1 of 5
BIDDING PROCEDURES**

**SECTION II
BID DATA SHEET**

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SECTION II: BID DATA SHEET

This section consists of provisions that are specific to each procurement and supplement the information or requirements included in **Section I** Instructions to Bidders.

A. GENERAL	
ITB 1.1	The number of the Invitation for Bids is: GKHEP/ICB-082/83/EPC-1 <i>The Bid is invited as International Competitive Bidding (ICB)</i> Replace the words “Section VI (Works Requirements)” from the end of the first sentence by “Volume 2 Employer’s Requirements”.
ITB 1.1	The Employer is: Remit Hydro Limited, New Baneshwor, Kathmandu Nepal
ITB 1.1	The number and identification of lots comprising this bidding process is: Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project Under Engineering, Procurement and Construction (EPC) Contract.
ITB 1.3	<i>Multiple Contract is “Not Applicable”</i>
ITB 2.1	Delete this Sub-Clause in its entirety and replace by the following: “The Implementing Agency as indicated in the BDS has completed the financial closure for debt portion required for the project with the Consortium led by Laxmi Sunrise Bank Limited. The equity investment will be made from the NEA, NEA, HIDCL, VUCL, Provincial Government and Local Government, Remittance and General Public and plans to apply the fund from these financial resources towards the cost of the Ghunsa Khola Hydroelectric Project. The Implementing Agency intends to apply portion of the funds allocated for the Project from the financing arrangement to eligible payments under the contract for which the Bidding Document is issued. w The implementing agency is: Remit Hydro Limited, New Baneshwor, Kathmandu Nepal
ITB 2.2	Not Applicable
ITB 3.4	Delete this Sub Clause in its entirety and replace by the following: A bidder declared blacklisted and ineligible by the GoN, Public Procurement Monitoring Office (PPMO), by a competent authority under the prevailing law for failure to repay a loan disbursed by a bank or financial institution, and/or the DP in case of DP funded project, shall be ineligible to bid for a contract during the period of time determined by the GoN, PPMO, the competent authority, and/or the DP.
ITB 4.1 (a)	Maximum number of partners in a joint venture shall be: 3 (three) including the lead firm. The lead firm shall have at least 40% of share and other partner shall have at least 25% of share in joint venture.

	In case of foreign Bidder, Joint Venture with Nepalese Bidder is: Mandatory . Replace “Section III: Evaluation and Qualification Criteria” by “Volume 1 Section III Evaluation and Qualification Criteria”
ITB 4.2 (b)	Add the following at the end of this Sub-Clause: The representative from the Lead Partner (firm) shall be authorized to act on behalf of the Joint Venture.
	Insert the following new Sub-Clause as
ITB 4.2 (c)	The Joint Venture Agreement shall be on the form as specified in the Section IV Bidding Forms. The JV agreement shall clearly state the engagement plan of each partner for the project execution.
ITB 4.2	Replace “Section V (Eligible Countries)” by “Volume 1 Section V Eligible Countries”.
ITB 4.4	<i>A list of debarred firms is available at http://www.ppmo.gov.np</i>
	<i>Insert the following new Sub-Clauses 4.9 to 4.11</i>
ITB 4.9	Domestic Bidder shall be eligible only if the Bidder has submitted the Company/Firm Registration certificate, obtained and submitted PAN/VAT registration certificate, and Tax Clearance Certificate or proof of submission of income return of Fiscal Year 2081/82 from the Inland Revenue Office and by each joint venture partners in the case of a joint venture. Foreign Bidder shall be eligible only if the bidder has submitted the Company/Firm registration certificate of the Bidder, and of each joint-venture partners in the case of a joint venture, issued by the government of the country where the bidder or each joint venture partner is registered. Pan VAT registration certificate shall be submitted by the successful bidder or Joint Venture in case of Joint Venture within 45 days of Signing of Contract Agreement. However, Resident foreign bidder shall submit PAN/VAT certificate and tax clearance certificate or proof of submission of Income Return of Fiscal Year 2081/82 at the time of Bid Submission.
4.10	The Bidder, including all parties constituting the Bidder, shall be ineligible to participate in the open competitive bidding process if it has already secured five (5) number of construction contracts (in open competitive bidding) and has not yet completed the work as stipulated in the respective contracts. Following Procurement of Works contracts shall not be counted for this purpose: a) The works for which tender were invited or contracts accepted before 2078-12-03 B.S (March 17, 2022 A.D). b) The works for which tender were invited and contracts accepted after 2078-12-03 B.S (March 17, 2022 A.D) but the work acceptance report has been approved according to Rule 117 of PPR.

	c) The works for which tenders were invited or contracts accepted under all types of foreign assistance.
ITB 4.11	For the purpose of ITB 4.9 above, the bidder shall declare that the bidder, and all parties constituting the Bidder have not already secured maximum number of construction contract (in open competitive bidding) as specified in BDS. If the bidder, and all parties constituting the Bidder has participated in bidding processes of many public entities and during that period the maximum number of contracts have been attained as specified saturates due to issuance of letters of acceptance by a particular public entity, the bidder shall inform in writing to all other concerned public entities, where the bidder have participated in bidding process, within three days of issuance of last letter of acceptance that saturates the maximum number of contracts as specified.
ITB 5.1	Replace “Section V (Eligible Countries)” by “Volume 1 Section V Eligible Countries”
B. BIDDING DOCUMENT	
ITB 6.1	Delete Sub-Clause 6.1 in its entirety and replace by the following: The Bidding Document consists of Volume 1, Volume 2, Volume 3, Volume 4 and Volume 5 which includes all the parts indicated below, and should be read in conjunction with any addenda issued in accordance with ITB 8. VOLUME 1: BIDDING PROCEDURES Section I Instructions to Bidders (ITB) Section II Bid Data Sheet (BDS) Section III Evaluation and Qualification Criteria (EQC) Section IV Bidding Forms (BDF) Section V Eligible Countries VOLUME 2: EMPLOYER’S REQUIREMENTS Section I – Scope of Works Section II – General Technical Requirements Section III – Standard Technical Requirements Section IV – Particular Technical Requirements Section V – Activity Schedule (ACS) VOLUME 3: CONDITIONS OF CONTRACT AND CONTRACT FORMS Section I - General Conditions of Contract (GCC) Section II - Special Conditions of Contract (SCC) Section III - Annexures Section IV - Contract Forms (COF) VOLUME 4: BASIC PROJECT REPORT Section I: GENERAL INFORMATION 1 – Introduction 2- Key Features of the project 3- Power and Energy Studies 4- Salient Features of Employer’s Concept Design Section II: PROJECT DESCRIPTION 1- Topographic Survey and mapping

	2- Hydrology and Meteorology 3- Sedimentology 4- Geology and Geotechnics 5- Seismicity VOLUME 5: EMPLOYER'S CONCEPT DRAWINGS
ITB 6.4	Insert "Employer's Requirements and other information included" after the word 'specifications' in second line.
ITB 7.1	For clarification purposes only, the Employer's address is: Attention: The Chief Executive Officer, Remit Hydro Limited, New Baneshwor Kathmandu Nepal Ghunsa Khola Hydroelectric Project, Kathmandu, Nepal Tel : 01-4581780 Email : procurement@remithydro.org.np
ITB 7.4	A Pre-bid meeting "shall be" held. Pre-bid meeting shall take place at the following date, time and place: Date: 29 January 2026 Time: 11:00 hour Place: Citizen Investment Trust Building, Fourth Floor, New Baneshwor, Kathmandu, Nepal A site visit "shall not be" organized by the Employer.
ITB 7.5	Time for request: Requests for clarification shall be received by the Employer no later than Fifteen (15) days prior to the deadline for submission of Bids.
C. PREPARATION OF BIDS	
ITB 10.1	The language of the bid is: English. All correspondence exchange shall be in English language. Language for translation of supporting documents and printed literature shall be English and shall be duly notarized. The Bidder shall submit the duly notarized copy of Original Documents in Original language too stating "Originals of Translated Documents"
ITB 11.2 (h)	The Bidder shall submit with its Technical Bid the following additional documents: Technical Data sheets _Hydromechanical Works List of sub contractor, in accordance with ITB 34.
ITB 11.3 (b)	In accordance with ITB 12 and ITB 14, the following schedules shall be submitted with the bid, including the Schedule of Prices: Volume II, Section V Activity Schedules (ACS)

ITB 11.3 (d)	The Bidder shall submit with its Price Bid the following additional documents: • Cash Disbursement schedule • Schedule of dayworks rates for Labour, materials and equipment • Breakdown of foreign currency requirement • Breakdown of rates of major construction items (Concrete works, Underground Excavation and supports, Cavern excavation and supports, Reinforcement bars and Shotcrete and, penstock pipe, radial gates and hydraulic hoisting), • Rates for items under Dayworks schedule.
ITB 12.1	Replace “Section IV (Bidding Forms)” by “Volume 1 Section IV Bidding Forms” Replace “Section VII (Priced Activity Schedule)” by “Volume 2 Section V Activity Schedule (ACS)”
ITB 13.1	Alternative bids “shall not be” permitted.
ITB 13.2	Alternative times for completion “shall not be” permitted.
ITB 13.3	Alternative technical solutions shall be permitted for the following parts of the Works: “Not Applicable”. Replace “Section VI (Employer’s Requirements)” by “Volume 2 Employer’s Requirements” Replace “Section III (Evaluation and Qualification Criteria)” by “Volume 1 Section III Evaluation and Qualification Criteria”
ITB 14.2	Replace “Section VII (Priced Activity Schedule)” by “Volume 2 Section V Activity Schedule (ACS)” Insert the following at the end of this Sub Clause: The Bidder shall submit a Price bid for the whole of the works and services described in ITB 1.1 in a turnkey basis such that the bid price covers all the contractors’ obligations under this Contract. Items against which no rate of price is entered by the bidder will not be paid by the Employer when executed and shall be deemed to covered by the rates for other items and prices in the “Volume 2 Section V Activity Schedule (ACS)”.
ITB 14.6	The prices quoted by the Bidder shall not be subject to adjustment during the performance of the Contract.
ITB 15.1	The currency applicable shall be: Nepalese Rupees (NRs) and US Dollars (USD). The maximum ratio of Foreign currency to Nepali currency with respect to the evaluated bid price shall not be more than 60 percent. a) Bidders shall indicate the portion of the bid price that corresponds to expenditures incurred in Foreign currency in the Activity Schedules (ACS).

	b) The rates of exchange to be used by the bidder for currency conversion during bid preparation shall be the selling rates for similar transactions prevailing on the date 30 days prior to the deadline for submission of bids published by Nepal Rastra Bank. Bidders should note that, as the bid is quoted in both the currencies (USD and Nepalese Rupees), for the purpose of payments, the exchange rates confirmed by Nepal Rastra Bank as the selling rates prevailing 30 days prior to the particular IPC submitted date shall apply, so that no currency exchange risk is borne by the bidder. c) Foreign currency requirements indicated by the bidders in the Schedule Summary of Payment Currencies shall include but not limited to the specific requirements for • expatriate staff and labor employed directly on the Works; • social, insurance, medical and other charges relating to such expatriate staff and labor, and foreign travel expenses; • imported materials, both temporary and permanent, including fuels, oil and lubricants required for the Works; • depreciation and usage of imported Plant and Contractor's Equipment, including spare parts, required for the Works; • foreign insurance and freight charges for imported materials, Plant and Contractor's Equipment, including spare parts; and • overhead expenses, fees, profit, and financial charges arising outside the Employer's country in connection with the Works. d) Bidders may be required by the Employer to clarify their foreign currency requirements, and to substantiate that the amounts included in the prices and shown in the Schedule Summary of Payment Currencies are reasonable and responsive to (b) above, in which case a detailed breakdown of its foreign currency requirements shall be provided by the Bidder. e) Bidders should note that during the progress of the Works, the foreign currency requirements of the outstanding balance of the Contract Price may be adjusted by agreement between the Employer and the Contractor in order to reflect any changes in foreign currency requirements for the Contract, in accordance with General Condition of Contract 58. Any such adjustment shall be affected by comparing the percentages quoted in the bid with the amounts already used in the Works and the Contractor's future needs for imported items.
ITB 16.1	Replace "Section IV (Bidding Forms)" by "Volume 1 Section IV Bidding Forms"
ITB 17.1	Replace "Section III (Evaluation and Qualification Criteria)" by "Volume 1 Section III Evaluation and Qualification Criteria" Replace "Section IV (Bidding Forms)" by "Volume 1 Section IV Bidding Forms"
ITB 18.1	The bid validity period shall be: One Hundred Twenty (120) days. Add the following at the end of this Sub Clause:

	If the prescribed bid submission deadline date falls on a government holiday, then the next working day shall be considered as the bid submission deadline date. In such case the validity period of the bids shall be considered from the original bid submission deadline date. In the case of electronic bid submission, if any technical issue arises in the handling of the e-GP system, the PPMO may extend the deadline for bid submission. However, the validity period of the bids shall still be counted from the original bid submission deadline.
ITB 19.1	The Bidder shall furnish a bid security, from “A” class Commercial Bank or Financial Institution eligible to issue Bank Guarantee as per prevailing Law with a minimum of Equivalent Nepalese Rupees 200 Million (In Words: Nepalese Rupees Two Hundred Million only). or USD 1.40 Million. The Bid security shall be maintained valid for minimum Thirty (30) days beyond the period of validity of Bid. A Bid security issued by any foreign Bank outside Nepal must be provided with a counter guarantee issued by an “A” class commercial Bank in Nepal.
ITB 19.2 (b)	Office Name: Remit Hydro Limited, Office Address: New Baneshwor, Kathmandu, Nepal Bank Name: Laxmi Sunrise Bank Limited Bank Address: Hattisar,, Kathmandu,Nepal Account Number: 1621512304011219 Swift Code: LXBLNPKA
ITB 19.2	Add the following at the end of this Sub-Clause: A bid security valid for a shorter period shall be rejected by the Employer as nonresponsive.
ITB 20.1	In addition to the original of the bid, the number of copy is: "Not Applicable"
ITB 20.2	The written confirmation of authorization to sign on behalf of the Bidder shall indicate: (a) The name and description of the documentation required to demonstrate the authority of the signatory to sign the Bid such as a Power of Attorney; and (b) In the case of Bids submitted by an existing or intended JV, an undertaking signed by all parties (i) stating that all parties shall be jointly and severally liable, and (ii) nominating a Representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution. (c) the Issuance of Power of Attorney is required subsequent to the date of bid publication and must adhere to the provided format.

D. SUBMISSION AND OPENING OF BIDS				
ITB 21.1	Add S.N. 12 at the end of the table of Technical Bid as follows			
	S. N.	Document	Requirement	Remarks
	1	Technical Proposal Schedules as per Volume 1 Section IV of the Bidding Document	Mandatory	PDF
ITB 21.1	<i>There is no provision of hard copy submission.</i> Therefore, copy is not required. The bids submitted electronically are considered as original. However, if required as per ITB 27, the Bidder shall be required to submit original Bid Security letter/documents and other clarifications as required.			
ITB 22.1	The deadline for bid submission is: Date: 23 February 2026 Time: 12:00 hour			
ITB 25.1	The bid opening shall take place at: Meeting Hall, Remit Hydro Limited Office 4 th floor, Citizen Investment Trust Building New Baneshwor, Kathmandu Nepal Date: 23 February 2026 Time: 14:00 hours			
E. EVALUATION AND COMPARISON OF BIDS				
ITB 30.3	Replace “Section VI (Works Requirements)” by “Volume 2 Employer’s Requirements”			
ITB 31.3	Replace “Section III (Evaluation and Qualification Criteria)” by “Volume 1 Section III Evaluation and Qualification Criteria”			
ITB 32.1	Replace “Section III (Evaluation and Qualification Criteria)” by “Volume 1 Section III Evaluation and Qualification Criteria”			
ITB 34.1	Replace “Section III” by “Volume 1 Section III Evaluation and Qualification Criteria” a) Contractor’s proposed subcontracting: Maximum percentage of subcontracting permitted is: 25% of the total contract amount.			
ITB 35.2 (a)	Replace “Priced Activity Schedule” by “Activity Schedule (ACS)”			
ITB 35.2 (e)	Replace ‘Section III (Evaluation and Qualification Criteria)’ by “Volume 1 Section III Evaluation and Qualification Criteria”			

ITB 35.2(f)	Nepali Currency
ITB35.2(g)	Domestic Preference A Domestic preference as per ITB 35.2 (g) shall be granted to eligible domestic bidders, as defined below, in accordance with the following provisions: (a) For the application of domestic preference, all responsive bids shall first be classified into the following two categories: i) Category I: Bids offered by domestic bidders (domestic firms, institutions, or companies, either in single or in joint venture, where all partners are domestic); and ii) Category II: Bids offered by bidders in a joint venture between international and domestic bidders. (b) The lowest evaluated bid of each category shall then be determined by comparing all evaluated bids in each category among themselves. (c) Such lowest evaluated bids shall next be compared with each other and, if as a result of this comparison, a bid from Category I is found to be the lowest, it shall be selected for the award of contract. (d) If, however, as a result of the comparison under (c) above, the lowest bid is found to be from Category II, it shall be further compared with the lowest evaluated bid from Category I. For the purpose of this further comparison, an upward adjustment (domestic preference) shall be made to the evaluated bid price of Category II by adding an amount proportionate to the shareholding of the domestic firm, institution, or company in the joint venture, provided that the maximum adjustment shall not exceed five percent (5%) of the bid price. For clarity, the full five percent (5%) adjustment shall apply when the domestic bidder's share in the Joint Venture is zero percent (0%), and this adjustment shall decrease linearly to zero percent (0%) when the domestic bidder's share in the Joint Venture reaches one hundred percent (100%). If, after such comparison, the Category I bid is determined to be the lowest, it shall be selected for award of the Contract. Otherwise, the bid from Category II with the lowest evaluated price after applying the domestic preference adjustment shall be selected for award of the Contract. Joint Ventures between a Domestic Bidder(s) and its foreign partner(s) shall be eligible for the Domestic Preference scheme only if the domestic bidder(s) (domestic firms, institutions, or companies) have at least twenty-five percent (25%) share in the Joint Venture.
ITB 35.4	Replace "Section III (Evaluation and Qualification Criteria)" by "Volume 1 Section III Evaluation and Qualification Criteria"
ITB 35.5	The amount of the performance security be increased by Eight (8) percent of the quoted bid price.
ITB 40	Rename this Clause as "Performance Security"

ITB 40.1	Replace “The Bid Price and Cost Estimate shall be exclusive of Value Added Tax.” by “The Bid Price and Cost Estimate shall be exclusive of Value Added Tax but including Provisional Sum.
ITB 40.2	Delete “Line of Credit or” in first sentence of this Sub-Clause.

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**VOLUME 1 of 5
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**SECTION III
EVALUATION AND QUALIFICATION CRITERIA**

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SECTION III - EVALUATION AND QUALIFICATION CRITERIA

This Section contains all the criteria that the Employer shall use to evaluate bids and qualify Bidders by post-qualification exercise. The Employer requires bidders to be qualified by meeting predefined and precise minimum requirements. The method sets pass-fail criteria, which, if not met by the bidder, results in disqualification. In accordance with **ITB 32 and ITB 35**, no other methods, criteria and factors shall be used. The Bidder shall provide all the information requested in the forms included in **Volume 1 Section IV Bidding Forms**.

1. Evaluation

In addition to the criteria listed in **ITB 35.2 (a) - (g)** the following criteria shall apply:

1.1 Adequacy of Technical Proposal

Evaluation of the Bidder's Technical Proposal will include an assessment of the Bidder's technical capacity, to mobilize key equipment and personnel for the contract consistent with its proposal regarding work methods, scheduling, and material sourcing in sufficient detail and fully in accordance with the requirements stipulated in **Volume 2 Employer's Requirements**.

1.2 Multiple Contracts:

Not Applicable

1.4 Completion Time

An alternative Completion Time, if permitted under ITB 13.2, will be evaluated as follows:

Not Applicable

1.5 Alternative Technical Solutions

Alternative technical solutions, if permitted under ITB 13.4, will be evaluated as follows:

Not Applicable

1.6 Quantifiable Nonconformities and Omissions

Subject to ITB 14.2 and ITB 35.2, the evaluated cost of quantifiable nonconformities including omissions, is determined as follows:

"Pursuant to ITB 31.3, the cost of all quantifiable nonmaterial nonconformities shall be evaluated, but excluding omission of prices in the **Activity Schedules (ACS)**. The Employer will make its own assessment of the cost of any nonmaterial nonconformities and omissions for the purpose of ensuring fair comparison of bid.

2. QUALIFICATION

2.1 Eligibility

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.1.1 Nationality					
Nationality in accordance with ITB sub-clause 4.2	Must meet requirement	Must meet requirement	Must meet requirement	not applicable	Letter of Technical BidForms ELI –1; ELI –2 with attachments
2.1.2 Conflict of Interest					
No conflicts of interest in accordance with ITB Sub-Clause 4.3.	Must meet requirement	existing or intended JV must meet requirement	must meet requirement	not applicable	Letter of Technical Bid
2.1.3 Government/DP Eligibility					
Not having been declared ineligible by government/DP, as described in ITB Sub-Clause 4.4.	Must meet requirement	must meet requirement	must meet requirement	not applicable	Letter of Technical Bid
2.1.4 Government-owned Entity					
Bidder required to meet conditions of ITB Sub-Clause 4.5.	must meet requirement	existing or intended JV must meet requirement	must meet requirement	not applicable	Forms ELI - 1, ELI - 2 , with attachments

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.1.5 UN Eligibility					
Not having been declared ineligible based on a United Nations resolution or Employer's country law, as described in ITB Sub-Clause 4.8.	must meet requirement	existing or intended JV must meet requirement	must meet requirement	not applicable	Letter of Technical Bid
2.1.6 Other Eligibility					
Firm Registration Certificate	must meet requirement	not applicable	must meet requirement	not applicable	Document attachment
Business Registration Certificate	Must meet requirement	not applicable	must meet requirement	not applicable	Document attachment
VAT and PAN Registration certificate (<i>only for domestic bidders</i>)	must meet requirement	not applicable	must meet requirement	not applicable	Document attachment
Tax Clearance Certificate/Tax return submission evidence for the F/Y <i>2081/82 (only for domestic bidders)</i>	must meet requirement	not applicable	Must meet requirement	not applicable	Document attachment

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
For Foreign Bidder as per Sub-Clause 4.9	must meet requirement	existing or intended JV must meet requirement	must meet requirement	not applicable	Declaration to submit PAN and VAT Registration Certificate at the time of Contract agreement
2.1.7 Bidders running Contract					
Bidders Running Contracts ¹ not more than five (5) as described in ITB 4.10 and ITB 4.11	must meet requirement	Existing and intended JV Must meet requirement	must meet requirement	must meet requirement	Form ELI-3

¹ **Following Procurement of Works contracts shall not be counted for this purpose:**

- a) The works for which tender were invited or contracts accepted before 2078-12-03 B.S (March 17, 2022 A.D)
- b) The works for which tender have been invited and contracts accepted after 2078-12-03 B.S (March 17, 2022 A.D) but the work acceptance report has been approved according to Rule 117 of PPR.
- c) The works for which tenders were invited or contracts accepted under all types of foreign assistance.

(2) This criteria is not applicable for bidders participating as JV with maximum share 25 % and not having signed more than two (2) contracts for works of similar nature since 2078-12-03 i.e. March 17, 2022 in Nepal.

2.2 Pending Litigation

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.2.1 Pending Litigation					
All pending litigation shall be treated as resolved against the Bidder and so shall in total not represent more than Fifty (50) percent of the Bidder's net worth.	must meet requirement by itself or as partner to past or existing JV	not applicable	must meet requirement by itself or as partner to past or existing JV	not applicable	Form LIT - 1

2.3 Financial Situation

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.3.1 Historical Financial Performance					

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
Submission of audited balance sheets and income statements, for the last Five (5) years to demonstrate the current soundness of the Bidder's financial position. As a minimum, a Bidder's net worth calculated as the difference between total assets and total liabilities should be positive .	must meet requirement	not applicable	must meet requirement	not applicable	Form FIN - 1 with attachments

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.3.2 Average Annual Construction Turnover					
Minimum average annual construction turnover of US\$ 18.20 million calculated as total certified payments received for construction contracts in progress or completed, within best Three (3) years out of last Ten (10) fiscal years.	must meet requirement	must meet requirement	must meet 25% of the requirement	must meet 40% of the requirement	Form FIN -2

Note: Only the net amount shall be calculated after deducting the amount for VAT.

The net amount in Nepalese Rupees of bidders from Nepal shall be adjusted to present value by applying wholesale price index of Nepal Rastra Bank.

In case of currencies other than Nepalese Rupees Present Value Conversion factor is taken as unity for all year in count; only multiplied by selling exchange rates confirmed by Nepal Rastra Bank as the selling rates prevailing **Thirty (30)** days prior to the deadline for submission of bids.

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
2.3.3 Required Bid Capacity					

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirements
		All Partners Combined	Each Partner	One Partner	
The bidding capacity of the bidder should be equal to or more than the US\$ 51.80 Million	must meet requirement	must meet requirement	must meet 25% of the requirement	must meet 40% of the requirement	Form FIN -3,4
2.3.4 Financial Resources					
Using Forms FIN - 3 and FIN - 4 in Section IV (Bidding Forms) the Bidder must demonstrate access to, or availability of, financial resources such as liquid assets ² , unencumbered real assets, Line of Credit and other financial resources, (other than any contractual advance payments) to meet the cash-flow requirement of US\$ 3.80 Million .	must meet requirement	must meet requirement	must meet 25% of the requirement	must meet 40% of the requirement	Form FIN - 5

² Liquid Assets mean cash and cash equivalents, short-term financial instruments, short term available-for-sale-securities, marketable securities, trade receivables, short-term financing receivables and other assets that can be converted into cash within ONE YEAR.

2.4 Experience

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirement
		All Partners Combined	Each Partner	One Partner	
2.4.1 General Construction Experience					
Experience under construction contracts in the role of contractor, subcontractor, or management contractor for at least the last Five (5) years prior to the applications submission deadline.	Must meet requirement	Not applicable	Must meet requirement	Not applicable	Form EXP - 1

Criteria		Compliance Requirements			Documents
Requirement	Single Entity	Joint Venture			Submission Requirement
		All Partners Combined	Each Partner	One Partner	
2.4.2 Specific Construction Experience					
(a) Contracts of Similar Size and Nature					
i. Participation as Prime Contractor, management contractor, or subcontractor, in at least one (1) EPC or DB or Turnkey contract within the last Ten (10) years prior to the applications submission deadline, with a value of at least or equivalent to US\$ 20.80 million that have been successfully or are substantially completed and that are similar to the proposed works: The similarity of the proposed work of the applicant’s participation shall be based on Civil or Civil and Hydromechanical works of a Hydropower project.	Must meet requirement	Not Applicable	Not applicable	Must meet requirement	Form EXP – 2(a)
ii. Participation as Prime contractor, management contractor, or subcontractor, Contract within the last Ten (10) years, with a value of at least US\$ 13.0 Million that have been successfully or are substantially completed. (for this the amount can be taken from only one contract or by adding maximum of two contracts.)	Not applicable	Not applicable	Must meet requirement	Not applicable	Form EXP – 2(a)

Only the net amount shall be calculated after deducting the amount for VAT and such amount shall be adjusted to present value by applying wholesale

price index of Nepal Rastra Bank.

Note 1: Works to be considered as substantially completed:

- i. Completion of testing and commissioning of project and taking over certificate has been issued in case of Hydropower Projects.
- ii. A contract for which a Taking-Over Certificate has been issued shall be considered as substantially completed for other projects.

Note 2:

1. Satisfactory completion and work experience shall be evidenced by the Client's reference including, scope of works and value of contract in their letter head with proper contact address, telephone, email etc. If the references are other than English languages, then the Applicant shall submit its English translated copies. All the copies of the reference documents and translated documents shall be duly authenticated by authorized notary agencies.
2. Bidder's experience will not be considered for evaluation if not accompanied with client's reference mentioned above.

Criteria		Compliance Requirements			Documents	
Requirement	Single Entity	Joint Venture			Submission Requirement	
		All Partners Combined	Each Partner	One member		
(b) Construction Experience in Key Activities						
For the above or other contracts executed during the period stipulated in 2.4.2(a) above, a minimum construction experience in the following key activities:						
2.4.2.b 1 Experience in Civil Works	(a) Successful completion of Diversion Weir / Dam in having concrete volume of $\geq 18,500 \text{ m}^3$ in a single contract which shall have been successfully completed within the last Ten (10) years. (b) Successful completion of at least one hydraulic tunnel in a single contract in a single project of Length $\geq 3.0 \text{ km}$ (Except length of Adit) with its finished diameter of $\geq 3.3 \text{ m}$, which shall have been successfully completed within the last Ten (10) Years. (c) Successful completion of at least 1 Vertical or inclined Shaft in a single contract in a single project (pressure tunnel) of 144 m in single stretch with excavation diameter $\geq 3.2 \text{ m}$, which shall have been successfully completed within the last Ten (10) years. (d) Successful completion of at least 1 underground powerhouse cavern in a single contract in a single project of excavation width $\geq 12 \text{ m}$, which shall have been successfully completed within the last Ten (10) years.	must meet all requirements	must meet all requirements	not applicable	not applicable	Form EXP - 2(b)

Criteria		Compliance Requirements				Documents
Requirement		Single Entity	Joint Venture			Submission Requirement
			All Partners Combined	Each Partner	One member	
2.4.2 b2 Experience in Hydromechanical Works	a) Must have experience in design, manufacturing, supply, installation, testing and commissioning of at least one (1) radial gate of size $\geq 12 \text{ m}^2$ that has been successfully completed in the last Ten (10) years. b) Must have experience in design, manufacturing, supply, installation, testing and commissioning of at least one (1) Steel lining in penstock pipes in vertical or inclined shafts (undergrund) in a single contract in a single project having length $\geq 144 \text{ m}$ in single stretch which shall have been successfully completed in last Ten (10) years.	must meet all requirements	must meet all requirements	not applicable	not applicable	Form EXP - 2(b)

Note:

1. To substantiate the above qualification and work experience, Satisfactory/successfully completion and work experience shall be evidenced by the Client's reference including, scope of works and value of contract in their letter head with proper contact address, telephone, email etc. If the references are other than English languages, then the Applicant shall submit its English translated copies. All the copies of the reference documents and translated documents shall be duly authenticated by authorized notary agencies.
2. Bidder's experience shall not be considered for evaluation if not accompanied with client's reference as mentioned above.

2.5 Understanding about the Project and Proposed Design

Understanding about the Project					
Submission of concept paper highlighting detail about understanding of the project from planning to completion stage including surveying, geotechnical investigation, environmental and social safeguard study, designing, procuring, constructing and operation and maintenance.	must meet requirement	must meet requirement	not applicable	not applicable	Form EXP – 2(B)
Proposed Design					
Submission of design methodology and concept design including design finalization procedure, assurance about design and relevant codes	must meet requirement	must meet requirement	not applicable	not applicable	Technical schedule 9

2.6 Personnel

The Bidder must demonstrate that it has the personnel for the key positions that meet the following requirements:

S.N.	Position/Academic Qualification [When position demands]	Total Work Experience [Year]	Experience in Similar Works [Years]
A. DESIGN WORK			
1	Team Leader, Design Section (Education – Preferably Master's Degree or at least Bachelor Degree in Civil Engineering)	For Bachelor's Degree	
		15 years	10 years in Design of Hydropower project of Capacity of at least 60 MW out of which at least 3 years as team leader
		For Master's Degree	
		10 years	7 years in Design of Hydropower project of Capacity of at least 60 MW out of which at least 3 years as team leader
2	Civil Design Expert (Education – Preferably Master's degree or at least Bachelor Degree in Civil Engineering)	For Bachelor's Degree	
		10 years	7 years in Civil Design of Hydropower projects of Capacity of at least 60 MW
		For Master's Degree	
		7 years	5 years in Civil Design of Hydropower projects of Capacity of at least 60 MW
3	Hydro-Mechanical Design Expert (Education – Preferably Master Degree or at least Bachelor Degree in Mechanical Engineering)	For Bachelor's Degree	
		10 years	7 years in Hydro-Mechanical Design (Gates, penstock pipes and Steel Structures) of Hydropower projects of Capacity of at least 60 MW
		For Master's Degree	
		7 years	5 years in Hydro-Mechanical Design (Gates, penstock pipes and Steel Structures) of Hydropower projects of Capacity of at least 60 MW
4	Structural Engineer (Education –At least Master's Degree in Structural Engineering)	7 years	5 years in Structural Design of Hydraulic Structures of Hydropower projects of Capacity of at least 60 MW
5	Hydraulic Engineer (Education – At least Master's Degree in Water Science / Hydropower Engineering)	7 years	5 years in Hydraulic Design of structures of Hydropower projects of Capacity of at least 60 MW
6	Geologist/ Geotechnical Expert (Education–At least Master's Degree in	7 years	5 years in Geological / Geotechnical investigation and Design of underground structures, foundation,

S.N.	Position/Academic Qualification [When position demands]	Total Work Experience [Year]	Experience in Similar Works [Years]
	Geology /Geo-technical Engineering)		slope protection of Hydropower projects of Capacity of at least 60 MW
B. CONSTRUCTION WORK			
7	Project Manager (Education- Preferably Master's degree or at least Bachelor's Degree in Engineering)	15 years	10 years in Construction Management out of which at least 5 years as a project manager in Hydropower projects of min. Capacity of 60 MW.
8	Construction Manager (Education- Preferably Master's degree or at least Bachelor Degree in Civil Engineering)	12 years	10 years as a construction engineer in Hydropower Projects of min. Capacity of 60 MW
9	Quality Control Engineer (Education- Preferably Master's degree or at least Bachelor Degree in Civil Engineering/ Material Engineering)	10 years	7 years as a quality control engineer in Hydropower projects of min. Capacity of 60 MW
10	Structural Engineer (Education –At least Master's Degree in Structural Engineering)	10 years	7 years as a structural engineer in Hydropower projects of min. Capacity of 60 MW
11	Hydro Mechanical Engineer (Education – Preferably Master's degree or at least Bachelor Degree in Mechanical Engineering)	10 years	7 years as a hydro-mechanical engineer in Hydropower projects of min. Capacity of 60 MW
12	Geologist/Tunnel Engineer/Geotechnical Expert (Education –At least Master's Degree in Geology/Geo-technical Engineering)	15 years	10 years as a Geologist /Geotechnical or a tunnel engineer in Hydropower projects of min. Capacity of 60 MW and tunnel size more than 3.0 m dia

In case the bidder proposes to consider Personnel that may be spared from committed/ongoing contracts for evaluation, the bidder shall provide details of personnel which will be spared from such committed/ongoing contracts based on the physical progress at the date of bid submission.

The Bidder shall provide details of the proposed personnel and their experience records in the relevant Information Forms included in Section IV (Bidding Forms).

The bidder may propose same person for the equivalent positions required to serve for engineering, procurement and construction phases if the person meets the criteria as above for all phases.

2.7 Equipment

The Bidder must demonstrate that it has the key equipment listed hereafter:

S.N.	Equipment Type and Characteristics	Minimum Number Required	Remarks
1	Tower Crane 30t	1	Technical Schedule 3 (i) and (ii)
2	Mobile Crane 20 t	1	
3	Truck Crane 25 t/50 t	2	
4	Dump Truck 15 t	10	
5	Dump Truck 10 t	10	
6	Bulldozer (160 HP)	2	
7	Excavators, 1.0 m ³	5	
8	Loader 1.5 m ³	4	
9	Loader 2.0 m ³	4	
10	Concrete Mixing Station (Automatic Batching Plant) min. production Capacity of 25 m ³ /h , set	2	
11	Concrete Mixing Truck, 3 m ³	5	
12	Vibrating Roller, 12 t	2	
13	Aggregate Crushing Plant, min. production capacity 40 m ³ /h with screening sets, Conveyors and sand pumps, set	2	
14	Wet shotcrete Machine, min. 5 m ³ /h capacity	6	
15	Concrete Pumps (Min. Capacity 10 m ³ /h), set	4	
16	Air compressor (12-17 m ³ /min), set	7	
17	Diesel Generator (400 kVA), set	2	
18	Core Drilling Machine	2	
19	Raise boring Machine/Alimak raise climber	1	
20	Submersible pump (5kW)	10	
21	Grouting Machine	7	
22	Penstock Pipe Rolling Machine	1	

S.N.	Equipment Type and Characteristics	Minimum Number Required	Remarks
23	Jumbo Boomer (minimum 4 arm)	2	
24	Hydraulic Down Hole Drill machine (DTH)	1	

In case the Bidder proposes to consider Equipment that may be spared from committed/ongoing contracts for evaluation, the Bidder shall provide details of Equipment which will be spared from committed / ongoing contracts clearly demonstrating the availability of such equipment with respect to the physical progress of the ongoing contracts on the date of bid submission.

In case of Equipment to be leased/hired the same procedure as mentioned above shall apply.

The Bidder shall provide further details of proposed items of equipment using the relevant Form in Volume 1 Section IV Bidding Forms.

2.8 Subcontractors

The experience and financial capacity of the sub-contractors shall not be added to those of the Bidder for purposes of qualification of the Bidder.

The sub-contractors and proposed personnel shall be fully qualified for their work proposed, and meet the following criteria:

2.8 (a) Nature of Works that can be sub contracted:

- i. Civil Works
- ii. Hydro-mechanical Works
- iii. Engineering Design Works

2.8 (b) Qualification Criteria

The Subcontractor shall meet the following requirements:

1. Completion of 80% of the quantity of work being sub contracted.
2. Average Annual Construction Turnover for the work being sub contracted should be at least $1.5 \cdot V/T$. where V is the proposed value of sub contract amount and T is the time in year. For contract duration up to 1 year T shall be "1".
3. Financial Resources: The Sub contractor must demonstrate that it has the financial resources to meet its current contract commitment plus three months requirements for the sub contracted work.

For specialized Subcontractors:

The Bidders can propose the Subcontractors for the following elements of works who meets the following criteria.

Item No.	Description of Item	Minimum Criteria to be Met	Document Submission requirements
1	Hydromechanical Works	c) Must hold a valid ISO9001:2000 (including design in scope of registration) certifications. d) Must have experience in design, manufacturing, supply, installation, testing and commissioning of at least one (1) radial gate of size $\geq 12 \text{ m}^2$ that has been successfully completed in the last Ten (10) years. (FIN 2 (b)) e) Must have experience in design, manufacturing, supply, installation, testing and commissioning of at least one (1) Steel lining in penstock pipes in vertical or inclined shafts (underground) in a single contract in a single project having length $\geq 144 \text{ m}$ in single stretch which shall have been successfully completed in last Ten (10) years. (FIN 2 (b)) f) Minimum average annual construction turnover of NRs. 290 Million above calculated as total certified payments received for contracts in progress or completed, within best three (3) years out of last ten (10) fiscal years. (FIN-2) g) Financial Resources: The sub-contractor must demonstrate that it has the financial resources to meet its current contract commitment plus three months' requirements for the sub contracted work as required under 2.8 (b) Qualification Criteria For other Subcontractors 2.8 (b) Qualification Criteria for other Subcontractors above. (FIN-5)	Bidder (s) must submit copies of all the necessary documents required to prove the above specified legal status (Notarized copy), valid ISO certificate (Notarized copy), experience eligibility requirements substantiated by end users' certificate (Notarized copy), and type test report. Additional to the required forms, the Bidder shall submit the Separate Form of Sub-Contractor's Manufacturers and Suppliers as attached in the Bidding Form.
2	Engineering Design Works	1. General Consulting firm experience of minimum Ten (10) years. 2. Must hold ISO 9001: 2015 (Quality Management System) 3. Experience in complete Detail Engineering Design of at least one (1) successfully completed and commissioned hydropower Project of	Bidder (s) must submit copies of all the necessary documents required to prove the above specified legal status (Notarized copy), valid ISO certificate (Notarized copy), experience eligibility requirements

Item No.	Description of Item	Minimum Criteria to be Met	Document Submission requirements
		minimum capacity 60 MW in the last Ten (10) years. 4. Experience in Detail Engineering Design of Headworks Structures of Hydropower Project. 5. Experience in Detailed Engineering Design of underground desander/ Settling basin for hydropower Project. 6. Experience in Detailed Engineering Design of headrace tunnel of minimum length 3.0 km in a single Project. 7. Experience in Detailed Engineering Design of headrace tunnel of finished diameter not less than 3.3 m for Hydropower Project. 8. Experience in Detail Engineering Design of underground powerhouse cavern having excavation width not less than 12 m. 9. Experience in Detail Engineering Design of Successfully completed underground pressure shaft (vertical or inclined) with excavation diameter not less than 3.2 m and height not less than 144 m in single stretch. 10. Minimum average annual turnover of equivalent as required under 2.8 (b) Qualification Criteria For other Subcontractors above calculated as total certified payments received for contracts in progress or completed, within best three (3) years out of last ten (10) fiscal years. 11. Financial Resources: The sub-contractor must demonstrate that it has the financial resources to meet its current contract commitment plus three months' requirements for the sub contracted work as required under 2.8 (b) Qualification Criteria For other Subcontractors 2.8 (b) Qualification Criteria For other Subcontractors above.	substantiated by end users' certificate (Notarized copy)

Note

1. In case a Bidder does not have the required design experience, the Bidder shall provide a Memorandum of Understanding (MOU) or a Letter of Intent (Form-LOI) from Design Consulting Firm who meets the above design requirements (Engineering Design Works). The MOU or LOI must show the Design Consulting Firm's intent to provide the Bidder design services under specialized subcontracting for design works and shall submit duly filled Form: EXP – DES.
2. To substantiate the above qualification and work experience, Satisfactory/successfully completion and work experience shall be evidenced by the Client's reference including, scope of works and value of contract in their letter head with proper contact address, telephone, email etc. If the references are other than English languages, then the Applicant shall submit its English translated copies. All the copies of the reference documents and translated documents shall be duly authenticated by authorized notary agencies.
3. If the proposed Specialized sub contractor does not meet the qualification criteria stated above, the Sub contractor shall be rejected but not the bidder.
4. If the proposed Sub-Contractor is found not meeting the qualification requirements, the Bidder shall replace the Sub-Contractor within fifteen (15) days after receiving the Employer's notice.
5. In case of a Bidder who offers to supply and install major Hydromechanical items under the contract (Valve at Valve Chamber) which the bidder did not manufacture or otherwise produce, the Bidder shall provide the manufacturer's authorization, using the form provided in Section IV: Bidding Forms (Form-AUTH), showing that the Bidder has been duly authorized by the manufacturer or the producer of the related equipment or component to supply and install that item in the Employer's country.
6. The Bidder shall fill the **Technical Schedule 15 - Schedule of Particulars (Guaranteed performance and technical parameters)** provided in Section IV – Bidding Forms.

REMIT HYDRO LIMITED

**GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 1 of 5
BIDDING PROCEDURES**

**SECTION IV
BIDDING FORMS**

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SECTION IV: BIDDING FORMS

This Section contains the forms which are to be completed by the Bidder and submitted as parts of its Bid.

List of Bidding Forms:

A. Bidding forms to be submitted with the Technical Bid

1. Letter of Technical Bid
2. Bid Security
3. Power of Attorney
4. Joint Venture Agreement (Mandatory for Foreign Bidders with Nepalese firms)
5. Consulting Firm/ Specialist Subcontractors Letter of Intent
6. Technical Schedule 1: Bidders information and Qualification Format
 - i. Form ELI – 1: Bidder's Information Sheet
 - ii. Form ELI - 2: JV Information Sheet
 - iii. Form ELI -3: Bidders Running Contracts in Nepal
 - iv. Form FIN - 1: Financial Situation
 - v. Form FIN - 2: Average Annual Construction Turnover
 - vi. Form FIN - 3: Bid Capacity
 - vii. Form FIN-4: Current Contract Commitments / Works in Progress
 - viii. Form FIN 5 Financial Resources
 - ix. Form EXP - 1: General Construction Experience
 - x. Form EXP - 2(a): Specific Construction Experience
 - xi. Form EXP - 2(b): Specific Construction Experience in Key Activities
7. Technical proposal format:
 - i. Technical Schedule 2: Personnel
 - a) Form PER-1: Proposed personnel
 - b) Form PER-2: Resume of proposed personnel
 - ii. Technical Schedule 3: Equipment
 - iii. Technical Schedule 6: Site organization
 - iv. Technical Schedule 7: Method of Statement
 - v. Technical Schedule 13: Mobilization Schedule
 - vi. Technical Schedule 10: Programme
8. Technical Schedule 4: Contractor's Work Force
9. Technical Schedule 5: Sub-Contractor, Manufacturers and Suppliers with

Annexes

- 10. Technical Schedule 8: Contractor's Concept Design
- 11. Technical Schedule 9: Contractor's Design Documents Submission Schedule
- 12. Technical Schedule 11: Quality Assurance
- 13. Technical Schedule 12: Health Safety and Environment
- 14. Technical Schedule 14: Insurance Schedule
- 15. Technical Schedule 15: Schedule of Particulars (Guaranteed performance and Technical Parameters)
- 16. Technical Schedule 17: Format for Understanding about the project
- 17. Technical Schedule 18; Proposed Design format
- 18. Any other documents required by the Bidding Documents

B. Bidding Forms to be submitted with the Price Bid

- 1. Letter of Price Bid
- 2. Volume II Section V Activity Schedules (ACS)
- 3. Table A. Summary of Payment Currencies
- 4. Schedule of Day Works rate for Labour, Materials and Contractor's Equipment and summary of Dayworks Schedule
- 5. Disbursement Schedule
- 6. Breakdown of Foreign Currency Requirements
- 7. Technical Schedule 16: Schedule of Recommended Spare parts, Accessories, Consumables and Tools for Operation and Maintenance
- 8. Breakdown of rates for major construction items
- 9. Any other documents required by the Bidding Documents

LETTER OF TECHNICAL BID

The Bidder must accomplish the Letter of Technical Bid in its letterhead clearly showing the Bidder's complete name and address.

Date:

Name of the contract:

Invitation for Bid No.:

**To: Ghunsa Khola Hydroelectric Project
Remit Hydro Limited
New Baneshwor, Kathmandu, Nepal**

Name of Contract: **Construction of Lot 1 – Civil and Hydro-mechanical Works of
Ghunsa Khola Hydroelectric Project under EPC Contract**

We, the undersigned, declare that:

- (a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB) Clause 8.
- (b) We offer to execute in conformity with the Bidding Documents the following Works:
Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under Engineering Procurement and Construction Contract.
- (c) Our Bid consisting of the Technical Bid and the Price Bid shall be valid for a period of [insert validity period as specified in ITB 18.1 of the BDS] days from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
- (d) Our firm, including any subcontractors or suppliers for any part of the Contract, have nationalities from eligible countries in accordance with ITB 4.2 and meet the requirements of ITB 3.4, & ITB 3.5.
- (e) We are not participating, as a Bidder or as a subcontractor, in more than one Bid in this bidding process in accordance with ITB 4.3(e), other than alternative offers submitted in accordance with ITB 13.
- (f) Our firm, its affiliates or subsidiaries, including any Subcontractors or Suppliers for any part of the contract, has not been declared ineligible by DP, under the Employer's country laws or official regulations or by an act of compliance with a decision of the United Nations Security Council;
- (g) We are not a government owned entity/We are a government owned entity but meet the requirements of ITB 4.5;
- (h) We declare that, we including any subcontractors or suppliers for any part of the contract do not have any conflict of interest in accordance with ITB 4.3 and we have not been punished

for an offense relating to the concerned profession or business.

- (i) We declare that we are solely responsible for the authenticity of the documents submitted by us. The document and information submitted by us are true and correct. If any document/information given is found to be concealed at a later date, we shall accept any legal actions by the Employer.
- (j) We agree to permit the Employer/DP or its representative to inspect our accounts and records and other documents relating to the bid submission and to have them audited by auditors appointed by the Employer.
- (k) If our Bid is accepted, we commit to mobilizing key equipment and personnel in accordance with the requirements set forth in Section III (Evaluation and Qualification Criteria) and our technical proposal, or as otherwise agreed with the Employer.
- (l) We declare that we have not yet secured five (5) number of construction contract (in open competitive bidding) as described in ITB Sub-Clause 4.10.

Name:

In the capacity of

Signed

Duly authorized to sign the Bid for and on behalf of

Date

LETTER OF PRICE BID

The Bidder must accomplish the Letter of Price Bid in its letterhead clearly showing the Bidder's complete name and address.

Date:

Name of the contract:

Invitation for Bid No.:

To: **Ghunsa Khola Hydroelectric Project**
Remit Hydro Limited
New Baneshwor, Kathmandu, Nepal

Name of Contract: **Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under EPC Contract**

We, the undersigned, declare that:

- (a) We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Bidders (ITB) Clause 8.
- (b) We offer to execute in conformity with the Bidding Documents the following Works:
Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under Engineering, Procurement and Construction Contract.
- (c) The total price of our Bid, excluding any discounts offered in item (d) below is: NRs/USD.
.....; or when left blank is the Bid Price indicated in the Activity Schedule.

Note: the US Dollar portion shall not exceed 60% of the total Bid Price.

- (d) The discounts offered and the methodology for their application are:
.....
- (e) Our bid shall be valid for a period of **120** days from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
- (f) If our bid is accepted, we commit to obtain a performance security in accordance with the Bidding Document.
- (g) We have paid, or will pay the following commissions, gratuities, or fees with respect to the

bidding process or execution of the Contract:¹

Name of Recipient	Address	Reason	Amount
.....			
.....			

- (h) We understand that this bid, *together with your written acceptance thereof* included in your notification of award, shall constitute a binding contract between us, until a formal contract is prepared and executed.
- (i) We understand that you are not bound to accept the lowest evaluated bid or any other bid that you may receive.
- (j) We declare that we are solely responsible for the authenticity of the documents submitted by us.
- (k) We agree to permit the Employer/DP or its representative to inspect our accounts and records and other documents relating to the bid submission and to have them audited by auditors appointed by the Employer.

Name:

In the capacity of

Signed

Duly authorized to sign the Bid for and on behalf of

Date

¹ If none has been paid or is to be paid, indicate "None".

Table A. Summary of Payment Currencies

(Applicable / Not Applicable)

Table: Alternative A

For [Insert name of Section of the Works]

Name of payment currency	A Amount of currency	B Rate of exchange (local currency per unit of foreign)	C Local currency equivalent $C = A \times B$	D Percentage of Total Bid Price (TBP) $\frac{100 \times C}{TBP}$
Local Currency NRS.		1.00		
Foreign Currency #1 US\$				
Total Bid Price				100.00
Provisional sums expressed in local currency	7,50,00,000.00		7,50,00,000.00	
TOTAL BID PRICE (including provisional sum)				

Table: Alternative B

To be used only with Alternative B Prices directly quoted in the currencies of payment. (Clause ITB 15.1)

Summary of currencies of the bid for _____ *[insert name of Section of the Works]*

Name of currency	Amounts payable
Local currency: _____	
Foreign currency #1: _____	
Foreign currency #2: _____	
Foreign currency #3: _____	
Provisional sums expressed in local currency	

BID SECURITY

Bank Guarantee

***Bank's Name, and Address of Issuing Branch or Office
(On Letter head of the A Class Commercial bank or any Financial Institution
eligible to issue Bank Guarantee as per prevailing Law)***

Bid Guarantee No.:

Beneficiary: Ghunsa Khola Hydroelectric Project
Remit Hydro Limited
New Baneshwor, Kathmandu, Nepal

Date: **Bid Security No.:**

We have been informed that, ... **[insert name of the Bidder]** (hereinafter called "the Bidder") intends to submit its bid (hereinafter called "the Bid") to you for the execution of **name of Contract.** under Invitation for Bids No. ("the IFB").

Furthermore, we understand that, according to your conditions, bids must be supported by a bid guarantee.

At the request of the Bidder, we..... **name of Bank** hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of . . . **amount in figures** (**amount in words**) upon receipt by us of your first demand in writing accompanied by a written statement stating that the Bidder is in breach of its obligation(s) under the bid conditions, because the Bidder:

- (a) has withdrawn or modifies its Bid:
 - i) during the period of bid validity specified by the Bidder on the Letter of Technical and Price Bid, in case of electronic submission
 - (ii) from the period twenty-four hours prior to bid submission deadline up to the period of bid validity specified by the Bidder on the Letter of Technical Bid and Price Bid, in case of hard copy submission; or
- (b) does not accept the correction of errors in accordance with the Instructions to Bidders (hereinafter "the ITB"); or
- (c) changes the prices or substance of the bid while providing information pursuant to clause 27.1 of ITB; or
- (d) having been notified of the acceptance of its Bid by the Employer during the period of bid validity, (i) fails or refuses to execute the Contract Agreement, or (ii) fails or refuses to furnish the performance security, in accordance with the ITB.
- (e) is involved in fraud and corruption in accordance with the ITB

This guarantee will remain in force up to and including the date **number** days after the deadline for submission of Bids as such deadline is stated in the instructions to Bidders or as it may be extended by the Employer, notice of which extension(s) to the Bank is hereby

waived. Any demand in respect of this guarantee should reach the Bank not later than the above date.

This Bank guarantee shall not be withdrawn or released merely upon return of the original guarantee by the Bidder unless notified by you for the release of the guarantee.

This guarantee is subject to the Uniform Rules for Demand Guarantees, ICC Publication No. 758.

. . . Bank's seal and authorized signature(s) . . .

Note:

The bid security of has been counter guaranteed by the Bank
..... on..... (Applicable for Bid Security of Foreign Banks).

POWER OF ATTORNEY

Ghunsa Khola Hydroelectric Project
Remit Hydro Limited
New Baneshwor, Kathmandu, Nepal

Tel:

Email:

KNOW ALL MEN by these presents that the undersigned [*person awarding the Power of Attorney*]

.....(name)

..... (title) of

.....

(company) lawfully authorised to represent and act on behalf of the said company, a corporation formed under the laws of(country) with head office situated at (complete address) do

hereby appoint [*person receiving the Power of Attorney*]

.....(name) of

..... (company) whose signature appears below to be the true and lawful attorney, and authorise said attorney to conduct negotiations with the Remit Hydro Limited. (hereafter referred to as the "Employer"), to sign the Bid and the Contract Agreement, and to execute all the necessary matters related thereto in the name of and on behalf of the said company in connection with the Works under the Contract entitled:

Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under Engineering, Procurement and Construction Contract.

IN WITNESS WHEREOF I have hereunto set my hand this day of in the year.....

.....
(signature, *person awarding the Power of Attorney*)

.....(signature of Attorney
hereby authorised, *person receiving the Power of Attorney*)

.....

(Signature of Witness)

JOINT VENTURE AGREEMENT

If a joint venture has or will be formed in order to carry out this Contract, the Bidder shall provide the following information regarding his Joint Venture Agreement:

This agreement is made and entered into this day of Year, by and between:

1.1

(Name and address of Lead Partner of Joint Venture)

1.2

(Name and address of all other Partners of Joint Venture)

1.3

1.4

1.5

associated under the name of

.....
(Name and address of the Joint Venture) for the exclusive purpose to Bid for this Contract for the **Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under Engineering, Procurement and Construction Contract.**

The members of this Joint Venture commit themselves to fulfil jointly and severally their responsibilities during the Bidding process, the execution of the entirety of the Works and all other legal and contractual obligations in case of Contract award.

The Partners of this Joint Venture agree as follows:

Note: *The terms and conditions of the JV agreement shall clearly define the following (as a minimum), but not limited to:*

1. Purpose of the Agreement

- Definition and limitation

2. Duties and Responsibilities

- Breakdown of participation in the Works
- Organisation and mode of operation
- Financial participation

3. Indemnification and Liability

- Cross indemnification
- Insurance

4. Costs

- Bearing of costs by each member and its distribution

5. Exclusivity

- For companies, associations

6. Insolvency

7. Duration of Agreement - Pre-Contract stage - Contract stage

8. Governing Law

9. Disputes

10. Other Provisions

Signed for and on behalf of:

1. _____
(Name and Designation)

2. _____
(Name and Designation)

3. _____
(Name and Designation)

FORM-LOI: CONSULTING FIRM/SPECIALIST SUBCONTRACTORS LETTER OF INTENT

To: (Name of Employer)

WHEREAS (Name of the consulting firm / specialist subcontractor)..... who are established and reputable consulting firm of(name and /or description of the services)do hereby submit Letter of Intent to provide specialized subcontracting for the Civil and Hydromechanical Design works against(reference of the Invitation for Bids).

.....
(Signature for and on behalf of Consulting firm / Specialist subcontractor)

Note: This letter of Intent should be on the letterhead of the consulting firm and should be signed by a person competent and having the power of attorney to bind the consultant firm. It should be included by the Bidder in his Qualification and Bid Documents.

Technical Schedule 1 - Bidder's Information and Qualification Format

To establish its qualifications to perform the contract in accordance with Volume I Section III (Evaluation and Qualification Criteria) the Bidder shall provide the information requested in the corresponding Information Sheets included hereunder.

Form ELI – 1: Bidder's Information Sheet

Bidder's Information	
Bidder's legal name	
In case of JV, legal name of each partner	
Bidder's country of constitution	
Bidder's year of constitution	
Bidder's legal address in country of constitution	
Bidder's authorized representative (name, address, telephone numbers, fax numbers, e-mail address)	
Name of Owner Name of Managing Director Name of Board of Director	
Attached are copies of the following original documents.	
1. In the case of single entity, articles of incorporation or constitution of the legal entity named above, in accordance with ITB 4.1 and 4.2. 2. Authorization to represent the firm or JV named in above, in accordance with ITB 20.2. 3. In the case of JV, letter of intent to form JV or JV agreement, in accordance with ITB 4.1. 4. In the case of a government-owned entity, any additional documents not covered under 1 above are required to comply with ITB 4.5.	

Signature of Bidder

Form ELI - 2: JV Information Sheet

Each member of a JV must fill in this form

JV / Specialist Subcontractor Information	
Bidder's legal name	
JV Partner's or Subcontractor's legal name	
JV Partner's or Subcontractor's country of constitution	
JV Partner's or Subcontractor's year of constitution	
JV Partner's or Subcontractor's legal address in country of constitution	
JV Partner's or Subcontractor's authorized representative information (name, address, telephone numbers, fax numbers, e-mail address)	
Attached are copies of the following original documents.	
Articles of incorporation or constitution of the legal entity named above, in accordance with ITB 4.1 and 4.2.	
Authorization to represent the firm named above, in accordance with ITB 20.2.	
In the case of government-owned entity, documents establishing legal and financial autonomy and compliance with commercial law, in accordance with ITB 4.5.	

Signature of Bidder

Form ELI - 2: JV Information Sheet

Each member of a JV must fill in this form

Pending Litigation			
☐ No pending litigation in accordance with Criteria 2.2 of Section III (Evaluation and Qualification Criteria) ☐ Pending litigation in accordance with Criteria 2.2 of Section III (Evaluation and Qualification Criteria)			
Year	Matter in Dispute	Value of Pending Claim in NRS	Value of Pending Claim as a Percentage of Net Worth

Signature of Bidder

Form ELI 3: Bidders Running Contracts in Nepal

Each member of JV must fill this form

Bidders running Contracts in Nepal				
Name of office	Contract Identification no.	Date of issuance of Letter of Acceptance	Status of contract**	Date of Issuance of Taking Over Certificate***

Note:

Only the contracts accepted since 2078-12-03 i.e. March 17, 2022 are to be mentioned.

* Mention GON funded or DP funded or Other PE (Insert name) funded

** Mention "Yet to sign" if contract is not signed, "Running" if contract has been signed and contract is running and "Substantially completed" if taking over certificate has been issued.

** Insert date of issuance of taking over certificate if the awarded contract has been substantially completed and taking over certificate has been issued.

Form FIN - 1: Financial Situation

Each Bidder or member of a JV must fill in this form

Financial Data for Previous 3 Years [in NRS/USD]

Information from Balance Sheet

Years	Year 1 :	Year 2 :	Year 3 :
Total Assets (TA)			
Total Liabilities (TL)			
Net Worth (NW) =TA-TL			
Current Assets (CA)			
Current Liabilities (CL)			
Working Capital = CA – CL			

Information from Income Statement

Years	Year 1 :	Year 2 :	Year 3 :
Total Revenues			
Profit Before Tax			
Profit After Tax			

- Attached are copies of financial statements (balance sheets including all related notes, and income statements) for the last three or above years, as indicated above, complying with the following conditions.
- All such documents reflect the financial situation of the Bidder or partner to a JV, and not sister or parent companies.
- Historic financial statements must be audited by a certified auditor.
- Historic financial statements must be complete, including all notes to the financial statements.

- Historic financial statements must correspond to accounting periods already completed and audited (no statements for partial periods shall be requested or accepted).

Note: *In case of e-submission the attachments should not be uploaded but shall be submitted on notification by the Employer as per ITB 27.1.*

Signature of Bidder

Form FIN - 2: Average Annual Construction Turnover

Each Bidder or member of a JV must fill in this form

The information supplied should be the Annual Turnover of the Bidder or each member of a JV in terms of the amounts billed to clients for each year for work in progress or completed to NRs/USD at the end of the period reported.

Annual Turnover Data for the Last 10 Years (Construction only)			
Year	Amount Currency	Present Value Conversion Factor for Works in NRs/USD.	Present Value of Annual Turnover

Average Annual Construction Turnover (Best three years within the last 10 years) = NRs/USD.....

Signature of Bidder

Note:

In Case of Currency other than NRs., Present Value Conversion Factor is taken as Unity for all year in count; only multiplied by exchange rates confirmed by Nepal Rastra Bank as the selling rates prevailing Thirty (30) days prior to the deadline for submission of bids.

Form FIN - 3: Bid Capacity

Each Bidder or member of a JV must fill in this form

$$\text{Bid Capacity} = [(5 \times A) - B]$$

A = Average Annual Turnover of the best three years out of the last ten fiscal years.

B = Annual Value of the existing commitments and works (ongoing) to be completed, calculated from FIN-4.

SN	Name of Bidder	Pan No.	A, in Million	B, in Million	Bid Capacity, in Million
1					
2					
3					

Total Bid Capacity:

Date: _____

Signature: _____

Form FIN-4: Current Contract Commitments / Works in Progress

Bidders and each partner to a JV should provide information on their current commitments on all contracts that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate has yet to be issued.

Current Contract Commitments (For Calculation of B with reference of FIN-3)									
SN	Name of Contract	Name of the Contractor/s	Employer's Contact Address, Tel, Fax	Contract Share in % (a)	Contract Amount in Millions (b)	Contract Date (yyyy-mm) (c)	Initial or Revised Contract Duration (months) (d)	Value of outstanding works [In Millions, NRS]# (e)	Estimated Time in Month to Complete the outstanding works (f) = (c) + (d) – Date of Invitation of Bid (f)
1									
2									
3									
4									

Date: _____

Signature: _____

The Outstanding Works means Contract Price (excluding Vat) minus Work Evaluated by Employer till the reference date. Bidder shall have to submit the

relevant documentary evidence to substantiate the facts/figures. Note 1: “B” shall be calculated as:
$$B = \sum \left[\frac{(e) \times (a)}{(f)} \right] \times 12$$
, If (f) is less than 12, then value of (f) shall be taken as 12.

Note 2: If Initial or Revised Contract Date is run out with respect to Date of Invitation of Bid, the Estimated Time in Month to complete the outstanding works shall be taken equal to 12 months.

Form FIN - 5: Financial Resources

Specify proposed sources of financing, such as liquid assets, unencumbered real assets and other financial means, net of current commitments, available to meet the total construction cash flow demands of the subject contract or contracts as indicated in Section III (Evaluation and Qualification Criteria).

Financial Resources		
No.	Source of financing	Amount (in NRS)
1		
2		
3		

Form EXP - 1: General Construction Experience

Each Bidder or member of a JV must fill in this form.

General Construction Experience				
Starting Month Year	Ending Month Year	Year	Contract Identification and Name and Address of Employer Brief Description of the Works Executed by the Bidder	Role of Bidder

Date: _____

Signature: _____

Form EXP - 2(a): Specific Construction Experience

Fill up one (1) form per contract.

Contract of Similar Size and Nature			
Contract No..... of	Contract Identification		
Award Date		Completion Date	
Role in Contract	☐ Contractor	☐ Management Contractor	☐ Subcontractor
Total Contract Amount	☐ NRS		
If Partner in a JV or subcontractor, specify participation of total contract amount	Percent of Total	Amount	
Employer's Name Address Telephone/Fax Number E-mail			
Description of the similarity in accordance with Criteria 2.4.2 (a) of Section III			
Note: The Employer should insert here contract size, complexity, methods, technology, or other characteristics as described in Volume 3 - Employer's Requirement (ERQ) against which the bidder demonstrates similarity in the box on the right-hand-side.			

Date: _____

Signature: _____

Form EXP - 2(b): Specific Construction Experience in Key Activities

Fill up one (1) form per contract.

Contract with Similar Key Activities			
Contract No..... of.....	Contract Identification		
Award Date		Completion Date	
Role in Contract	☐ Contractor	☐ Management Contractor	☐ Subcontractor
Total Contract Amount	☐ NRS		
If Partner in a JV or subcontractor, specify participation of total contract amount	Percent of Total	Amount	
Employer's Name Address Telephone/Fax Number E-mail			
Description of the similarity in accordance with Criteria 2.4.2 (b) of Section III			
Note: The Employer should insert here production rate(s) for the key activity (activities) subject contract against which the bidder demonstrates in the box on the right-hand-side production rates achieved by him on previous contracts.			

Date: _____

Signature: _____

Form EXP - DES: Criteria for Design and Engineering

Fill up one (1) form per contract.

Details of similar assignments undertaken in the last 10 years

Assignment name:	Approx. value of the contract (in current NRs:)
Award date:	Completion date:
Country: Location within country:	Duration of assignment (months):
Client's Name Address Telephone/Fax Number E-mail	
Name of joint venture partner or sub-Consultants, if any:	Narrative description of Project:
Description of actual services provided in the assignment:	
<i>The complexity will be based on the requirements set in Evaluation and Qualification Criteria.</i>	

Technical Schedule 2 – Personnel

Form PER – 1: Proposed Personnel

Bidders should provide the names of suitably qualified personnel to meet the specified requirements for each of the positions listed in Section III (Evaluation and Qualification Criteria). The data on their experience should be supplied using the Form below for each candidate.

SN.	Name	Position*	Academic Qualification	Total Work Experience [Years]	Experience in Similar Works [years]
1.					
2.					
3.					
4.					
5.					

As listed in Section III (Evaluation and Qualification Criteria).

Date: _____

Signature: _____

Form PER – 2: Resume of Proposed Personnel

The Bidder shall provide all the information requested below. Fields with asterisk (*) shall be used for evaluation.

Position*		
Personal Information	Name	Date of Birth
	Professional qualifications	
Present employment	Name of employer	
	Address of employer	
	Telephone	Contact (manager/personnel officer)
	Fax	E-mail
	Job title	Years with present employer

Summarize professional experience over the last twenty years in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

From*	To*	Company, Project, Position and Relevant Technical and Management Experience*

Note:

In case of e-submission the Resume of Proposed Personnel shall be submitted on notification by the Employer as per ITB 27.

Date: _____

Signature: _____

Technical Schedule 3 – Equipment

The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment listed in Section III (Evaluation and Qualification Criteria). A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Bidder. The Bidder shall provide all the information requested below, to the extent possible. Fields with asterisk (*) shall be used for evaluation.

For the equipment under Bidder's ownership

SN	Equipment Type and Characteristics	Total Nos. of Equipment under Bidder's Ownership	No. of Equipment engaged/proposed for ongoing/committed contracts	Nos. of Equipment proposed for this contract
1.				
2.				
3.				
4.				
5.				

For the Equipment to be leased/hired

SN	Equipment Type and Characteristics	Total Nos. of Equipment under the ownership of lease/hire provider	No. of Equipment engaged/committed for other works	Nos. of Equipment proposed to be leased/hired for this contract
1.				
2.				
3.				
4.				
5.				

Type of Equipment*		
Equipment Information	Name of manufacturer	Model and power rating
	Capacity*	Year of manufacture
Current Status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	

The following information shall be provided only for equipment not owned by the Bidder.

Owner	Name of owner	
	Address of owner	
	Telephone	Contact name and title
	Fax	email
Agreements	Details of rental / lease / manufacture agreements specific to the project	

The Bidder shall be solely responsible for the data provided. However, this shall not limit the right of Employer to verify the authenticity of submitted information.

Note:

In case of e-submission the “Agreements” shall be submitted on notification by the Employer as per ITB 27.1

Date: _____

Signature: _____

Technical Schedule 4 - Contractor's Workforce

In the following table, the Bidder shall provide detailed numbers of the workforce planned for executing the Works, which shall include staff and personnel engaged in support activities such as camp workshops, stores, security, etc. on a monthly basis.

Monthly Period from commencement	Total Number of Personnel		Average no. of persons in period			
	Foreign	Local	Engineers and other professionals	Foreman including Team Leaders	Other Skilled and Semi- skilled Tradesmen	Laborers
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						

19						
20						
21						
etc.						

Note: A graph in the form of an “S Curve” shall be attached, showing the forecast deployment of the total work force over the duration of the project

Date: _____

Signature: _____

Technical Schedule 5 - Sub-Contractors, Manufacturers and Suppliers

The Bidder shall provide details of the Subcontractors and Suppliers proposed to be used on the Works and the specific work which they are intended to undertake or materials they are intended to supply. Service providers shall be included.

A separate Annex to Technical Schedule 5 (as attached) shall be submitted for each proposed Subcontractor and Supplier.

Element of Work	Approximate Value, US\$	Name and Address of Subcontractor/Manufacturer/Supplier

Date: _____

Signature: _____

Annex 1 to Schedule 5 - Sub-Contractors, Manufacturers and Suppliers

Name of Subcontractor/Manufacturer/Supplier:
Address:
Section or item of work:
Value of work

Date: _____

Signature: _____

Annex 2 to Schedule 5 - Manufacturer's Authorization

The Bidders shall submit signed affidavits from the proposed manufacturers on the supplier's headed notepaper and addressed to the Employer that the components offered will meet in every aspect the requirements set forth in the Employer's Requirements and if the components manufactured by the manufacturers are subsequently found to be not in accordance with the Employer's Requirements, the Bidder shall confirm that these will be provided as specified from approved alternative manufacturers at no additional cost to the Employer and within the time for completion stated in the Bid.

The affidavit shall confirm that the components can be delivered to the site on a schedule such that the Contractor can meet the construction schedule. The affidavit shall also confirm that all components supplied are fully compatible and complete as required for a complete and fully operational installation at no additional cost to the Employer.

The affidavits from the proposed suppliers and manufacturers must be signed by the relevant supplier or manufacturer.

To: Ghunsa Khola Hydroelectric Project
Remit Hydro Limited
New Baneshwor, Kathmandu, Nepal

Date

WHEREAS [Name of the manufacturer] who are established and reputable manufactures of [name and/or description of the goods] having factories at [address of factory] do hereby authorize [name and address of Bidder] to submit a Bid and subsequently negotiate and sign the Contract with you against **Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under Engineering, Procurement and Construction Contract**. [Tender No.:] for the above goods manufactured by us. We hereby extend our full guarantee and warranty as per the Conditions of the Contract for the goods offered for supply by the above firm against this Bid.

(Signature for and on behalf of Manufacturer)

Note: This letter of authority should be on the letterhead of the Manufacturer and should be signed by a person competent and having the power of attorney to bind the manufacturer. It should be included by the Bidder in his Bid Documents.

Date: _____

Signature: _____

Technical Schedule 6 - Site Organization

The Bidder shall provide details of his proposed method for site establishment, with a comprehensive description, complemented by illustrative drawings, to show a thorough understanding of the requirements. The information to be provided includes, but is not limited to, the items listed below:

- Layout of camps and other site facilities;
- Drawings for temporary buildings and facilities, including camps, offices, laboratory, workshops, storage areas, etc.;
- Mobilization of labour and equipment;
- Mobilization of crushing and batching plants;
- Construction of temporary and permanent roads;
- Methodology for obtaining visas, permits, etc.;
- Construction and maintenance of site utilities (access road, power, telecom, water, wastewater, etc.); and
- Provision of site services (messaging, laundry, camp/office maintenance, etc.).

Date: _____

Signature: _____

Technical Schedule 7 - Method Statement

The Bidder shall provide details of proposed method statements, with a comprehensive description, complemented by illustrative drawings, to show a thorough understanding of the requirements. The method statements shall cover the resources required, including labour, contractor's equipment, materials, etc. and temporary works required for the construction of the permanent works.

The method statements shall cover

- (i) all design and construction of the civil works
- (ii) all design, manufacture, supply, erection, testing and commissioning of the hydro-mechanical works
- (iii) interface management plan with the Lot 2 (Electromechanical Contractor)

The information to be provided includes, but is not limited to, the items listed below:

- Setting out and survey control;
- Site investigation works;
- Design of civil works;
- Design of hydro-mechanical works;
- Design of electro-mechanical works;
- Materials acquisition plan to show details of procurement, transportation and storage for aggregates, cement and extenders, reinforcing steel, bitumen, fuel, etc.;
- River diversion works;
- Surface excavation and slope stability works;
- Underground excavation and temporary support works;
- Details of concrete manufacture, including temperature control;
- Details of concrete construction, including underground works;
- Structural steel fabrication and installation;
- Building construction, including finishing's;
- Hydro-mechanical equipment erection, testing and commissioning;
- Penstock steel liner fabrication, erection and testing;
- Details of road works, including bituminous sealing and associated structures for drainage;
- Effects of rainy season on construction activities;
- Methodology, sequencing of Works;
- Subcontracted work; and
- Site supervision and Construction management.

The method statements shall be consistent and compatible with the Programme (Technical Schedule 10). The method statements should clearly identify the assumed cycle times based on estimated quantities to support the activity durations shown in the Programme.

Date: _____

Signature: _____

Technical Schedule 8 - Contractor's Concept Design

The Bidder shall submit concept drawings for the Civil and Hydro-mechanical works, including layout plans, sketch designs for the various equipment, proposed specifications and countries of origin for the various materials and equipment etc., for the Ghunsa Khola Hydroelectric Project.

Date: _____

Signature: _____

Technical Schedule 9 - Contractor's Design Documents Submission Schedule

The Bidder shall submit in this Schedule a list of all design documents to be submitted to the Employer for review and approval, including but not limited to design standards and assumptions, design briefs, calculation notes, preliminary drawings, detailed drawings, technical specifications, material data sheets, shop drawings, erection drawings and method statements, testing and commissioning procedures, as-built drawings, etc., and the dates at which these will be submitted.

Date: _____

Signature: _____

Technical Schedule 10 - Program

The Bidder shall submit a Works programme generally prepared in accordance with the requirements for preparation of the detailed programme required by General Condition of Contract 41[*Program and Progress*] of the Volume 2 and the Employer's Requirements, and in sufficient detail to show that the Bidder has a thorough understanding of the Works. This programme shall be fully compatible with the method statements provided in accordance with Technical Schedule 7 and the items provided in the Bid Price Schedules.

The programme shall be based on network logic diagrams showing all design, manufacture, supply, construction or erection, testing and commissioning activities and logic relationships between all such activities and shall include as a minimum:

- activity code definitions presenting the work breakdown;
- activity listing;
- logic linked bar chart (Gantt chart).
- In relation to each activity the following minimum information shall be presented:
 - identification number (ID);
 - description;
 - duration in working days;
 - early start and early finish dates;
 - bar indicating early start date, early finish date and duration;
 - total, float;
 - full details of resources including labour, Contractor's Equipment, materials, etc. allocated to the activity; and
 - periods required for initial establishment.

The specified Milestones shall be clearly identified. Mobilization, temporary works, design activities, including Employer's review and approval, equipment design, manufacturing, testing, shipping and installation, and commissioning shall be clearly identified as separate activities.

Date: _____

Signature: _____

Technical Schedule 11 - Quality Assurance

The Bidder shall provide a complete description of the Quality Assurance system that he proposes to implement for this Contract. The system shall include a quality assurance plan, quality assurance procedures and quality control procedures, in accordance with the Specification. An inspection and test plan for mechanical equipment shall be provided. The plan and procedures shall cover the work of all Subcontractors and Suppliers.

Date: _____

Signature: _____

Technical Schedule 12 - Health, Safety and Environment

The Bidder shall provide a complete description of the Environment Management System he proposes to implement for the Contract. The system shall be in accordance with the Conditions of Contract, the Employer's Requirements, local regulations and international standards.

Date: _____

Signature: _____

Technical Schedule 13 - Mobilization Schedule

The bidder shall provide here a general description of the arrangements and methods which he proposes to adopt for the detailed site investigation, design and execution of the works which shall include but not be limited to:

- (a) Mobilization period including periods required for establishing the Contractor's offices, workshops etc. and the facilities requires for the Engineer and his staff if applicable;
- (b) Mobilization procedure for the detailed site investigation and design works; and
- (c) Sources of Contractor's equipment and mobilization periods for items of plant.

Date: _____

Signature: _____

Technical Schedule 14 - Insurance Schedule

The Bidder shall provide the schedule of insurances pursuant Clause of 23 *[Insurance]* of the General Conditions of Contract.

Date: _____

Signature: _____

Technical Schedule 15 - Schedule of Particulars
(Guaranteed performance and technical parameters)

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
1. INTAKE FINE TRASH RACK			
1.1. GUARANTEED DATA			
Manufacturer			
Standards adopted			
Type (fixed or removable)	Fixed		
Trashracks Gross Area	m ²		
Trashracks Net Area	m ²		
Clear size of the trashrack opening			
Clear width	3.5 m		
Clear height	5.0 m		
Inclination of trashrack with horizontal	80°		
Max headwater level	1953.80 masl		
Sill elevation	1943.10 masl		
Elevation of operating platform	1955.00 masl		
Design head on sill	10.70 m		
Number of trashracks to be supplied	4 Sets		
Number of Trashrack panels for one set			
Head losses at design discharge	mm		
Clear rack bar spacing	80 mm		
Maximum water velocity through clean net area	m/s		
1.2. INFORMATIVE DATA			
Materials of Trashracks			
Bar element			
Tie bars			
Horizontal girders			
Embedded parts			
Fixing material			
Bar Element Type:			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Thickness of bar element	mm		
Width of bar element	mm		
Size of tie bars	mm		
Pitch of tie bars	mm		
Natural frequency of screen bars Excitation frequency of screen bars	Hz		
Trashrack Anticorrosion Treatment Purity of applied raw zinc Zinc coat cover	Galvanizing ≥ 98.5 % 1000 g/m ²		
Weights			
One trash rack panel	Kg		
Total weight of trashracks panels	Kg		
One set embedded part	Kg		
Total weight of supply	Ton		
Heaviest & Largest Part to Transport to Site			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
2. TRASHRACK CLEANING MACHINE AT INTAKE (TRCM)			
2.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Lifting capacity	Ton		
Clear size of the trashrack opening			
Clear width	3.5 m		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Clear height	5.00 m		
Inclination of trashrack with horizontal	80°		
Max headwater level	1953.80 masl		
Sill elevation of trashrack	1943.10 masl		
Elevation of operating platform	1955.00 masl		
Number of TRCM to be supplied	1 Set		
Clear rack bar spacing	80 m		
2.2 INFORMATIVE DATA			
TRCM operation			
Operating mechanism	Hydraulic		
Operating mechanism manufacturer			
Hoisting speed	m/min.		
Travelling speed	m/min.		
Maximum lifting height	m		
Maximum power input	kW		
Rated voltage	V		
Rated current	A		
Control and instruments			
Type of control			
Control panel manufacturer			
Instruments manufacturer			
Instruments protection class (IP)			
Operating temperature range	°C		
Overall dimension (LxWxH)	m × m × m		
Rail			
Type of rail			
Length	m		
Span	mm		
Paint			
Paint type			
Dry film thickness of paint	µm		
Color	Yellow		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Weights			
TRCM set complete	Ton		
Embedded parts complete	Ton		
Total weight of supply	Ton		
Heaviest & Largest Part to Transport to Site			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
3. UNDERSLUICE MAINTENANCE GATE			
a. GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	1		
Gate type	Panel, vertical lift bulkhead		
Number of panels per gate	2		
Clear size of gate opening:			
Width (W)	3.5 m		
Height (H)	4.5 m		
Max headwater level	1953.8 masl		
Elevation of sill	1939.45 masl		
Design head on sill	14.35 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
3.2 INFORMATIVE DATA			
Materials			
Gate sections			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, Downstream		
Parts Embedded in Concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Overall Dimension of Lifting Beam			
Length	mm		
Width	mm		
Height	mm		
By-pass Valves			
Type			
Casing material			
Seat material			
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gates complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
3.3 GATE LIFTING APPLIANCES			
Manufacturer			
Standards adopted			
Rated hoisting capacity	Ton		
Type of hoist	Electric Monorail		
Elevation of operating floor			
Insert a drawing complete with all dimensions and elevations complete with a table showing all monorail crane or lifting appliances data			
Monorail hoist travelling speed	m/min		
Low			
High			
Monorail hoist travelling speed (under load)	m/min		
Low			
High			
Hoisting speed	m/min		
Normal			
Inching			
Hoist mechanism			
type of motor(s)			
rated capacity	kW		
type of load brake			
drums diameter	mm		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
sheave diameter	mm		
rope diameter	mm		
Hoist travelling mechanism			
number of motors			
type of motor(s)			
rated capacity	kW		
number of wheels			
wheel diameter	mm		
Runway beam size	mm x mm		
Total weight of monorail hoist	ton		
4. INTAKE MAINTENANCE GATE			
4.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	1		
Gate Type	Vertical lift bulkhead		
Number of panels per gate	2		
Clear size of gate opening:			
Width (W)	3.1 m		
Height (H)	3.1 m		
Max headwater level	1953.80 masl		
Elevation of sill	1941.00 masl		
Design head on sill	12.80 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
4.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, Downstream		
Parts Embedded in Concrete			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Overall Dimension of Lifting Beam			
Length	mm		
Width	mm		
Height	mm		
By-pass Valves			
Type			
Casing material			
Seat material			
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gates complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Height	mm		
Weight	Kg		
4.3 GATE LIFTING APPLIANCES			
Manufacturer			
Standards adopted			
Rated hoisting capacity	Ton		
Type of hoist	Electric Monorail		
Elevation of operating floor			
Insert a drawing complete with all dimensions and elevations complete with a table showing all monorail crane or lifting appliances data			
Monorail hoist travelling speed	m/min		
Low			
High			
Monorail hoist travelling speed (under load)	m/min		
Low			
High			
Hoisting speed	m/min		
Normal			
Inching			
Hoist mechanism			
type of motor(s)			
rated capacity	kW		
type of load brake			
drums diameter	mm		
sheave diameter	mm		
rope diameter	mm		
Hoist travelling mechanism			
number of motors			
type of motor(s)			
rated capacity	kW		
number of wheels			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
wheel diameter	mm		
Runway beam size	mm x mm		
Total weight of monorail hoist	ton		
5. UNDERSLUICE RADIAL GATE			
5.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	2		
Gate type	Radial		
Clear size of gate opening:			
Width (W)	3.5 m		
Height (H)	4.5 m		
Radius of skin plate	m		
Max headwater level	1953.80 masl		
Elevation of sill	1939.25 masl		
Design head on sill	14.55 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
5.2 INFORMATIVE DATA			
Materials			
Gate			
Gate arms			
Type and material of gate seals			
Position of seal	4-way, Upstream		
Parts Embedded in Concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Type of truinnion bearing and manufacturer			
Dimension of truinnion assembly (LxWxh)	mm x mm x mm		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
5.3 HOISTING SYSTEM			
Type of Hoist	Hydraulic		
Lifting capacity	Ton		
Oil Hydraulic Unit			
Manufacturer			
Size of oil tank (w x h x d)	m × m × m		
Oil pressure	≤ 10 MPa		
Type of oil			
Oil pumps			
- Type/number			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
- Manufacturer			
- Flow	lt/s		
- Speed	rpm		
- Capacity	kW		
Motors			
- Type/number			
- Manufacturer			
- Rated power	kW		
- Rated voltage	V		
- Rated current	A		
Oil Hydraulic Cylinders			
- Manufacturer			
- Number per gate	2		
Stroke of hydraulic cylinder	mm		
Diameter of hydraulic cylinder	mm		
Diameter of piston rod	mm		
Rated working pressure	MPa		
Allowable working pressure	MPa		
Type and material of piston rod packing			
Type of bearing for hydraulic cylinder hoist trunnion pin			
Oil leakage from piston packing (under rated pressure)	lt/min		
Oil leakage from rod packing	lt/min		
Force of hydraulic cylinder hoist for opening /closing	kN		
Controls and Instruments			
Local control boards			
- Manufacturer			
- Type			
- Protection class	IP		
- Material			
Digital indicators			
- Manufacturer			
- Type			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
- Front dimensions			
- Accuracy			
- No. of indicated figures			
- Type of indicated figures			
- Type of inputs			
Ambient temperature range	°C		
Electrical indicator (Analogous)	IP		
- Manufacturer			
- Type			
- Accuracy	%		
- Type of inputs			
- Ambient temperature range	°C		
- Input signal (4-20 mA/bus)			
6. INTAKE SERVICE GATE			
6.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	2		
Gate Type	Vertical fixed wheel		
Clear size of gate opening:			
Width (W)	3.1 m		
Height (H)	3.1 m		
Max headwater level	1953.80 masl		
Elevation of sill	1941.00 masl		
Design head on sill	12.80 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
6.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type and material of gate seals			
Position of seal	4-way, downstream		
Parts embedded in concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
6.3 HOISTING SYSTEM			
Manufacturer			
Standards adopted			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type of hoist	Rope Drum		
Lifting capacity	ton		
Elevation of operating floor			
Insert a drawing complete with all dimensions and elevations complete with a table showing all rope drum hoist			
Hoisting speed	m/min		
Normal			
Inching			
Hoist mechanism			
type of motor(s)			
rated capacity	kW		
type of load brake			
drums diameter	mm		
sheave diameter	mm		
rope diameter	mm		
7. TRASH REMOVAL GATE			
7.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	1		
Gate Type	Vertical lift gate		
Clear size of gate opening:			
Width (W)	2.0 m		
Height (H)	2.0 m		
Max headwater level	1953.80 masl		
Elevation of sill	1946.50 masl		
Design head on sill	7.17 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
7.2 INFORMATIVE DATA			
Materials			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Gate			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, downstream		
Parts embedded in concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
7.3 HOISTING SYSTEM			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Manufacturer			
Standards adopted			
Rated hoisting capacity	kN		
Type of hoist	Motorized screw spindle		
Elevation of operating floor	masl		
Insert a drawing complete with all dimensions and elevations complete with a table showing all lifting hoisting data			
Lifting capacity of hoist	kN		
Opening Speed (Average)	m/min		
Closing Speed (Average)	m/min		
Number of Motors			
Type of Motor(s)			
Rated capacity of Motor(s)	kW		
8. SILT FLUSHING GATE			
8.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	4		
Gate Type	Vertical lift bonneted gate		
Clear size of gate opening:			
Width (W)	1.0 m		
Height (H)	1.0 m		
Max headwater level	1947.00 masl		
Elevation of sill	1927.58 masl		
Design head on sill	19.42 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 20 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
8.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type and material of gate seals			
Position of seal	4-way, Upstream		
Parts embedded in concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
8.3 HOISTING SYSTEM			
Manufacturer			
Standards adopted			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type of hoist	Hydraulic hoist		
Lifting capacity	ton		
Elevation of operating floor	masl		
Insert a drawing complete with all dimensions and elevations complete with a table showing all rope drum hoist			
Lifting capacity of hoist	kN		
Opening Speed (Average)	m/min		
Closing Speed (Average)	m/min		
Number of Motors			
Type of Motor(s)			
Rated capacity of Motor(s)	kW		
9. DESILTING CHAMBER OUTLET GATE/ HEADRACE TUNNEL INLET GATE			
9.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	2		
Gate Type	Vertical fixed wheel		
Clear size of gate opening:			
Width (W)	3.9 m		
Height (H)	3.9 m		
Max headwater level	1947.00 masl		
Elevation of sill	1939.90 masl		
Design head on sill	7.10 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
9.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, downstream		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Parts embedded in concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
9.3 HOISTING SYSTEM			
Manufacturer			
Standards adopted			
Type of hoist	Rope Drum		
Lifting capacity	ton		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Elevation of operating floor	masl		
Insert a drawing complete with all dimensions and elevations complete with a table showing all rope drum hoist			
Hoisting speed	m/min		
Normal			
Inching			
Hoist mechanism			
type of motor(s)			
rated capacity	kW		
type of load brake			
drums diameter	mm		
sheave diameter	mm		
rope diameter	mm		
10. TAILRACE GATE			
10.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	2		
Gate Type	Vertical Fixed wheel		
Clear size of gate opening:			
Width (W)	2.25 m		
Height (H)	4.20 m		
Max headwater level	1511.00 masl		
Elevation of sill	1507.25 masl		
Design head on sill	3.75 m		
Elevation of operating floor	masl		
Thickness of skin plate	≥ 12 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
10.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type and material of gate seals			
Position of seal	4-way, downstream		
Parts embedded in concrete			
Side guide frames			
Sill beams			
Sealing faces	Stainless steel		
Track plates	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
10.3 HOISTING SYSTEM			
Manufacturer			
Standards adopted			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type of hoist	Rope drum hoist		
Lifting capacity	ton		
Elevation of operating floor	masl		
Insert a drawing complete with all dimensions and elevations complete with a table showing all rope drum hoist			
Lifting capacity of hoist	kN		
Opening Speed (Average)	m/min		
Closing Speed (Average)	m/min		
Number of Motors			
Type of Motor(s)			
Rated capacity of Motor(s)	kW		
11. ADIT NO. 1 BULKHEAD GATE			
11.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	1		
Gate Type	Hinged Type		
Clear size of gate opening:			
Width (W)	2.5 m		
Height (H)	2.5 m		
Max headwater level	1970.71 masl		
Elevation of sill	1938.765 masl		
Design head on sill	32.0 m		
Thickness of skin plate	≥ 24 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
11.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, downstream		
Parts embedded in concrete			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Bottom guide frames			
Sealing faces	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
12. ADIT NO. 3 BULKHEAD GATE			
12.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			
Number of gates	1		
Gate Type	Hinged Type		
Clear size of gate opening:			
Width (W)	2.5 m		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Height (H)	2.5 m		
Max headwater level	1970.71 masl		
Elevation of sill	1912.37 masl		
Design head on sill	58.34 m		
Thickness of skin plate	≥ 24 mm		
Total guaranteed leakage under max headrace level	≤ 1.5 lt/s		
12.2 INFORMATIVE DATA			
Materials			
Gate			
Gate main beams			
Type and material of gate seals			
Position of seal	4-way, downstream		
Parts embedded in concrete			
Bottom guide frames			
Sealing faces	Stainless steel		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour	Black		
Weights			
Gate complete	Kg		
Embedded parts complete	Kg		
Total weight of supply	Ton		
Heaviest & Largest Parts to transport to Site			
Heaviest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight	Kg		

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Largest part			
Name of part			
Length	mm		
Width	mm		
Height	mm		
Weight, Kg	Kg		
13. BOTTOM SLUICE ISOLATION GATE VALVE			
13.1 GUARANTEED DATA			
GENERAL			
Manufacturer (Name and Place)			
Designer (Name and Place)			
Number of Valvea	4		
Valve inside diameter	0.80 mm		
Design water level	1953.80 masl		
Sill level	1941.12 masl		
Design water head	m		
Pressure rating	PN 2.0		
Length (valve body)	mm		
Total weight of the valve	kg		
Opening time max. / min. adjustable	s		
Closing time max. / min. adjustable	s		
Max. torque required for closing under max. head	kNm		
Max. plate thickness	mm		
Material			
SHAFT AND BEARINGS/BUSHING			
Shaft diameter	mm		
Material of shafts			
Material of bearing bushings			
Type / material of shaft seals			
DISC SEAL			
Type of seal (cross section)			
Material of seal			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Material of sealing face in valve body			
OPERATING MECHANISM			
Motor with gear			
Rated power of electric motor	kW		
Total weight	kg		
Total length	mm		
Plate thickness	mm		
Material of:			
Sleeve and flanges			
Sealing face			
14. GRAVEL TRAP GATE VALVE			
14.1 GUARANTEED DATA			
GENERAL			
Manufacturer (Name and Place)			
Designer (Name and Place)			
Number of Valve	4		
Valve inside diameter	0.50 mm		
Design water level	1953.80 masl		
Sill level	1941.12 masl		
Design water head	m		
Pressure rating	PN 2.0		
Length (valve body)	mm		
Total weight of the valve	kg		
Opening time max. / min. adjustable	s		
Closing time max. / min. adjustable	s		
Max. torque required for closing under max. head	kNm		
Max. plate thickness	mm		
Material			
SHAFT AND BEARINGS/BUSHING			
Shaft diameter	mm		
Material of shafts			
Material of bearing bushings			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Type / material of shaft seals			
DISC SEAL			
Type of seal (cross section)			
Material of seal			
Material of sealing face in valve body			
OPERATING MECHANISM			
Motor with gear			
Rated power of electric motor	kW		
Total weight	kg		
Total length	mm		
Plate thickness	mm		
Material of:			
Sleeve and flanges			
Sealing face			
15. CRANE FOR SILT FLUSHING CHAMBER			
15.1 GUARANTEED DATA			
Name of manufacturer			
Location of Factory			
Type and structure of crane with hoists			
Guaranteed Efficiency			
Capacity of Hoist	5 t		
Rail span (center to center of rails)	m		
Lifting height	m		
Hoisting Speed			
Maximum speed at rated load	m/min		
Speed range (variable step-less speed)	m/min		
Inching speed at rated load	m/min		
Travelling Speed of Trolley			
Maximum speed at rated load	m/min		
Speed range (variable step-less speed)	m/min		
Inching speed at rated load			
Travelling Speed of Bridge			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Maximum speed at rated load			
Speed range (variable step-less speed)			
Inching speed at rated load			
Deflection of Bridge Girder at Rated Load			
Under rated load the deflection of the bridge girder shall exceed			
15.2 INFORMATION DATA			
Dimensions and Weights			
Length			
Height			
Weight			
Type and Ratings			
Wire rope			
Type, construction, diameter, number of ropes			
Motors			
Type and rating			
Materials and Design stresses of Major Parts			
Axles			
Gears and Pinons			
Drums			
Sheaves			
Hooks			
Wheels			
Wire ropes			
Rail (bridge travel)			
Rail (Trolley travel)			
Weights of Parts			
Weight and name of the heaviest part of crane for assembly at the site			
Weight of each major parts			
16. STEEL LINERS			
16.1 GUARANTEED DATA			
Manufacturer			
Standards adopted			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Internal diameter	m		
Bend angle	Degree		
Bend radius	m		
Insert a drawing complete with all dimensions and thicknesses and with a table with internal and external design pressures			
16.2 INFORMATIVE DATA			
Materials			
Material standard			
Tensile strength	N/mm ²		
Yield strength	N/mm ²		
Notch impact strength (Charpy V), at -20°C	J		
Elongation percentage	%		
Brinell Hardness	HB		
Mitering segments			
Maximum deflection angle of mitering segment			
Number of mitering segments			
Stiffener rings			
Number			
Spacing			
Width			
Thickness			
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour			
Weights			
Weights of the various components:	Ton		
Total weight of supply	Ton		
17. BIFURCATION AND MANIFOLDS			
17.1 GUARANTEED DATA			

Hydro-Mechanical Equipment Schedule of Particulars

Description	Employer's Requirements	Bidder Offer	Remarks
Manufacturer			
Standards adopted			
Insert a drawing complete with all dimensions and thicknesses and with a table with internal and external design pressures			
17.2 INFORMATIVE DATA			
Materials			
Material standard			
Tensile strength	N/mm ²		
Yield strength	N/mm ²		
Notch impact strength (Charpy V), at -20°C	J		
Elongation percentage	%		
Brinell Hardness	HB		
Surface preparation and painting			
Surface treatment			
Material			
Paint type			
Dry thickness of paint	μm		
Colour			
Weights			
Weights of the various components:	Ton		
Total weight of supply	Ton		

The contractor shall supply all the hydro-mechanical equipment's and parts as per employer requirements in bid price schedule with delivery schedule.

Bidder shall list below the spare parts, accessories, consumables and tools which he recommends for the operation and maintenance of all the permanent plant included in the Contract.

[illegible]

Technical Schedule 17: Format for Understanding about the project

Knowledge about project area

Knowledge about planning stage

Approach towards surveying and types of surveys to be done,

Approach for geotechnical investigation and reporting details

Types of environmental and social safeguard study to be done including the way such studies shall be conducted, Environmental Protection Plan

Approach for designing

Procurement detailing including subcontracting

Construction stage detailing (approach, quality assurance and control mechanism)

Health Safety Plan

Finalization of construction & modality of handover

Mechanism for operation and maintenance

Technical Schedule 18; Proposed Design format

Design methodology

Concept design

Design finalization procedure

Assurance about design

Relevant codes for design

BREAKDOWN OF FOREIGN CURRENCY REQUIREMENTS

The Bidder shall substantiate the Foreign Currency requirements in the following Schedule of Foreign Currency Requirements.

Item		Foreign Currency Amount in USD	% of Bid Price
1	Foreign Staff and Manpower		
	1.1 Salaries and wages		
	1.2 Social charges		
	1.3 Overseas allowances		
	1.4 Insurance coverage		
	1.5 Medical care		
	1.6 Travel expenses, etc.		
2	Imported Materials		
	2.1 For Temporary Works		
	2.1.1 Timber for formwork		
	2.2 For Permanent Works		
	2.2.1 Cement		
	2.2.2 Steel reinforcement		
	2.2.3 Hydro-mechanical equipment		
	2.2.4 Electrical-mechanical equipment		
3	Contractor's Equipment (depreciation and usage only)		
	3.1 Heavy mobile equipment		
	3.2 Major items of non-mobile equipment (crushing, concrete batching plants)		
	3.3 Light vehicles, instruments, laboratory equipment, machinery		
	3.4 Spare parts, tyres etc.		
4	Overheads, Fees, etc.		
	4.1 Foreign overseas head office		
	4.2 Fees, profit		
	4.3 Finance charges		
	4.4 Freight		
	4.5 Insurance		

Item		Foreign Currency Amount in USD	% of Bid Price
5	Miscellaneous		
	Total		

DISBURSEMENT SCHEDULE

The Bidder shall give the total cash flow for this Contract. He shall complete the table below and include the value of the anticipated Interim Payments in accordance with the completion of the Milestones in the Schedule of Payments, Activity Schedule (ACS), Section-VII, Part II Employer's Requirements.

Construction year	Quarter	Value of Total Payment (NRs)	Value of Total Payments USD (In equivalent NRs)
Year 1	First		
	Second		
	Third		
	Fourth		
Year 2	First		
	Second		
	Third		
	Fourth		
Year 3	First		
	Second		
	Third		
	Fourth		
Year 4	First		
	Second		
	Third		
	Fourth		
Defect Liability Period (5 years)			
Final Payment			

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT NO. 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**INTERNATIONAL COMPETITIVE BIDDING (ICB)
[Single Stage Two Envelope Bidding Procedure]**

**VOLUME 2 of 5
Employer's Requirements**

January 2026

Invitation for Bids No.: GKHEP/ICB-082/83/EPC-1
Employer: Remit Hydro Limited
Country: Nepal

Remit Hydro Limited
Ghunsa Khola Hydroelectric Project
Citizen Investment Trust Building, New Baneshwor
Kathmandu
NEPAL

Tel.: +977-1- 4581780
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PREFACE

This volume is part of the Tender Documents for Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under EPC contract. The complete set of Tender Documents consists of the following volumes.

Volume 1	Bidding Procedures Section I - Instructions to Bidders (ITB) Section II - Bid Data Sheet (BDS) Section III - Evaluation and Qualification Criteria (EQC) Section IV - Bidding Forms (BDF) Section V - Eligible Countries
Volume 2	EMPLOYER'S REQUIREMENTS Section I – Scope of Works Section II – General Technical Requirements Section III – Standard Technical Requirements Section IV – Particular Technical Requirements Section V – Activity Schedule (ACS)
Volume 3	Conditions of Contract Section I - General Conditions of Contract (GCC) Section II - Special Conditions of Contract (SCC) Section III - Annexures Section IV - Contract Forms (COF)
Volume 4	Basic Project Report Part A: General Information 1 – Introduction 2 – Key Features of the project 3 – Power and Energy Studies 4 – Salient Features of Employer's Concept Design Part B: Project Description 5 – Topographic Survey and mapping 6 – Hydrology and Meteorology 7 – Sedimentology 8 – Geology and Geotechnics 9 – Seismicity
Volume 5	Employer's Concept Drawings

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2 of 5
EMPLOYER'S REQUIREMENTS

SECTION I
SCOPE OF WORKS

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1 GENERAL

The Ghunsa Khola Hydroelectric Project (GKHEP) is a Run-of-River project located in Taplejung district of Province No. 1. The project utilizes river discharge flowing in the Ghunsa River.

The construction of the project is planned to be carried out in three lots: Lot 1 – Civil and Hydro-mechanical Works, Lot 2 – Electromechanical Works and Lot 3 – Transmission Line Works. PPMO's Standard Bidding Document for EPC contract will be used for Lot 1 while Lot 2 and Lot 3 will be carried out using FIDIC Plant and Design Build contract.

This section of the document defines the scope of the Works to be completed under the EPC Construction of Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project. The principal elements of scope of works are:

- Investigations, Design, Planning and Supervision of the Works;
- Provision of Materials, Labour, Construction Plant and Equipment;
- Provision of Services;
- Construction of Temporary Works;
- Construction of Access road to Headworks and Surge Shaft including bridge(s);
- Construction of Permanent Works;
- Completion and Commissioning of Plant and the Works;
- Provision of Permanent Equipment (shop testing, delivery at site, handling and storage, complete installation, check-ups, spare parts);
- Testing and Taking Over of the Works by the Employer;
- Security Arrangements and Personnel Safety for both Permanent and Temporary Works and Structures;
- Environmental Protection;
- Training;
- Remedy of Defects during the Defects Notification Period.

The work, services and supplies described in this Section I - Scope of Works for Civil and Hydro-mechanical works are the part of the Works and are without prejudice and do not limit or reduce the scope of or the requirements for the Works set forth in the Contract documents. The project requirements include:

- The Contractor shall strictly observe the requirements of all the Technical Requirements and shall carry out all the work in a skilled and workmanlike manner in complete accordance with modern methods of engineering. All design, calculations, materials, manufacture and testing shall be in conformity with the most recent applicable standards;
- The Contractor shall comply with all applicable regulations regarding the execution of construction and installation work;
- The Contractor shall carry out and be responsible for the preparation of the design, construction, testing and commissioning of power plant, as built drawings, stress analyses, detailed material specifications etc.;
- The Contractor shall design, manufacture, supply, install, test and commission all equipment including all necessary accessories for a reliable continuous operation, even if all details are not explicitly stated in the Contract Documents;

- The Contractor shall, in the performance of the Works, provide for and include all materials, permanent and temporary equipment, tools and accessories for transport to the site, including loading, unloading, if necessary, reloading at the port of arrival, intermediate storage, protection of the Works against the effects of weather;
- The Contractor shall make competent and experienced staff available for the training and assistance of the operating staff during commissioning and trial operation and, if required by the Employer, for a period after completion of the trial operation which shall be agreed separately;
- The Contractor shall supply the operation and maintenance manuals before the Taking-Over Certificate is issued by the Employer;
- The Contractor shall be responsible for all his general site installations including supply, furnishing, transport, erection, operation and maintenance, supplementing (if required) and removal of all temporary plant, machinery, vehicles, scaffolding, all construction equipment, auxiliary equipment, materials, personnel; and work instruments, all temporary and permanent installations, workshops, office buildings, stores, housing, labour camps, canteen, and all other facilities required for the Contractor's personnel or in connection with the construction of the works and the fulfilment of the Contractor's obligations;
- The Contractor shall fulfil all other contractual obligations, inter alia in respect of such matters as construction programming, quality control, training, health and safety, environmental protection, and all coordination and liaison requirements including with the Employer's other contractors;
- The Contractor shall fulfil all other contractual obligations, inter alia in respect of such matters as construction planning and programming, quality control, training, health and safety, environmental protection, and all coordination and liaison requirements including with the Employer's other contractors. It is the intent of these Specifications, together with other relevant documents issued as part of the EPC Contract Documents or to follow later on, to provide the Contractor with complete and detailed information and subsequent instructions necessary to enable him to carry out the design, where and when required, and to execute the work prescribed;
- The Employer might delegate their duties to Third Parties as the Independent Engineer. In this case, it could be understood in the Contract Documents, that the expression "Employer's representative" can be replaced by the expression "Independent Engineer."

2 TEMPORARY FACILITIES

The Contractor shall supply temporary facilities for executing the works. Such facilities shall include but not be limited to:

- Accommodation for labor and staff employed for the work;
- Temporary construction road, temporary culvert and bridges where necessary
- Contractor's Offices, stores and workshops;
- Construction Power including construction of line from powerhouse location to Headworks, surge shaft and other project structure locations;
- Communication facilities;
- Protection works against floods and slides;

- Plant and facilities required for the execution of the project;
- Facilities, Water Supply and Sanitation works required for compliance with health, safety, and environmental requirements.

3 SCOPE OF CIVIL WORKS

- (a) The Civil Works shall consist of the following principal elements but not limited to,
- i. Construction of permanent access road from roadhead near powerhouse location to headwork and other project locations.
 - ii. Construction and maintenance of the access and project roads, including permanent bridges across Tamor River and Ghunsa Khola and temporary bridges as necessary.
 - iii. Construction maintenance, repair and dismantling of structures for the river diversion works;
 - iv. Construction of the ungated Weir including bridge over the weir and all appurtenant works on Ghunsa Khola;
 - v. Construction of the undersluice and all appurtenant works;
 - vi. Construction of upstream and downstream guide walls and training walls for weir and undersluices.
 - vii. Construction of the Intake, trash passages, bed load sluices, bed load sluice flushing, Gravel Trap, gravel trap flushing, and intake gate chamber and shaft;
 - viii. Construction of connecting tunnels
 - ix. Construction of the under-ground desilting basin structure and silt flushing arrangement;
 - x. Construction of gate-cum-ventilation tunnel, gate chambers and gate shafts.
 - xi. Construction of link tunnels.
 - xii. Construction of Adits to Headrace tunnel and pressure shaf.
 - xiii. Construction of the headrace tunnel and rock trap;
 - xiv. Construction of the surge shaft;
 - xv. Construction of the valve chamber;
 - xvi. Construction of the horizontal and vertical pressure shaft with steel liner/penstock;
 - xvii. Construction of the underground powerhouse comprising the machine hall, transformer-cum-GIS hall, office, control room, switchgear room, associated access and cable cum ventilation tunnels, including architectural and utility facilities;
 - xviii. Construction of tailrace tunnel and tailrace outlet.;
 - xix. Construction of outdoor takeoff yard.
 - xx. Construction and maintenance of river protection works at headworks, takeoff yard, Main access tunnel portal and tailrace area.
 - xxi. Construction and maintenance of spoil disposal areas.
 - xxii. Installation, monitoring and maintenance of instrumentation in all project components as per requirement and analysis of instrumentation data
 - xxiii. Geological and Geotechnical investigation as required;
 - xxiv. Site environmental mitigation works (as required);

- (b) The Contractor can propose the alternative solution to the type of structures or to the arrangements, or to the powerhouse and related facilities, provided these new arrangements are compliant with the terms of the Contract Agreement, and have been defined and duly justified to the satisfaction of the Employer and submitted at Preliminary design stage;
- (c) The scope of the civil works includes additional surveying works, geological and geotechnical investigations, design, construction, tests and training for Employer's personnel to meet the requirements in the Contract;
- (d) The Contractor shall design and construct underground support systems to achieve long-term stability, ensuring that deformations remain within acceptable performance limits as defined in the Technical Requirements. Support design shall consider seismic and hydrostatic loads. Minor localized rock mass deterioration that does not compromise structural and hydraulic integrity of the system or safety shall not be deemed a defect.

4 SCOPE OF HYDRO-MECHANICAL WORKS

- a) The work, services and supply described in this Section I of the Employer's Requirements form part of the Hydro-mechanical Works.
- b) The detailed composition of the supply is described in Volume 2, Section IV, Particular Technical Requirements for Hydro-mechanical Works.
- c) The Contractor without prejudice shall not limit or reduce the scope of, or the requirements for the Electrical and Mechanical Works set forth in Volume 2: Employer's Requirements, or Volume 3: Conditions of Contract.
- d) The description of the scope of supply in the Bidding Documents does not relieve the Contractor to supply any equipment or device necessary for a reliable and safe operation of the whole Plant.
- e) The Hydro-mechanical Works shall consist of the following principal elements.

4.1 Gates

◆ Undersluice Radial Gate

Two (2) complete sets of radial gate, embedded parts and hydraulic hoisting system and its accessories all complete.

◆ Undersluice maintenance gate (Stoplog)

One (1) complete set of vertical lift maintenance gate for two guides opening and electric operated monorail hoist and its accessories all complete.

◆ Trash removal gate

One (1) complete set of vertical slide gate, embedded parts and electrically operated screw hoist arrangement and its accessories all complete.

◆ Bottom Sluice Isolation Valves

Four (4) sets of Motorized bottom sluices isolation valves and upstream and downstream steel pipes with flanged end for connection with valve.

◆ Gravel Trap Flushing Valves

Four (4) complete sets of Motorized gravel trap flushing valves upstream and downstream steel pipes with flanged end for connection with valve. with provision of manual operation and its accessories.

◆ **Intake Service Gate**

Two (2) complete sets of vertical fixed wheel gate, embedded parts and rope drum hoisting system and its accessories.

◆ **Intake maintenance gate (Stoplog)**

Two (2) complete set of vertical lift gate for two guide openings, electric operated monorail hoist and its accessories

◆ **Desilting Chamber Outlet/Headrace Tunnel Inlet Gate**

Two (2) complete sets of vertical fixed wheel gate, embedded parts and rope drum hoisting system and its accessories. with provision of manual operation and its accessories all complete.

◆ **Silt Flushing Service Gates**

Two (2) complete sets of bonnet type gates, embedded parts and hydraulic hoisting system with provision of manual operation and its accessories all complete.

◆ **Silt Flushing Emergency Gates (Stoplog)**

Two (2) complete sets of bonnet type gates, embedded parts and hydraulic hoisting system with provision of manual operation and its accessories all complete.

◆ **EOT Crane**

EOT crane at silt flushing chamber all complete.

◆ **Adit Tunnel Bulkhead Gate**

Two (2) complete set of double hinged type bulkhead gate at Adit 1 and Adit 3 (1 set for each Adit) all complete.

◆ **Tailrace Gate**

1(1) complete sets of bulkhead gate, embedded parts and rope drum hoisting system and its accessories. with provision of manual operation all complete.

4.2 Trashracks

◆ **Intake Coarse Trash Rack**

Four (4) complete sets of fine trashrack, embedded parts and its accessories all complete.

◆ **Trashrack Cleaning Machine at Intake (TRCM)**

One (1) complete set of hydraulic trashrack cleaning machine and its accessories all complete.

4.3 Steel Liners and Accessories

◆ **Steel Liners**

Complete lane of tunnel steel liners upstream of surge shaft, surge shaft orifice, the vertical shafts and horizontal pipes before Wye branching or Trifurcation including bends, reducers etc. all complete.

Complete lane of steel liners after after bifurcation or trifurcation including bends, reducers and steel manhole at adit 5, etc. all complete.

◆ **Wye Branching or Trifurcation**

One (1) complete set of double Wye branching or Trifurcation and related manifolds all complete.

4.4 Auxiliary Electrical System

- a) Design, procurement, fabrication, erection, testing of electrical supply and controls for Hydromechanical Works including:
 - Feeder supply cables and controls except main distribution panels and control board (Supplied under LOT 2).
 - All power and control cables starting from the main distribution board O/G terminals and downwards up till the connected equipment forming part of this package.
 - All instrumentation cables required for instruments included under this package, including cables required for carrying signals from the MCC panel to I/O terminal block of intake control board (ICB- RTU panel supplied under LOT 2).
 - Earthing of all gates operating mechanism, structure and cable trays to the local Earth grid.
 - Safety earthing of all electrical apparatus installed at all locations.
 - Illumination of gate decks and hoists along with photocell and timer controls.
 - A Local/MCC/Off control selector shall be supplied for each gate at the respective MCC control compartment.
 - All panels and compartments of MCCs, PDB, etc. shall be provided with space heaters with thermostat control, panel illumination lamp, socket, etc.
- b) Other detailed scope of work is covered under standard technical requirements and particular technical requirements.

4.5 Fittings, accessories, spare parts and special tools

Complete set of fittings, accessories, spare parts and special tools as prescribed in the technical requirements.

The Contractor shall execute, design, fabricate, install /erect, test and train for the operation and maintenance to the Employer's personnel to meet the requirements in the Contract.

5 WORK BY OTHERS

- a) The Project includes various other works, which are not included in the works under this contract. In particular, the works do not include Lot 2 – Electromechanical Works and Lot 3 – Transmission Line Works including the permanent staff quarter.
- b) Interfaces between the Contractor and the other parties on Site shall be managed and coordinated in accordance with Volume 2 Section II Chapter 15 Interfaces. The Lot 1 Contractor shall be the Incharge for management of interface and coordinate with the other Contractors.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2 of 5
EMPLOYER'S REQUIREMENTS**

**SECTION II
GENERAL TECHNICAL REQUIREMENTS**

**CHAPTER 1
GENERAL ADMINISTRATION**

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CHAPTER-1: GENERAL ADMINISTRATION

1.1 PROJECT MANAGEMENT

1.1.1 Project Management Plan

- a. The Contractor shall submit a Project Management Plan for the Employer's Review and Approval within **Sixty (60)** days of the Commencement Date, which shall provide, but not limited to, the following information:
 - A diagram showing the organisational structure for the management of the Contract, with associate organisations and Subcontractors and show the lines of responsibility linking the various groups and describe interactions;
 - A resource histogram and timeline of key personnel, Subcontractors and labour distribution; and
 - A narrative describing the sequence, nature and inter-relationship of the Contract activities.
- b. The Employer will review and approve the Contractor's Project Management Plan and shall have the right to require the Contractor to make amendments as deemed necessary by the Employer acting reasonably. Any change proposed by the Contractor to the Project Management Plan shall be submitted for the Employer's Review and Approval.

1.1.2 Method Statements

- a. The Contractor shall submit a method statement/s with its Tender/Bid which shall be updated as the Works progress.
- b. The method statements (method statements for construction and erection of all Works, major Plant, equipment and systems) shall be submitted for the review and approval to the Employer prior that said construction and erection being carried out on the Site.
- c. Four (4) hard copies and an electronic copy of each method statement shall be submitted to the Employer not less than Thirty (30) days prior to the commencement of the relevant activity.
- d. Method statements shall include, but not be limited to, a detailed account of how the works shall be carried out, sequence drawings or flow chart of activities, Temporary Works requirements, a risk assessment to identify potential hazards and the measures taken to remove or minimise those hazards, a program for the works covered by the method statement, required resources with respect to plant, material and labour, the effects on any interfacing or adjacent works and environmental compliance.
- e. In addition, the organisation structure with respect to supervision, health and safety, environmental and quality shall be included in the method statements.

- f. As part of the method statements, a Site Utilisation Plan for each worksite shall be submitted. The Site Utilisation Plan shall show, inter alia, proposed location of offices, sheds, temporary buildings, temporary services, access roads, surface drainage, spoil dumps, temporary roads, fuel stores, explosives stores, etc. The Site utilisation plan shall also include, but not limited to, all land boundaries, extent of forestry management, existing roads and buildings, etc.

1.1.3 Manuals

1.1.1.1 General

- a. The Contractor shall provide Four (4) hard copies, and an electronic copy of the manuals as further detailed below, as well as any other manuals the Employer may instruct the Contractor to produce, which the Employer considers necessary for the satisfactory completion of the Works.
- b. The Contractor shall identify the delivery dates for each of the following manuals on the Program, and shall monitor the ongoing status against this Program and issue with the monthly progress report to the Employer a section which shall include progress achieved during the month, packages completed, work programmed for the following period and any areas of concern.

1.1.1.2 Procurement Manuals

- a. The Procurement manual shall contain a single copy of all key and critical purchase requisition/orders, as agreed with the Employer and any revision thereto. The Procurement manual shall include cross-references to all items of Plant, Materials and equipment included within the Contract. This manual shall be delivered to the Employer within Thirty (30) days of the Commencement Date and shall be updated by the Contractor on a monthly basis.

1.1.1.3 Construction Manuals

- a. The Construction Manual shall contain all records of construction (erected fabrication inspection, testing, commissioning and pre-commissioning), "as built" drawings reflecting all aspects of the Works including any design changes agreed by the Employer and waivers/concessions to specifications. This manual will also contain weld test and material traceability documentation.
- b. The format of the data included will be of two specific types; those documents that apply to the construction and commissioning activities for a single system, e.g. materials, tests, inspections etc. and those not system specific, i.e. welder certificates and procedures.
- c. The weld procedures, welder qualifications, non-destructive test (NDT) procedures etc., the levels of review for each shall be scheduled and included as part of the index.
- d. For all system-related documents the Contractor shall include a system/book index for the total submissions and inclusion within all manuals. These manuals shall be delivered for Employer's Review and Approval within **Sixty (60)** days of the Commencement Date and shall be updated by the Contractor on a weekly basis.

1.1.1.4 Health and Safety Manuals

- a. The Health and Safety Manuals, policies, plans, guides etc., shall cover all aspects of Health and Safety and shall comply with the requirements set out in **Chapter 3 – Health and Safety of the General Requirements.**

1.1.1.5 Quality Control Manuals

- a. The Quality Control Manuals, policies, plans, guides etc., shall cover all aspects of Quality Control and shall comply with the requirements set out in **Chapter 4 – Quality Management of the General Requirements.**

1.1.1.6 Environmental Management Manuals

- a. The Environmental Management Manuals, policies, plans, guides etc., shall cover all aspects of Environmental Management and shall comply with the requirements set out in **Chapter 5 – Environment at Construction Site of the General Requirements.**

1.1.1.7 Instruction Manuals

- a. The Instruction Manuals, shall describe the complete Works and shall give a step-by-step procedure for any operation likely to be carried out during the life of the Works, after the site delivery, including identification, erection, setting to work, testing, commissioning, operation, maintenance, dismantling, repair, adjustment and re-assembly of all parts of the Works., and shall comply with the requirements set out in **Part 2 – Design Requirements.**

1.2 SUBMITTALS

1.2.1 General Requirements

1.2.1.1 General

- a. The Contractor shall provide to the Employer the Contractor's Documents as described in this section. All reports, design drawings, detail drawings, working drawings, shop drawings, plans, as-built drawings, specifications, notes, annotations, and information shall be provided by the Contractor in such sufficient format, detail, extent, size and scale and within such time as may reasonably be required to ensure effective execution of the Works. All dimensions shall be in metric units and all drawings shall be produced to adequate scale.
- b. All documents and drawings required to be submitted by the Contractor under the Contract shall be clearly readable prints or photocopies with a soft copy. Size of the drawings shall be unified as far as practicable (see sub-paragraph 1.2.1.6 hereunder). The number of copies to be submitted depends on nature of drawings and documents and is specified in the General Technical Specification of the individual works. These documents and drawings shall be submitted with stamps of "FOR APPROVAL" or "FOR INFORMATION", date of submission and the Contractor's seal.
- c. The Contractor shall, except as specifically noted elsewhere in the Contract, submit his documents in time and in a logical order (general and layout drawings,

calculation/explanatory notes, foundation drawings, detailed drawings, etc.) to the Employer for review or approval.

- d. The submission shall be made with a formal transmittal letter signed by the Contractor's Representative and titled "**Ghunsa Khola Hydroelectric Project**". Systematic serial numbers shall be assigned to the letters by the Contractor for easy reference. The submission shall be affected when such submission has arrived at the Employer's Site Office.

1.2.1.2 Control

- a. The Contractor shall establish and maintain a comprehensive computer-based document control system for all work to be performed under the Contract. The document control system shall ensure that the identification, revision, status and location of all documentation are determined during all phases of the work. This shall include, but not be limited to, correspondence, reports, drawings, specifications and trade literature relating to Plant or Materials to be supplied, installed or constructed under this Contract. The Contractor's system shall also provide for all Subcontractors' documents.
- b. The comprehensive computer system, submitted to the Employer, shall be updated on a monthly basis and the updated file shall be submitted each month on an electronic copy to the Employer.

1.2.1.3 Identification

- a. The Contractor shall utilize and maintain an identification system acceptable to the Employer for all project documentation for permanent inclusion in the Works, which shall enable the Contractor and the Employer to control the documentation in the live phase of the Project. The documents identification system, following the ISO 9001 procedures as applicable, shall be submitted to the Employer as part of the Document Schedule.
- b. Provision shall be made by the Contractor to provide full training in the use of the identification system by the Employer in readiness for handover of the Works.
- c. All documents supplied by the Contractor shall include the following indications in the title block of the document:
 - i. Nepal
 - ii. Remit Hydro Limited
 - iii. Ghunsa Khola Hydroelectric Project
 - iv. Name and Logo of Contractor
 - v. Name of Works: Lot 1 – Civil and Hydro-mechanical Works
 - vi. Name of structure or component
 - vii. Issue date
 - viii. Drawing number

Each drawing shall be provided on the external frame line with letters and numbers for easy identification of any part of the drawing.

- d. All documents title block shall include a revision block provided for inscription of modifications in the contents, listing the revision date, number and description. For an easy identification of any modification content, they shall be inscribed in a "cloud" mark identified with the revision number. The Contractor shall submit a drawing specimen with a title block and a revision block to the Employer for approval before starting with the design.

1.2.1.4 Organisation of Documentation

- a. All documentation shall be organized in a logical manner and all contents shall be properly indexed. A revision status record sheet at the front of each document shall facilitate recording of amendments in logical manner. Revision indication and issue dates shall also appear in each amended sheet. All submissions, except drawings, shall be housed in durable loose-leaf folders suitable for the addition of amendment data. The cover shall identify the contents and carry the Contract reference number.

1.2.1.5 Quality

- a. Paper used for documentation shall be suitable for long-term storage (minimum 80 g/m²) and all drawings shall be prepared upon 0.003-inch polyester film. All drawings shall comply with the requirements of appropriate and recognized standards for drawings practice for engineering drawings and engineering diagrams.

1.2.1.6 Size

- a. With the exception of drawings and certain other forms such as certificates, all other documents shall be size A4. The preferred sheet size for drawings shall be size A1 or A3.
- b. Drawings for inclusion in technical manuals should be size A3, double folded to size A4, title visible with the drawing folded and bound along the left-hand side. If drawings of size larger than A3 are required to facilitate clarity they shall be folded and placed into plastic wallets, with each wallet clearly identifying the enclosed drawing. The wallets shall be secured in the manual cover and permit easy access to the enclosed drawing.
- c. All vendor documents greater than size A3 must be capable of reduction to size A3 with no loss of symbol, lettering, legibility, or other forms of quality degradation. Such drawings shall also have a minimum left-hand margin of 25 mm at size A3 to ensure that binding obscures no information.

1.2.1.7 Symbols

- a. All symbols shall comply with the appropriate and recognized British, European, International or national standards as applicable.

1.2.1.8 Units and Scale Ratios

- a. All design documents and drawings shall be supplied in SI metric units.
- b. Drawings shall be produced using one of the following scales 1:1, 1:2, 1:5, 1:10, 1:25, 1:50, 1:100, 1:200, 1:500, 1: 1,000, and 1: 2,500. Where applicable, third angle projection shall be used throughout.

1.2.1.9 Number of Copies

- a. Unless the Contract requires otherwise the Contractor shall submit **Four (4)** hard copies and an electronic copy on a USB flash drive/CD-R disks of each Contractor's Document for the use of the Employer.

1.2.1.10 Electronic Copies

a) General

- a. All information supplied to the Employer by the Contractor shall be provided in electronic as well as hard copy format.

b) Word Processed text documents, manual, spread sheets, etc.

- a. All word documents shall be handed over in software files compatible with those of the Employer (latest version Microsoft Office Software) on USB flash drive/CD-R disks. All spread sheet information shall be handed over in software files compatible with those of the Employer. These disks shall be properly indexed both on the individual disks with the appropriate directory names, containing the data files, as well on a separate master directory disk, plus a separate list of all the documents concerned on paper. All relevant documents shall be in an uncompressed original format. All documents in this section shall also be presented in PDF format.

c) Drawing Files

- a. All drawing files shall be handed over as current AutoCAD format software files (.dwg or .dxf) on non-rewritable compact laser disks ("CD-R disks"). These disks shall be properly indexed both on the individual disks with the appropriate directory names, containing the data files, as well as on a separate master directory disk, plus a separate list of all the documents concerned on paper. All documents in this section shall also be presented in PDF format.

d) Document Images, Computer Aides and Graphic Files

- a. All non-word processed and spread sheet documents, such as photographs, videos, maps, graphic document files, data sheets and such like shall be handed over on USB flash drive in one or more or of the following file formats, as appropriate: TIF v6, CLAS 2, CCITT GROUP 4, HPGL, IGES, JPEG, PCX, GEM, GTX, RLE, BMP. The indexing of such documents shall be in the same way as outlined above for word-processed and spread sheet documents.

e) Indexing

The indexing referred to in b), c) and d) above shall include any relevant tag, equipment, item and stock numbers cross referenced to drawings and documentation both electronically and in hard paper copy.

f) Key Words

- a. When undertaking indexing the Contractor shall ensure that a keyword is entered for each item of information.

1.2.2 Specific Information

1.2.2.1 Document Schedule

- a. The Contractor shall provide a detailed schedule of documents including drawings (the "**Document Schedule**") to be produced during execution of the Works pursuant to the Contract for submission to the Employer. The Document Schedule shall indicate, by generic type, those supplied for review and comment (design reports, procedures, etc.) and those for information. The Contractor shall submit this Document Schedule for Employer's Review and Approval within Thirty (30) days of the Commencement Date and monthly thereafter as part of the monthly progress report, required under Clause 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract.
- b. The Document Schedule shall also indicate to the Employer those specific design, safety and related elements required for third party verification and, where possible, the proposed third party.

1.2.2.2 Purchase Information

- a. The Contractor shall, at a minimum, submit copies of the following as part of the Procurement Manual:
 - Unpriced key and critical external supply purchase orders.
 - Subcontract packages.
 - Subcontract information.
 - Expediting and inspection reports.
 - Shipping schedule for major items of Contractor's Equipment, estimated dates of shipment and arrival and dutiable value of goods, to be provided two months in advance of shipment.

1.2.2.2.1 Construction and Procurement Records

- a. The Contractor shall generate records as required by the Contract and the project specific Quality Plan, **Chapter 4 – Quality Management** of the General Requirements.
- b. All records including those generated by Subcontractors or suppliers, shall be concisely compiled, indexed and uniquely identified with the Contract reference number clearly identifiable to the individual parts and assemblies to which they refer.
- c. The Contractor shall ensure that all Site and Works documentation is maintained and stored in accordance with the Quality Plan, **Chapter 4 – Quality Management** of the General Requirements.
- d. For items of Plant, Materials or Contractor's Equipment that are being delivered to the Site, the Contractor shall ensure that all records required by the Employer pertaining to such items arrive on Site with the relevant Plant, Material or equipment. Such records shall include all traceable records, including reports and certification in respect of any components.

- e. The compilation and storage of records during the term of the Contract shall be controlled to ensure adequate security, verification and traceability prior to taking over of the Works by the Employer. The storage conditions shall maximize resistance to damage and deterioration.
- f. The Contractor shall retain copies of all records generated during the course of the Contract by the Contractor, its Subcontractors and suppliers for a period of five years from the Date of Completion. These records shall be made available to the Employer on request.
- g. The Contractor shall submit a monthly Documentation Schedule for the Employer's Review and Approval as part of the monthly progress report as required under the Conditions of Contract. The Contractor shall maintain the Documentation Schedule throughout the project to show the up-to-date status and revision of each document. The transfer of this information should be achieved by electronic transfer (disk) from the Contractor's central system.
- h. The Contractor shall submit documents to the Employer in accordance with the Documentation Schedule and the quality requirements, quality procedures and Quality Plan. Prior to issue of the Taking-Over Certificate, final documentation shall be handed over by the Contractor to the Employer in Four (4) hard copies and an electronic copy.

1.2.2.2.2 Electronic Document

Emergency Contingency Planning and Recovery

- a. At all times during the performance of the Contract, the Contractor shall have in place a valid and working emergency contingency plan, recovery procedures and appropriate means, facilities, methodology and personnel to deal with emergencies. The emergency contingency plan and recovery procedure should come into action if and when any of the communication, hardware, software, or services are terminated or interrupted as a result of events such as, but not limited to: storm, flood, fire, sabotage, accident, computer system or component failure (hardware or software).
- b. The Contractor shall review the contingency plan monthly and shall update it as necessary. The Contractor shall have in place a draft emergency contingency plan from the Commencement Date and shall submit the draft emergency contingency plan to the Employer for the Employer's Review and Approval within Thirty (30) days of the Commencement Date.

Storage at Site

- a. The Contractor shall provide permanent library facilities for the hard copies and the software and hardware for electronic format information. All the stored information shall be kept within the permanent site offices in an area that is sufficiently protected and equipped with viewing facilities and a copying facility up to A3 and printing facility up to A1 size.

- b. The atmospheric storage conditions within this area shall be such as to prevent deterioration of the information. The Contractor shall back up all types of information, data, records, manuals, and photographs and documents on paper or electronically, on a regular basis and store a copy safely both on and off site. These shall include commissioning, testing and take-over phases of the Plant. The area shall provide secure storage of the information.
- c. The Employer shall be granted full and unrestricted access to this facility and to the information stored therein, excluding commercially sensitive information relevant to the Contractor.

1.2.2.2.3 Certification Schedule

- a. The Contractor shall be required to develop and maintain a current certification schedule for any items of Plant and Contractor's Equipment requiring periodic inspection/testing in accordance with the respective mandatory codes, applicable standards and laws (e.g. pressure vessels, rigging and lifting appliance, pressurized systems etc.). Procedures shall be individually developed for each item, forming part of the operation and maintenance manual presented prior to issue of the Provisional Acceptance Certificate. Such procedures shall also be identified in accordance with the project identification procedure.

1.3 STANDARDS AND CODES

1.3.1 General

- a. Certain Standard and codes issued by national or other recognized international bodies are referred to in the Employer's Requirements. Pertinent provisions of these standards shall apply to the work and are hereby incorporated in the Technical Specifications. All standards and codes employed or referred to shall be the latest current issue.
- b. Where a manufacturer is named in the Technical Specifications, other manufacturers' products will also be acceptable provided the designated material or workmanship is of equivalent or better quality.
- c. If the Contractor prefers to use equivalent standards not mentioned in these Technical Specifications, the Contractor shall submit the authorized English version or the original standard's copy with English translation/comments showing the correspondence with the specified standards. The final assessment on the equivalence, between the original standard(s) specified herein and the alternative standard proposed by the Contractor, is subject to Employer's judgment. No adverse claim from the Contractor on the said final assessment shall be accepted. If the Contractor cannot submit the English version or the equivalent, the Contractor shall use the specified standards mentioned in the Technical Specifications.
- d. In case of discrepancies between these Technical Specifications and national or international standards and codes, these Technical Specifications being part of Contract Documents shall govern, unless otherwise established by the Employer in each particular case.

- e. The Contractor shall obtain any related Standards or Codes as required. Copies of these Standards and Codes shall be supplied to the Employer on request. The Standards and Codes shall be printed or translated in English.
- f. The Contractor shall ensure that the types of Standards and Codes used for the various phases of the Project (design, control of materials and control of construction quality) are technically and qualitatively compatible. If Standards or Codes of different sources (i.e. ASTM / DIN/Euro codes or British Standards (BS)) are used for different phase of the Project, the Contractor shall thoroughly check on a continuously basis that such use does not lead to any conflicts or inconsistencies during the implementation of the Project.
- g. Although the Works shall comply with International Standards or Codes, any instruction in the Employer's Requirements that a particular aspect of the Works shall comply with a named Standard or Code shall take precedence, and that particular aspect of the Works shall comply with the named Standard or Code.

1.3.2 National Standards, Codes, Laws and Regulations

- a. The Contractor's shall acquaint himself with all available national codes, standards, laws and regulations related to the Works in anyway and shall procure and keep at the Site a copy of each of such applicable documents. The Contractor shall make such Standards, Codes, Laws and Regulations available to the Employer.
- b. Throughout the duration of the Contract, the materials, equipment, services, design and workmanship shall conform to applicable national codes, standards, laws and regulations in force in Nepal if not otherwise specified.

1.3.3 International Standards and Codes

- a. The following international standards/codes series may be adopted, unless otherwise detailed in the Specifications:
 - International Standardization Organization (ISO)
 - Nepal National Code
 - US (ASTM, ANSI, USBR, ACI, AASTHO etc.)
 - European codes (EC)
 - German standard (DIN, VDI)
 - Japan International Standards (JIS)
 - British Standard (BS)
 - Bureau of Indian Standards (IS)
 - National Standard of the People's Republic of China (GB)
 - Australian Standards and codes

And others standard provided:

- The standards/codes proposed are at least as stringent as the equivalent national ones relevant to the Works, or if there is no applicable national standard/code for the specific item concerned.
- The Contractor states, prior to starting the work, the international standard/code he proposes to apply, giving full identification of each of them. The Contractor's proposals are subject to the approval by the Employer.

- b. Where reference is made in the technical documents to standards/codes of the country of origin for a supply item, it shall be a recognized national standard/code of the country where the specific supply item is manufactured. To be acceptable under the Employer's Requirements, such standards/codes must comply in all respects with the quality requirements of above-mentioned international standards/codes and must be approved by the Employer.
- c. When documents in the Contract contain particular specifications or more restrictive standards than required in specified above, the documents in the Contract will always prevail.
- d. In case of lack of precise requirements in the Employer's Requirements and even if no reference to any Standard or Code is made, the Standards and Codes listed above shall be used as reference.

In referring to the Standards and Codes the following abbreviations are used:

AASHTO	American Association of State Highway and Transportation Officials	aashto.org
ABB	Allgemeine Blitzschutzbestimmungen	vde.com
ACI	American Concrete Institute	aci-int.net
AFNOR	Association Francaise de Normalisation, France	afnor.fr
AISC	American Institute of Steel Construction	aisc.org
ANSI	American National Standards Institute	ansi.org
APAVE	Groupement des Associations de Proprietaires d'Appareil a Vapeur et Electriques, France	apave.com
API	American Petroleum Institute	api.org
ASA	American Standards Association	
ASCE	American Society of Civil Engineers	asce.org
ASHRAE	American Society of Heat, Refrigerating and Air Conditioning Engineers	ashrae.org
ASME	American Society of Mechanical Engineers	asme.org
ASTM	American Society for Testing and Materials	astm.org
AWS	American Welding Society	aws.org
AWWA	American Water Works Association	awwa.org
BAW	Bundesanstalt für Wasserbau, Germany	baw.de
BS	British Standard	bsi.org.uk
BSCP	British Standard Code of Practice;	
CEPT	Comité Européen de la Chaudronnerie et de la tolérances	
CEE	International Commission of Rules for the Approval of Electrical Equipment	
DIN	Deutsches Institut für Normung, e.V., Germany	din.de
IS	Bureau of Indian Standards	
GB	National Standard of the People's Republic of China	

EMAS	Eco-Management and Audit Scheme, EU	http://ec.europa.eu/environment/emas/index.htm
EN	Euronorm	euronorm.de
FEM	Fédération Européenne de la Manutention, France	fem-eur.com
HSE	Health & Safety Executive, United Kingdom	open.gov.uk/hs
IEC	International Electrotechnical Commission	iec.ch
IEE	Institution of Electrical Engineers, United Kingdom;	iee.org.uk
IEEE	American Institute of Electrical and Electronic Engineers	ieee.org
IFC	International Finance Corporation	
ISO	International Organisation for Standardisation.	iso.ch
NEMA	National Electrical Manufacturer's Association;	nema.org
NF	Norme Française, France;	afnor.fr
OSHA	Occupational Safety and Health Administration	www.osha.gov
RAL	RAL Deutsches Institut für Gütesicherung und Kennzeichnung e.V., Germany	ral.de
S&H	Safety and Health in Building and Civil Engineering Works of the International Labour Organization	ilo.org
USACE	United States Army Corps of Engineers;	usace.army.mil
USBR	United States Bureau of Reclamation;	usbr.gov
VDE	Verband der Elektrotechnik Elektronik Informationstechnik	vde.de
VDI	Verein Deutscher Ingenieure Essen	vdi.de
UVV	Unfallverhütungsvorschriften	
VDMA	German Machinery and Plant Manufacturer's Association	vdma.de
SIS	Sveriges Standardiserings Kommission	
WHO	World Health Organisation	who.int

1.3.4 Standards for the Works

- All materials and Works shall be designed, erected or installed, tested and commissioned in conformance with the latest issues of the relevant internationally recognized Standards and Codes. However, any specific requirement of the documents in the Contract shall prevail.
- All plant and equipment supplied under this Contract shall be proven in service and/or references from users of similar plant and equipment shall be made available to the Employer by the Contractor, if so required.

1.3.5 Substitution of Standards and Codes

- The Contractor may offer Works which comply with international standards, or internationally recognized national codes or standards, which differ from those specified. However, such substitution is subject to the Contractor demonstrating to

the Employer satisfaction, that the Works offered are equal or superior to that which would have resulted had the specified code or standard been used. This substitution of codes or standards for those specified will only be acceptable if the manufacturing organization in charge of the works has extensive experience with the alternative code or standard offered.

- b. The Contractor shall supply these substitute Standard and Codes to the Employer on request. The standard and codes shall be printed or translated in English.

1.3.6 Hierarchy of Standards and Codes

- a. In the event of any conflict in the Standard and Codes, the Standard or Code with the highest requirements or most stringent provisions should take precedence, unless instructed by the Employer.

1.3.7 Seismic Loads

- a. Based on the Earthquake Hazard Analysis, the Peak Ground Acceleration (PGA) at the project site is adopted as follows:
- b. The MDE and OBE specifications (PGA of 0.25 and 0.167 g respectively) are derived from a general evaluation of the seismic environment of the project area based on our previous knowledge of the regional geology and seismotectonic and on an updated instrumental earthquake catalogue. The specifications are not derived from a specific calculation but are to be taken as conservative minimum requirements for aseismic design, from our general experience and common practice, taking into consideration the low to very low seismic activity of the project region.

1.3.8 System of Units

- a. The SI (System International) system of units has been used throughout, and this system of units shall be used throughout the duration of the Contract for all technical and contractual purposes.
- b. Following abbreviations are used in the Employer's Requirements and related other contract documents:

	Unit	Abbreviation
Length:	Millimeter	mm
	Centimeter	cm
	Meter	m
	Kilometer	km
Area:	Square Millimeter	mm ²
	Square Centimeter	cm ²
	Square Meter	m ²
Volume:	Cubic meter	m ³
	Litre	l
Mass:	Kilogram	kg

	Unit	Abbreviation
	Tonne	t
Density	Kilogram per Cubic meter	kg/m ³
Specific Weight:	KiloNewton per Cubic meter	kN/m ³ g
Force:	Newton	N
	KiloNewton	kN
	MegaNewton	MN
Moment:	KiloNewton-meter	kN.m
Stress or	Newton per Square Millimeter	N/mm ²
Strength:	KiloNewton per Square Millimeter	kN/mm ²
	KiloNewton per Square Meter	kN/m ²
Pressure:	Bar	bar
	Pascal	Pa
	MegaPascal	MPa (N/mm ²)
Time:	Milisecond	ms
	Secondl	s
	Minute	min
	Hour	h
	Day	Day
	Week	Wk
	Month	Mth
	Year	Year
Rate of Flow:	Liters per second or minute	l/s,l/min
	cubic metersper second	m ³ /s
	cubic metersperminute	m ³ /min
Velocity:	meters per second	m/s
	kilometer per hour	Km/h
Velocity of	revolutions per minute	rpm
Rotation:		
Temperature:	Degree Celsius	°C
Concentration:	partsper million	ppm
Illumination	lux	lx or lux
Intensity		
Energy:	kiloWatthour	kWh
Power:	Watt	W
	kiloWatt	kW
	megaWatt	MW

	Unit	Abbreviation
Scope and Percentage:	percent	%

- c. Any other system of units utilized shall have only a descriptive value and shall in no case replace the above-mentioned SI system.

1.4 SETTING OUT AND SURVEY

- The requirements of this Clause apply to the set out of the works and to conformance surveying of the completed works. It describes the survey necessary to confirm that these works conform to the requirements of the Employer, in regard to line, length, thickness, level, position, dimension and performance.
- The position, level and dimension of elements of completed works shall be measured and recorded using the same coordinate and level reference shown on the Employer's Concept Drawings: Volume 5.
- All conformance surveys shall be conducted and the results certified by a qualified and experienced Surveyor, acceptable to the Employer for this purpose.
- Survey results shall be reduced to chainage and offset from the centreline of the diversion tunnels, or designated set-out points.

1.5 WATER USAGE

- This Contractor shall be responsible for the design, supply and installation of an adequate water supply for the permanent equipment supplied under this Contract, in particular for the shaft seal water and the equipment cooling water. The water supplied shall be of a suitable quality. If necessary, a suitable filter system shall be installed.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 2
DESIGN REQUIREMENTS

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CHAPTER 2 - DESIGN REQUIREMENTS

2.1 GENERAL

- a. The Contractor shall perform engineering services pertinent to planning and designing of the Works, as specified in this Chapter 2.
- b. The Employer has provided a Design of the Project in Volume 4 – Basic Project Report and Volume 5 Employer's Drawings, which is intended to illustrate, for information of the Contractor, the overall concept arrangement, and key features of the works.
- c. The Contractor shall be fully responsible for the detailed design, as required, for implementation of the Project according to the Employer's requirements. Any details, dimensions, or information shown in the Concept Design shall be confirmed by the Contractor before incorporation into the Preliminary Design of the Works.
- d. The Contractor's design shall include the following phases:
 - **Preliminary Design Phase** – First stage of detailed design where general arrangements and basic dimensions for the works are defined. It is envisaged that the Preliminary Design will be provided to a similar level of detail as provided in the Employer's Concept Design.
 - **Detailed Design Phase** – Detailed design of the various components including, but not limited to, complete concrete outlines, reinforcing drawings, excavation drawings, and details to a level which are issued for construction purposes.
 - **Construction Design Phase** – Design which is undertaken during the construction phase, which may include shop drawings, assembly drawings, reinforcing schedules, and other similar documentation.
 - **As-built Documentation Phase** - At completion of the works, the details of the construction will be documented in 'as built' drawings and documentation.

As part of the design submissions, the Contractor shall be required to provide the following documentation:

- Design Management Plan;
- Design Criteria Reports;
- Design Report;
- Calculations; and
- Drawings.

2.2 SITE INVESTIGATIONS

- a. Preliminary site and geological investigations have been carried by the Employer, the findings of which are provided for information only and are contained in Volume 4 – Basic Project Report. It is the Contractor's responsibility to determine where necessary, to

undertake additional investigations and studies to justify the proposed design and verify site conditions.

2.3 DESIGN SCOPE

- a. The Contractor shall be responsible for developing the Employer's Concept Design into a detailed design for construction, including detailed design criteria, design analyses, detailed construction specifications and detailed construction drawings, which shall be subject to the review and approval of the Employer to ensure compliance with the Employer's Design Criteria, the Employer's Requirements, referenced documents, the best international engineering practice and the particular geology, hydrology and topography of the site.
- b. The Contractor shall also be responsible to obtain timely approvals from the relevant authorities in accordance with the relevant regulations.
- c. Long term behaviour and durability, assuming regular maintenance, shall be a prime consideration when developing the detailed design particularly for parts that are not easily repaired, to achieve the economic life of the Works as specified.

2.4 DESIGN CRITERIA

- a. The Employer's Design Criteria is an integral part of the Employer's requirements and shall form the basis of the design to be prepared by the Contractor.
- b. The Employer's Design Criteria serve the purpose of:
 - providing the location and overall general arrangement of the Project Works and main dimensions to meet the functional requirements for the operation of the Project;
 - providing suitable space and facilities required by the Employer for the administration, maintenance and operation of the Project Works;
 - defining the minimum design parameters to be adopted to achieve the required minimum factors of safety for stability, remain within the limits of allowable stresses and strains and achieve the required durability of the Project Works;
 - meeting the design standards and guidelines of internationally accepted institutions and governing authorities; and
 - satisfying the environmental and social obligations imposed on the Employer by the respective Government agencies.
- c. Details of the Employer's Design Criteria are provided in Volume 2, Sections III and IV.
- d. The Employer's Design Criteria, together with the Standards and Regulations referred to in Clause 2.8 of this Chapter 2, and any design guidelines are to be considered the minimum standards to which the work is to be designed. The Contractor shall use a more conservative approach to the design where in his professional judgement, such is appropriate.

- e. Temporary works shall be designed to be safe, reliable, and adequate for all loads and uses, and where they are to be incorporated into the permanent works, temporary works shall be designed in strict compliance with the criteria adopted for the permanent works.
- f. The Contractor shall confirm compliance with the Employer's Design Criteria when submitting his design drawings and calculations to the Employer approval.

2.5 FIXED ELEMENTS OF THE DESIGN

- a. Various elements of the Employer's Concept Design may be fixed, as indicated on the Concept Drawings, and are not subject to change except where site conditions determine otherwise. However, such a change will be subject to:
 - the Contractor providing valid reasons for such a change; and
 - the Employer's review and approval, who's decision shall be final.

2.6 CONTRACTOR'S DESIGN ENGINEERS

- a. The Design shall be carried out by professionally qualified groups or firms of engineering designers. The groups or firms shall be represented by professionally qualified engineer. Both the groups or firms and the Contractor's Design Engineer shall have proven experience in the planning and construction design of similar Works.
- b. The Contractor's Design Engineer shall oversee all the design works and endorse all design calculations and drawings submitted to the Employer for approval. The Contractor and/or the Contractor's Design Engineer shall appoint from time to time suitably qualified engineers to represent him on site and they shall be available for discussions and clarifications throughout the period of the Contract.
- c. The Contractor's Design Engineer shall inspect the works at all times and certify, in accordance with the quality assurance obligations of the Contract, that the whole of the Works has been constructed and completed in accordance with the Employer's requirements.

2.7 ECONOMIC LIFE OF THE WORKS

- a. The design shall be based upon a useful economic life of Fifty (50) years for all elements of permanent structural facilities assuming the Employer will perform normal routine maintenance.

2.8 STANDARDS AND REGULATIONS

2.8.1 Standards

- a. All design, workmanship, material and equipment supplied shall conform to the latest edition of the code of practice, standard, internationally recognised recommendations and guidelines stated in the relevant parts of the Design Criteria and Specifications.
- b. Within **Sixty (60)** days from the Date of Commencement, the Contractor shall supply an indexed list of all standard, codes and associated literature referred to in executing

the works and a copy of the same in the English language shall be submitted to the Employer.

- c. The Contractor shall ensure that the various Standards, Codes of Practice and other literature employed for each structure, system or network are consistent and compatible with each other.
- d. The standards and associated literature shall include, but not be limited to, the following:
- American Army Corp of Engineer's;
 - American Society of Testing and Materials (ASTM) Standards and Code of Practice;
 - American Concrete Institute (ACI) publications;
 - American Water Works Association (AWWA);
 - American Society of Civil Engineers (ASCE) publications;
 - American Association of State Highway and Transportation Officials (AASHTO) publications;
 - American Institute of Steel Construction (AISC) publications;
 - Association of Engineering Geologist;
 - British Standards (BS), Codes of Practice and guidelines;
 - Deutsche Industries fur Normung (DIN), The German Standard and Code of Practice;
 - European Standards (EN);
 - International Commission on Large Dams (ICOLD) publications;
 - International Finance Corporation (IFC) Standards, Codes of Practice and Guidelines
 - Institution of Mining and Metallurgy, London, publications;
 - International Standardization Organisation (ISO);
 - International Hydropower and Dam;
 - International Society for Rock Mechanics (ISRM);
 - Japanese Industrial Standards (JIS);
 - United States Bureau of Reclamation (USBR) publications;
 - Water Power and Dam Construction.
 - Bureau of Indian Standards (IS)
 - National Standard of the People's Republic of China (GB)
 - Australian Standards and codes

2.8.2 Statutory Regulations

- a. The design, execution and equipment supplied shall conform to the requirements of, but not limited to, the following regulating and statutory bodies:
- The Department of Urban Development and Building Construction, Nepal
 - The Department of Roads, Nepal
 - The Department of Transport Management, Nepal
 - Ministry of Science, Technology and Environment, Nepal
 - Department of Electricity Development, Nepal
 - Department of Health, Nepal
 - Department of Immigration, Nepal

- Department of Labour, Nepal
- Department of Soil Conservation and Watershed Management, Nepal
- Nepal Engineering Council
- Nepal Army Regulations

2.8.3 Compliance with Authorities

- a. In addition to the complying with the design criteria, the Contractor's design shall also conform to the requirements of all relevant local and national federal authorities, where approvals for that section of works is needed from the relevant authorities.

2.8.4 Language and Units of Measurement

- a. All documents, drawings, calculations, reports, etc., prepared by the Contractor shall be in the English Language and all units of measurements shall use the International System of Units (SI).

2.9 SUBMITTALS

2.9.1 General

- a. The Employer shall undertake a review of the design submitted by the Contractor for the Project. To facilitate this review, the Contractor shall meet the requirements noted in this section.
- b. Notwithstanding any review or approval by the Employer, the Contractor shall be responsible for all aspects of the design, procurement, construction and commissioning of the Project.

2.9.2 Review and Approval

- a. Review and approval of the Contractor's design/s for the Project by the Employer shall be carried out in the following stages:
 - **"Preliminary Design Phase"** - review of the Contractor's proposed conceptual design, includes general arrangements and basic dimensions;
 - **"Detailed Design Phase"** - Contractor's detailed design and drawings, including, but not limited to, complete concrete outlines, excavation drawings, fabrication drawings, technical specifications, etc. to a level to be issued for construction purposes;
 - **"Construction Design Phase"** – design which is undertaken during the construction phase, which may include shop drawings, assembly drawings, reinforcing schedules, and other similar documentation;
 - **"As-Built Documentation Phase"** - the details of the construction to be documented in 'as built' drawings and documentation at the completion of the works.

With respect to custom engineered and manufactured items, Detail Design Phase and Construction Design Phase reviews shall take place prior to commencement of Works.

- b. All design criteria, design statements, design calculations, computer input and output, specifications, method statements, drawings, catalogue cuts, and any other information submitted, shall be individually numbered on each sheet, indexed, collated, bound, and with summary sheets for discrete portions of the records so that adequate monitoring of revisions, modifications, and the general flow of the design process can be easily understood. Text shall include both line numbering statement of the input/output and analytical process. The Contractor shall make available, at the Employer request, any or all information upon which the Project design is based, suitably collated and indexed, including, but not limited to, the results of any survey, geotechnical and materials investigations, hydraulic and other model test results and manufacturer 's data.
- c. In order to facilitate the design review process, the Contractor shall make accommodation for full-time representatives of the Employer in any or all of the Contractor's design offices, and such representatives shall be given full and complete access to the development of design concepts, and detailed design process.
- d. Schedules of all proprietary components proposed for use in the Project shall be provided at the "Detailed Design Phase" and shall fully describe each component. The proposed use of components with poor availability and/or service support may be rejected at the sole discretion of the Employer. Where components have been specified by a proprietary brand name the Employer reserves the right to reject alternatives.
- e. **Four (4)** hard copies and an **electronic** copy of the detailed construction and fabrication drawings shall be issued to the Employer not later than **Thirty (30)** days prior to construction, fabrication or procurement of any particular aspect of the Work is commenced. The Employer will not carry out a formal review of final construction drawings, and schedules but reserves the right to require revisions where design aspects do not comply with those reviewed at the "Detailed Design Phase".
- f. When drawing up the construction schedule, the Contractor shall make adequate allowance of the **Thirty (30)** days design review period by the Employer and other authorities concerned with the design and environmental impact aspects of the Work.

2.9.3 Preliminary/Basic Design

- a. The Contractor shall, within **Sixty (60)** days, from the Commencement Date, submit general arrangement drawings showing the conceptual layout of works, hydraulic steel structure, mechanical and electrical plant and control equipment, together with commentaries giving design philosophy, construction standards, and criteria, principal design data, project procedures, quality assurance systems, and the proposed construction schedule taking into account of all clarifications offered during the Tender Stage.
- b. The Employer shall review and approve in principle or otherwise respond in accordance the requirements of Clause 27[Design by Contractor] of the Conditions of Contract. Reviews may be by section by section following discussions on particular aspects of the Contractor's proposals. Information required by Employer for the Preliminary Design Phase review shall include, not necessarily be limited to:

- **Drawings** - Site layout; general arrangements of intakes, diversion facilities, tunnels, outfall, powerhouse, transformer cavern, access roads, switchyard; single line diagrams and construction schedules.
- **Design Statements** - Overall design concept, stability and detailed design criteria for civil works, loading conditions, hydraulic design criteria, equipment and control systems for intake.
- **Project Procedures Manual** - Procedures for design, approvals, procurement, construction, scheduling, progress reports, etc.

2.9.4 Detailed Design

- a. Following the Approval in Principle to the Contractor's Preliminary Design, the Contractor shall submit detailed general arrangement drawings, specifications and calculations of all principal component parts of the Project for review by the Employer.
- b. The Contractor shall also submit a list of all the drawings and documents together with a schedule for submission of the same. The Drawings and Document list and schedule shall be updated and resubmitted at intervals throughout Detailed Design Phase review period.
- c. Drawings and documents shall be submitted in a logical sequence and in a structured manner to provide an even flow of material, and the Employer will review, comment or approve in accordance with the requirements of Clause 27 [Design by Contractor] of the Conditions of Contract.

2.9.5 Review Process

- a. The Contractor shall provide on each submittal a clear space for the Employer's review and comment.
- b. After the Employer has performed his review of submittals, the Employer will return one copy of the Contractor's Design to the Contractor with one of the following notations:
 - NO-OBJECTION
 - NO-OBJECTION EXCEPT AS NOTED
 - RETURNED FOR CORRECTIONS
 - NO-OBJECTION NOT REQUIRED

The submission of the Contractor's Documents specified in the Employer's Requirements "for review and approval" shall be interpreted as "for review and no-objection" by the Employer and Employer's "approval" or "approved" shall be interpreted as "no-objection" issued for the design and execution of Works.

- c. When submittals are returned marked with "Returned for Corrections", the Contractor shall make such revisions and/or corrections and resubmit the drawings or other material in the same manner as specified.
- d. When drawings and submittals are returned with "NO-OBJECTION", the Contractor shall issue to the Employer **Four (4) hard** copies and an **electronic** copy of the drawings.

- e. The Employer will review submittals only for conformance with the design concept of the project and for compliance with the Contract Documents. The Contractor shall make any and all corrections required or instructed by the Employer.
- f. Drawings and all supporting data, catalogues, or similar information and samples shall be prepared at the site by the Contractor in the manner and number as specified elsewhere sections of these Specifications. Affected finish work shall not be commenced until the Employer has approved the field samples, in writing.
- g. Contractor shall check the submittals of his suppliers and subcontractors, as well as his own submittals, before submitting them to the Employer. In particular, the Contractor shall ascertain that the submittals meet all requirements of the Contract, Design Drawings and Specifications and conform to all structural and space conditions.
- h. All drawings when submitted to the Employer shall be accompanied by a written statement, signed by the Contractor, that they have been checked by Contractor and have found to be in accordance with the Contract and that proper provision have been made to accommodate all abutting work.
- i. Submittals, including manufacturers' literature, catalogue cuts, or other printed material, shall be titled with the name of the project on each sheet and shall otherwise be identified by listing the particular Division, Section, Article, or reference of the Work and Contract Documents pertaining thereto. Differing items shall not be submitted on the same sheet.

2.10 PANEL OF EXPERTS

- a. In line with the international practices, a Panel of Experts may be engaged by the Employer to carry an independent review of the Project during the design, construction and the water filling. The Panel of Experts may consist of members who are appointed for their specific expertise of geo-technical, hydraulics aspects.
- b. The Contractor shall provide all required information for and make all presentations to the Panel of Experts, and answer all questions. The Employer may make additional meetings. The Contractor with its design and construction personnel shall have attendance at such meetings as necessary to fulfil his responsibilities to the Panel of Experts.
- c. The Contractor shall present any design and construction issues and recommendations, orally and in writing, at each Panel of Experts meeting. The Panel of Experts shall review the Contractor's Design, make comments, concerns, recommendations and suggestions. Any and all responses shall be in writing following the Panel of Experts meeting, with commentary relating to acceptance or rejection of the Panel of Experts recommendations.
- d. If the Contractor rejects or advocated changes to the Panel of Experts recommendations, the Contractor is to provide in its response the technical reasons for such rejection or change.
- e. The recommendations of the Panel of Experts and/or the Contractor shall be subject to review and approval of the Employer.

2.11 DESIGN MEETINGS

2.11.1 General

- a. The Contractor shall, in close liaison the Employer administer:
 - Pre-design meeting
 - Design progress meetings
 - And specially called meetings throughout the progress of the Work. In addition, the Employer may call extraordinary meetings as necessary. Predesign, Preconstruction, Progress meetings shall be held during both the design and construction phases on a schedule acceptable to the Employer.
- b. The Contractor shall:
 - Prepare agenda for meetings. Proposed agenda for all meetings shall be submitted to the Employer at least 3 days prior to each meeting.
 - Distribute written notice of each meeting **Seven (7)** days in advance of meeting date.
 - Make physical arrangements for meetings.
 - Make detailed graphically supported presentations regarding the status of the Work.
 - Employer will attend and preside at meetings to monitor progress of the Work and will confirm and sign off the minutes before they are distributed.
 - The Contractor shall reproduce and distribute copies of minutes signed by the Employer within 3 days after each meeting.
 - to all participants in the meeting.
 - to all parties affected by decisions made at the meeting.
 - Furnish 3 additional copies of minutes to Employer including one digital copy
 - Representatives attending the meeting from the Contractor, the Contractor's design engineer, subcontractors and suppliers shall be qualified and authorized to act on behalf of the entity each represents.

2.11.2 Pre-Design Meeting

- a. The pre-design meeting agenda shall include, but not be limited to:
 - Distribution and review of design progress schedule.
 - Proposed additional investigations.
 - Contacts with regulatory agencies.
 - Equipment supply contract.
 - Procedure for submittal and review of design documents.
 - Quality assurance procedures.
 - Project Configuration
 - Technical Matters

2.11.3 Design Progress Meetings

- a. The design progress meeting's agenda shall include, but not be limited to:
 - Review and approval of previous meeting minutes.
 - Review of progress since previous meetings.

- Status of submittals and approvals
- Problems which impede design progress schedule.
- Corrective measures to regain projected progress schedule.
- Revisions to progress schedule.
- Proposed progress during succeeding work period.
- Status of reviews by regulatory agencies.
- Status of Equipment supply contract.

2.12 INSTRUCTION AND OPERATION & MAINTENANCE MANUALS AND AS-BUILT DRAWINGS

2.12.1 General

- a. The Contractor's obligations shall include the provision of complete sets of design reports, manuals comprising operating instructions, maintenance instructions and parts manuals, and As-Built drawings.
- b. The document numbering system instituted shall be extended to the numbering of all manuals and other documents produced in respect of operation and maintenance. The Contractor shall arrange that uniform presentation, terminology, and style is adopted by all Contractors, Sub-contractors and Suppliers.
- c. Colour coding shall be used to differentiate between different types of documents and, where appropriate, between documents prepared by different Contractors Sub-contractors and Suppliers.

2.12.2 Instruction and Operation & Maintenance Manuals

- a. Instruction and Operation & Maintenance Manuals shall describe the complete Works and shall give a step-by-step procedure for any operation likely to be carried out during the life of the Works, including identification, erection, setting to work, testing, commissioning, operation, maintenance, dismantling, repair, adjustment and re-assembly of all parts of the Works. The greatest importance shall be attached to completeness and presentation.
- b. The manuals shall comprise separate comprehensive documents for operating instructions, maintenance instructions, and spare parts. One section of the manual shall contain breakdown details of prices for spare parts.

2.12.3 As-Built Drawings

- a. As-Built Drawings shall cover all aspects the Works as completed, incorporating all modifications carried out during manufacture or after, by the Contractor or its Sub-contractors or Suppliers and all actions carried out in the course of the erection, testing and commissioning of Plant and the construction of the works.
- b. These As-Built drawings may be produced by drawings produced for the manufacture and/or construction or may be produced separately. All As-Built drawings shall be prepared using the latest release of and a licensed copy of the software, which shall be provided to the Employer.

- c. The As-Built drawings shall include all those provided by the Contractor, together with drawings submitted by the Contractor at time of Tender, as appropriate.
- d. The Contractor shall be responsible for ensuring that all As-Built Drawings are correct reflect the 'As-Built' condition. The Contractor shall endorse and certify all the As-Built Drawings and Documents to confirm that the As-Built Drawings and Documents have been checked for their accuracy and to the 'As-Built' condition.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 3
HEALTH AND SAFETY

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CHAPTER 3: HEALTH AND SAFETY

3.1 GENERAL REQUIREMENTS

- a. This section comprises the Employer's minimum general health and safety requirements that, in accordance with Clause 28 [*Safety, Security and Protection of the Environment*] of the Conditions of Contract, shall be observed by the Contractor at all times, with a very high degree of diligence and care.
- b. All security, safety measures and health controls necessary for the execution of the Works such as safe working practices, sanitary arrangements, land clearing of the Site, handling and storage of explosives and fuel, temporary fencing, lighting, safety precautions and fire prevention in accordance with the requirements of ISO 18000 standard and all relevant Nepal Regulations shall be established and maintained by the Contractor throughout the period of the Contract.
- c. The Contractor shall be responsible for all security, safety measures and health controls and shall provide personnel, equipment necessary to accomplish them. The Contractor shall take full responsibility for the prevention of unhealthy or unsafe conditions and practices and for the promotion, implementation and control of healthy and safe working procedures and practices for all phases of the Work and shall provide a safe working environment for its employees, employees of Subcontractors, visitors, and Employer's personnel at its own cost.
- d. All requirement specified herein shall relieve the Contractor of any obligation or responsibility in this regard. The Employer shall not be obliged to attend inspections of work areas if the required or approved safety measures have not been implemented and such works shall not proceed. Any delay to the Works so caused shall be the full responsibility of the Contractor.
- e. The Contractor shall also provide security to the site so that the health and safety of the public is not compromised. The Contractor shall institute and operate an effective security system on a 24 hour/day basis at all the areas comprising the Site. He shall cooperate with the local Police and comply with the Employer's requirements on all matters relating to Security of the Works and persons entering the Site. Such a system shall include appropriate identification procedures for all persons, vehicles, etc. entering and leaving to the site. In addition, a particular identification system and emergency evacuation procedure shall be established for all underground works.
- f. The Employer shall have the right to request the Contractor to upgrade the operation of the approved security programme and system under Health and Safety Management Plan whenever this is deemed necessary by the Employer
- g. The Contractor shall carry out the Works in a safe, workmanlike manner, in accordance with good working practice to a recognized code of practice and in compliance with requirements set out in the Contract. Tunnelling works shall, at a minimum, comply with the requirements of the International Tunnelling Association (ITA) - Guidelines for Good Tunnelling Practice, Good Industry Practice and any applicable standards.
- h. Approved Personal Protective Equipment (PPE) shall be worn by all persons at all times whilst on the Works. Suitable clothing, high-visibility reflective vests, footwear, helmets, cap lamps, waterproofs, safety glasses, ear protectors, gloves, goggles,

harnesses, breathing apparatus, etc. appropriate to the work being undertaken, shall be provided to and worn by all workmen. The workmen shall be trained in the use of all such equipment before entering working areas.

- i. The Contractor shall submit the Health and Safety Management Plan for security, safety, health, etc. as required here into the Employer for review and approval within Ninety (90) days from the Commencement Date. The Employer's notification of no-objection of the Health and Safety Management Plan shall not relieve the Contractor in any way from his responsibilities in this regard.
- j. In accordance with Clause 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract, the Contractor shall establish a security control system and its organizations for the Works.

3.2 HEALTH AND SAFETY POLICY

- a. The Contractor shall, in the form of a Health and Safety Policy Statement, state his target, commitment and strategy with regard to safety on the Project.
- b. The Health and Safety Policy Statement shall be signed by the Contractor's Representative.
- c. The Health and Safety Policy Statement shall be displayed in a prominent position within the Contractor's offices on each worksite.
- d. The Contractor shall implement the health and safety policy, which shall be in force throughout the duration of the Contract. Without in any way limiting the Contractor's responsibility for health and safety, for the purpose of implementing the health and safety policy, the Contractor shall prepare a Site Health and Safety Manual, in accordance with Clause 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract. The Contractor shall also constitute a duly empowered committee designated as the Health and Safety Committee, which shall convene monthly.
- e. The Health and Safety Committee and which shall include, but not be limited to following personnels:
 - The Safety Officer (accident prevention officer in accordance with 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract) and his deputy who shall be fully engaged for health and safety aspects of the project;
 - Representatives of supervisory staff; and
 - Representatives of the various categories of workmen.
- f. The arrangements for implementing the health and safety policy shall be not less than those required by the Laws and Regulations of Nepal and will include, but not be limited to:
 - The duties of the Safety Officer and his Deputy;
 - Implementation and monitoring of compliance with the Site Safety Manual and updating of its contents as deemed necessary;
 - Notification, investigation and recording of accidents;

- Codes of practice to be used to ensure healthy and safe working conditions and the management of hazardous conditions;
 - The arrangements for the frequency and occasions of routine and special meetings of the Health and Safety Committee, the keeping of records, rights and access to information; and
 - The arrangements for disseminating information, training and supervision to ensure the codes of practice are conformed with.
- g. The code of practice shall be based on a recognised international standard and shall be of no less a standard than that of ILO Code of Practice "Safety and Health in Construction" (1992) and the training manual "Safety, Health and Welfare on Construction Sites" (1995) of the International Labour Office (Geneva) and shall encompass the Laws and Regulations of the Nepal.

3.3 PROJECT HEALTH AND SAFETY MANUAL

- a. The Contractor shall submit for Employer's Review and Approval, a Health & Safety Manual (the Project Health and Safety Manual), which shall address the matters described in this Chapter 3. The Plan shall be based on International Labour Organization (ILO) requirements for Occupational Safety and Health (OSH) and ensure compliance with safety regulations commensurate with the hazardous nature of the Work.
- b. The Health and Safety Manual complete with the Workspace and Adjacent Space Risk Assessment shall be submitted within Ninety (90) days from the Commencement Date and, if necessary, amendments shall be made to the booklet to satisfaction of the Employer. The Contractor shall issue the booklet immediately after approval as required herein and ensure that all employees are fully conversant with the instructions.
- c. The Contractor shall prepare and issue to all of his employees, those of his Subcontractors and Employer's staff a booklet on safety precautions based on good work practice, printed in English and Nepalese, and be of the type and size after notification of approval by the Employer.
- d. Each Health and Safety Document shall:
- incorporate any directions or requirements from the Employer, including those in respect of the earlier draft of that Health & Safety Document;
 - address health and safety subjects in greater depth where working methods and sequences have been developed or changed since the previous draft of the Health & Safety Document; and
 - Identify Works, by area or subject and the persons responsible for supervising those on Site.
- e. Only after notification of no-objection by the Employer, the Project Health & Safety Manual shall become effective, for the purposes of this Contract.
- f. The Contractor shall manage in accordance with the Project Health and Safety Manual and shall review and update the manual on a regular basis at the own cost,

with the Employer's Review and Approval, or as instructed by the Employer in order to ensure that the plan continues to give guidance during the life of the Contract,

- g. The Employer may monitor and review the Contractor's health and safety performance and may undertake formal safety audits of the Contractor's performance.
- h. Non-compliance with the health and safety Laws shall be considered a major contract default.

3.4 SAFETY PROCEDURES

- a) The Contractor shall include in the Project Health and Safety Manual a dedicated assessment for all Workspace or adjacent space lurking risks and, based on said assessment, shall take all necessary precautions against risks of injury or loss of life to any person employed on the Works or to employees of the Employer or to visitors or to persons having good and sufficient reasons to be around the Works, and to this end he shall properly safeguard the Works to the satisfaction of the Employer.
- b) The Contractor shall furthermore take all necessary precautions against damage to the property of the Employer or of others located at or adjacent to the Site.
- c) The Contractor shall all times comply with any accident prevention regulations and any safety regulations applicable to the various trades employed on the Works, and any safety regulations published by the Government of Nepal.
- d) The Contractor shall develop and update as necessary a set of safety procedures that shall be submitted for the Employer's Review and approval.
- e) The procedures shall include the necessary forms to be completed for various events. The procedures shall include, but not be limited to:
 - ◆ immediate reporting and formal investigation and reporting of accidents;
 - ◆ immediate reporting and formal investigation of dangerous occurrences;
 - ◆ the emergency evacuation of worksites, in particular underground works and deep excavations;
 - ◆ the storage of Materials, in particular, explosives, chemicals, flammable materials and gas bottles;
 - ◆ the transport of Materials, in particular explosives, gas bottles and large or heavy materials;
 - ◆ the use of Materials, in particular those that may cause injury, illness or require special PPE;
 - ◆ the use of PPE;
 - ◆ working at height;
 - ◆ working in a confined space;
 - ◆ the use, maintenance and storage of lifting equipment;
 - ◆ electrical, systems and appliances;
 - ◆ Permits to work;
 - ◆ safety training and task training;

- ◆ the operation of a powerhouse and switchyard;
 - ◆ fire prevention and firefighting;
 - ◆ health, welfare and hygiene; and
 - ◆ security and access and access control through means of identification cards, site passes, security checks, booking systems etc.
- f) The procedures shall be developed and updated as the Contract progresses for the Employer's Review and Approval. The procedures shall be transmitted to the workforce during safety inductions, tool box talks, safety presentations, method statements and supervisors' instructions. Safety instructions shall deal with all safety measures including but not limited to the following:
- ◆ Use of safety wears (PPE) such as protective clothing, helmet and footwear,
 - ◆ Use of lifting equipment,
 - ◆ Precaution against electrical shock,
 - ◆ Welding,
 - ◆ Routine procedure in case of accidents, fires, etc.,
 - ◆ Watchmen, warning notices and barriers,
 - ◆ Use of drilling equipment, and dust suppression,
 - ◆ Use and storage of explosives and blasting rule,
 - ◆ Tunnelling practices and
 - ◆ Usage, storage and handling of any other hazardous material

3.5 GENERAL RULES AND APPLICABLE LAWS

- a) The Contractor (including its employees, subcontractors or manufacturers) must fully comply with, and establish an efficient management to put in practice, all Laws, relevant general rules and specific procedures relating to health, safety and environmental issues (as amended from time to time by the relevant authority). The Contractor must also comply with all written and verbal instructions (later confirmed in writing) given by the Employer or by the relevant Governmental Agency during the Works if they are in accordance with Law and/or the Health and Safety Plan.
- b) For the purposes of the Project Health and Safety Plan, a reference to the Contractor includes its employees, subcontractors, subcontractors' employees, advisors, consultants, vendors, suppliers and visitors or any other person or entity which is in relation with the Contractor.
- c) The Project Health and Safety Manual shall be applicable for any facility and premises of the Works.
- d) The Project Health and Safety Manual may be amended by agreement between the Employer and the Contractor if operational circumstances, or risks of accident so require, so as to comply with all applicable Laws and Good Industry Practice. All amendments will be notified by the Contractor to the Employer and the Contractor must comply with these amendments at its own cost.

- e) All communications, permitting, applications, etc., to or with Government Agency and/or their representatives must be notified and approved beforehand by the Employer.
- f) The Project Health and Safety Manual, the Project Health and Safety Plan as well as any health and safety document (including their drafts) must demonstrate and specifically deal with all applicable Laws, regulations, codes, rules and any amendments thereto, including, but are not limited to:
 - ◆ Labour Act, 1992
 - ◆ Labour Rules, 1993
 - ◆ Labour and Employment Policy, 2062
 - ◆ Bonded Labour Prohibition Act, 2002
 - ◆ Child Labour (Prohibition and Regulation) Rules, 2006
 - ◆ Nepal Labour Act, 2074
 - ◆ The Nepal Electricity Act, 1992
 - ◆ The Electricity Rules, 1993
 - ◆ Fire Services Rules and Regulations
 - ◆ Building Regulations and Codes
 - ◆ Work Permit Requirement (Immigration Department Requirement) for foreign workers;
 - ◆ The Health and Safety Act 1974 (UK);
 - ◆ The Health and Safety at Work Act 1975 (USA);
 - ◆ The International Finance Corporation (IFC) Environmental, Health and Safety Guidelines, 2007; and
 - ◆ The Safeguards Policy Statement (2009) and the Social Protection Strategy (2001) published by the Asian Development Bank.

3.5.1 Project Health and Safety Plan

- a) Without limiting any other provision of the Contract (including Clauses 28 Safety, Security, and protection of the Environment] of the Conditions of Contract, the Project Health and Safety Plan must meet the requirements of Good Industry Practice, all applicable Laws, rules, regulations, international norms or procedures as well as all of the obligations of the Contractor under the Contract, and shall systematically address all aspects of the Work engaged.
- b) The Project Health and Safety Plan must itemise the specific plans and programs to set out in an agreement with the health and safety requirements. The Project Health and Safety Plan may be a collection of documents and manuals (for example: emergency plans, training manuals, data sheets, etc.).
- c) The Contractor shall fulfil and comply with the Project Health and Safety Plan.
- d) The Employer and or the Contractor's Health and Safety Department has the right to stop any work, if there is imminent danger to him or others, if the person stopping the work honestly believes that the work being done is unsafe.
- e) Without limiting 28[Safety, Security and Protection of the Environment] of the Conditions of Contract, the Project Health and Safety Plan including Health and Safety

personnel once accepted must not be changed without prior consultation with and acceptance by the Employer.

- f) All personnel of the Contractor and any subcontractor must receive training and induction by the Contractor on the Project Health and Safety Plan to ensure that all personnel are aware of the requirements that pertain to their job functions.
- g) The Project Health and Safety Plan shall demonstrate that the management and commitment of the Contractor for health and safety is an integral part of Contractor's management process and will be established in a planned, systematic and documented manner.
- h) The Project Health and Safety Plan shall cover and detail the following health and safety requirements as a minimum in order to comply with all applicable Laws, standards, norms or regulations and Good Industry Practice:
 - The Contractor's health and safety Policy Statement;
 - The Contractor's Organization Chart;
 - The Organization Chart of the health and safety Area;
 - Health and Safety Sanctions
 - Medical examinations;
 - Induction Program, training and skill building;
 - Objectives and goals and performance indicators;
 - Definition of Health and Safety roles and responsibilities for each position occupied by persons in the Contractor's organization;
 - Applicable standards, law and guidelines to be adopted;
 - Governmental permits, approvals and licenses for the Project;
 - Issue of a Health and Safety Hand book guide to all personnel;
 - Work program for the Worker-Management Joint Health and Safety Committee;
 - Risk identification, analysis and control;
 - Behavior observation program (safe and at risk behaviors), which must have the minimum requirement of workers for the development of such a program;
 - Implementation Program to control High Risk activities;
 - Personalized program of Health and Safety activities for Contractor's front line Supervisors visiting the site as well as for, the Management Health and Safety staff visiting the construction site;
 - Occupational Health Program, including respiratory tract and hearing protection, hygiene, alcohol and drugs, health and physical condition, protection from sunlight, restriction of smoking, asbestos, first aid and access to medical treatment, lighting, vibrations, etc.;
 - Monitoring of the exposure of workers to noise, dust and other potentially hazardous pollution or substances;
 - Accident/Incident investigation and reports;
 - Health & Safety record-keeping;
 - Internal and external audits;
 - Those persons within the Contractor's parent and Site organisations who will be responsible for coordinating and monitoring the Contractor's health and safety

- performance on Site and reporting these matters to the Contractor's board of directors;
- The proposed level of Site safety surveillance together with the nomination of safety supervisors and a safety officer who will have an overview of all Site safety matters. The responsibilities, qualifications, training and experience of those nominated shall be specified;
 - The Contractor's procedures for reporting and investigating accidents, dangerous occurrences and occupational illness;
 - The Contractor's procedures for identifying hazards, assessing risk and eliminating potential site hazards. Reference shall also be made to mitigating measures which include procedures for the identification of the need for and the provision of personal protective equipment (PPE), permits systems, safety rules and safety training;
 - Safety procedures for working with major items of plant such as, excavators, overhead cranes, tunnelling equipment, etc.;
 - The Contractor's procedures for assessing the suitability of Sub-contractors with respect to health and safety; and
 - The Contractor's procedures for ensuring that his personnel are medically fit for tasks they are carrying out. The procedures shall take into account working hours and environment.
- i) The Project Health and Safety Plan must also address as a minimum the following matters which are exposed in more detail in the following sub-sections:
- Safety during construction;
 - Personal protective equipment;
 - Areas and zones;
 - Health and Safety Induction;
 - Health and Safety Inspections;
 - Health and Safety Audits;
 - Radioactive Sources;
 - Job Safety Analysis (JSA) Requirement;
 - Excavations;
 - Work Permits;
 - Emergency Response Plan;
 - Evacuation Training;
 - Emergency Equipment.

3.6 SAFETY DURING CONSTRUCTION

3.6.1 General

- a. The Contractor shall advise the Employer of all accidents, occurrences or incidents in a format to be agreed prior to the commencement of work on Site.
- b. The Contractor shall keep at the Site offices an accident report book and maintain proper records therein. The accident report book shall be available for inspection at all reasonable times by the Employer. The Contractor must communicate all serious incidents to its workers.

3.6.2 Electricity

- a. The Contractor shall give at least Fifteen (15) working days' notice to the relevant electricity company with a copy of the notice to the Employer, before starting any work under any overhead lines, with consideration given to the possible revision to the route of the Works or method, to avoid Works under power lines. This is to be subject to the agreement of the Employer which shall not be unreasonably withheld. If this option is not viable then investigation into the possible temporary disconnection of electricity supply should be investigated. If this option is not viable then provision should be made to ensure that all equipment that can extend to exceed the safe working headroom is fitted with limiters that will provide safe working headroom or other alternatives shall be investigated.

3.6.3 Health and Safety Reporting

- a. The Contractor shall provide the following information on a weekly and monthly basis as part of the weekly and monthly progress reports (required under Clause 24[Site Data and Reports] of the Conditions of Contract):
 - number of hours actually worked;
 - number working days lost due to injury;
 - number and nature of lost time injuries;
 - accident frequency & accident severity;
 - number and nature of near misses;
 - current status of any injured personnel, damaged property or environmental damage;
 - status of the implementation and outcomes of corrective actions undertaken as a result of health & safety inspections, risk assessments, lost time injuries and near misses; and
 - status of OHS management system audits undertaken and audit reports.
- b. The Contractor shall report all accidents and incidents to the Employer as soon as any accident or incident occurs followed by a formal accident/incident investigation report in a format acceptable to the Employer within 24 hours of any accident or incident occurring. More detailed reports may be required by the Employer depending on the nature of the accident/incident.

3.6.4 Health and Safety Procedures

- a. The Contractor shall develop and update as necessary a set of safety procedures that shall be submitted for Employer's Review and Approval. The procedures shall include the necessary forms to be completed for various events.
- b. The procedures shall be developed and updated as the Contract progresses for Employer's Review and Approval.
- c. The procedures shall be transmitted to the workforce during safety inductions, tool box talks, safety presentations, and method statements and supervisors' instructions.
- d. The Contractor shall develop and update as necessary specific procedures as a minimum for the following non-exhaustive items:

- Driving and maintenance of light vehicles;
- Inspection, operation and maintenance of equipment and machinery;
- Lock-out/tag-out of equipment and machinery;
- Electrical wiring, cables and extension cords;
- Handling of hazardous materials;
- Elevated work;
- Rigging and lifting maneuvers, lifting equipment, the use, maintenance and storage of
- Excavations and trenches;
- Confined spaces;
- Internal Health and Safety Work permits;
- Hot work;
- Assembly and disassembly of scaffolding;
- Reinforcing steel work and concrete forms;
- Erection work;
- Use of hand tools;
- Use of and inspection of electrical tools, electrical, systems and appliances;
- Use of personal protective equipment;
- Safe commissioning procedures;
- Operation, transportation and storage of radioactive equipment;
- Work instruction sheets;
- Handling of wastes and residues;
- Findings of archeological remains;
- Handling of used oil and oil filters;
- Handling of fuels;
- Handling of concrete remains and debris;
- Prevention and control of spills (Solids and liquids);
- Environmental closure and jobsite demobilization;
- Control of particulate matter;
- Supply and consumption of potable water;
- Supply and maintenance of chemical toilets;
- Use of elevated work platforms suspended from cranes (e.g., work baskets and work buckets);
- Work safety risk analysis;
- Ladders and stairs;
- Use of explosives;
- Surface drilling;
- Underground Emergencies;
- Underground Drilling;
- Underground Loading of explosives;
- Underground Scaling;
- Underground Rock bolting (mechanical, resin, concrete, etc.);
- Underground Reinforcement with Shotcrete;
- Underground Surveying;
- Underground marking of the face;
- Underground mucking of the face;

- Underground Blasting;
- Surface Blasting;
- Blasting tools;
- Cutting tools;
- Sandblasting;
- Flushing;
- Fire prevention;
- Work surfaces;
- Transportation of personnel;
- Communications of policies;
- Change Management
- First aid;
- Emergencies, the emergency evacuation of worksites, in particular underground works and deep excavations;
- Immediate reporting and formal investigation of accidents;
- Safety training and task training; and
- Interruption of traffic (including its management);
- Temporary facilities and/or construction camp (including handling potable water, toilets, cleaning, refrigeration, air-conditioning; smoke detectors etc.);
- The Contractor's safety proposals for compressed air working;
- An outline program for safety tours and detailed safety inspections.

3.7 PERSONAL PROTECTIVE EQUIPMENT

- a. The Contractor's shall provide training and enforce the use of personal protective equipment (PPE) and related compliance with international or official Nepalese standards on Health and Safety for regulation of protective equipment.
- b. Notwithstanding the aforesaid, the Works may require the use of other specific types of personal protective equipment for certain works in accordance with the corresponding risk analysis done by the Contractor.
- c. The Contractor shall provide free of charge and maintain in good condition, to all of its personnel, its Sub-contractor's personnel, as well as the Employer's Personnel and Visitor's where applicable by law, the following personal protective equipment:
 - High visibility, reflective vest or shirt
 - Safety helmet and Miner's Safety helmet only for underground personnel
 - Safety footwear (Rubber or leather Boots or Shoes with protective steel toe caps and steel sole inserts, or FRP toe for electricians)
 - Ear Protectors
 - Dust Masks
 - Safety gloves (in accordance with the activities to be performed)
 - Respirators with filters, in accordance with the pollutants existing at the jobsite (when applicable)
 - Self-rescuers for all workers underground or alternatively provision in a container box close to the working faces and along the tunnels or as otherwise agreed.
 - Safety goggles with UV and impact protection (dark lenses for daytime use)

- Work suit or work clothes.
- Two-piece rubber suit for underground tunnelling
- Sun block protection for all surface workers exposed to daily UV radiation
- All personal protective equipment shall be of an 'Approved Standard', which for the purpose of this section, shall mean "CE" marked in accordance with the requirements of the amended Personal Protective Equipment Regulations 2002 of the United Kingdom or equivalent standard.
- Exposure to hand/arm vibration or whole body vibration is to be controlled by the choice of equipment, installation of dampening pads or devices, and by limiting the duration of exposure. Limits for vibration, duration and the action values shall be in accordance with ACGIH (2005).
- The use of chemical hazards shall be minimised by the use of alternative materials or by the implementation of measures to avoid or control their use and release into the working environment. Where chemical hazards or irritant or toxic substances may come in contact with the skin or clothing, the Contractor's personnel shall be provided with and wear appropriate protective clothing, gloves, aprons, splash suits, face shields, goggles, etc.
- Contractor's personnel involved with welding or hot-work shall be provided with and wear appropriate protective clothing, gloves, welder goggles, etc. A welding/hot-work permit system shall be implemented and enforced.
- Contractor's personnel working on steep slopes or otherwise subject to possible falls from height shall be subject to fall prevention/protection measures, which include the installation of guardrails, mid-rails and toe boards; proper use and training in the use of scaffolding and ladders; and the use of full body safety harness with shock absorbing lanyards, restraints or lifelines.
- Types of contracts or activities (such as office administrative personnel etc.) may exist that generally do not require the use of some or all of the aforesaid personal protective equipment. In such cases, the exemption from any use of PPE in the un-hazardous working areas must be notified by the Contractor complete with the list of un-hazardous working areas and approved by the Employer. Said personnel is anyway obliged to wear personal protective equipment (PPE) when leaving the un-hazardous working areas. Personal protective equipment must always be kept in good working condition and replaced when necessary.
- If the Contractor fails to provide such Personnel Protective Equipment, the Employer shall be entitled to provide the same and recover any and all costs from the Contractor.

3.8 AREAS AND ZONES

- a. At the start of any job or work, all Contractors must familiarize themselves with the hazards and risks present in each area, zone or workplace involved and perform a risk analysis.
- b. If the Employer requests the Contractor, the Contractor shall, to the satisfaction of the Employer, erect, maintain and remove on completion of the Works at his own expense suitable and approved temporary fencing to enclose such areas of the Works to be carried out and all areas of land occupied by the Contractor within the Site as may be

necessary to implement his obligations as specified in 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract.

- c. The Contractor must install hard protections or fences or equivalent at jobsites and workplaces whenever working in excavations, limiting lifting maneuvers, and work at heights.
- d. Contractor and Contractor's sub-contractor's personnel may only travel through or enter those specifically authorized areas and zones by the Employer and for the purpose of the Project.
- e. All work that the Contractor is to perform in an area other than the Construction Site designated by contract must be coordinated by the Employer's Construction Site Technical and Health and Safety Supervision.

3.9 HEALTH AND SAFETY INDUCTION

- a. Health and Safety Induction is the formal presentation, in the form of a course of study, of the Health and Safety practices and procedures that must be honored and obeyed by all employees of all the Contractors, Sub-Contractors and Suppliers working on the Project.
- b. The Contractor must impart to all the Contractor's employees and employees of its Sub-Contractors, a formal Health and Safety Induction process. These courses shall be imparted by Contractor personnel or by such third parties as as designated by the Contractor and constitute a prerequisite for access to the project premises. Compliance with this obligation must be accredited by Contractor, by means of exhibiting and submitting the related attendance records, and proof of mark (test result), that are to be issued for each Health and Safety Induction.

3.10 HEALTH AND SAFETY INSPECTIONS

- a. At least one person of the Contractor Management Team shall make at least one inspection per week in which Contractor shall check on the state of the construction work and report thereon to the Employer. The Employer, acting alone or jointly with the Contractor, may also inspect the construction works at any time.
- b. All substandard conditions detected during these inspections shall be documented and informed to the Employer, and corrected as soon as possible or by specific deadline set by the Contractor, which shall be recorded in the inspection format used for each inspection.

3.11 HEALTH AND SAFETY AUDITS

- a. The Employer will perform at least two Health, Safety and Environmental (HSE) audits per year on the Contractor.
- b. The first audit will be performed any time after the first 180 days from the start of construction in the field or whenever the Employer deems appropriate.
- c. All nonconformities found during the conduct of these audits shall be documented and corrected as soon as possible or by a reasonable deadline set by the Employer, which

shall be recorded in a memorandum drawn up for such purposes at the time of each audit.

- d. The auditing process will be aimed at determining the degree of adequate compliance with the performance standards and requirements defined and set out in the "Health and Safety Plan", Applicable work procedures, and a Compilation of all relevant Nepalese regulations and relevant international practices.

3.12 RADIOACTIVE SOURCES

- a. The Contractor shall maintain up-to-date records of people and sources, to ascertain that valid permits and authorizations for the movement, installation and handling of radiation sources in accordance with current standards and law, are in place at all times.
- b. The Contractor, prior to any movement, installation or handling of each radioactive source, shall submit to the Employer copies of all permits issued by the authority or agency having jurisdiction.

3.13 JOB SAFETY ANALYSIS (JSA) REQUIREMENT

- a. For all critical work to be performed, the Contractor shall elaborate a documented Job Safety Analysis before starting the work.
- b. If the work must continue into the night or as conditions change, the changes involved must be noted as a step or stage. The risks associated with working at night must be specified, and the related risk controls must be implemented.
- c. The JSA can be amended during the work shift by attaching an appendix to the original JSA and identifying the changes.
- d. During the development of the JSA, the employees who are to participate in the work must be informed accordingly.
- e. Contractor's Supervisor including the workers involved, are to complete the Job Safety Analysis (JSA), and sign the completed sheet.
- f. The Contractor is responsible for completing the JSA forms, for using the process to identify the steps, the evaluations and control and for giving the approval prior to the start of work.

3.14 EXCAVATIONS

- a. Without limiting any obligation under the Contract, the Contractor, when undertaking excavation works shall comply with the relevant laws, regulations, rules and codes of practice applicable to such excavation works.
- b. Before proceeding with excavations or trenches, the Contractor shall investigate and establish if any of the following exist in the ground:
 - Buried or underground pipelines.
 - Components of cathodic protection systems, grounding grids, etc.

- Sewer pipes and conduits.
- Buried electric cables.
- Overhead electric lines

3.15 INTERNAL HEALTH AND SAFETY WORK PERMITS

- a. Internal Health and Safety Work permits consist of a system designed to protect workers, the environment and property. The following types of work permits will be applicable at the Project and shall be considered in their respective procedures.
 - Heavy lifts and lifts in tandem
 - Entry into confined spaces
 - Hot work
 - Energizing of electrical equipment
 - Work at heights
 - Handling of radioactive material and work with radiography and gamma radiography
 - Other specific activities as determined by the Project Health and Safety Team.

3.16 EMERGENCY RESPONSE PLAN

- a. The Contractor shall, within 120 days from the date of issue of the Notice to Commence, submit for approval a comprehensive Emergency Response Plan, in accordance with the general requirements of the "Performance Standards on Social & Environmental Sustainability, Performance Standard 3" published by the International Finance Corporation.
- b. The Emergency Response Plan shall be revised and/or updated as necessary, or, without relieving the Contractor of any of his obligations or responsibilities, as instructed by the Employer. Revisions and/or updates of the Emergency Response Plan shall be submitted as required.
- c. The Emergency Response Plan shall detail procedures and plans which the Contractor intends to implement, and shall demonstrate that the Contractor has the facilities and personnel required to implement the approved Emergency Response Plan.
- d. The emergency response plan shall cover, but not be limited to the following:
 - Medical emergencies
 - Rescue procedures
 - Evacuation procedures, (medical, civil unrest, etc.)
 - Fire and fire fighting
 - Hazardous materials
 - Biological hazards
 - Radiological hazards
 - Natural disasters,
 - Epidemics
 - Pollution prevention (from any source)
 - Waste

- Cofferdam overtopping
- Collapse of tunnels and underground excavations

And shall include:

- Procedures for immediate actions;
 - Procedures for reporting incidents to the Employer, the local and national authorities and health authorities
 - Complete list of equipment available for use in emergency situations.
 - Procedures for informing neighbours and downstream users in cases of release of hazardous substances and/or pollutants
 - Procedures for reporting irregular events.
 - Procedures for dealing with the instance/s
 - Program for training of key staff in emergency responses. The training will be based on various emergency scenarios.
- e. The Contractor is responsible for the proper instruction and training of Contractor's personnel according to the Emergency Response Plan, for those Events and or Circumstances as identified in the Health and Safety Plan, in their respective Contractor's area and for being integrated and coordinated with the Employer's Emergency Response Plan.
- f. The Contractor has the ultimate responsibility in case of an emergency for properly stopping the construction activities at the affected areas and under Contractor's supervision, the subsequent evacuation to Emergency Meeting Points (EMP) and the performance of headcounts of personnel following the evacuation, and the submission of the related notes to the person in charge of the emergency situation.

3.17 EVACUATION TRAINING

- a. The Contractor shall carry out with the Employer, emergency drills for purposes of training as frequently as specified as the corresponding Emergency Response Plan.
- b. The Contractor must provide support for the preparation and execution of the evacuation training that will be of use for the safety of all employees.

3.18 EMERGENCY EQUIPMENT

- a. Emergency equipment consists of the key equipment for the prevention, detection, mitigation, recovery and rescue associated with emergency and includes personal protective equipment and other safety equipment related with the areas and types of work performed by the Contractor.
- b. The Contractor must ensure that all emergency equipment is regularly tested, and that it is always in working condition and its personnel is trained and, whenever required, certified in the use of that equipment.

3.19 REPLACEMENT OF UNSATISFACTORY WORKERS

- a. The Contractor shall remove immediately any of the Contractor's workers if after the corresponding investigation is evident that such worker does not meet the

requirements or the necessary skills, his conduct is harmful for the performance of the Works or commits acts that are against his own safety or the safety of other workers.

3.20 CONTRACTOR'S STAFF AND PERSONNEL OBLIGATIONS

3.20.1 List of Intolerable Acts and Omissions

- a. The following is a non-exhaustive list of acts and omissions that are not tolerable and shall not be done and will lead to the application of Contractor's Health and Safety Sanctions Procedure:
- non-reporting of any accidents or injuries;
 - non-use of the safety harness and fall arrest systems when working at heights;
 - being in an unauthorized or restricted area without authorization;
 - not obeying Health & Safety lock-out procedures for personnel & equipment;
 - overriding, removing or elimination of safety devices;
 - using lifting equipment beyond the range of their design criteria;
 - operating or working on equipment without authorization and appropriate certification;
 - being on the construction site or working under the influence of alcohol, drugs or prohibited substances;
 - being located underneath suspended loads;
 - not using basic Personnel Protective Equipment (PPE); and
 - handling of hazardous material by unauthorized personnel.

3.20.2 Delegation

- a. The Contractor may delegate the Contractor's authority and obligations, to other members of the Contractor's organization. Such delegates shall be identified (name, position, items under delegate's responsibility) on a detailed list that shall be submitted to the Employer prior to the start of the Contractor's Site mobilization.

3.20.3 Roster of Workers

- a. The Contractor shall maintain at the Site, an up-to-date roster (list) of all of the Contractor's workers with the following information for each individual:
- name;
 - identification card number;
 - age;
 - position or job assigned;
 - starting date;
 - area where working; and
 - induction training course certificate.

3.20.4 Co-ordination of Staff

- a. The Contractor is required to coordinate the participation of the Health and Safety staff of the Employer, in all agreed joint inspections to be made by the Contractor and Subcontractors to their respective working areas.

- b. The Contractor shall hold regular safety meetings at least once every month with his construction supervisors and foremen, and those of his Subcontractors. When directed by the Employer, additional meetings shall be held. The Contractor shall keep the Employer informed as to when these meetings are to be held and shall provide the Employer with a copy of the proposed agenda. The Employer reserves the right to attend any of the meetings.

3.20.5 Safety Specialist – Accident Prevention Officer / Safety Officer

- a. a. In accordance with Clause 28 [Safety, Security and Protection of the Environment] of the Conditions of Contract, as part of the Contractor's safety policy, the Contractor shall appoint a Safety Specialist/Accident Prevention Officer according to International Recognized Standards with at least five (5) years of experience, to assist in the construction of the Works. He shall be qualified in safety procedures and familiar with the type of work being performed. His assignment shall be full-time, and his duties shall include initiation of measures for the prevention of accidents and the enforcement of all safety rules and regulations.
- b. Together with the Accident Prevention Officer/ Safety Officer, the Contractor shall appoint sufficient Deputy Safety Officers who shall be responsible for ensuring that the safety procedures, safety policy, applicable laws and codes of practice are adhered.
- c. The Safety Specialist/Accident Prevention Officer or one of his deputies shall be available on a 24 hour basis and shall carry out regular and random checks of all parts of the Site where Works are taking place.
- d. Particular attention shall be given by the Safety Officers to aspects such as lighting, handrails, especially around all dangerous openings, access stairs, toe plates, ventilation of enclosed spaces, blasting procedures, removal of construction rubble, orderly storing and stacking of construction equipment and materials and general cleanliness of the Works.
- e. The Safety Specialist/Accident Prevention Officer and his deputies shall have the authority to stop work if, in their opinion, the Work is being carried out in an unsafe manner or method.

3.20.6 Submission of Reports

- a. The Contractor shall submit all reports to the enforcement authorities as applicable according to provisions of current law. These reports shall be submitted first to the Employer's for Review and Approval.

3.20.7 Internal Health and Safety Regulation

- a. The Contractor shall distribute to every one of its workers a copy of its Internal Health and Safety Regulation as required by labour law.

3.20.8 Health and Safety Supervision

- a. The Contractor is required to facilitate the following in connection with the Health and Safety supervision responsibilities of the Employer:
 - All stoppages or suspensions of work demanded by the appropriate authorities, shall be informed immediately and further confirmed in writing and submitted to the Employer.
 - The Employer's Health and Safety supervisors shall have access to the construction site log.

3.21 HAZARDOUS SUBSTANCES

- a. The Contractor shall identify and keep records of all hazardous equipment, materials, or other substances and any other health hazards in his undertaking of the Contract. Newly created hazards or new hazardous equipment, materials or other substances brought on to Site shall be added to the record. The Contractor shall draft codes of practice appropriate to the said hazards. The Employer shall be granted access to such records at all times.
- b. The Contractor shall regularly check the storage areas for Contractor's Equipment, transport vehicles and hazardous materials, for spillages and leaks. The Contractor shall make adequate provisions, to the satisfaction of the Employer, to prevent such spillages of toxic materials from entering natural streams or areas outside the Site.

3.22 FIRST AID

- a. The Contractor shall provide, maintain and operate an adequate number of First Aid stations as necessary at or close to the areas of the Site where most of the works are being carried out. The First Aid post shall be suitably equipped with medical supplies and staffed during all Site working periods by competent medical orderlies who shall have direct voice communication with a medical clinic, and shall be assisted as required by some of the Contractor's employees with first aid qualification. The First Aid stations shall provide first aid services for the others, provided that all expenses for such services will be borne by the relevant party.
- b. The Contractor shall provide and maintain one ambulance approved by relevant governmental authorities. The ambulance shall normally be stationed close to the first aid post in ready position.
- c. The Contractor shall provide and maintain in ready condition boxes of first aid materials together with stretchers at each working place or as required by the Employer. The contents of the first aid boxes must be available in emergencies without use of a key. The contents of each first aid box shall be determined in the Health and Safety Manual after having performed a dedicated risk assessment, but shall include at least:

S. N.	Item	Unit	Quantity	Remarks
1	Triangular Bandage	No	5	White cotton
2	Roller Bandage	No	3	50 mm x 5 m

3	Roller Bandage	No	3	80 mm x 5 m
4	Roller Bandage	No	3	100 mm x 5 m
	Sterile gauze pad			
6	Forceps	No	1	Steel
7	Scissor (Small)	No	1	Steel
8	Hoop pin (small)	No	12	
9	Dettol	Bottle	2	50 ml
	Soap (Dettol/Savlon)			
11	Mask	No	2	Medicated
12	Rubber gloves	No	3	Medicated
13	Towel (small)	No	1	
14	Handiplast	No	12	
15	Betnovet	Bottle	2	100 ml
16	Adhesive Tape	No	2	50 mm x 5 m
17	Crepe Bandage	Roll	2	100 mm
18	Note-book	No	1	Small
19	Pencil	No	1	
20	Pencil cutter	No	1	
21	Thermometer	No	1	
22	Jeevan Jal	Packet	4	For rehydration
23	First Aid box	No	1	As per need
24	Carrying Bag	No	1	To carry attendance

(Source: Nepal Red Cross Society except # 24)

- wound cleaner (500 ml) 6 roller bandages (80 mm x 5 m)
 - swabs for cleaning wounds 6 roller bandages (100 mm x 5 m)
 - cotton wool for padding (250 g) 2 rolls elastic adhesive (25 mm x 3 m)
 - sterile gauze (5 packets) 2 anti-allergenic adhesive strip (25 mm)
 - 1 pair forceps (for splinters) 2 packets adhesive dressing strips
 - 1 pair scissors (100 mm) 6 large dressings (975 mm x 100 mm)
 - 2 cards of 6 safety pins 6 shell dressings (150 mm x 200 mm)
 - 24 triangular bandages 4 straight
 - splints sterile eyewash eye pads
 - 3 pairs disposable gloves
- d. The first aid boxes shall be checked every week and all used items shall be replaced immediately.
- e. The Contractor shall institute and operate a basic first aid training programme to ensure that each foreman or work crew leader in control of 20 or more workmen is trained in first aid and possesses a certificate to that effect issued by the Red Cross Society of Nepal, or equivalent qualification within 3 months of his appointment.
- f. The Contractor shall designate one or more qualified medical doctors experienced in construction projects to supervise the first aid facilities, to control the implementation of the Health and Safety policy defined by the Contractor and consented to by the Employer, and to operate a medical screening and examination system for prospective employees. The qualified medical doctor(s) shall be ready to supply medical and surgical services at short notice on request.

- g. The Contractor shall submit for approval of the Employer and, upon such approval, install a means of rapidly summoning the doctors to the site of an accident or fire.

3.23 LIGHTING AND POWER

3.23.1 General

- a. All power and lighting circuits are to be fitted with earth leakage systems. Any circuit where the earth leakage system is malfunctioning shall be repaired immediately or removed from the working area.

3.23.2 Lighting

- a. The Contractor shall provide and maintain during the execution of the Works an adequate lighting system both for the working and for the transit areas.
- b. In the areas where works are in progress, mobile or stationary flood-lights or equivalent type of lights shall be installed so that the activities can be executed with safety and accuracy.
- c. Lighting cables and their fittings shall be installed and maintained during the execution of the Works in the best safety conditions and in accordance with the regulations in force in Nepal
- d. Unless different lighting levels are otherwise specified, the lighting system during construction shall have minimum intensity of 50 lux in transit areas and 200 lux in working areas.

3.23.3 Grounding and Control of Electric Discharge

- a. All equipment and appliances shall be electrically grounded/earthed, and the effectiveness of such grounding/earthing shall be periodically checked by the Contractor's specialized personnel.
- b. Energized electrical equipment, appliances and lines are to be clearly labelled with warning signs.
- c. Locking out and tagging out devices shall be used during servicing or maintenance.
- d. All electrical leads, cables and hand-held power tools are to be checked regularly for frayed and exposed cables and replaced if damaged.
- e. Power leads, cables, extension leads, junction boxes and distribution boxes shall be protected from damage, including damage from traffic, and replaced if damaged.
- f. Establish and maintain "No Approach" zones around or under high voltage power lines.
- g. Where electrical blasting is used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. Whenever electrical discharges are experienced which could affect the safety grade of detonators, electrical blasting operations shall be interrupted and fuse blasting shall be resorted to instead.

3.24 SIGNAGE, LABELING AND HAZARD CODES

- a. Hazards and areas forming a danger to the safety of all personnel shall be clearly marked and labelled. Labels and signage shall be clear and in accordance with international standards.
- b. Copies of Hazard coding system shall be displayed at all entrances to the site, site working areas, office areas and accommodation areas.

3.25 FIRE PRECAUTIONS

- a. The Contractor shall provide, equip and maintain adequate firefighting facilities.
- b. The Contractor shall organize a fire brigade equipped for the fighting of any fires which may break out at the Site.
- c. The Contractor shall provide suitable and adequate firefighting equipment, to the satisfaction of the Employer, for immediate use in all his buildings or works under construction including his residential quarters, labour camps and ancillary buildings. The Contractor shall maintain all such fire-fighting equipment in good working condition until construction is completed and the Works are taken over by the Employer.
- d. The Contractor shall take every precaution to prevent fire occurring on or near the Site. The Contractor shall comply with laws and regulations regarding fires and with respect to the prevention of fires
- e. Fire protection facilities which are provided shall be of the gas, dry power or other approved chemical type and/or pump water type.
- f. No fire shall be lit in the dry season without permission in writing obtained from the Employer and/or the relevant Authority.
- g. The Contractor shall fight diligently against any fire which occurs on the Site wherever the fire may originate. In this regard, he shall employ all requisite equipment and trained manpower.
- h. Fire hazard areas shall be clearly defined, with appropriate signage and labelling.

3.26 STORAGE OF FLAMMABLE MATERIALS, LIQUIDS AND GASES

- a. Flammable materials, liquids and gases shall be in suitable and approved storage facilities, remote from entry and exit points into the site works, offices and other buildings.
- b. Flammable materials, liquids and gases shall be kept away from sources of naked flames or other sources of ignition, as well as away from ventilation intakes of vents.
- c. The storage facilities shall have spark proof fittings and fixtures, with natural or passive floor and ceiling level ventilation and explosion venting.
- d. Benzene, diesel fuel and oil, liquefied petroleum gas and other flammable materials shall be stored at places and in a manner complying with all relevant regulations. Above-ground storage tanks for fuel, chemicals and any flammable material shall not be located within the limits of camp sites or closer than 50 m to any building or structure on the Site.
- e. The storage facilities shall be equipped with fire extinguishing devices, and made of materials which can withstand flame impingement.

- f. Containers shall be bonded and grounded, with the addition of mechanical floor level ventilation.
- g. Personnel in charge of or handling flammable materials shall have specific training in handling flammable materials, and in fire prevention and suppression.

3.27 TRANSPORT OF LABOUR

- a. The Contractor shall be responsible for, and make provision for, the safe vehicular transport of all labourers between the labour camps and/or established collection points and their work areas, and vice versa. The Contractor shall provide sufficient transport, properly fitted out for the safe transport of labour in a form acceptable to the Employer.
- b. The transport shall provide for safe entry and egress, prevent persons jumping or climbing over the sides, and be fitted with seating. Under no circumstances shall labour be transported on flatbed trucks, rail or similar vehicles which do not comply with the requirements of this Sub-Clause. Weatherproof covers shall be available for use at all times following the onset of the rains until such time as the Employer agrees that the provision is no longer required. The Contractor shall prevent overloading of vehicles, and suitable crush barriers shall be provided at main loading points.

3.28 SAFETY OF THE PUBLIC

- a. Where the public could be exposed to danger by any of the Site activities the Contractor shall close off such access and erect suitable warning and "no trespassing" signs in English and Nepalese.
- b. Where shown on the Drawings or instructed by the Employer the Contractor shall provide alternative safe access routes. The cost of such alternative accesses shall be borne by the Contractor.

3.29 USE, HANDLING AND STORAGE OF EXPLOSIVES

- a. The Contractor shall make arrangements to transport, store and handle explosives, fuels and chemicals in a safe manner for protecting the public works, other properties and environment in accordance with guidelines given in the ICI Nobel's Explosives Company Blasting Practice Handbook and with all statutory regulations of Nepal.
- b. The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the licenses as may be necessary for the purpose of importing and moving explosives fuels and chemicals from place to place and storing the same, and shall make all applications and obtain approvals from relevant authorities of the Government of Nepal.
- c. The Contractor shall submit a written programme under Health and Safety Management Plan to the Employer for approval for the safe handling and storage of explosives, fuel and chemicals. Following the issuance of approval from the Employer, the Contractor shall issue a copy of this programme to each of his personnel involved with the handling of explosives, fuels and chemicals.
- d. The Contractor shall construct his explosives magazines at locations and in a manner complying with the relevant regulations of Nepal and approved by the Employer.

Detonators and fuse shall be stored in a separate magazine away from explosives. In no case shall they be transported in the same vehicle with explosives.

- e. The handling or use of explosives shall be discontinued during the approach and progress of a thunderstorm. All persons shall be removed from danger areas to a place of safety during such periods.
- f. The Contractor shall provide adequate security including a police post in accordance with the prevailing law of the country subjected to the Employer's approval to the arrangement and protective facilities to safely store and to prevent the loss or theft of explosives and detonators. Overnight storage of explosives and detonators outside of the magazines will not be permitted. Magazines shall be securely locked when not in use.
- g. The Contractor shall maintain an inventory record of storage and withdrawal of all explosives and detonators. This record shall be available to the Employer, and the Employer and other relevant authorities shall be promptly notified by the Contractor of any loss or theft of explosives
- h. The Contractor shall engage an approved shot-firer as per the requirements of the Regulation.

3.30 WARNING OF BLASTING

- a. The Contractor shall install and operate a siren of sufficient volume to be easily heard above the general Site noise from all points within a radius of 1.0 km of surface blasts, including by those operating construction vehicles and machinery.
- b. Hand operated sirens shall not be accepted.
- c. The Contractor shall submit details of his blasting procedures to the Employer for consent and shall ensure that such procedures are adhered to at all times. The procedures shall be coordinated with all other organizations in the area which may also be undertaking blasting or be affected by blasting.
- d. Relevant aspects of the procedures shall be agreed with the local civil and military authorities and disseminated as widely as practicably possible amongst the local population.

3.31 SCAFFOLDING, FALSEWORK AND FORMWORK

- a. Scaffolding, falsework and formwork is to comply with relevant International applicable standards.
- b. Portable and access ladders shall be wooden or steel ladders sufficiently strong and with suitable size for the use intended, and are to comply with relevant applicable standards. Wooden ladders shall have the steps fixed to the longitudinal posts by assembly. The use of ladders with steps nailed or wired along the longitudinal posts is not permitted.

3.32 BIOLOGICAL HAZARDS

- a. The Contractor shall introduce and maintain a strict regime for measures to control biological agents or hazards which exist on, or are introduced to the site, as required by Government or the local and international health, medical or sanitary authorities.

3.33 SANITARY AND HYGIENE MEASURES AND EPIDEMICS

- a. The Contractor shall comply in all respects with the rules, regulations and instructions of the relevant Government and health authorities as regards sanitary and hygiene requirements in connection with the Works.
- b. The contractor shall implement an educational programme and awareness campaign covering sanitary & hygiene; contagious diseases; sexually transmitted diseases (STDs); and HIV/aids.
- c. In the event of any outbreak of illness of an epidemic nature, the contractor shall immediately report such occurrence to the Employer and the relevant authorities, and shall comply with and carry out such regulations or orders and requirements as may be made by the government or the local and international health, medical or sanitary authorities for the purpose of dealing with, and overcoming same.

3.34 RADIOLOGICAL HAZARDS

- a. The Contractor shall introduce and maintain a strict regime of measures for the prevention and control of exposure to radiation which exists on, or are introduced to the site, as required by the Government or international authorities.

3.35 TRAFFIC MANAGEMENT AND SAFETY PLAN

- a. The Contractor shall, within 120 days from the date of issue of the Notice to Commence, submit a comprehensive Traffic Management and Safety Plan prepared specifically for the Site, covering all aspects of traffic management and safety.
- b. The traffic management and safety plan proposed by the contractor shall be subject to the Employer's approval.
- c. The Contractor shall closely cooperate with the police and shall plan and direct the traffic in a manner that conforms to traffic laws and regulations. The Contractor shall assign appropriate personnel for traffic control at all points which require close traffic supervision and direction.
- d. All associated drivers engaged in the project should be periodically educated about safety and traffic regulations and regularly be informed of related traffic plans and specific regulations applicable to the project area. By means of public relation and close cooperation with the police and relevant authorities, the Contractor shall notify them of the schedule of heavy machine, construction materials and excavated muck transportation to be publicized to the near communities as well those traveling the roads and access roads.
- e. The Contractor shall provide all necessary signs for his temporary construction roads and for the Works. These shall include but not be limited to the following:
 - Standard road traffic sign boards,
 - Warning sign boards,
 - Danger sign boards,
 - Control sign boards,
 - Safety sign boards and
 - Direction sign boards.

- f. Wording on all signboards shall be in English and Nepalese. The size, colour, lettering and locations of all signboards shall be subjected to approval of the Employer. The Contractor shall maintain all signboards placed by him. If the Employer considers that the system of sign boards provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to the satisfaction of the Employer.
- g. The Contractor shall pay particular attention to traffic control on the construction roads where vehicle may frequently pass. If necessary, the Contractor shall post flag men at key places on such roads in addition to the signboards/signals. Roads closed for traffic shall be barricaded and posted with adequate warning signals. Suitable red lights shall be kept on from sunset to sunrise.
- h. The Traffic Management and Safety Plan shall cover, but not be limited to:
 - Scheduling of vehicle movements.
 - Travelling in convoys
 - Qualifications of drivers/operators
 - Vehicle inspections and testing
 - Vehicle maintenance
 - Spare parts purchasing and storage
 - Emissions and emission control
 - Speed limits and speed controls
 - Fines procedure
 - Procedure to ensure compliance
 - Training and education
 - Signposting
 - Monitoring

3.36 RESCUE TEAMS

- a. Prior to the commencement of construction, the Contractor shall organize and train Rescue Teams composed of his employees. The Rescue Teams shall be capable to render help after accidents at work.
- b. The Rescue Teams shall be organized in such a way that a sufficient number of members are ready for action at any time and shall be effective for the whole duration of the Works.
- c. The Rescue Teams members shall be instructed and trained for their task by qualified and experienced persons.
- d. Each Rescue Team member shall be skilled in giving first-aid, dealing with the appliances for artificial respiration and firefighting equipment, and shall possess a good local knowledge.
- e. The contractor shall submit the details of the proposed rescue team organization to the Employer for approval.

3.37 SECURITY MEASURES

- a. The Contractor shall be responsible for the security of the project sites and shall provide and maintain an adequate security force to fulfil this obligation. This will

include the provision of identification badges for access to work sites and clear marking of all project vehicles.

- b. Security personnel shall keep 24 hours watch and control work sites and camps and stop all attempts of illegal activities including drunken driving.

3.38 ADDITIONAL HEALTH AND SAFETY REQUIREMENTS FOR UNDERGROUND WORK

3.38.1 General

- a. In addition to the minimum general health and safety requirements contained in Part 2, additional requirements are to be complied with when undertaking activities underground, which include, but not limited to, complying with:
- US Bureau of Mines regulations, standards and codes;
 - USBR – Construction Safety Standards;
 - and which form part of the Contractor's obligations, duties and responsibilities in accordance with the Contract.

3.38.2 Lighting.

- a. The Contractor shall provide sufficient lighting to ensure the following conditions:
- Safe working conditions are provided for all personnel on the work sites.
 - The Works can be constructed in complete compliance with the contract
 - Complete inspections of all works in progress can be made by the Employer and
 - Security of the Works areas and public safety measures are adequate and effective.
- b. Unless otherwise directed by the Employer, the minimum illumination on the ground or working surfaces to be provided for the various operations or work areas shall be as follows:

Operation / Area	Minimum Value of Illumination (Lux)
a) Earthworks	35
b) Concrete placing	100
c) Haul roads and bridges where hazardous conditions exist	20
d) Underground works	50
e) Workshops and mechanical and electric works	200
f) Tunnel heading during drilling, mucking and scaling	100

Illumination for areas of operation not listed above shall be as instructed by the Employer.

- c. Tunnels shall be illuminated with electric lamps with adequately insulated branch circuits. A voltage in excess of 110 volts shall not be permitted for underground illumination. Emergency lighting with a minimum intensity of not less than 10 lux shall be provided in case of a power failure.
- d. All mobile equipment or plant used during night operation shall be equipped with sufficient lights and reflectors to ensure safe working conditions.
- e. Lighting cables shall be installed on one side of the tunnels, and telephone or communication system wires shall be laid on the opposite side. All cables installed in underground shall be firmly fixed on sidewalls with supports and insulators of adequate design and capacity, and their installation shall be made so that they cannot be damaged by the equipment operating in tunnel.
- f. At least Thirty (30) days prior to starting night operations the Contractor shall submit his proposals for lighting systems in the areas where he proposes to work at night to the Employer for his information. The Contractor shall modify the proposals, if required by the Employer, and shall not begin such operations in such places as the case may be, until approval has been issued by the Employer. Approval of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.
- g. Where in the Employer's opinion, it is impracticable to place and use electrical cable at the excavation face of the tunnels, pneumatic or carbide lamps shall be used.

3.38.3 Ventilation

1.38.3.1 Quality of Air

- a. The air in tunnels shall contain at least 19 % of oxygen at all time and the concentration of contaminants such as gases, vapours, and dust shall never exceed the limits established here below for the workmen's health, taking into account the effects of time, temperature, humidity and the cumulative effects of contaminants.
- b. Without prejudice to the adoption of such lower figures as may be required by the Employer, the air breathed by workmen and other persons in tunnels shall not contain more than 5 p.p.m. of nitrous fumes (measured as NO₂) for longer than 10 minutes after each blast and 30 p.p.m. of carbon dioxide as an absolute maximum.
- c. Concentrations of fumes in excess of 5 p.p.m. of nitrous fumes, 100 p.p.m. of carbon monoxide, 200 p.p.m. of hydrogen sulphides and 5,000 p.p.m. of carbon dioxide shall be allowed within a maximum distance of 3 m of the point of discharge of fumes from internal combustion engines provided that no plant operator or other persons stay within this distance
- d. Concentrations of methane shall not exceed one and one-half percent (1.5%) at the heading and one percent (1%) in the general tunnel atmosphere.
- e. Concentrations of other flammable gases shall not exceed forty percent of the lower explosive limit at the heading, and twenty percent of the lower explosive limit in the general tunnel atmosphere. The lower explosive limit for some gases that might be found in underground works are listed below:
 - Benzene 1.3%
 - Butane 1.8%
 - Carbon Disulfide 1.3%

▪ Carbon Monoxide	12.0%
▪ Ethane	3.0%
▪ Fuel Oil	0.7%
▪ Gasoline	1.4%
▪ Kerosene	0.7%
▪ Methane	5.0%
▪ Propane	2.1%

1.38.3.2 Internal Combustion Engines

- Underground use of internal combustion engines burning gasoline or liquefied petroleum gases, propane, butane propylene and butylene is forbidden.
- The Contractor shall obtain proof from prospective suppliers of diesel-powered equipment for use in underground that the proposed equipment conforms to the requirements of the U.S. Bureau of Mines Circular No. 8183, "Mobile Diesel-powered Equipment for Non-coal Mines Approved by the Bureau of Mines," and supplements thereto.
- The Contractor shall maintain all such diesel equipment in safe operating condition, insuring compliance with the requirements of the above circular. In the event the Employer is of the opinion that these requirements are not being met, the Contractor shall perform at his own costs all required tests as specified in U.S. Bureau of Mines Report of Investigations RI 5616.

1.38.3.3 Minimum Quantitiy of Air

- For each person working underground, a minimum amount of fresh air of 3 m³/min or 100 l/s per square meter of excavation cross section, whichever is larger, shall be provided.
- In addition to the requirements above for personnel, if diesel-powered equipment is used, then an additional minimum quantity of fresh air of 2.0 m³/min for each horsepower at work inside the tunnel shall be supplied.

1.38.3.4 Ventilation System

- The ventilating system for the underground works shall be of sufficient capacity to maintain an adequate supply of uncontaminated air at all points in the tunnels.
- The Contractor shall design a ventilating system that shall, during tunnel driving, allow a continuous flow of air at the face of the heading. The design of the ventilation system shall be calculated according to the size and capacity of all equipment to be used and the number of personnel working in the specific underground work.
- The ventilating pipe or fan line shall terminate no more than 30 m away from the face of heading.
- For at least the first 20 minutes after each blast, the fan shall be run to exhaust smoke and dust and to remove from the face dynamite fumes and fine silicates to the satisfaction of the Employer.
- When necessary to reduce the amount of dust, all rock surfaces and blasted rock at the working faces shall be kept wet. During mucking, muck piles shall be watered down to prevent dust hazards.
- If during the execution of the work the Employer realizes that the capacity of the ventilation system is inadequate for the good health of the workers and for removing

possible noxious gases, the Contractor shall install additional fans and take all necessary measures to obtain the required safety conditions at no additional cost.

- g. The Contractor shall submit the detailed design, equipment specifications and operation plan of the proposed ventilation system to the Employer for approval not later than Thirty (30) days before beginning installation. The details shall show pipe size, pipe material and type of joints, type and capacity of fans, suspension devices, power supply and distribution system and any other data required by the Employer.

3.38.4 Control of Noxious Gases

1.38.4.1 Testing Instruments and Equipment

- a. The Contractor shall provide and operate proper apparatuses and equipment for detecting possible noxious (toxic and flammable) gases in tunnel. The instruments shall be approved by the Employer before placing the purchase order or being transported to the Site.
- b. The Contractor shall obtain and maintain a gas detector at the heading for determining the presence of methane and other flammable gases. The Contractor shall also obtain an approved type portable oxygen indicator for measuring concentrations of oxygen within the range of 0 to 25 percent, by volume.
- c. Monitoring concentrations of carbon monoxide, carbon dioxide, nitrogen dioxide, hydrogen sulphide, methane, other noxious or flammable gases, as well as oxygen content of tunnel atmosphere shall be carried out by the Contractor at specific locations at regularly scheduled intervals on each shift, and a record of readings shall be maintained and submitted to the Employer.

1.38.4.2 Suspension of Construction Activities

- a. Should the concentrations of carbon monoxide, nitrogen dioxide, hydrogen sulphide, methane, or other noxious or flammable gases exceed the permissible limits or should the oxygen content in the tunnel be below the limit as set forth in Sub-Clause 1.38.3.1 herein above, all operations shall be immediately suspended and the personnel shall be moved to a safe area.
- b. Further, should concentration of flammable gases exceed the permissible limits, all sources of ignition shall be extinguished or removed and all equipment, with exception of ventilation and exhaust equipment, shall be shut down until the concentration of gas is brought within the permissible limits.
- c. The Contractor shall in no case resume work without having previously taken all necessary safety measures.
- d. Should exploding gases be detected, the Contractor shall provide the construction equipment with explosion-proof electric motors, exhaust pipes of fuel type engines with proper spark absorber and any other accessory and device necessary for assuring the required safety in underground. The provision of such safety measures shall not be construed by the Contractor as a basis for additional compensation over the stipulated unit and lump sum prices.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 4
QUALITY MANAGMENT

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CHAPTER 4 - QUALITY MANAGEMENT

4.1 GENERAL

- a. The Contractor shall, in accordance with Clause 47[*Quality Assurance*] of the Conditions of Contract, establish, implement and maintain a Quality Management System which shall, as a minimum, meet the requirements set out in ISO 9001: 2015. The Quality Management Plan shall cover all aspects of the Works to be performed under the Contract and shall be used: 1) as an aid to achieve compliance with the Contract and to document such compliance; and 2) by the Employer to monitor the application and compliance with the approved procedures throughout the Contract period. Wherever possible, diagrams, charts and organograms should be used in preference to lengthy descriptions.
- b. The Quality Management System (PDCA - Plan-Do-Check-Act) shall provide procedures for the design (Plan), procurement of material and equipment, construction (Do), testing, check and review (check, Act), handover of the Works and Materials to be used in the Works, and shall cover all aspects of the Works whether on or off Site.
- c. The Quality Management System shall provide documentary evidence that procured materials and equipment are in agreement to the Contract requirements, the tests and inspections specified have been undertaken, that the specified test results have been achieved, that all detected unconformities have been resolved and that actions are taken to maintain and improve the process performances. Within 90 days from the Commencement Date and in any event prior to any work proceeding, the Contractor shall submit for Employer's Review and approval a Preliminary Quality Plan.
- d. Works carried out prior to approval of the Contractor's quality procedures shall require separate approval of individual Quality Plans for each of such works, with the exception of site establishment temporary works and site surveys.
- e. The Contractor's Quality Management Plan shall comply all the requirements of the Contract as well as with the requirements for quality assurance and testing as set out in this document. It shall be the responsibility of the Contractor to demonstrate to the Employer that compliance with the specified requirements is achieved.
- f. The Contractor is responsible for measuring the quality of the Work in accordance with the requirements of the Contract.
- g. The Preliminary Quality Plan shall include, but not be limited to, the following information:
 - Identification and scope of certifying authority involvement;
 - Summary of the Project requirements including all proposed quality activities;
 - Contractor's Organization Chart;
 - All quality assurance and quality control procedures proposed by the Contractor for its use in the execution of the Works;
 - Responsibilities of quality assurance personnel;
 - Description of procedures for quality control of documentation;
 - Description of identification, segregation, return or rectification of non-conforming Works and Materials;
 - Description of document control procedures;

- Description of procedures for handling site information requests;
 - Proposed list of all the codes of practice, standards and specifications that the Contractor is to apply to its work;
 - Description of the Contractor's internal and sub-contractor quality assurance audits;
 - A statement detailing the records that the Contractor proposes to keep, the time during which they shall be prepared and the subsequent period and manner in which they shall be stored and submitted to the Owner; and
 - Scope of inspection and test plans for every activity requiring inspection. The scope shall describe the plans required, level of inspection and who is responsible for releasing an activity from a "hold point".
- h. Within Fifteen (15) days of the Employer's approval of the Preliminary Quality Management Plan, the Contractor shall provide the Employer with a Detailed Quality Management Plan for the Employer's Review and Approval taking into account any directions or requirements from the Employer on the Preliminary Quality Management Plan. The Detailed Quality Management Plan shall include but not be limited to, the following additional information:
- Descriptions of the following interfaces:
 - Between the Contractor and the Employer;
 - Within the Contractor's project teams including Contractor's Design Group or Firm;
 - Between the Contractor, Subcontractors and suppliers;
 - Between the Contractor and local and statutory authorities; and
 - Between the Contractor's internal quality management personnel and project personnel.
 - All quality assurance and quality control procedures proposed by the Contractor for its use in the execution of the Works, including but not limited to:
 - Procedures for quality control of documentation;
 - Procedures for identification, segregation, return or rectification of non-conforming Works and Materials;
 - Procedures for document control;
 - Procedures for handling site information requests.
 - Inspection and test plans for every activity requiring inspection. The plans shall describe the level of inspection and who is responsible for releasing an activity for a "hold point"; and
 - Contractor's internal and sub-contractor quality assurance audits.
 - A statement detailing the records that the Contractor proposes to keep, the time during which they shall be prepared and the subsequent period and manner in which they shall be stored and submitted to the Employer.
- i. The Contractor shall prepare a set of coordinated quality procedures designed to ensure that materials and workmanship by himself, Suppliers and his Subcontractors will meet the specified requirements for quality, and these procedures shall comply

with the quality systems which the Contractor proposes and the Employer issues approval for application on the Contract.

- j. The Contractor shall develop a Quality Assurance Program (QAP) defining quality control activities such as testing, inspection and procedures for scheduling and managing submittals and reporting in accordance with the Contract. The QAP shall fulfil but not limited to the following conditions:
- The Quality Assurance Program shall outline sampling techniques, sample size, and inspection methods. Verification inspection shall be performed independently by personnel whose primary responsibility is quality assurance and not production.
 - The QAP shall provide full details of the proposed contract management structure, identifying personnel responsible for the overall management and control of the Contract and the site representatives responsible for quality control.
 - The QAP shall include a description of how the quality standards of Subcontractors will be supervised and monitored.
 - The QAP shall include a description of how materials suppliers will be controlled to ensure that only materials complying with quality standards are produced and delivered to site, and methods for identifying and removing from the site any non-conforming materials.
 - The QAP shall include a description of how quality will be recorded, samples of standard records and methods for storage, retrieval and maintenance of these records.
 - The QAP shall provide details of how materials or Works, which do not conform to specified requirements, will be identified, corrective action determined, evidence of corrective action being taken and methods to avoid future non-conformance.
- k. The Contractor's proposed Quality Assurance Program shall be submitted by the Contractor as part of his Tender, and the final Quality Assurance Program will be agreed and incorporated in the Contract.
- l. The Contractor shall perform sufficient inspections and tests of all items of work, including those of subcontractors, to ensure compliance with the Contract. This includes, but is not limited to, all the inspection and tests specified in the Contract. While carrying out his own quality control as specified, the Contractor shall provide the Employer with all facilities for inspecting the work, witnessing required tests and analyzing test results.
- m. The QAP shall be updated as required, to incorporate all changes to the Contractor's procedures that have been agreed by the Employer.
- n. The QAP shall make reference (where appropriate) to other documents issued by the Contractor to illustrate the main tasks within the Project, their subdivision and the reporting structure to be established for the Project.
- o. The Contractor shall prepare all charts, submission schedules and the proposed content and format of all quality control certification systems to demonstrate that the Contractor will meet its obligations under the Contract, as follows:

- In coordination and by agreement with the Employer, inspection and test plans, which shall indicate effective quality control checks and inspections as well as routine and random inspections; and
 - By agreement with the Employer, (i) a schedule for submission of quality control data and (ii) the content and format of all quality control certification systems and submittals.
- p. The Contractor shall submit a detailed organization chart, in accordance with Clause 28[*Safety, Security, and Protection of the Environment*] of the Conditions of Contract.
- q. This detailed organization chart shall identify the responsibilities, authority and interrelation of all personnel who manage, perform and verify work affecting quality. The detailed organization chart shall be specific only to this Contract. The detailed organization chart shall identify the quality management representative who shall act as the quality coordinator for the Contractor in all dealings with the Employer.
- r. The Quality Management Plan shall be reviewed, updated and resubmitted as necessary throughout the period of the Contract, or as instructed by the Employer.

4.2 INSPECTION AND TEST PLANS

- a. The Contractor shall prepare, and submit for approval, the relevant inspection and test plan ("ITP") for all supplies, materials and prefabricated items and for all works on or off Site with the Employer prior to commencing work on each activity. The format of the ITPs shall be to the approval of the Employer and shall indicate, where applicable, the method of testing, the type of test, inspection and hold points for the inspections, testing, audits and approvals to be carried out by the manufacturer, third party inspection body, Contractor's or the Employer. They shall also include details of the testing establishments the Contractor proposes to use.
- b. The Contractor shall prepare, and update daily, control charts or graphs of the results of quality control tests. A separate control chart or graph shall be kept for each type of procedure or test. These charts shall be kept on display in an area at the Works site readily accessible to the Employer. A copy of the updated charts shall be provided to the Employer not less frequently than once per week and whenever requested by the Employer. All records shall be maintained on Site in a secure storage area. Access to inspect and examine these records shall be provided by the Contractor at the request of the Employer at all times.
- c. The plans shall cover manufacture, transportation, acceptance, storage, installation, commissioning and tests, as appropriate. All references in the Contract of the need for the Contractor to obtain the Employer's approval or consent shall be deemed a Hold Point unless otherwise agreed by the Employer to designate any as witness points.
- d. The Contractor shall be responsible for testing and inspecting all materials and workmanship. No work shall be covered up without the written approval of the Employer. All items of work concealed in the finished work shall be inspected immediately before they are covered up. Inspection and testing shall be recorded according to the procedure specified in the Employer's Requirements.
- e. The records shall identify the inspector, the place, the date and time when the inspection was completed, the section of the Works and the materials tested or

inspected, and its state of completion. Reference shall be made to the relevant detailed drawings and the specific aspects or properties which were checked or measured shall be recorded. Four (4) hard copies and electronic copy of each record of inspection by the Contractor shall be submitted to the Employer.

- f. The records of inspections and tests shall be stored in an orderly fashion on the Site by the Contractor until the issue of the Taking-Over Certificate for the whole of the Works, or such earlier time as the Employer may instruct, and the Employer shall have the right of access to them at all times.
- g. In addition to the Contractor's testing and inspection, the Contractor shall afford and facilitate access at all times for the Employer's inspection and testing of materials and workmanship on Site and, when so ever required by the Employer, off-site and at manufacturers' workshops. The Contractor shall provide means of safe access and assistance as may reasonably be required by the Employer. For all items of work the Contractor shall give adequate notice in writing to the Employer that the item in question is complete and is ready for inspection, and shall not cover it by subsequent work until the Employer has confirmed in writing that it has been inspected and is approved. No inspection or approval by the Employer shall relieve the Contractor or any of his duties, obligations and responsibilities under the Contract. The Contractor shall ensure that such access and records are also provided for all off-site fabricated items and proprietary products.

4.3 QUALITY TESTS

- a. The Contractor shall be responsible for the quality of all products, processes and services supplied under the Contract, and shall provide all test facilities and perform demonstrative conformance of all products, processes and services to the requirements of the Contract.

4.4 EXTERNAL QUALITY AUDITS

- a. External quality audits shall be carried out in accordance with the Contractor's Quality Plan but shall be conducted no later than Twelve (12) months apart. Upon request, the Employer shall be given access in conjunction with or through the Contractor to carry out quality audits, reviews or surveillance or ascertain the effectiveness of the quality system put in place by the Contractor.
- b. The Employer shall be entitled to carry out audits of the Contractor's quality system by:
 - Review of the Contractor's conformance with the Quality Plan; and
 - Review and verification of the Contractor's quality procedures and work instructions and documentary evidence of compliance with the technical requirements of the Contract.
- c. The Employer may require compliance audits of the Contractor's quality system. Not less than three (3) weeks' notice will be given by the Employer. During audit by the Employer, the Contractor shall provide staff trained and registered as ISO auditors to

accompany the Employer. The Contractor shall make available on request any document which relates to internal audits.

- d. Internal audits shall be carried out at Four (4) monthly intervals. A copy of all quality audit results, reports and corrective actions shall be submitted to the Employer.

4.5 TRACEABILITY

- a. The Contractor shall maintain records clearly identifying the source and condition of all Plant, Materials and equipment used for construction of the Works, along with any relevant test results, design drawings, and the place and time of delivery to store or to Site. The Contractor shall be able to demonstrate ease of traceability of non-conforming items for rectification.

4.6 QUALITY RECORDS AND REPORTS

- a. Quality records shall be stored and maintained such that they are readily accessible in facilities that provide a suitable environment to minimize deterioration or damage, and to prevent loss.
- b. Quality records shall be available for the evaluation of the Employer during the term of the Contract and shall include all pertinent Subcontractor or secondary consultant records.
- c. The Contractor shall maintain quality records for a period of Four (4) years from the Completion Date.
- d. The Contractor shall maintain records in Two (2) categories:
 - Test records - which shall comprise all working sheets including manufacturers' certificates (i.e. mill certificates) associated with testing in accordance with the inspection and test plans.
 - Project quality records - which shall include, but not be limited to, site meeting minutes, technical reviews, minutes of meetings with the Employer, Subcontractors and consultants, non-compliance reports, corrective action reports, registrations, all calculations, as-built drawings and other relevant documentation.
- e. The Contractor shall submit for the Employer's Review and Approval, quality reports as evidence that the work has complied with the specified quality requirements. These reports shall include summaries of inspection and test results. The reports shall be submitted within seventy-two (72) hours of the relevant inspection or testing, or, if that falls on a non-working day, on the start of business of the next working day.
- f. The Contractor shall supply together with each monthly progress report, an updated register of all the quality records held and a list of non-compliances. The Contractor shall also supply a list of all items of non-compliance, which have been rectified since the previous monthly progress report. The Contractor shall supply a copy of all quality records requested by the Employer.

4.7 INSPECTIONS

- a. The Employer shall be given access in conjunction with or through the Contractor to all laboratories and other facilities used for quality control tests to verify that the specified requirements are being met.

4.8 COMPLIANCE

- a. To ensure the Contractor, the Contractor's personnel, the Contractor's Sub-Contractors and Suppliers will comply with the Contractor's quality assurance obligations under the Contract, the Contractor shall translate into English and national language of the Contractor, all documents to ensure the Contractor, the Contractor's personnel, the Contractor's Sub-Contractors and Suppliers understand the requirements for executing the Works in accordance with the Contract. The Contractor shall also submit copies of the translated documents to the Employer.

4.9 PROJECT PROCEDURES

- a. Consistent with the approved Quality Management Plan, the Contractor shall prepare a Project Procedures Manual, for review and approval of the Employer, and implement the approved procedures together with suitable communication systems for the efficient management of the Contract covering responsibilities, communications, document control, meetings, reporting and administration. The Contractor shall provide to the Employer, for the duration of the Contract all software (if any) needed to implement these systems free of charge or liability.
- b. The Project Procedures Manual shall be reviewed, updated and resubmitted as necessary throughout the period of the Contract, or as instructed by the Employer.

4.10 QUALITY CONTROL MANAGER

- a. The Contractor shall appoint a Quality Control Manager with authority to develop and enforce the Contractor Quality Assurance Plan and Quality Control activities, as well as coordination with the Employer.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 5
ENVIRONMENT AT CONSTRUCTION SITE

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CHAPTER 5 - ENVIRONMENT AT CONSTRUCTION SITE

5.1 GENERAL REQUIREMENTS

- a. This section comprises the Employer's minimum general environmental requirements that shall be observed by the Contractor at all times.
- b. The Employer has committed to undertake the construction of the Project in a manner that results in the least impact on the physical, biological and social environments in line with the Environmental Impact Study. The Contractor shall be required to submit any document on environmental protections specified in this Clause and elsewhere in the Contract to the Employer for their review and approval.
- c. In accordance with Clause 28[*Safety, Security and Protection of the Environment*] of the Conditions of Contract, the Contractor shall comply with all the environmental regulations that apply to the Project and all other Laws, including legal requirements issued by related authorities.
- d. Applicable laws, regulations, codes and rules include, but are not limited to:
 - Environment Protection Act, 2076 (2019)
 - Environment Protection Rules, 2077 (2020)
 - National Environmental Impact Assessment Guidelines, 2050 (1993)
 - Forest Act, 2076 (2019)
 - Forest Regulation, 2079 (2023)
 - National Forest Policy, 2075 (2019)
 - Guideline for Use of Forest Land for Other Purposes, 2074 (2017)
 - Soil and Watershed Conservation Act, 2039 (1982)
 - Aquatic Animals Protection Act, 2039 (1982)
 - Water Resources Act, 2049 (1992)
 - Water Resources Rules, 2050 (1993)
 - Electricity Act, 2049 (1992)
 - Electricity Regulations, 2050 (1993)
 - Electricity Development and Management Act, 2062 (2005)
 - Hydropower Development Policy, 2058 (2001)
 - Land Acquisition Act, 2034 (1977)
 - Local Government Operation Act, 2074 (2017)
 - Labour Act, 2074 (2017)
 - Motor Vehicles and Transport Management Act, 2049 (1993)
 - Explosives Act, 2018 (1961)
 - National Parks and Wildlife Conservation Act, 2029 (1973)
 - Wildlife Reserve Rules, 2034 (1977)
 - Guideline for Physical Infrastructure Development and Operation in Protected Areas, 2065 (2008)
 - Wildlife Friendly Infrastructure Development Directives 2078
 - Kanchanjunga Conservation Area Management Regulation 2064.
 - ISO 14001:2015 – Environmental Management Systems

- e. The Contractor shall be responsible for complying with the Environmental Impact Assessment (EIA) or any other requirements due to changes in the Project design in addition to the Employer's Environmental Management Plan (EMP), Attachment to Chapter 5. In order to demonstrate the compliance, the Contractor shall be responsible for the preparation and implementation of an Environmental Management Plan during all the construction phases.
- f. The Contractor shall plan and adopt his work methods and equipment in such a way that the construction activities shall have the least possible impact on the environment and the nearby residents. Those will include management of air quality, water quality, ground water, noise and ground vibration and protection of flora and fauna.
- g. The Contractor shall appoint a suitably qualified Environmental and Social Safeguard Officer acceptable to the Employer, who shall be the primary point of contact within his organization for all matters relating to environmental management. The Environmental and Social Safeguard Officer will have the authority to instruct to implement the requirements of the "Environmental Management and Monitoring Plan" and any instructions from the Employer in any area of the Contractor's operations.
- h. The Contractor shall ensure that all personnel employed by or contracted to him are given introduction and on-going trainings in environmental issues and requirements for environmental management. The Contractor shall keep records of attendance at the trainings.
- i. The Contractor shall obey all laws, notifications, standards and guidelines for environmental protection in force of Nepal. The Contractor shall be responsible for the potential damages due to the non-conformity of the law and shall pay any fine imposed by the law.
- j. Failure by any employee of the Contractor to comply with the instructions regarding environmental protection shall be sufficient cause for the Employer to order the removal of the offending person from the Site, in terms of the Contract.
- k. The Contractor shall have a system for recording and communicating any complaints received by general public or any person employed or contracted to the Contractor. All complaints related to environmental issues shall be communicated in writing to the Employer within twenty-four (24) hours after his receipt.
- l. The Contractor shall manage the Environmental Management Plan and shall review it on a regular basis and shall update or revise the Plan as necessary, with the Employer's acceptance. This process is in order to ensure that the Environmental Management and Monitoring Plan continues to give guidance during the life of the Contract and incorporate new elements to address subjects in greater depth where new environmental issues have been identified during construction.
- m. The Employer will monitor and review the Contractor's environmental performance and will undertake formal environmental audits of the Contractor's performance.

5.2 ENVIRONMENTAL MITIGATION

- a. An Environmental and Social Unit shall be established under RHL to monitor the Contractor's environmental performance. The Contractor shall also establish a unit for implementing the mitigation measures and monitoring programs.

- b. Land acquisition and compensation for project area will be carried by the Employer. The Contractor shall carry out the environmental impact mitigation works as mentioned in this section as per the findings of the EIA report and the Employer's Environmental Management Plan.
- c. The Contractor shall follow good management and environmental practices during the construction work activities, which include, but not limited to, the following:

5.2.1 Physical Environment

- a. The Contractor shall take all necessary care and appropriate action to conserve and protect the environment at the construction sites and in the immediate vicinity of the construction sites;
- b. The Contractor shall take due care to minimize land requirements for temporary structures and facilities;
- c. Only assigned or approved quarries and borrow sites approved by the Employer shall be exploited;
- d. The Contractor shall implement an integrated Health and Safety and Environmental Management System;
- e. The Contractor shall dispose the muck in the designated areas as directed by Employer;
- f. The Contractor shall spray water along the road and in and around the construction areas at least three times a day depending upon the construction schedule, season and intensity of the dust pollution;
- g. The Contractor shall prepare a Waste Management Plan which details the controlled usage of treatment of all toxic materials and wastes, sanitary wastes and solid waste used or produced on-site and in relation to the works;
- h. The Contractor shall meet all existing environmental standards and those environmental standards which come into effect during the construction period;
- i. The Contractor shall restore the temporary areas like construction camps, garage and construction yards once it is not required, to its original state; and
- j. The Contractor shall rehabilitate Borrow areas and quarry sites.

5.2.2 Biological Environment

- a. The Contractor shall see that the clearance of vegetation will be restricted only in the required area;
- b. The Contractor shall prepare re-vegetation plan in consistent with mitigation measures proposed in EIA report;
- c. The Contractor shall inform the officer of the forest department before proceeding with any activities like vegetation clearance and any type of construction work inside the government area;
- d. The cleared area for construction shall be replanted as per the relevant agency rules and regulations;

- e. The Contractor shall handover all the felled timber and timber products from the construction area over to landowners/Forest User's Group/District Forest Office depending from where the timber is felled;
- f. The Contractor shall take all reasonable steps to ensure that the staff and labour force does not engage in hunting or trapping of wildlife;
- g. The Contractor shall be liable for any illegal use of explosives for the purpose of fishing; and
- h. The Contractor shall not release toxic materials, or other pollutants that would damage aquatic life into Ghunsa Khola and other water bodies.

5.2.3 Socio-economic and Cultural Environment

- a. The Contractor shall minimize disturbance to religious sites, archaeological sites, public infrastructure and cremation areas through careful siting and scheduling;
- b. Any conflicts and problems arising during construction which cannot be resolved by the Contractor shall be referred to the Employer;
- c. The Contractor shall be responsible for any compensation due or reinstatement in respect of any damage caused by the construction activities to areas outside the site and no separate payment will be made in this regard;
- d. The Contractor shall erect necessary warning signs and barriers at construction areas and road bends for safety and to prevent accidents; and
- e. In events like blasting, the Contractor shall give notice to the public through various media prior to undertaking the blasting operations to prevent accidents.

5.3 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

- a. The Contractor shall submit an Environmental Management and Monitoring Plan which is to be implemented on site, for Employer's Review and Approval at within 120 days after the Commencement Date and in any event prior to any work proceeding which shall take the structure and approach of an environmental management system based on ISO 14001 and shall have as a minimum the following structure of content:
 - Environmental Policy Statement;
 - Environmental Management and Monitoring Manual;
 - Environmental Procedures Manual;
 - Environmental Controls;
 - Statutory requirements, including approvals and licences;
 - Assignment of responsibility for implementing, maintaining, assessing and monitoring each environmental control;
 - Procedures and instructions for implementing, maintaining, assessing and monitoring of each and every environmental control;
 - Reporting procedure (incident, compliant and non-compliance);
 - Emergency procedures;
 - Corrective action requirements and verification;
 - Records;
 - Environmental documentation; and

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- Environmental programs (training, right to know, internal audit, monitoring, etc.).
- b. The Contractor shall consider in the preparation of the Environmental Management and Monitoring Plan the following guidelines:
- Sets out full details of all activities that will avoid or mitigate environmental damage during construction and conforms with requirements described in the Employer's Environmental Management Plan and any further requirements of relevant authorities;
 - Conform with the Environmental Management Plan in undertaking the Works including erosion control plan and making good the Site prior to issue of the Taking-Over Certificate;
 - Submit regular monthly, or more frequently as required by the Employer, environmental compliance reports to the Employer in a form to agree with the Employer;
 - Ensure that the disposal of all surplus excavated materials, from whatever source, complies with all statutory and environmental requirements of Nepal, including any necessary landscaping and reinstatement of Site conditions;
 - As part of the Environmental Management Plan, the Contractor shall submit a detailed organization chart which shall be consistent with and based upon the Construction Organisation Chart, identifying the responsibilities, authority and interrelation of all personnel who manage, perform and verify work affecting the environment; and
 - The organization chart shall be specific to this Contract and shall identify the environmental management representative and the team of professionals where necessary to include the following expertise: (i) forestry, (ii) archaeology, (iii) environmental specialists. The environmental management representative shall act as the environmental coordinator for the Contractor in all dealings with the Employer and third parties. The environmental management representative shall have enough power to stop the work because of environmental reasons and shall report directly to the highest senior management in charge of the Project.
- c. The plan shall also stipulate the methods the Contractor will use to meet the specified requirements, together with any additional environmental measures which are necessary or appropriate to prevent or mitigate potential or actual environmental adverse impacts which are not foreseen or which are greater than those anticipated and which can be attributed to activities of the Contractor or to the Project and any activities related thereto, in order to minimise the impact of the project construction on the physical and local socio-economic environment.
- d. The Environmental Management and Monitoring Plan proposed by the Contractor shall be subject to the Employer's approval.
- e. The Environmental Management and Monitoring Plan shall be revised, supplemented and/or updated as deemed necessary, or, without relieving the Contractor of any of his obligations or responsibilities, as instructed by the Employer. Revisions, supplements and/or updates of the Environmental Management and Monitoring Plan shall be submitted not later than Thirty (30) days from the dated deemed necessary or from the date of the Employer's instruction.

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- f. The Environmental Management and Monitoring Plan shall be binding for the Contractor and all his Subcontractors.
- g. During the course of the Contract, environmental protection audits will be undertaken by the Employer and the Contractor to ensure compliance with the Contractor's Environmental Management and Monitoring Plan, and Environmental Protection System Manual, and with the requirements of the Specifications.
- h. The Contractor shall ensure that all works are undertaken in a manner that minimises the impact on the environment. In particular, the Contractor shall:
- Undertake all works in an environmentally sound manner;
 - Undertake no works outside of the designated Site without prior written approval from the Employer;
 - Minimise the effects of runoff and erosion at the Site and take all necessary actions to ensure that water quality in the Ghunsa Khola and other streams is not adversely affected; and
 - Ensure that at all times the work site is maintained in a neat and tidy condition.
- i. Before any work is carried out in any area of the Site, including access and temporary roads, all specified or approved environmental protection measures shall be in place and operational.

5.4 CONTRACTOR ENVIRONMENT POLICY

- a. The Contractor shall, in the form of an Environmental Policy Statement, state his target, management commitment, and strategy with regard to environmental issues of the Project. The Environmental Policy Statement shall be fully acknowledged by the senior management of the Contractor.
- b. The Environmental Policy Statement shall be displayed in a prominent position within the Contractor's offices on each worksite and communicated to all employees.
- c. The Environmental Policy Statement shall include all those requirements set on the ISO 14001 Standard, this means that the Contractor's management shall define the environmental policy and ensure that it complies with the following:
- is appropriate to the nature, scale and environmental impacts of its activities, products or services;
 - includes a commitment to continual improvement and prevention of pollution;
 - includes a commitment to comply with relevant environmental legislation and regulations, and with other requirements to which the organization subscribes;
 - provides the framework for setting and reviewing environmental objectives and targets;
 - is documented, implemented and maintained and communicated to all employees; and
 - is available to the public.

5.5 ENVIRONMENTAL PROTECTION SYSTEM MANUAL

- a. The Contractor shall produce the Environmental Protection System Manual under the Environmental Management and Monitoring Plan, which includes the following structure or similar:
 - 1) Environmental Management System
 - a. Introduction
 - b. Scope
 - c. Structure of the EMS
 - 2) Environmental Policy Statement
 - 3) Planning
 - 4) Implementation and Operation
 - a. Resources, roles, responsibilities & authority
 - b. Competence, training & awareness
 - c. Communication
 - d. Documentation
 - e. Control of documents
 - f. Operational control
 - g. Emergency preparedness and response
 - 5) Checking and corrective action
 - 6) Management review

5.6 ENVIRONMENTAL PROCEDURES MANUAL

- a. The Contractor shall produce an Environmental Procedures Manual under the Environmental Management and Monitoring Plan that shall include all the necessary environmental procedures to ensure compliance with all environmental legal requirements, the Employer's Environmental Management Plan and other needs as required by the Employer or legislation during the contract period. The Contractor shall prepare at a minimum the following procedures:
 - Environmental communication and reporting
 - Environmental training
 - Work instructions
 - Documents and records control
 - Legal and Permits compliance
 - Environmental internal audits and inspections
 - Environmental work areas clearance
 - Non-conformance and incident reporting
 - Emergency preparedness and response
 - Spill prevention and control
 - Handling of domestic, industrial and hazardous wastes
 - Air pollution control
 - Fire prevention and control
- b. Each procedure shall be prepared in a format acceptable to the Employer that shall include the following aspects: (i) purpose and scope; (ii) timing; (iii) responsibilities;

(iv) procedure; (v) register of environmental aspects. Also, the format shall detail the necessary information to keep control of it, dates, approvals and reviews and descriptions of the revisions made.

- c. The Contractor shall identify environmental issues by area or subject and identify the responsible persons who shall supervise the implementation of the procedures and communicate the needs of new procedures or modifications to those in use.

5.7 ENVIRONMENTAL RECORDS

- a. The Contractor shall produce and maintain formal records of environmental matter that shall include all the necessary environmental records that demonstrate compliance with legal requirements, implementation of the Environmental Management Plan, and other environmental aspects. Each record shall be in a format according to the information being kept. Records shall include, but not limited to the following:
- Monitoring results
 - Non-conformance and incidents reports
 - Training performed
 - Corrective actions
 - Permits
 - Internal audits performed
- b. The Contractor shall develop and incorporate any new records as required by the Environmental Management and Monitoring Plan or the Employer during the course of the Works.

5.8 ENVIRONMENTAL DOCUMENTATION

- a. The Contractor shall keep and maintain a copy of the following documentation on Site for reference by the Employer:
- Social and Environmental Impact Assessment;
 - Independent audits report;
 - Environmental resolutions;
 - Applicable environmental legislation;
 - Agencies inspection acts; and
 - Internal environmental reports.
- b. The Contractor shall incorporate any new documentation required by the Employer in order to address all environmental issues that have been identified during construction.

5.9 ENVIRONMENTAL SCHEDULE

- a. The Contractor shall produce a schedule of environmental activities, as part of the implementation of the Environmental Management and Monitoring Plan. The schedule shall address all environmental related activities that will be required for the works and shall include but not limited to:

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- Internal audit,
 - Regular inspections,
 - Training,
 - Monitoring,
 - Reporting.
- b. The schedule shall include activities, dates, personnel involved and manager responsible together with a narrative describing the activities.
- c. The schedule shall be adjusted as required to suit the findings of audits, inspections, etc., to ensure environmental regulatory compliance and good environmental practices.

5.10 CONTRACTOR'S ENVIRONMENTAL OFFICER

- a. The Contractor shall designate a qualified Environmental Management Representative , with appropriate certification from the relevant authorities, to act as the Environmental Officer, who shall have the authority to administer and be responsible for the implementation of, and ensure compliance with the Contractor's Environmental Plans and Manuals. In conjunction with the Safety Officer, he/she shall carry out frequent inspections at random intervals and monitoring activities at the working areas of personnel, materials, and equipment, and shall submit records to the Employer

5.11 PRESERVATION OF FLORA AND FAUNA

- a. The Contractor shall not be permitted to destroy, remove or clear trees, timber, scrub and other flora to an extent greater than that approved by the Employer, as being necessary for the execution of the Contract, nor use such material in the construction works.
- b. The Contractor shall ensure that all works are undertaken in a manner that minimises the impact on the local flora and fauna and shall take such measures as may be necessary to prevent his employees and those of his Sub-contractors from hunting and fishing, disturbing, capturing or destroying, and trading in wildlife or parts of these and any such flora and fauna as may be protected by relevant statutes.
- c. The Contractor shall ensure that the work site is kept clean and tidy and free from rubbish which would attract animal pest species.
- d. There shall be no feeding of native animals.
- e. If, in the opinion of the Contractor, a particular animal species becomes a pest by virtue of its nature, population numbers or other factors, the Contractor may apply to the Employer for a control programme to be initiated. Such application shall be in writing and shall contain justifications as to why a control programme is needed. The Contractor shall be responsible for obtaining necessary approvals from the relevant government or local authorities and for undertaking the control programme.

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- f. The Contractor will be held liable, and shall indemnify the Employer against any consequences for any act or omission which causes or allows to be caused a breach of this clause by its personnel or those of its Sub-Contractors.

5.12 SOIL EROSION AND SEDIMENT CONTROL

5.12.1 General

- a. All precautions shall be taken by the Contractor to prevent the erosion of soil from any lands used or occupied by the Contractor for the purpose of the Works. Precautions shall also be taken to prevent the deposition of excavated or eroded material in the bed or banks of Ghunsa Khola and other streams that may result from the execution of the Works.
- b. If, in the opinion of the Employer, the Contractor's operations cause erosion hazards, the Contractor shall undertake soil conservation measures in these areas as directed by the Employer. The details of proposed soil conservation measures shall be submitted by the Contractor to the Employer for his approval prior to the execution of the said measures.
- c. All soil conservation measures shall be carried out at the earliest possible time, as approved by the Employer, to ensure that the required protection is established most effectively during the progress of the Works.
- d. To this end, the Contractor shall take any or all of the following measures:
- Control the surface run-off by:
- Construction of stabilised diversion or perimeter cut-off drains to intercept run-off from undisturbed areas and to divert run-off around the works areas.
 - Installation of stabilised interceptor and collector drains.
 - Construction of sedimentation retention ponds.
 - Construction of gabion weir structures.
 - Limit movement of vehicles and contractor's equipment.
 - Minimize the disturbed area exposed by:
 - Staging operations.
 - Progressive stabilization of works as soon as they have been completed.
 - Provision of top soils, re-vegetation, sodding, grassing or other treatments to disturbed areas.
- e. All diverted and pumped water shall be discharged at locations from which it cannot re-enter the Works and in a manner which does not cause erosion, pollution or nuisance to landholders, Other Contractors employed by the Employer or other persons within or adjacent to the Site.

5.12.2 Sedimentation Ponds

- a. The Contractor shall design and construct sedimentation ponds for the treatment of construction waste water, particularly possible turbid water from quarries, dump sites, batching and aggregate crushing and screening plants. Turbid water from dumpsites may also be avoided by appropriate compaction, and subsequent re-vegetation using topsoil.

- b. Rivers and streams shall be protected from direct or indirect spills of pollutants such as garbage, sewage, cement, oils, fuel, chemicals, aggregate tailings, wash and waste water or organic material resulting from the Contractor's activities by construction of sedimentation ponds. In the event of a spill from such ponds, prompt action shall be taken to clear polluted or affected areas.
- c. If embankments are built to create sedimentation ponds, they shall be constructed on a foundation cleared of topsoil and other unsuitable material. Suitable material from required excavation or borrow areas shall be used to form the embankments. All excavated surplus or unsuitable material shall be disposed of in approved disposal areas.
- d. The sedimentation ponds shall be emptied only by discharge from outlet pipes following treatment of the stored water. Before discharge, the stored water in the sedimentation ponds shall be dosed with an approved flocculation agent, and/or a sufficient retention time for sedimentation should be allowed. Such water shall not be discharged if the non-filterable residue (suspended solids) in the discharge exceeds 50 mg/litre and total filterable residue in the discharge exceeds 600 mg/litre. The Contractor may be required to monitor turbidity, concentration of suspended solids, and/or TDS before the water will be discharged from the sedimentation ponds.
- e. An approved oil skimming device shall be provided for the removal of oil from the surfaces of the ponds.
- f. The sedimentation ponds shall be kept empty for the longest practicable periods. In Commencement drainage during wet weather shall be promptly corrected. Water in the ponds shall be treated within 24 hours before water level of the sedimentation ponds reaches discharge levels.

5.12.3 Water Quality Standards

- a. Within 120 days from the Commencement Date, the Contractor shall submit his Water Quality Monitoring Plan, which is to be implemented on the site.
- b. The plan shall specify the methods the Contractor will use to monitor and meet the water quality standards, in accordance with the Nepalese National Standards and/or IFC Guidelines (whichever is the stricter), together with measures which are necessary or appropriate to prevent or mitigate potential or actual impact on the quality of water, which are not foreseen or which are greater than those anticipated, and which can be attributed to activities of the Contractor, in order to minimise the impact of the project construction on the local environment and water supply.
- c. The Water Quality Monitoring Plan proposed by the Contractor shall be subject to the Employer's approval.
- d. The Contractor shall ensure that all waste water is treated prior to being discharged to water courses. The Contractor shall regularly test and record the water quality in sedimentation tanks and settling ponds prior to being discharged. The Contractor shall obtain the Employer's approval for such waste water discharge system. Where necessary, fence, entrance gate, or other relevant facility shall be installed to prevent indiscriminate access or use.

- e. If poor water quality is detected, the Contractor shall immediately submit mitigation measures to the Employer for approval. Following the notification of approval by the Employer, the Contractor shall implement them immediately.
- f. Grease and waste oil shall be prevented from entering waterways. Grease traps shall be installed at maintenance workshops and regularly cleaned out to ensure clean runoff from these sites, even during periods of rain. Oil separators shall be setup at maintenance work shops. The Contractor shall obtain the Employer's approval for grease and waste oil trap/separator system
- g. The Contractor shall implement the following mitigation measures:
 - pit toilets at construction sites
 - Standard toilets at camps with a central wetland type treatment facility or with other appropriate type treatment facility
 - Settlement pond or treatment plant for concrete batching plant
 - Fraction fence installation work
 - Sedimentation tanks to arrest the introduction of total suspended solid in site drainage water, and regular maintenance of these (sediment removal)

5.13 SPOIL AREAS

- a. Spoil management measures to be implemented by the Contractor shall include but not limited to the following conditions:
 - Contractor shall not dispose excess spoil, at designated and pegged disposal areas, then been approved by the Employer.
 - Contractor shall not side-cast the excess spoil over the edge of excavation sites or place spoil in drainage lines or water courses, above houses or at other sites where it is likely to cause damage to structures or natural features.
 - The Contractor's must flow the instructions to the construction workforce on the approved fill disposal locations and shall be responsible for supervision of the correct placement of fill at sites.
 - Topsoil (where present) shall be well stripped and stockpiled prior to spoil placement for future landscaping use after closure of the site.
 - Contractor shall progressively install retaining structures, benches and drains to ensure land form stability and minimize erosion and sedimentation. This will include stabilizing the toe of the spoil disposal sites that front onto the Ghunsa Khola using rock gabion walls or other materials designed by the Contractor and approved by the Employer, and benching the fill batters of each disposal area that exceeds 7 m in height.
 - Contractor shall properly layer and compact the spoil as the material is placed, with daily inspection by the Employer.
 - After a spoil disposal area is closed, top soil spreading and site re-vegetation works of the final land form must be carried out, as designed by the Contractor to the satisfaction of the Employer;
 - The Employer shall inspect and issue no-objection for the final land shaping at each designated spoil disposal site prior to and following top-soiling.

-
- b. A report on environmental management and monitoring shall be prepared for each spoil disposal site.

5.14 QUARRY AND BORROW AREAS

- a. The Environmental Management Plans for quarry and borrow areas shall include:
- Description of the measures taken to minimise the quarry and borrow areas and the efforts planned to reduce the visual impacts.
 - Measures to be taken at the closure of the quarries to re-establish vegetation, natural water courses and drainage pattern.

5.15 CONTROL OF SOIL, WATER AND AIR POLLUTION

5.15.1 General

- a. The Contractor shall design, construct, maintain and operate suitable pollution control facilities to prevent air pollution, dust, and discharge of water containing polluting matters or visible suspended materials into rivers, streams or existing drainage systems. Such polluting matters includes but are not restricted to dust, refuse, garbage, cement, concrete, sewage effluent, industrial waste, oil and other petroleum products.

5.15.2 Hazardous Material and Chemical Store, Handling, Waste and Spillage Management

- a. Hazardous materials and chemicals that will be used during the construction include explosives, fuel and oils, paints, solvents, acids, concrete additives and other materials. The Contractor shall develop and submit to the Employer for approval, detailed plans for transport and handling/storage of all such materials and for the collection and handling of the corresponding wastes. The plan shall foresee:
- Conditions for handling and storage of fuel, explosives and other chemicals to prevent accidental pollution and injury.
 - Facilities for collection of waste oil products. The locations for machinery and vehicle repair, maintenance and washing should be equipped with concrete floors and provided with oil skimmers / separators and collection facilities. Drainage from fuel storage and machinery maintenance areas shall be treated to remove oil and/or fuel. The oil collected in this manner should be disposed of or reused safely.
 - Diesel fuel shall be stored in standard skid tanks with concrete bunker / building, which can provide 110% volume of the total capacity of the skid. The skid tank shall be located at least 100 metres away from any watercourse.
 - The Contractor shall establish a standard procedure for loading the diesel into the skid tank to prevent any oil spillage and soil contamination from occurring.
 - Spent oil or used oil generated from the workshop maintenance yard is categorised as a scheduled waste. This scheduled waste is to be stored in containers, with proper bunds, which are able to prevent spillage or leakage of the scheduled wastes into the environment. The containers of the scheduled wastes shall be clearly labelled for identification and warning purposes.

- The Contractor shall engage a licensed Subcontractor to collect, transport and dispose all the scheduled waste (spent oil) generated at the project site.
- The oil waste should not be allowed to be used for uncontrolled burning or heating in the villages or the labour camps. Oil should not be allowed to be spread on roads or dumpsites as a mean of dust control.
- Soil contaminated by fuel or oil leakage shall be removed and placed in approved disposal areas.

5.15.3 Waste Management

- a. The Contractor shall be responsible for the management, collection, and disposal of all construction and domestic waste generated at construction sites, work sites and workforce camps. The Contractor shall manage waste disposal at Project sites by providing
 - separate containers for the collection of recyclable /reusable construction material waste and non-recyclable waste at work sites,
 - waste disposal containers for the collection of domestic rubbish generated at work sites and work force camps,
 - collection and storage of waste oils, fuels and chemicals in sealed containers in bunded areas for subsequent on-site recycling or safe disposal.
- b. Waste materials that cannot be reused or recycled shall be burned or land-filled in designated areas on-site in appropriate manner. The burning of waste shall be favoured -filling where feasible, to reduce the potential for ground water contamination. If waste is to be land-filled, it shall be covered with a layer of soil at the end of each day to reduce odours and prevent scavenging. Following the completion of filling, the land fill shall be capped with a 600 mm layer of soil, then top-soiled and re- vegetated or treated with an approved method of the Employer.
- c. The Contractor shall be responsible for collect and dispose of garbage, rubbish and waste from its construction activities, housing, camp accommodations, camp amenities, workshops, stores, offices, public areas, etc. The Contractor shall construct and operate the necessary collection facilities such as diversion mounds, ditches, drains, dams, oil separation sumps, sedimentation ponds etc.to prevent such contamination and to settle out suspended matter and shall dispose of collected materials as approved by the Employer.
- d. The Contractor shall ensure that rubbish collection and disposal do not encourage scavenging by animals and birds.
- e. Waste materials shall be reused or recycled on-site where possible, to minimize the generation of waste. In particular;
 - Excavated rock and spoil material shall be used where possible as aggregate in concrete, in dam wall construction, as road base and for road maintenance.
 - Cleared vegetation shall be made available to local communities or stockpiled for use during re-vegetation.
- f. The Contractor shall develop a detailed Waste Management Plan and submit to the Employer for approval within 120 days of the Commencement Date, for collection,

transport and handling / storage of waste. Particular care has to be taken to avoid spreading of waste, plastic etc. in the project site or labour camp surroundings. The waste handling shall be designed with an ecological, an aesthetic and a hygienic perspective. The plan shall include the following requirements:

- Waste from construction activities shall be cleared/collected, at a minimum, daily and shall be disposed of at designated waste sites.
- Waste collection containers shall be placed at regular intervals at the project site and in labour camps. These containers should be marked with clear labels for 'organic', 'paper' and 'other waste' for sorting waste collection.
- Garbage shall regularly be collected and disposed at designated sites, located above the 20-year flood levels of adjacent water courses and at least 2 km from the nearest village.
- The disposal sites shall be protected from contaminating groundwater by an impermeable membrane or clay. Leachate shall be collected and properly treated before released into water courses.
- Garbage collections shall be made on a daily basis and the services shall be continued until completion of the construction work.
- Once a week the disposal sites shall be compacted and covered with soil. At closure the site shall be covered with at least 1.5 m of topsoil.

5.15.4 Wastewater Management

- a. The Contractor shall supply, install, operate, maintain and subsequently remove unless otherwise specified elsewhere in the Contract, the adequate treatment process for disposal of sewerage from all temporary buildings including houses, offices, camps and work sites, etc. to be constructed by the Contractor. Sewage from these facilities shall be collected and treated in septic tanks, or by aeration methods, chemical or other approved methods. Effluent from the treatment processes shall be discharged into absorption trenches. Solid waste shall be disposed of in a hygienic manner as approved.
- b. The Contractor shall also install operate and maintain temporary toilet facilities at all work sites. The facilities shall be complete with adequate closets, urinals and hand basins, septic tanks, absorption trenches or other sewerage disposal installations. The facilities shall be for use of its own personnel, Subcontractors' personnel and those of the Employer. On completion of the Works, the temporary sewerage/sanitation systems shall be removed and the Contractor shall fill in all tanks, trenches and other sewage treatment installations.
- c. The Contractor shall take all reasonable precautions to prevent silting, erosion of beds and banks and pollution of rivers, streams and water courses; and interference with the supply to or abstraction from underground water sources and pollution of the water.
- d. If any accidental pollution of any river should occur, the Contractor shall report the fact as quickly as possible to the Employer in no circumstances later than 24 hours and steps should be taken to correct above.

- e. Wastewater from the camps and offices shall be collected and properly disposed of. The sanitary water and the grey water (used household water) should be kept separate. The grey water should be infiltrated in the ground at sites with soils of suitable filtering capacity and minimum 500 m away from watercourses and water supply springs in the area.
- f. The sanitary water should be treated by compact treatment units or by septic tanks before infiltration in the ground. At least one chemical portable toilet shall be installed for each 20 workers.

5.16 EMISSION, DUST AND NOISE CONTROL

5.16.1 Emission, Dust and Noise Control

- a. The Contractor shall prepare an emission and dust control plan for the approval of the Employer, within 120 days of the Commencement Date.
- b. The emission and dust control shall be based on Nepalese standards for ambient concentrations of particulate matter. The emission and dust control plan shall identify all relevant places for emissions and dust control and monitoring. This includes roads, quarry sites, crushing and concrete batching sites, earthworks, waste burning sites, etc.
- c. Ambient air quality measurements shall be carried by monitoring the particulate matter (PM₁₀) level at sites where construction related transport on dirt roads passes populated areas and if stone crushing takes place close to populated areas.
- d. The Contractor shall have available at site an approved particulate matter measuring equipment and shall take regular measurements as directed by the Employer.
- e. The WHO guidelines for particulate matter (IFC, 2007) are as follows:

	Averaging Period	Guideline value (µg/m ³)
Particulate Matter (PM ₁₀)	24 hours	50
Particulate Matter (PM _{2.5})	24 hours	25

- f. Water spraying on all roads used by the Contractor and at construction sites using mobile water tankers shall be implemented to control dust pollution. The frequency of water spraying shall be 2 to 3 times per day for normal weather conditions. The water spraying frequency shall be increased to 4 to 6 times a day during dry and windy seasons.

5.16.2 Noise Control

- a. The Contractor shall prepare a noise emission and control plan for the approval of the Employer, within 120 days of the Commencement Date.
- b. In addition to complying with the requirements the Contractor shall comply with the requirements of Nepalese National Environmental Standards.
- c. The Contractor shall have available at site an approved sound level meter and shall take regular measurements of noise levels at critical spots, as directed by the

Employer, including the rock quarrying site, other areas of outdoor rock drilling operation, and at villages with heavy construction traffic.

- d. The Contractor shall inform, through the Employer, to local villages about construction schedules, likely commencement and completion dates of work at each site, and the dates and times when blasting will be conducted.
- e. The Contractor shall only permit the use of air horns around villages for safety purposes. Blasting shall be required at most construction sites. Uncontrolled blasting can cause extensive damage. Controlled blasting shall be used during construction to limit the volume and extent of rock throw, and to reduce the disturbance to local villages. Maximum charge weights shall be determined from test blasting or international practical methods.
- f. The Contractor shall seek approval for blasting from the Employer. The Employer will inspect proposed blasting sites prior to granting approval. The Employer will inspect blasting operations during the weekly site inspection. The Contractor shall provide compensation to house owners, if structural damage occurs as a direct result of Project construction activities.
- g. The Contractor shall minimize noise and vibration impacts at construction sites by:
 - locating stationary plants (e.g. Generators) as far away as possible from local villages and workforce camps
 - maintaining all equipment to manufacturers' General Technical Specifications
 - fitting mufflers on road vehicles and construction equipment
- h. The Contractor shall take the provisions required to assure that noise from his construction activities and from the operations of his industrial plants are within the World Bank Environmental, Health, and Safety Guidelines (IFC, 2007) as shown in the table herein below.

Receptor	One Hour L_{eq} (dBA)	
	Daytime (07:00–22:00)	Nighttime (22:00–07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

- i. The Contractor shall provide ear protectors to all personnel subject to noise levels above 85 dB on a continuous basis during work shifts.

5.17 ENERGY CONSERVATION

- a. The Contractor shall prepare an Energy Conservation Plan for the approval of the Employer, within 120 days of the Commencement Date, to minimise the energy used in the construction of the project. The Energy Conservation Plan is to cover all aspects of the Contractor's operations.

5.18 WATER CONSERVATION

- a. The Contractor shall prepare a Water Conservation Plan for the approval of the Employer, within 120 days of the Commencement Date, and is to cover all aspects of the Contractor's operations.

5.19 CONTAMINATION OF LAND

- a. The Contractor shall prepare a plan dealing with Land Contamination for the approval of the Employer, within 120 days of the Commencement Date, and which shall cover all aspects of the Contractor's operations.

5.20 OFFSITE WASTE

- a. The Contractor shall prepare a Plan dealing with off-site waste caused by the Contractor's activities, for the approval of the Employer, within 120 days of the Commencement Date and which shall cover all aspects of the Contractor's operations.

5.21 LANDSCAPING AND RE-VEGITATION

- a. A joint survey of all the areas identified for the temporary use for construction purposes, and assets present on those areas, shall be undertaken by the Employer and the Contractor prior to hand-over of the areas.
- b. The Contractor shall prepare and submit to the Employer for approval a Landscaping, Re-vegetation and Replacement of Assets Plan encompassing all areas temporarily used for construction purposes, such as camps, areas for industrial plants, spoil areas, quarry, construction roads, etc., within 120 days before implementation.
- c. Requirements to be met by the Contractor are the following:
 - All land where the natural vegetation has been destroyed or damaged shall be restored as far as possible to its initial status.
 - Spoil heaps shall be profiled to allow for future use and erosion protection;
 - Excavated topsoil shall be used for landscaping and if possible, for agriculture;
 - All damaged assets (structures, fencing, etc.) shall be restored to their former condition;
 - Land shall have cleared of any waste or contamination;
 - Any modifications to drainage channels, irrigation channels, water retaining walls or bunds, shall be reversed;
 - Drainage shall be restored should it have been impacted by construction activities;
 - Only indigenous and preferably local plant species shall be used for replanting and erosion control. The most relevant methods for creating a vegetation cover would

be; close turfing, spot turfing, hydroseeding or vetiver. Which method to be used will depend on the soil conditions and slope; and

- The Contractor shall be held liable, and shall indemnify the Employer for any costs caused by the Contractor, its personnel or its Sub-Contractor's actions during the construction of the Works.
- d. Landscaping and re-vegetation shall be implemented as soon as possible after the completion of different construction activities so as to minimise the periods when bare soil will remain exposed.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 6
REPORTING AND PROGRAMMING

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CHAPTER 6 - REPORTING AND PROGRAMMING

6.1 PROGRAMME

6.1.1 General

- a. The Contractor shall employ an experienced Planning and Scheduling Engineer, who will be responsible for the planning, preparation and updating of programmes and progress reports. Programmes shall be realistic and adequately detailed and shall be used by the Employer as a basis for monitoring progress.
- b. Where access must be given to Subcontractors for the erection of plant and equipment while his own operations are still in progress, the Contractor shall programme the work in such a manner that the erection operations can be carried out in safety and without undue obstruction or hindrance.

6.1.2 Submission of Works Programme

- a. Within sixty (60) days after the Commencement Date, the Contractor shall submit the Works Programme covering i) the design, construction and test on completion of Civil Works and ii) the design, manufacture, delivery, erection, testing and commissioning of the Hydro-mechanical Works, in sufficient detail to define the various parts of the Work in accordance with Clause 41 [Program and Progress] of the Conditions of Contract.
- b. The methodology and the sequence shall be so planned as to provide proper safety and avoid interruption to the operation and maintenance of the Facilities. The Works Programme shall be prepared using a programming software acceptable to the Employer.
- c. The order in which the Contractor proposes to execute the Permanent Works is subject to adjustment and approval by the Employer, and the Contractor shall have allowed for any reasonable and necessary adjustments required by the Employer during the course of the Works.
- d. In preparing each Programme, the Contractor shall make due allowances for possible delays, which may be caused by floods, inclement weather, all types of holiday periods, local working conditions, problems relating to maintaining equipment, problems relating to obtaining materials and supplies, and similar items. Under no circumstances shall the Programme show a completion date in excess of the “Time for Completion” stated in the Contract Data of the Particular Conditions of Contract.
- e. Further, within the time specified above, the Employer shall be given by the Contractor the following documents in the form agreed and approved by the Employer for the purpose of monitoring the progress of the Works.
 - A detailed programme, in the same form mentioned above, covering the activities for the first six (6) months of the Contract, including mobilization, transport to the Site, and erection of the Temporary Civil Works.
 - A detailed programme covering the activities for the first six (6) months, including design and material procurement of the Plant.
 - List of construction equipment to be used for the Civil Works.

- Forecast of total labour requirements for the Works.
 - Site management organization chart for the first six (6) months.
 - Histogram of staff requirements.
 - Work schedule presented in an S-Curve showing the proposed weighted monthly percentage of work accomplished for Civil Works.
 - List of those drawings, which the Contractor will submit during the first six (6) months of the Contract period.
- f. During the construction period, the Construction Schedule shall be closely monitored and kept current, and in accordance with Clause 41[*Program and Progress*] of the Conditions of Contract, revised schedules shall be furnished to the Employer as and when directed.
- g. The Contractor shall provide the Works Programme in the form of a critical path network or a time-based linked bar chart produced as a result of a critical path analysis and must abide by the constraints. It shall show the level of detail appropriate to each stage of the Works and all activities and constraints, each of which shall be given a short title. All activities and events shall be numbered and annotated with the earliest and latest event dates. In constructing the critical path network of his Works Programme, the Contractor shall comply with the following:
- no circular loop linkages between any two activities;
 - the units of time used for activity durations shall be days. Durations and lags must be measured as whole number of days.
 - show early and late starts and finishes, and free and total floats;
 - any grouping together of activities must be represented by a heading activity, below which these grouped activities must be embedded in such a way that the heading activity acquires the overall duration of the grouped activities; and
 - the calendar recognising all holidays, leave periods and religious events which impact on productivity.
- h. It is essential that the Contractor provides a high level of control over the programming in order that progress is not disrupted in any way whatsoever and absolute safety is assured on all parts of the Site and the Facilities.
- i. The Works Programme shall include, but not limited to, the following items:
- All constraints specified for maintaining uninterrupted operation and maintenance of the Facilities, available working seasons and agreed milestones;
 - Mobilisation of Contractor's site establishment, facilities and major items of Contractor's Equipment;
 - Provision of site offices and facilities for the Employer;
 - Development of the construction sequence, timing and methods, investigation and design of works to be designed by the Contractor, design and checking of the Temporary Works and temporary conditions of the Permanent Works and approvals;
 - Development and approval of the Quality Assurance Plan, Health and Safety arrangements including Site Safety Manual, and contract administration systems;
 - Independent design checks and reviews;

- Procurement of Materials and Contractor's Equipment (covering the order, manufacture, transport, receipt and associated critical inspection, test and approvals activities);
 - Investigations for quarries areas;
 - Submission of samples and product data, trials and approvals;
 - Location and protection of utilities/services, and relocation as necessary;
 - Construction of Temporary Works;
 - Construction and removal of cofferdams, and access and haulage roads and bridges;
 - Materials/equipment delivery and reception at Site;
 - Fabrication, inspection and testing of equipment, systems and components at workshop and Site;
 - All Employer reviews, consents and approvals required under the Contract; and
 - Any other details required by the Employer.
- j. At the time of presentation of the Works Programme the Contractor shall provide a detailed breakdown of his resource inputs and rates for completion of the various stages of the Works.
- k. The Employer reserves the right to permit the Contractor to commence the Works at the site only after submission of the documents specified above. Upon approval by the Employer, it shall thereafter be referred to as the Schedule of Work. However, the no-objection of such Schedule shall not relieve the Contractor of any of his duties or responsibilities under the Contract.
- l. During the contract period, the Contractor shall submit to the Employer:
- A detailed Schedule for each consecutive six (6) months periods at least two (2) months prior to the commencement of the relevant period, with a histogram of staff requirements for the period.
 - A list of drawings (including the order and anticipated date of issue of such drawings) which the Contractor may require the Employer to approval during each consecutive six (6) months period at least three (3) months prior to commencement of the relevant period.
- m. All the documents to be submitted in accordance with this Clause shall contain the information required by the Employer. However, the Employer shall be entitled to request the Contractor to revise any approved schedule from time to time in accordance with Clause 41[*Program and Progress*] of the Conditions of Contracts.
- n. In addition to the documents and information as required above the Contractor shall supply to the Employer at such times as the Employer may direct during the progress of the Works such further or special written particulars and information as required by the Employer to enable a progress record to be maintained in respect of the Works or for the supervision of the Works.
- o. The Works Programme shall include all the activities listed above but with further breakdown of items and details as may be required by the Employer.
- p. Following review of the Works Programme by the Employer and consultation with the Contractor, if requested to do so, the Contractor shall amend, reschedule and resource the activities as agreed or as otherwise instructed by the Employer and

resubmit the amended Works Programme to the Employer within Fifteen (15) days of the request for amendments.

- q. The Contractor shall not amend the accepted Works Programme without the direction of the Employer. In accordance with 41[*Program and Progress*] of the Conditions of Contract, any event giving rise to a need to amend the Works Programme shall be notified to the Employer as soon as practicably possible after its occurrence and a revised Works Programme submitted accordingly.
- r. On acceptance of the Works Programme or a subsequent amendment or revision thereof, the Employer shall return a copy to the Contractor marked accordingly.
- s. Until such time as the Programme has been agreed and accepted, work shall commence and proceed and progress shall be monitored against the programme submitted with the Tender as amended at the award of Contract.
- t. Before commencing the Works or any portion thereof, the Contractor shall furnish to the Employer with full information as to his plans and methods for carrying out the Works or any portion thereof.

6.1.3 Site Conditions

- a. The Contractor's program shall make adequate allowance for the seasonal site conditions anticipated at the site.

6.1.4 Review of Progress

- a. During the execution of the Works, the Contractor shall monitor the activities relative to the Works Programme or an accepted revised Works Programme and progress shall be reported on a weekly and monthly basis. All variances shall be promptly reported. The future impact of major variances shall be determined and analysed by the Contractor, and necessary corrective measures established, subject to the consent of the Employer.
- b. As part of the Monthly Progress Report described in Clause 6.2.2 of this Chapter, the Contractor shall incorporate the Works Programme to show actual progress against the accepted baseline program.

6.2 PROGRESS REPORTS

6.2.1 General

- a. In accordance with Clause 41 [Program and Progress] of the Conditions of Contract, the Contractor shall prepare monthly progress reports, which shall be submitted to the Employer in a regular basis.
- b. Reporting shall continue until the Contractor has completed all work and the Taking-Over Certificate for the Works.

6.2.2 Monthly Reports

- a. The Contractor shall, before the tenth (10) day of each month, submit four (4) hard copies and Electronic Copy to the Employer of a monthly progress report detailing the progress and financial status of the Works for the previous month on a format

acceptable to the Employer. The Report shall contain activities which were scheduled to be in progress and activities actually in progress during the month, together with the Contractor's estimate of progress achieved and actual/forecast start and/or completion date for each activity.

- b. The monthly report shall also incorporate monthly bar chart type of schedule at the end of each month to show the activities, which is proposed to be accomplished during the successive month. The schedule shall show, by means of bars, the days within the month on which each main activity will be executed. The submitted monthly reports shall be subjected to review by the Employer.
- c. The schedule shall contain arrival and leaving schedule of the Contractor's staff and details of any matter which may interfere with the works during the month.
- d. Each Monthly report shall Include, but not limited to, the following:
 - A table showing the accurate position of activities associated with the design, material procurement, manufacture, shop tests, shipping, site erection, testing and commissioning during the month.
 - A table showing those activities scheduled to be conducted in the next three month.
 - Number and classification of the Contractor's manpower (skilled and unskilled) employed during the month, and a statement on labour relations and an explanation of any actual or potential problems.
 - A list of expatriate personnel and local supervisory staff (number, name and designation) employed during the month.
 - Electric power consumption at various locations.
 - A list of accidents involving, hospitalization and/or death of any person, damage of equipment requiring major repairs and a list of any major thefts.
 - Details of any delay affecting activities such as design, material procurement, manufacture, shop tests, shipping, site work /site installation, testing and commissioning.
 - Financial status of the Works, including a list of payments received during the month and the amount of any invoice submitted but not yet paid and a list of claims (if any) submitted during the month, including claim amounts and extension(s) of time.
 - A list of each Milestones, including Temporary Works, performed during the month, and illustrations showing the exact the location of Work done.
 - A quantity list of the Contractor's construction material consumed or used during the month and accumulated totals thereof and materials now on site.
 - A list of major work activities scheduled to be carried out in the following three month, and estimated quantities thereof.
 - A table showing working hours of construction equipment, a list of equipment including a list of standby equipment, and a list of equipment not available for operation.
 - Charts and detailed descriptions of progress, including each stage of design (if any), Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection, testing: and including these stages for work by each Subcontractor;
 - Photographs showing the status of manufacture and of progress on the Site;
- For the manufacture of each main item of Plant and Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:
 - commencement of manufacture,

- Contractor's inspections,
- tests, and
- shipment and arrival at the Site
- Records of Contractor's personnel and equipment as per Clause 18[*Personnel and Equipment*] of the Conditions of Contract;
- Copies of quality assurance documents, test results and certificates of Materials;
- List of notices given under Clause 34[*Employer's Claims*] of the Conditions of Contract;
- List of notices given under Clause 35[*Contractor's Claims*] of the Conditions of Contract;
- List and status of all Variations;
- Health and Safety statistics, including details of any incidents or activities;
 - Public relations issues or incidents;
 - All aspects of environmental monitoring and management including the Contractor's Environmental performance and all environmental issues that have arisen during the period;
- Critical path analysis updated to reflect the actual progress of the works;
- S-curve updated to display actual versus early and late planned progress;
- Comparisons of actual and planned progress;
- Details of all matters affecting, or likely to affect, the progress or cost of the Works and particulars of the preventative and remedial measures which have been, is being, or may be taken in respect of those matters;
- Any other matters as may be set out in the Contract or other information reasonably required by the Employer from time to time; and
- Such other matters as are required to be included, in accordance with the Employer's Requirements.

6.2.2 Progress Photographs

- a. The Contractor shall, throughout the Contract period as requested herein, furnish to the Employer colour photographs (of size not less than 8 cm x12 cm) of the work in progress. The colour photographs shall be taken at the start, during stages and at completion of each major component of the work and at times as directed by the Employer. Copies of each photograph with brief explanation shall be attached to the applicable monthly report. Soft copy of the photographs shall be submitted to the Employer together with monthly report.
- b. A brief description and the date of each photograph shall be indicated.
- c. The electronic version of the photographs shall be the property of the Employer, and no print from the electronic version shall be supplied to any person unless so authorized by the Employer. Upon completion of the Project, the Contractor shall submit three (3) sets of the electronic version of all the photographs arranged chronologically with brief explanation in a portable hard disk to the Employer.

6.2.3 Site Diary

- a. The Contractor shall keep a true Site diary for daily record of weather conditions on Site, listing major plant, equipment, machinery, supplies, materials, labour, etc.,

employed or used, respectively, for all and any Temporary and Permanent Civil Works and Hydro-mechanical Works.

- b. This diary shall furthermore describe all special events, additional work, accidents, malfunctioning, commencement and completion of structures and the likely events, which might affect the work in anyway. While this diary shall generally be kept by the Contractor, the Employer has the right to add any entry he considers necessary or desirable at any time.
- c. The Contractor's and the Employer's signatures shall by no mean simply agreement with content, interpretation or deductions of the other party's entries, but only certify to have taken notice thereof.

6.2.4 Failure to Submit Reports

- a. If the Contractor fails to submit the Progress and Environmental reports in accordance with Clause 41 [*Progress Reports*] of the Conditions of Contract and this Chapter, the Employer may, at the Employer's sole discretion, withhold part of the payment due to the Contractor relevant to the period corresponding to the missing report/s, until such time as the reports have been submitted.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 7
MEETINGS

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CHAPTER 7 -MEETINGS

7.1 GENERAL

- a. The Contractor shall attend regular design meetings, site management meetings, progress meetings, and any other meeting deemed necessary to resolve design, technical, commercial and progress issues, which shall be chaired by the Employer. Invitation and agenda shall be prepared and distributed by the Contractor to each attendant. During the design, engineering and procurement phases, these meetings will be held in the Employer's offices or at some other suitable location. Once construction activities commence, all meetings will normally be held at the Site.
- b. The Contractor shall be required to attend regular monthly Progress Meetings with the Employer where the progress of the design, procurement and construction will be reviewed. Such meetings shall normally be held monthly, or at any other time required by the Employer or the Contractor.
- c. The Contractor shall present with progress reports in accordance with Chapter 6 – Reporting and Programming to the Employer. The Contractor shall present at the meeting the actual progress in the previous month and the forthcoming one-month.
- d. The minutes of the meeting will be prepared by the Employer during the meeting and will be shown on a monitor to the participants for agreement.
- e. Before the meeting closure, the agreed minutes of the meeting will be signed by the Employer and all the Participants. The minutes will be deemed to be a true record of the declarations, instructions and decisions taken during the meeting.
- f. The Contractor shall reproduce and distribute copies of minutes signed by the Employer and all the participants within 3 days after each meeting.
- g. The Contractor shall also attend a weekly meeting with the Employer with detailed programmes showing separately the excavation, support (if any), grouting, instrumentation, reinforcement, formwork, concreting, earthworks and hydro mechanical works and other Works anticipated over the forthcoming two weeks period as well as the progress achieved over the preceding week.

7.2 SPECIAL MEETING

- a. The Employer may call for, at his discretion, a special meeting, to be held at the Employer's site office, with the Contractor. The objective of the said meeting will be to scrutinize the progress of the Work and the Contractor's anticipated schedule and to discuss technical details and all other matters related to the project in order to achieve a smooth and undisturbed progress of Work as well as expeditious supply, delivery or construction. The Contractor's Representative as well as other authorized personnel and representatives of the Subcontractor(s), if deemed necessary, shall be present at the meeting.
- b. If the Employer considers the progress of any part of the Work to be unsatisfactory, the Employer will be free to call a "Delay Meeting," either at the Employer's office or at the Contractor's head office, as deemed necessary.
- c. The minutes of the meeting prepared by the Employer during the meeting will be shown on a monitor to the participants for agreement. Before the meeting closure, the

agreed minutes of the meeting will be signed by the Employer and all the participants. The minutes will be deemed to be a true record of the declarations, instructions and decisions taken during the meeting.

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CHAPTER 8
FACILITIES

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CHAPTER 8 - FACILITIES

8.1 GENERAL

- a. The Contractor shall provide and maintain the facilities mentioned in this part for the use of the Contractor and the Employer as applicable, for the duration of the Contract. The Contractor shall be responsible for providing and maintaining the following facilities:
- i. Permanent and temporary site access roads/bridges;
 - ii. Contractor's accommodation;
 - iii. Contractor's general labour accommodations;
 - iv. Contractor's office buildings;
 - v. Material Testing Laboratories including all furniture and accessories/equipment;
 - vi. Contractor's construction yard, equipment yard and storage;
 - vii. Site Cabins for Employer's use;
 - viii. Site Cabins for Contractor's use
 - ix. Sanitation and cleaning for Contractor's facilities;
 - x. Water supply;
 - xi. Sewerage and sewage treatment;
 - xii. Utilities;
 - xiii. Contractor's Messing/Catering Facilities;
 - xiv. Medical Facilities;
 - xv. Contractor's Laundry Facilities;
 - xvi. Fire Control;
 - xvii. Power, Lighting, Communication and Access;
 - xviii. Administration and Maintenance;
 - xix. Security Fencing;
 - xx. Site Security;
 - xxi. Name Board and Signs; and
 - xxii. Any other facilities mentioned in this Chapter 8.
- b. Within Thirty (30) days after the Commencement Date the Contractor shall submit general drawings, proposals and a programme for the establishment of the Contractor's facilities (Permanent and Temporary) to the Employer for approval. All facility shall be completed later than 180 days after the Commencement Date.
- c. The Contractor shall also obtain all necessary approvals from local, statutory or other authority before construction.
- d. When directed by the Employer, the Contractor shall dismantle and remove from the Site all buildings and related facilities provided under this Chapter, which are no longer required by the Employer or the Contractor. After such removal the area shall be reinstated to a condition similar to adjacent natural areas as per the Environmental Management and Monitoring Plan to the satisfaction of the Employer. Vegetation in national forest areas stipulated in regulations in country shall not be cut except where necessary and then only after the approval from the relevant authorities.

- e. The Contractor shall be responsible for keeping his site establishment areas and temporary buildings in a clean, sanitary and orderly condition and to the satisfaction of the Employer. The Contractor shall remove all refuse, debris and other objectionable materials before leaving the camp.
- f. Site buildings shall be maintained in good condition and appearance for the duration of the Contract.
- g. Fuel shall be stored in properly constructed underground tanks and fuel installations shall be secure against unauthorized persons. The fuel depot shall be buried to a minimum depth of 0.50 m with a capacity to retain all spillage.
- h. Without in any way limiting the Contractor's responsibility for security of the Site, the Contractor shall fence off all his designated site establishment areas and shall be responsible for the security of all buildings, equipment and materials within these areas.

8.2 ACCESS TO SITE

- a. The Contractor shall be responsible for the construction, upgrading and maintenance of the permanent and temporary access roads, construction of the permanent bridges and temporary river crossings including additional accesses and temporary crossings to work fronts, construction yards, quarry areas, muck disposal areas and borrow areas as necessary. The maintenance works of the above shall be performed in accordance with Part III Standard Technical Requirements for the Civil Works. The Contractor shall show his plan on temporary access and construction roads in the temporary works plan.
- b. The Contractor shall also be responsible for the construction and maintenance of any required temporary road and maintenance of access roads within his working areas and for haul roads to spoil areas.
- c. The Contractor shall use the permanent and temporary access roads in the construction of the Permanent Works and will make every effort to minimize the use of existing roads and tracks during construction of the Site infrastructure and Temporary Works. The use of permanent roads shall be subject to complying with all road and traffic laws.
- d. When temporary haulage and construction roads are no longer required, the Contractor shall rip to break up hardened surfaces, remove all imported material and shall reinstate the area in accordance with the provisions of the Employer's Requirements, unless otherwise directed by the Employer.
- e. If at any stage the Contractor requires additional access outside the Project areas, or if the use of existing access is curtailed, the Contractor shall submit details to the Employer, who will assist the Contractor in obtaining the approval of the relevant authorities. The construction activities shall be full responsibility of the Contractor under consultation with and support from the Employer.
- f. The requirements of this section shall apply to transport of rock, aggregates and granular materials supplied from quarries or borrow pits also not owned or operated by the Contractor and access to such quarries and borrow pits.
- g. The Contractor is solely responsible for all his access and transport needs to the site and shall have collected all necessary information and made his own assessment of the road and bridge conditions and capacities of the roads from port of entry to the Project site.

- h. Without limiting any of his obligations or responsibilities under the Contract, the Contractor will be deemed to have obtained all necessary information pertaining to and to have complied with all regulations and procedures governing the use of national and international facilities such as access, transport, handling and storage facilities, including roads, railroads, harbors, airports, airways, border crossings and the like for the due fulfilment of the Contract.

8.3 BUILDING AND CONSTRUCTION STANDARDS

- a. The buildings constructed for the site establishment shall be weatherproof, rodent and termite-proof and burglar resistant. They shall be constructed of treated timber, fiber cement, brick, concrete block or other materials as approved by the Employer/ Employer's Representative.
- b. Foundations for the buildings shall extend below the adjacent external ground level and shall include reinforced concrete spread footings.
- c. The floor shall be damp-proof, raised at least 225 mm above the highest adjacent external ground level and be finished with vinyl tiles and skirting except where otherwise specified.
- d. The floor of the laboratory shall be a dustproof finish. The minimum clear height between floor and ceiling shall be 2.4 m. The ceiling shall have at least 100 mm thickness of fiberglass insulation or an equivalent thermal barrier above.
- e. External walls shall be of cavity construction. Internal walls shall be plastered and painted. External walls constructed of concrete blocks shall be rendered and painted. All internal partition walls and ceilings shall have a fire rating of at least 60 minutes in accordance with approved standards.
- f. Buildings shall have fully glazed windows each at least 30 per cent opening for ventilation. Wire anti-mosquito gauze screens shall be provided to opening windows. Total window area for each room shall be at least 20 per cent of floor area. Windows shall be metal-framed commercially manufactured with airtight seals.
- g. Each room shall have at least one door and each door shall be provided with a three-lever lock and three keys. In addition, three master keys that fit all locks shall be provided. External doors and doors for rooms for senior staff, computer server room and storage rooms shall be fitted with cylinder locks with three keys. External doors shall be commercially manufactured metal type with metal frames with airtight seals.
- h. The Contractor shall provide and maintain in the building suitable air-conditioning system to enable adequate control of the thermal environment throughout the building. The size and number of the air-conditioner system shall be not less than the required number in compliance with the manufacturer's written recommendations. Buildings shall be insulated as necessary. Lighting shall be of the fluorescent tube type and shall provide not less than 300 lux at 700 mm above floor level and shall be verified by the Contractor.

- i. All rooms including open plan areas shall have twin switched electric socket per 5 sq. m or part thereof, with a minimum of two twin switched sockets.
- j. Roofing to buildings shall be waterproof and hail proof, with adequate drainage and constructed of approved materials to the Employer's satisfaction. Eaves shall have a minimum width of 1 m. Roof guttering will be provided to divert water away from external entrances.
- k. The Contractor shall provide hot and cold treated potable water, electricity, telephones and a sewerage system to the building(s).
- l. Concrete paved footpaths shall be provided around the building to connect with access roads, parking areas and adjacent buildings.
- m. Roads, parking areas and footpaths, including existing ones modified in the course of these activities, shall be laid to falls and provided with proper drainage facilities to safely dispose of all rainwater and surface water falling on them or running onto them from surrounding areas. All access and service roads connecting from the public roads to the offices and accommodation shall be constructed to Nepali Standards and have a minimum width of 4 m with 1 m shoulders on each side.

8.4 MATERIAL TESTING LABORATORY

8.4.1 General

- a. The Contractor shall provide, operate and maintain until completion of the Works a materials testing laboratory at the Site complete with furnishing, fixtures and equipment and carry out all routine tests including preliminary tests for the Works as required.
- b. The laboratory, equipment and records will be suitable for accreditation to ISO/EC 17025. Calibrations of equipment shall be carried out on a regular basis by persons certified by an independent organization as competent in accordance with ISO/EC 17025.
- c. The laboratory shall be for the use of the Contractor and for audit testing by the Employer. If the Contractor prefers not to undertake any tests required by the Contract at the Site laboratory, he must obtain the Employer's approval and any such tests, if approval is granted, shall only be tested at an approved laboratory at the Contractor's expense. The Employer will only grant such approval for tests which are not usually carried out at project sites and not for reasons of the Contractor's failure to provide or maintain testing apparatus. The Contractor shall give adequate notice to the Employer, in accordance with the Contract, to allow the Employer to witness all sampling and testing, on and off the Site.
- d. The site for the laboratory shall be subject to no-objection from the Employer prior to any establishment works.
- e. The Employer shall have uninterrupted access to the laboratory as well as access to the tests undertaken by the contractor and use of the laboratory equipment and facilities to undertake any testing that he may require. The Contractor shall provide the Employer with a full set of all standards used for testing of the Works by the time the laboratory has been completed.

- f. The laboratory shall be provided within 180 days after the Commencement Date but, in any case before any Works are carried out for which testing is required.
- g. The Contractor shall submit the design, specifications and working drawings of the laboratory to the Employer/ Employer's Representative and shall not commence any construction or fabrication work on the building or services until the Employer/ Employer's Representative has approval for the Contractor's submittals.
- h. Wastewater containing chemicals, cement, grease, oil, detergent shall not be discharged to any natural water courses or temporary diversion works without being treated to the satisfaction of the Employer.
- i. Cube curing tanks shall be installed in an air-conditioned room and maintained at a constant temperature of $23 \pm 5^\circ \text{C}$. The tanks shall be provided with a permanent water supply. As an alternative, the Contractor may propose a fog room, but this alternative shall be approved by the Employer/ Employer's Representative prior to use.

8.4.2 Furniture for the Laboratory

- a. The Contractor shall provide and maintain furniture of good quality to the satisfaction of the Employer. The provision of laboratory furniture shall be sufficient to carry out all the specified tests with those requirements in all respects including the provision of electric sockets.

8.4.3 Laboratory Equipment

- a. The Contractor shall be responsible for providing all equipment, apparatus, materials and consumables required to undertake all of the testing work required by the Contract:
 - 1) Soils Testing Equipment;
 - 2) Meteorological Equipment;
 - 3) Aggregate Testing Equipment;
 - 4) Concrete Testing Equipment;
 - 5) Grout Testing Equipment;
 - 6) Water Quality Equipment;
 - 7) Miscellaneous.
- b. The laboratory equipment shall be purchased from reputable, international suppliers. All laboratory equipment shall be supplied with calibration certificates, apparatus for checking calibration and English manuals for operation, maintenance and calibration. The Contractor shall provide qualified personnel experienced for materials testing and shall carry out all sampling and testing required by the Contract.
- c. The Contractor shall provide labour and other assistants to the Employer's staff, as and when required by the Employer, for carrying out any field or laboratory audit testing of the Contractor's work. Such testing shall be under the control of the Employer.
- d. The laboratory shall at all times be provided with a sufficient stock of consumable equipment, to allow for usage, breakage and deterioration. In the event of any item of

equipment becoming unserviceable through any cause, the Contractor shall arrange for replacements in due time to avoid any delay to the Works.

- e. The Contractor shall supply all equipment, supplies, consumables and copies of the relevant standards (in addition to the copies of the standards to be supplied to the Employer) for the laboratory necessary to perform the tests stipulated in the Specification or instructed by the Employer. These tests shall include, but not be limited to, the following:
- Concrete Aggregates: Particle size analysis, flakiness index, strength, soundness, alkali-silica reactivity, shell content, sand equivalent and Los Angeles abrasion;
 - Cement: Measurement of Blaine fineness, setting time, compressive and tensile strength;
 - Flyash: Measurement of Pozzolanic activity, loss of ignition, sulphate content, mortar expansion, soundness, fineness, specific gravity, autoclave expansion, alkali content.
 - Concrete: Mix design, measurement of workability, slump, temperature; curing and crushing of 200 mm and 150 mm concrete cubes, measurement of compressive and tensile strength, shrinkage, density, air content, permeability;
 - Shotcrete: Flexural strength of concrete beams to ASTM C1609. Bond strength in accordance with EFNARC, drying shrinkage in accordance with ASTM C 157;
 - Grout: Design and performance testing of grout materials and grout mixtures, compression and tensile strength, permeability, stability, setting time, shrinkage;
 - Bentonite slurry: Mix design, density, viscosity, sand contents.
 - Plastic concrete: Mix design, workability, compression and tensile strength in uniaxial test, shear in triaxial cell, permeability in triaxial cell, modulus of elasticity in triaxial compressive test, erodibility;

8.4.4 Performance Tests

- a. The tests specified below shall be carried out by the Contractor in the Materials Testing Laboratory or in other laboratories proposed by the Contractor and subject to no-objection by the Employer:
- Water: Chemical analysis (chloride, sulphate content), pH, dissolved oxygen, hardness, faecal coliform count, turbidity, electrical conductivity, suspended sediment, temperature and COD;
 - Soil: identification, particle size analysis, natural moisture and water content, Atterberg Limits, density Proctor compaction, density using 4.5 kg rammer, maximum and minimum dry density, in-situ density, density, permeability coefficient, specific gravity, dispersity, direct shear strength, soundness and CBR test;
 - Rockfill and Riprap: Los Angeles abrasion test, Bulk density, unconfined compressive strength, point load test, apparent gravity, porosity, water absorption, soundness, abrasion loss, wetting and drying, crushing test, particle size analysis, particle mass distribution; and

- Meteorological records: Temperature, humidity, evaporation, wind speed.
- b. The cost of such tests including the preparation and transportation of the samples shall be borne by the Contractor.
- c. The Contractor shall also provide any additional equipment as may be required by the nature of work or by the Employer.
- d. The laboratory building shall be handed over to the Employer at the completion of construction work. Furniture shall be handed over to the Employer in its actual condition at that time. The equipment will remain the property of the Contractor and shall be re-exported if no longer required.

8.5 SITE CABINS FOR THE EMPLOYER

- a. Site cabins for the Employer use, shall be supplied by the Contractor and shall generally be located adjacent to the Contractor's facilities in the vicinity of each major item of work. The site cabins may be moved from time to time as work progresses, as directed by the Employer. The Contractor shall supply 2 fully furnished and equipped 15 m² field cabins for the Employer's use along with the required connection for electricity, water and telecommunication. He shall be responsible for adequate regular maintenance and repairs of the structures, furniture, equipment and appliance therein, and shall shift these field cabins as directed by the Employer.

8.6 CONTRACTOR'S ACCOMMODATION

- a. The Contractor shall construct and maintain housing and quarters for all Contractor's Personnel, and their immediate dependents, required to live at the Site for the duration of the Contract. The Employer has made areas available, designated on the Employer's Concept Drawings, for the Contractor to construct housing for staff and accompanying dependents. In case, the land area provided by the Employer is not sufficient for Contractor's accommodation including housing and storage yard, the Contractor himself shall manage the required area at their own cost in appropriate locations and agreed by the Employer.
- b. The accommodation and facilities shall be completed within 180 days after the Commencement Date.
- c. Unless otherwise agreed by the Employer on completion of the Works, the Contractor shall remove the housing and associated facilities constructed by him and reinstate the area to its original condition to the satisfaction of the Employer.
- d. The Employer shall provide the required land for accommodating Army and storage facility of explosive at only one phase and the Contractor shall be responsible for making such facilities as required by Nepal Army protocol at his own cost.

8.7 CONTRACTOR'S GENERAL LABOUR ACCOMMODATION

- a. The Contractor shall construct accommodation units or quarters for his labour force with the necessary infrastructure on an approved site. The Contractor shall furnish, equip, administer, maintain and operate all general labour accommodation constructed under

this Contract. On completion of the Contract, the Contractor shall remove all temporary accommodation from the site and reinstate the area to a condition satisfactory to the Employer.

- b. All facilities shall be in accordance with the requirements of the Ministry of Health and the Ministry of Labour.
- c. The accommodation and facilities shall be completed within 120 days after the Commencement Date.

8.8 CONTRACTOR'S EQUIPMENT YARD AND STORAGE

- a. The Contractor shall be responsible for providing platforms and associated equipment areas including, but not limited to:
 - Equipment maintenance yards;
 - Stockpile areas;
 - Batching areas; and
 - Storage areas for supplies and equipment.
- b. The Contractor shall provide adequate site security to take care of his own material. On completion of the works, any building shall be removed from the site and the site left in a neat and tidy condition.

8.9 SANITATION AND CLEANING

- a. The Contractor shall provide all sanitary services necessary to ensure that the Site is maintained in a clean, sanitary and hygienic condition throughout the Contract.
- b. The sanitary services shall comply with all applicable laws and regulations and shall be located conveniently to all points where work is in progress. The services shall include, but not limited to:
 - Provision of waste collection bins at all of the Contractor's offices, buildings, compounds, workshops, stores and other facilities and throughout the working areas of the Site, with separate bins for separate waste types, clearly marked with different colours
 - Regular refuse collection and disposal including the cleaning of drainage channels;
 - Cleaning of drains frequently to maintain the Site in a neat and tidy condition;
 - Collection of used oil filters and used batteries separately and stored temporarily in a well-protected location after draining and neutralising the oil and hazardous acid;
 - Storing of used engine oil in properly constructed and isolated tanks attached with piping system to facilitate the recycling option by a competent agent/facility;
 - Operation of the centralized waste facility, including secondary separation of waste as necessary, onward transfer of materials for re-use, recycling, or disposal, and the keeping of full records of waste types, volumes, weights, and destinations on a daily basis;

- Operation and maintenance of the overall solid waste management system including disposal of kitchen wastes, sewage sludge, grit etc. to prevent flies, vermin and smells and avoid occupational health hazards to waste disposal workers;
- Pest and Vermin Control; and
- Cutting of Grass and Vegetation.

8.10 WATER SUPPLY

8.10.1 General

- a. The Contractor shall be permitted to extract water from any natural sources only with the limit specified by the Employer. All extractions of water from natural sources require permits from the relevant water authority, and the no-objection of the Employer will only be given after the Contractor has obtained such licenses and permissions as may be required.
- b. The Contractor shall design, construct, equip, operate and maintain the installation necessary for the adequate supply of raw water for firefighting and industrial use and drinkable water for human consumption at the various work areas as well as at the camps. Regulating, transporting, treating and distributing the water to the domestic, firefighting and industrial utilities shall be included.
- c. The Contractor shall provide water supply system for the Works. The water supply system stipulated in this paragraph consists of, but not be limited to, pump stations, storage tanks, filter tanks, and water distribution system to the individual construction area such as intake, waterway, powerhouse, etc.
- d. Quantities of water extracted from the approved sources shall be such that the requirements of the local population in respect of water for drinking, cooking and sanitary purposes, irrigation etc., are not interfered with.
- e. The Contractor shall satisfy himself that the points of extraction and any other sources of water supply will provide sufficient water to meet the anticipated demand. He shall design and construct appropriate storage facilities to overcome low flow periods without interruptions to the work.
- f. The Contractor shall provide three days storage of raw and potable water at his establishment area and shall provide distribution systems to any working areas where water is required including the Employer's site cabins.
- g. The Contractor shall submit detailed drawings and calculations of his proposed extraction, treatment, storage and distribution systems to the Employer within Ninety (90) days after the Commencement Date. Once obtained, the Contractor shall submit to the Employer a copy of all the licenses and permissions required in respect of the Contractor's proposed extraction points and details to demonstrate compliance with these requirements.

8.11 SEWERAGE AND SEWAGE TREATMENT

- a. The Contractor shall provide adequate sewage treatment plants at the site establishment areas, including the Employer's site cabins, and work sites, as necessary for the Contractor, Contractor's Personnel and Employer's Personnel.
- b. Adequate mobile or other toilets shall be provided at the work sites controlled by the Contractor and such toilets shall be connected to or emptied into the sewerage system. The Contractor shall ensure that such toilets are always kept in a hygienic and sweet condition by regular attendance and are kept disinfected.
- c. The quality of any sewerage and sewage treatment facilities shall comply with the requirements of the local authorities.

8.12 MEDICAL FACILITIES

8.12.1 General

- a. The Contractor shall be responsible for the provision of medical and health care facilities and all the medical and health care facilities established on Site for his Contractor's Personnel and Subcontractors' personnel shall be continuously available free of charge to the Employer's Personnel including Employer's staff, immediate family and visitors, provided that any such use shall conform to the normal controls and regulations which the Contractor applies to his own or Subcontractors' personnel.
- b. The medical and health care facilities shall comply fully with all Government of Nepal, Ministry of Health requirements or relevant Government ordinance or factories act specifically in relation to staffing levels, technical equipment and supplies as well as building standards.
- c. The Contractor shall designate one or more qualified medical doctors experienced in construction projects to supervise the first aid facilities, to control the implementation of the Health and Safety policy defined by the Contractor, and to operate a medical screening and examination system for prospective employees. The qualified medical doctor shall be ready to supply medical and surgical services at short notice on request.

8.12.2 Emergency Evacuation and Referral of Patients

- a. The Contractor shall investigate and determine the emergency treatment capabilities of hospitals and shall establish standby arrangements for emergency evacuation to hospitals with facilities suitable for treating and caring for the particular ailments or injuries of a patient. The Contractor shall be responsible for the ongoing treatment and care of Contractor's Personnel evacuated to hospital and the costs thereof.
- b. The arrangements and procedures subject to the satisfaction of the Employer shall be incorporated into the Contractor's Health and Safety Plan and Emergency Preparedness and Response Plan.
- c. Evacuation and/or referral shall be at the sole discretion of the Contractor's Medical Officer, which may not be delegated except to his Deputy and must be effected by the

most direct and expeditious route and method, given the time and nature of the emergency and the transport options available including by ambulance or helicopter.

- d. The Contractor shall arrange or provide medical staff and a helicopter transport service for medical cases requiring medical treatment in Kathmandu, Nepal.
- e. The Contractor shall institute emergency evacuation procedures at the work sites and site establishment areas.

8.12.3 First Aid

- a. Without limiting his obligations in terms of the Conditions of Contract, the Contractor shall provide First Aid posts at or close to each of the main areas of the Site where most of his work is being carried out.
- b. The First Aid posts shall comply fully with all Ministry of Health requirements or relevant Government ordinance and shall be suitably equipped with medical supplies and staffed during all working periods by a competent medical orderly who shall have direct voice communication and shall be assisted as required by some of the Contractor's employees with first aid qualifications.

8.12.4 Emergency Medical Services and Transportation

- a. For transporting and evacuating sick or injured persons from the site, the Contractor shall maintain, at all times during the execution of the Works, one (1) dedicated vehicle in good operating condition for the purpose of emergency transportation and evacuation of sick or injured persons from the Site. The vehicle shall be kept on standby and shall be readily available at all working hours and shall be operated by personnel trained in basic first aid.
- b. The Contractor shall establish and operate an on-site medical facility appropriate to the scale and nature of the Works. The facility shall be equipped to provide immediate medical attention, first-aid services and stabilization of injured or ill persons. The Contractor shall deploy qualified medical personnel at the Site in accordance with applicable laws and good industry practice.

8.12.5 Health Information for Employees

- a. As part of his Health and Safety Plan, the Contractor shall develop and implement a health awareness program for workers covering hygiene, prevention of infectious diseases, prevention of vector-borne diseases, prevention of occupational health hazards including dust and noise, and other health topics as determined to be appropriate or as directed by the Employer or medical authorities.

8.13 FIRE CONTROL

- a. The Contractor shall take all reasonable precautions against outbreaks of fire and ensure that a nucleus of persons trained in the use of firefighting equipment is available in each section of work on each shift. The Contractor's arrangements to prepare for and respond to fire shall be documented in the Emergency Preparedness and Response Plan.

- b. The Contractor shall take every precaution to prevent fire occurring on or near the Site. The Contractor shall comply with laws and regulations regarding fires and with respect to the prevention of fires. No fire shall be lit in the dry season without permission in writing obtained from the Employer and/or the relevant Authority.
- c. The Contractor shall provide suitable and adequate firefighting equipment, to the satisfaction of the Employer, for immediate use in all his buildings including his residential quarters, labour camps and ancillary buildings. The Contractor shall maintain all such firefighting equipment in good working condition until construction is completed and the Works are taken over by the Employer.
- d. The Contractor shall fight diligently against any fire which occurs on the Site wherever the fire may originate. In this regard, he shall employ all requisite equipment and trained manpower. All equipment, appliances and personnel shall be in a state of readiness and available at short notice for the firefighting service which shall be tested at least once per month. Under no circumstances, and without the written consent of the Employer, shall this firefighting equipment and appliances be used for any purpose other than the control of fire.
- e. In the event of a fire, the Contractor shall mobilise all nearby personnel, and shall do everything possible to extinguish the outbreak.

8.14 POWER, LIGHTING, COMMUNICATIONS AND ACCESS

8.14.1 Power

- a. The Employer will assist the Contractor to get grid supply of Nepal Electricity Authority (NEA) available at the project site. The Contractor shall bear all the cost of electricity connection. He shall assess the quality of the available grid supply.
- b. The Contractor shall make arrangements for all the power requirements and shall submit his proposed power generation and distribution systems to the Employer within 90 days after the Commencement Date.
- c. The Contractor shall supply electricity for all of his own operations, services and accommodation buildings throughout the duration of the Contract.
- d. The Contractor shall provide and operate sufficient standby diesel generator sets to supply power to meet the requirements. This provision shall include providing power to the Employer's laboratory, site cabins and accommodation on a 24 hour a day basis.
- e. The location of the electricity generating equipment and associated fuel storage facilities within the designated Site establishment area will be agreed with the Employer. The Contractor shall extend his distribution system to any other area where he requires power.

8.14.2 Lighting

- a. Whenever the Contractor is engaged in approved night work, the Contractor shall provide and maintain in good condition, adequate high powered flood lighting for all portions of the work in progress and the accesses thereto. This shall include the stockpile and spoil areas if machinery is operating in any of these areas. If, in the opinion of the Employer,

the resulting illumination is not adequate for the safe and efficient execution of the work, additional lighting shall be provided by the Contractor without additional payment.

- b. Unless otherwise directed by the Employer, the minimum illumination on the ground or working surfaces to be provided for the various operations or work areas shall be as follows:

S. No.	Operation Area	Minimum Value of Illumination (Lux)
a)	Earthworks	35
b)	Concrete placing	100
c)	Haul roads and bridges where hazardous conditions exist	20
d)	Underground works	50
e)	Workshops and mechanical and electric works	200
f)	Tunnel heading during drilling, mucking and scaling	100

- c. Illumination for areas of operation not listed above shall be subject to the no-objection by the Employer. All mobile equipment or plant used during night operation shall be equipped with sufficient lights and reflectors to ensure safe working conditions.
- d. At least Thirty (30) days prior to starting night operations the Contractor shall submit his proposals for lighting systems in the areas where he proposes to work at night to the Employer for his information. The Contractor shall modify the proposals, if required by the Employer, and shall not begin such operations in such places as the case may be, until the Employer has issued no-objection on the proposals for lighting systems. However, no-objection of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

8.14.3 Communications

- a. The Contractor shall provide and maintain adequate voice communications (conventional telephone, mobile telephone, radio, satellite telephones) around the Site. Principal offices, the Medical Centre, field First Aid Stations, major work sites and other major installations and site facilities shall be served by a land-line telephone network and/or mobile telephone/radio network. The Contractor shall make his own arrangements with the authorities for land-line and mobile communication systems.
- b. The Contractor shall be solely responsible for the payment to the national communications office or any other authority of any deposits, connection fees and all other charges in accordance with the regulations of the national telecommunications office and other authorities in connection with telecommunications.
- c. The Contractor shall provide adequate telephone or radiotelephone communications between all his site offices and his main administration offices. This shall include the supply of adequate telephone or radiotelephone communications.

8.14.4 Access

- a. The Contractor shall provide and maintain all temporary gangways, ladders, staging and covers for protection against falling objects and debris on and about the Site necessary for the purposes of the Contract and shall remove such gangways, ladders, staging and protective covers when no longer required.

8.15 ADMINISTRATION AND MAINTENANCE

- a. The Contractor shall for the duration of the Contract maintain and repair to the satisfaction of the Employer all structures, buildings, housing and facilities (including equipment and furniture) provided by the Contractor whether for the use of the Contractor's Personnel or otherwise. He shall provide all professional, administrative, supervisory, and technical staff and all labour, communications, transport, equipment, materials, tools, instruments, fuel, spare parts and the like required for the prompt and proper execution of such maintenance and repairs. The work of maintenance shall include such repainting and redecoration as may be required for protection against corrosion and to present a reasonable appearance both externally and internally, at all times to the satisfaction of the Employer.
- b. All such structures, building, housing and facilities shall remain the property of the Contractor and shall be removed from the Site in accordance with the Contract, unless otherwise agreed by the Employer, and the areas reinstated to their original condition to the satisfaction of the Employer.

8.16 SECURITY FENCING

- a. All site establishment areas and the boundary of the Interconnection area, Headworks, Headrace Tunnel portals and the Powerhouse construction pits shall be securely-fenced prior to any work starting.
- b. All fences shall be regularly inspected and maintained in good condition for the duration of the Contract.
- c. The Contractor shall confine his activities to the Site unless otherwise no-objection issued by the Employer.

8.17 SITE SECURITY

- a. To comply with his obligations under the Contract, the Contractor shall institute and operate a security system on a 24-hour a day basis, at his site establishment areas and all work sites, including the Employer's laboratory and site cabins, and all points of access. He shall cooperate with the local Police and comply with the Employer's requirements on all matters relating to security of the Works.
- b. For the purpose of complying with his security obligations under the Contract, the Contractor shall establish and submit the Site Security Plan to the Employer for approval within 90 days after the Commencement Date and in any case in due time before the mobilization of the Contractor to the Site.

- c. The Contractor shall ensure that no firearms are brought to the Site. No alcoholic beverages will be permitted at the Site. Contravention of these requirements will be cause for removal of the offender under the provisions of Sub-Clause 6.9 of the Conditions of Contract.

8.18 NAME BOARD AND SIGNS

- a. The Contractor shall construct, erect, maintain and remove on completion of the Works a comprehensive set of road signs to guide visitors and suppliers to the project to the correct working area or site establishment areas.
- b. The Contractor shall construct, erect, maintain and remove on completion of the Works a main sign board at the intersection of the public road and the main access road to the Contractor's and the Employer's Site offices.
- c. The sign board shall include the name of the Employer, Contractor and all Subcontractors.
- d. The Contractor shall erect and maintain one name board at the main entrance to his site establishment area. The design of the name board shall be agreed with the Employer and provision shall be made for Subcontractors' names to be mounted on panels attached beneath the Contractor's name board. The Contractor shall ensure that these are painted and attached to the board when the Subcontractors arrive on Site.

8.19 PROPERTY OUTSIDE SITE

- a. The Contractor shall not enter upon private or government land outside the Site, as defined in the Contract, without written approval from the Employer and the owner and/or occupier of the land.
- b. The Contractor shall take all practicable measures, in coordination with appropriate authorities or private owners of the land in the immediate vicinity of the Contractor's working sites or site establishment areas, to ensure that no member of his workforce or person or persons connected in any way with or intending to conduct any business with members of his workforce erects or situates any temporary accommodation, shelter, trading stall or any other type of settlement or establishment on this land unless such person or persons have obtained written permission from the appropriate authorities or private owners of the land for the erection or situation of such settlement or establishment.

8.20 RELATIONS WITH LOCAL AUTHORITIES AND RESIDENTS

- a. The Contractor shall liaise with local government authorities on matters concerning the impact of his operations on the local communities. Any problems which cannot be resolved by the Contractor shall be referred to the Employer via the Employer's Representative.

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CHAPTER 9
ORGANIZATION AND RECORDS

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CHAPTER 9 - ORGANISATION AND RECORDS

9.1 ORGANISATION STRUCTURE

- a. The Contractor shall submit as part of the Project Management Plan referred to in Chapter 1 – General Administration for the Employer's review and approval:
- b. The Contractor shall submit the organizational structure for the management of the Contract, with names and designation of staffs and their line relationship. The diagram shall include associate organizations and Sub-contractors and show clearly the individuals and lines of responsibility linking the various groups and describe interactions. It shall also indicate the persons designated for communication with the Employer. If staffs are not manning for the entire duration of the Contract, these shall be explained in a narrative, indicating in detail when such staff are mobilized and demobilized.
- c. The names, qualifications, positions and current resumes of key executive, supervisory and engineering staff to be employed full-time on the Project shall be included with the submission including principals of and Sub-contractors;

9.2 KEY PERSONNEL

- a. The key positions and the qualifications/experience of the individuals shall be as indicated in the Bid documents. The key positions include, but are not limited to:
 - i) **Design**
 - Design Team Leader
 - Civil Design Expert
 - Hydro-mechanical Design Expert
 - Structural Engineer
 - Hydraulic Engineer
 - Geologist/Geotechnical Expert
 - ii) **Construction**
 - Project Manager
 - Construction Manager
 - Quality Control Engineer
 - Hydro-Mechanical Engineer
 - Geologist/ Tunnel Engineer/ Geotechnical Expert
 - Safety Officer

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CHAPTER 10
ENGAGEMENT OF STAFF AND LABOUR

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CHAPTER 10 - ENGAGEMENT OF STAFF AND LABOUR

10.1 GENERAL

- a. The Contractor shall comply with requirements of Clause 38 [*Staff, labour and their facility*] of the Conditions of Contract, and the provisions contained herein, with regard to the engagement, and welfare of all the Contractor's Personnel.
- b. For avoidance of doubt, Contractor's Personnel includes the Contractor's Staff, Labour, Employees, Representatives and agents, as well as the Contractor's Subcontractors and Suppliers Staff, Labour, Employees, Representatives and Agents.

10.2 LABOUR LAWS

- a. The Contractor shall comply with all the relevant Labour Laws applicable in Nepal with regard to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights.
- b. The Contractor shall require his employees to obey all applicable Laws, including those concerning health and safety.
- c. The Contractor is solely responsible for the industrial relations of the Contractor's Personnel, including obtaining the required residential and work permits, visas and any other clearances (if any) required.
- d. For avoidance of doubt, Contractor's Personnel includes the Contractor's Subcontractors and Suppliers personnel, Agents and employees.

10.3 LOCAL EMPLOYEES

- a. The Contractor shall institute and operate a comprehensive policy towards recruitment, training, and employment of the local population in the project area. The Contractor shall, before the commencement of the Works, inform the Employer of his labour needs both in numbers and categories. As part of that policy Contractor shall:
 - provide opportunities for trainees to obtain job site experience;
 - provide opportunities for trainees to be tested and promoted;
 - pay all trainees their normal wage while undergoing training and testing; and
- b. For the purpose of implementing the training and testing policy, the Contractor shall nominate a permanent professional Training Officer, whose appointment shall be subject to the approval of the Employer.

10.4 RATES OF WAGES

- a. The Contractor shall pay rates of wages, observe working hours, conditions of labour, and other conditions of employment, which are not lower than those established for the trade or industry than those applying generally in, and/or as stated in the Labour Laws, and other laws as are applicable.

- b. If no established rates or conditions are applicable, the Contractor shall pay rates of wages and observe conditions which are not lower than the general level of wages and conditions observed locally by employers whose trade or industry is similar to that of the Contractor.
- c. The Contractor shall inform the Contractor's Personnel about their liability to pay personal income taxes in respect of such of their salaries, wages, allowances, and any benefits under the Laws for the time being in force, and the Contractor shall perform such duties in regard to such deductions thereof as may be imposed on him by such Laws.

10.5 FACILITIES PERSONNEL

- a. The Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel, in accordance with requirements as stated Chapter 8 - Facilities. If no requirements are stated then the minimum requirements for labour accommodation as stated in the Labour Laws, and other laws as are applicable, shall apply.
- b. The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the permanent works.
- c. The Contractor shall provide at the Site, to the satisfaction of the Employer, an adequate supply of drinking and other water for use by the Contractor's personnel.
- d. The Contractor shall take all precautions against the spread of infectious diseases and the development of unsanitary conditions at or adjacent to the Site and take all necessary precautions against insects and pest nuisance.
- e. In the event of any outbreak of illness of an epidemic nature, the Contractor shall inform the Employer and the appropriate authorities immediately and comply with and carry out such regulations, orders and requirements as may be made by the GoN or the local medical, health or sanitary authorities for the purpose of dealing with and overcoming the same.

10.6 DISCRIMINATION

- a. The Contractor shall provide equal opportunities in the employment of staff and labour, and shall not discriminate, or cause to be discriminated against any person due to racial, ethnic, religious, gender or age reasons or grounds.

10.7 CODE OF CONDUCT

- a. The Contractor shall within Sixty (60) days from the Commencement Date shall prepare and issue a Code of Conduct to all its personnel, representatives and agents as part of their Employment Contracts, and shall ensure that it is properly understood by all the Contractor's personnel, and be enforceable. The Code will guide and govern the employees' behaviors when employed on the Works, when interacting with other workers, and when interacting with members of the public on or off construction sites.
- b. To avoid interference with the livelihoods of members of the public, the Contractor's personnel will not be allowed to the use of local natural resources such as fishing,

hunting, and/or collection of non-timber forest products (NTFPs). Construction workers are not allowed to trade, consume or keep wildlife.

- c. The Code of Conduct shall include, but not be restricted to, the following:
- possession of an employee identity card
 - avoidance of all discrimination, with specific reference to culture, ethnic identity, religion, age, social status, and gender
 - respect for personal integrity
 - avoidance of all forms of bribery or corrupt behaviour
 - avoidance of misuse of alcohol or drugs
 - participation in training sessions
 - following instructions, respecting rules, regulations, and procedures with specific reference to health, safety, and the environment
 - grievance procedures
 - respecting property
 - respectful behaviour towards local communities
 - respect towards women
 - avoidance of any behaviour or language which might be considered violent, abusive, or disrespectful
 - avoidance of any activity considered illegal, including violence, prohibition of involvement in production, misuse or trafficking in drugs, or involvement in trafficking of people
 - acknowledgement of health and safety procedures
- d. Breaches of the Workers Code of Conduct will be the basis for investigation and dismissal.

10.8 PROHIBITION OF FORCED OR COMPULSORY LABOUR

- a. The Contractor shall not employ "forced or compulsory labour" in any form. "Forced or compulsory labour" consists of all work or service, not voluntarily performed, that is extracted from an individual under threat of force or penalty.

10.9 WORKING HOURS

- a. The Contractor shall in all dealings with its personnel, in connection with the Works, have due regard to all recognized days of rest, local festivals, religious holidays, other customs.

10.10 HEALTH AND SAFETY

- a. The Contractor shall, in accordance with the Contractor's Site Health and Safety Manual Chapter 3 – Health and Safety, issue to all the Contractor's personnel a "Guide to Health and Safety booklet" covering all aspects of the Health and Safety policies, regulations, procedures and manuals whilst on site.
- b. The Contractor shall remove from the Site any Contractor's Personnel who do not comply with the Site Health and Safety policies, regulations, procedures, manuals and guides.

- c. The Contractor shall inform the Employer of any accident occurring at the Site or in connection with the Works as soon as practicable after its occurrence and shall provide a written report within 24 hours from its occurrence. In the case of any fatality or serious accident the Contractor shall in addition notify the Employer immediately.

10.11 ALCOHOLIC LIQUOR OR DRUGS

- a. The Contractor shall not import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift, barter or disposal thereof by the Contractor's Personnel.

10.12 ARMS AND AMMUNITIONS

- a. The Contractor shall not, otherwise than in accordance with the Laws of the Country, import, sell, give, barter, or otherwise dispose of to any person or persons, any arms or ammunition of any kind, or allow the Contractor's Personnel to do so.

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CHAPTER 11
TESTING

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CHAPTER 11 – TESTING AND INSPECTION

11.1 General

- (a) In accordance with Clause 48 [Test] and 74 [Test on Completion] and of the Conditions of Contract, this Chapter and the testing requirements contained in the Employer's Requirements, the Contractor shall issue for the Employer's review and approval a method statement incorporating a schedule of any proposed tests and inspections. This method statement shall conform to the Contractor's agreed Quality Plan. The tests shall include any statutory test if required. The Contractor shall include with the method statement, the proposed preformats for recording the results of the tests that the Contractor intends to start the tests or inspections, the Contractor shall issue a program of the tests for the Employer's review and approval.
- (b) Before the dispatch of Plant and Materials, the Contractor shall carry out all manufacturer's standard quality tests and all factory inspections and tests called for in the Employer's Requirements. The Contractor shall notify the Employer in writing at least Thirty (30) days in advance of the date of any such factory test or inspection.
- (c) The Contractor shall at all times carry out testing and inspection according to the agreed quality control procedures including independent factory testing as required by the agreed procedures. The Employer may at any reasonable time audit the Contractor's quality control implementation and records to confirm the Contractor's adherence to the agreed quality control procedures.
- (d) Whether or not the Employer attends a test or inspection, within 7 days of a test or inspection the Contractor shall submit one (1) signed copy of all factory inspection test reports to the Employer.
- (e) Copies of the entire Maker's Works Test Certificates for materials, plant and equipment shall be provided in triplicate to the Employer. These shall include the following;
 - Physical tests and Chemical Analyses of steel and other principal metals used; and
 - Factory Acceptance Tests (FATs) of any permanent plant and/or equipment provided for the project.

11.2 Testing Instruments

- (a) The Contractor shall supply and maintain all testing instruments necessary for carrying out the various tests required for the Works. All instruments shall have a current certificate issued by an approved testing laboratory, certifying that they have been checked and correctly calibrated.

11.3 Workshop Inspections and Tests

- (a) As far as practicable, quality of materials, workmanship and performance of all items of the work and equipment to be furnished under this Contract shall be inspected at the places of manufacture.

- (b) Where the Contractor desires to use stock material, not manufactured specifically for the work, satisfactory evidence shall be submitted that such material conforms to the requirements of the Contract. Tests on these materials may be waived subject to Employer's judgement.
- (c) Arrangements shall be made for expediting the shop inspection by having all shop assemblies or pieces covering a single shipment ready at one time. Any material/equipment transport to the site shall not be started if the approval of the Employer has not been obtained.
- (d) Three copies of all orders for manufactured or fabricated items, including relevant specifications, shall be submitted to the Employer at the time that each order is placed. The Employer will notify the Contractor of:
 - Items which he wishes to inspect, giving the details of the scope of inspection and the tests that he wishes to witness.
 - Items that are not to be packed and/or delivered to the Site until he has received from the Contractor satisfactory inspection and test reports.
- (e) The Contractor shall notify the manufacturer or fabricator of the Employer's inspection and testing requirements.
- (f) During the manufacture or fabrication, the Contractor shall submit to the Employer Two (2) copies of progress reports at regular intervals as instructed by the Employer. The Contractor shall also submit to the Employer Two (2) signed copies of his inspection and tests reports during manufacture or fabrication and on completion of testing of each item.
- (g) The Contractor shall give the Employer not less than Thirty (30) days' notice in writing of the date and place at which any item under (d) above will be ready for inspection or testing. Notwithstanding, the Contractor shall give sufficient notice to enable the Employer's personnel to obtain the visas, if required, to attend a country(s) where inspection and testing will be carried out and the Contractor shall not entertain any claim for delays resulting from the late issuing of visas on completion of inspection procedures and satisfactory testing of items under (d) and (e) above, the Contractor shall apply to and obtain the Employer's written notification that the item(s) may be released for delivery to Site.

11.4 On Site Testing

- (a) The Contractor shall provide, use and maintain adequate equipment operated by competent staff for carrying out test required for the control of quality of materials and workmanship in accordance with the Specification. The testing shall be carried out in the laboratory constructed, furnished, equipped and maintained by the Contractor.
- (b) The testing shall be undertaken by suitably qualified and experienced laboratory technicians, under the supervision of the Contractor's Materials Engineer (Key Personnel). The Contractor may arrange for certain testing to be undertaken at an independent laboratory approved by the Employer.
- (c) The Contractor shall provide the specified notice to the Employer to enable the Employer to witness each test undertaken by the Contractor on the Site including the field sampling and testing. The Contractor shall carry out all necessary tests

- and shall report to the Employer the results of such test before submitting materials and finished work to the Employer for approval.
- (d) Copies of all the Site Laboratory's Test Certificates for materials, plant and equipment shall be provided in triplicate to the Employer. These shall include the following:
- Periodic physical tests and chemical analyses of steel and other principal metals used.
 - Periodic physical Tests and chemical analyses of soil, rock fill, sand, cement, shotcrete, grout, and any other aggregate materials used in the Works.
 - Periodic Compression test results on cylindrical or cube concrete probes.
 - Periodic Water quality analyses.
 - Periodic Meteorological Data reports.

11.5 Payment for Inspection Services by Employer's Personnel

- (a) Contractor shall make all necessary arrangements to the Employer's personnel for the visit to the manufacturer's premises to inspect the works, after the Contractor has indicated that a particular item of work is ready for inspection. The Contractor shall facilitate these visits as per approved Quality Assurance Programme submitted with the Bid and agreed with the Employer (Minimum 2 persons) and will provide air flight tickets (Economy Class), accommodation including meals (breakfast, lunch and dinner), all transportation costs, costs for visas etc. A daily allowance of 200 USD for the Employer's staff shall be paid by the Contractor. All these costs are deemed to be included in the Contract.
- (b) If the Employer's personnel subsequently find on arrival at the manufacturer's premises that the item of Work which the Contractor has indicated is ready for inspection is either not ready for inspection or the item fails to pass the appropriate tests then the Contractor shall pay all travelling, accommodation, subsistence and time costs of the Employer's personnel for all subsequent visits to the manufacturer's premises for the purpose of inspection of that item of work until it is passed the tests.

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CHAPTER 12
MATERIALS

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CHAPTER 12 - MATERIALS

12.1 GENERAL

- a. All materials used in the permanent works shall generally be of standard quality available in Nepal and except where otherwise specifically instructed or where specific standards are referred to, comply with any of the latest issues of the relevant Standards and Codes of Practice as mentioned in the Technical Specifications.
- b. The Contractor shall be fully responsible for the provision of all materials required for the Works and other purposes in accordance with the Employer's Requirements and the Contract.
- c. The approval of the Employer for the use of the sources of such materials will be dependent on the Contractor demonstrating to the satisfaction of the Employer that the maximum practicable use of materials available from excavations for the Permanent Works has been made and that appropriate provisions have been made for the health, safety and welfare of workers at that source in accordance with the Contract.
- d. Where required, the Contractor shall submit samples for the Employer's approval. He shall have the responsibility to provide test reports of proposed materials and manufactured articles, and such samples shall be kept by the Employer for reference.
- e. If any materials or articles brought onto the site are found to be of inferior quality or in any way unsuitable, such materials or manufactured articles shall forthwith be removed from the site at the Contractor's expense.
- f. Materials shall be stored in such a manner as to preserve their quality and condition to the standards required by the Contract. The quantity of materials and components stored on the Site shall consistent to the satisfaction of the Employer.
- g. In any case, materials for which no-objection has been issued by the Employer shall not be replaced by other materials from other manufacturers or suppliers. Under specific condition if that has to be done, prior no-objection of Employer shall be required.

12.2 QUARRY AND BORROW AREAS

- a. Potential quarry and borrow areas are shown on the Employer's Concept Drawings, and the Contractor shall at his cost explore, investigate, test material quality, and develop such quarries and borrow areas that he may require to meet his requirements under the Contract. Such development of quarries and borrow areas shall include, where applicable, construction, operation and maintenance of the required access roads and docks, shipping and haulage arrangements, and removal and stockpiling of overburden material and restoration.

12.3 APPROVAL OF MATERIALS AND PLANTS

12.3.1 Manufacturer's Certificate of Compliance

- a. In the case of standard labelled stock products of standard manufacture which have a record of satisfactory performance in similar work over a period of not less than 2 years, the Employer may accept a notarized statement from the manufacturer certifying that the product conforms to the applicable Specifications.

12.3.2 Mill Certificates

- a. In the case of materials for which such practice is usual, the Employer may accept the manufacturer's certified mill and laboratory certificate.

12.3.3 Timber Certificates

- a. Any new timber used by the Contractor whether for temporary or permanent purposes may be rejected by the Employer unless originating from a managed renewable resource and certified as such by an independent inspection agency.

12.3.4 Cooling Plant

- a. All air-conditioning, refrigeration, freezing, and cooling units supplied by the Contractor for use on the Site whether in buildings, plant or vehicles shall be certified by the manufacturer as not containing chlorofluorocarbon (CFC) based or hydrofluorocarbon (HFC) based refrigerants.

12.3.5 Supplier's Environmental Certification

- b. Where materials and equipment of equal quality are available from more than one supplier, preference shall be given to those suppliers certified as implementing environmental management systems under ISO 14000 or EMAS.

12.3.6 Supply, Storage and Use of Explosives

- a. The Contractor shall supply, store, and use explosives in accordance with the laws, regulations and codes of practice applicable in Nepal.

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VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 13
SPARE PARTS, TOOLS AND APPLIANCES

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CHAPTER13 - SPARE PARTS, TOOLS AND APPLIANCES

13.1 GENERAL

- a) The Contractor shall provide the spare parts as listed in the Standard Technical Requirements and Particular Technical Requirements contained in the Employer's Requirements, and as recommended by the manufacturer of the hydro-mechanical equipment. All spare parts shall be duplicates of the original parts furnished and interchangeable therewith.
- b) Spare parts shall be clearly designated and referenced in the Operation and Maintenance Manuals with sketches of each part with the part number and the designation of the part cross- indexed with the Contractor's assembly drawings.

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CHAPTER 14
TRAINING

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CHAPTER 14 - TRAINING

14.1 GENERAL

- a. The Contractor shall, design, arrange and carry out training programmes during the period of contract, for the Employer's Personnel. The training shall include overseas courses, on-site training courses and on-the-job training. The training programmes shall be subject to no objection by the Employer, and the Contractor shall provide experienced training staff, all training materials and facilities at the Site as required.
- b. The methodology for training to be provided by the Contractor shall be agreed with the Employer and shall follow the concepts of counterpart personnel attachment ("On-the-job training"), technical skills philosophy, and modular tasks in various technical disciplines.

14.2 BASIC CRITERIA

14.2.1 Civil Works

Overseas training for Civil Engineers shall be prepared to suit individual requirements and shall include, but not be limited to, the followings:

- ◆ 3D flow analysis of hydraulics structure
- ◆ Finite element and geotechnical analysis for different components of hydropower
- ◆ Oracle Primavera software
- ◆ Construction management
- ◆ Health, Security and Safety management
- ◆ Contract management
- ◆ Numerical Modelling/FEM technique for underground excavation.

14.2.2 Hydraulic Steel Structure

- a) For Hydraulic structure, the training shall be implemented through two different types of courses, namely:
 - Overseas Courses to provide the personnel, with the basic knowledge regarding the equipment, its technical characteristics and functionality, the organization and management of the plant.
 - On Site Courses to prepare engineers, technicians and operators of Hydroelectric Plant on all operational aspects such as:
 - ◆ equipment functionality;
 - ◆ operation philosophy;
 - ◆ maintenance (overhaul, predictive, preventive) and relevant procedures and actions
- b) With reference to maintenance activity, particular importance shall be given to the problem-solving approach and to the rules of the use of specific equipment and appliances. Training activities shall be coordinated by a training specialist monitoring the implementation of the training according to the program agreed.

14.3 OBSERVATION TOUR FOR THE COMPANY'S MANAGEMENT STAFF

- a) The Contractor shall arrange at least Ten (10) days observation tour for 10 Employer's management staffs which shall include site visit to hydropower plants under different stages of development in his home country or outside his country. The Contractor shall bear all cost associated with transportations, lodging and fooding, insurance, visa fees and provide out of pocket expanses of US\$ 200 per day to each participant. The cost associated with observation tour shall be deemed to be included in Contract Price.

14.4 TRAINING PROGRAMME AND STAFF

- a) The Contractor shall nominate a Training Manager, who together with the Contractor's Representative, shall be responsible for all liaison with the Employer with regards to the structure and content of the training programmes, the allocation and methods for site and on-the-job training, and the conduct and evaluation of all training activities.
- b) Within 180 days after the Commencement Date, the Contractor shall submit to the Employer, the detailed training programme for review and no-objection. The detailed training programme shall be in the form of two separate but related method statements:
- ◆ Detailed Method Statement – Training for Employer's personnel during Manufacture; and
 - ◆ Detailed Method Statement – Training for Employer's personnel at Site.
- c) These method statements shall include as a minimum the following information:
- ◆ the Time schedules and grouping of classroom sessions, including the average number of participants in each classroom session and covering the entire period of the Contract;
 - ◆ the Time schedules and grouping of any proposed overseas course, including the average number of participants of each type for the courses;
 - ◆ the Time schedules and grouping of any proposed overseas or local factory visits, including the average number of participants of each type for the visits;
 - ◆ the detailed content of the training sessions;
 - ◆ details and particulars of the Training Engineers/Instructors;
 - ◆ the Time schedules and grouping of the on-the-job training;
 - ◆ the number of trainees to be assigned to the different on-the-job training activities.
- d) The fundamental training process to be reflected in the detailed method statement is to incorporate the basic principles summarised as follows:
- ◆ determination of exactly what each skilled (i.e. fully trained) person should be able to do, and the instruction required to achieve this;
 - ◆ definition of the instructional requirements as specified objectives, and establishment of a test item for each objective so that the instructors can evaluate the achievement of the objective by the trainee;
 - ◆ design of instructional procedures and materials to help the trainees achieve objectives;
 - ◆ performance of the instruction;

- ◆ evaluation of the success of the instruction.
- e) The training work shall be executed taking into consideration the education, background, language ability and experience of the Employer's personnel trainees, listed in their CVs received and duly examined by the Contractor. All written course materials shall be provided in both Nepali and English upon consultation with the Employer.
- f) The Contractor shall review the progress of the training activities and shall periodically issue, revise and modify the training plans to be used on Site. The Contractor shall review the progress of each of the Employer's personnel trainees and shall advise the Employer thereof.
- g) The Employer's personnel to be allocated for training will mainly be made up of the following qualified professionals and technicians:
 - ◆ Civil Engineers
 - ◆ Mechanical Engineers
 - ◆ Electrical Engineers
 - ◆ Health and Safety Engineers
 - ◆ Planning Engineers
- h) The details of the types and times of the formal training sessions to be provided on Site and at the various places of manufacture, and the number of trainees in each case, shall be recommended by the Contractor in his training programme.
- i) The Employer shall have the right to modify and/or adjust the Contractor's detailed training programme during the period of the Contract and to add particular topics according to his specific requirements, provided that this does not result in the need for the Contractor to provide additional net training resources. Such modifications, adjustments and/or additions shall be made in close co-operation with the Contractor.

14.5 ON THE JOB /SITE TRAINING

On-the-job training shall be provided for all key construction, erection, testing, and commissioning activities related to civil works and mechanical/electrical equipment. Trainees shall be integrated into Contractor's work teams wherever practicable.

On the job training program shall specify:

- Time schedules,
- Grouping of trainees, and
- Assignment of trainees for different activities.

The Contractor shall ensure that its own construction and management personnel responsible for on the job training receive supervisor level instruction to ensure effective skill transfer. This supervisor training shall be managed by the Training Manager and aligned with the overall training schedule.

14.6 FORMAL TRAINING COURSES

- a) Formal (classroom) training sessions shall be held by the Contractor on Site for the different types of work and equipment involved in the Works. The purpose of these formal training sessions shall be to explain clearly and provide details of the design features, purposes and features of the different items of equipment and the procedures required for their fabrication, handling, erection, maintenance and operation.
- b) The Contractor shall design the programmes of instruction and training for Employer's Personnel with respect to the types of hydro-mechanical and electrical equipment to be supplied and installed by the Contractor under the Contract.
- c) The training is to utilise as much as actual forms, manuals, tools, equipment and parts. All written training materials, including course notes, diagrams, manuals etc. shall be provided in English languages. All training materials provided by the Contractor shall be handed over to the Employer in good condition at the end of the Contract.
- d) The formal programmes of training of the Employer's Personnel shall include:
 - appropriate time schedule for the different Site training sessions;
 - the grouping of the training sessions (contract management, work activity planning and overall programming, mechanical and electrical equipment fabrication and handling, erection, testing and operation, interfacing with hydro-mechanical and electromechanical equipment contractors etc.), including the average number of participants in each session; and
 - the detailed content of the training sessions.

14.7 OVERSEAS TRAINING/INSPECTION PROGRAMME

The Contractor shall submit a tentative overseas training program specifying duration, content, and location, for several trainees nominated by the Employer.

The Contractor shall bear all expenses, including:

- Economy-class air travel,
 - Local transportation,
 - Insurance,
 - Accommodation and meals,
 - Visa fees,
 - USD 200 daily allowance per trainee.
- Each program shall preferably include at least one visit to a hydropower plant.

A total of 15 Employer's and Employer's Representative technical personnel shall participate in overseas training. Training shall be at least 15 days in duration and shall relate to the topics listed in Clauses 14.2.1 and 14.2.2. Inspection duration shall be as proposed by the Contractor.

All associated costs shall be included in Activity Schedule.

14.8 EVALUATION OF TRAINING

- a) To monitor and control the results of the training of the Employer's personnel, including both the formal (classroom) training sessions, the on-the-job training and the training provided at the places of manufacture, the Contractor shall carry out a training survey and prepare and submit to the Employer a Training Assessment Report to the Employer.
- b) The Training Assessment Reports shall be based on questionnaires which are to be filled in by all the trainees. The questionnaires shall be prepared by the Contractor in such manner as to reflect the training topics. All filled in questionnaires shall be evaluated and assessed by the Contractor before submitting to the Employer.
- c) The Contractor shall prepare the Training Assessment Report within Twenty-one (21) days of each survey, which shall contain as a minimum the followings;
 - Type, number, length and content of the training sessions conducted;
 - Name of the Employer's personnel trained according to the training groups;
 - Complete questionnaires from this particular survey;
 - Results, assessments and conclusions of the survey; and
 - Recommendations from the Contractor regarding adjustments and/or modifications to the planned future training.
- d) Within Fourteen (14) days after the receipt of the Training Assessment Report by the Employer, a meeting is to be held between the Employer and Contractor to analyse jointly the results of the training and to introduce modifications and/or adjustments if considered necessary by the Employer. This meeting shall be organised by the Contractor.

14.9 COSTS

- a. The Contractor shall bear the costs for training and documentation for all trainees.
- b. All Costs for training shall be included in MS-15 Detail design, of the Activity Schedule.

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CHAPTER 15
INTERFACES

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15 INTERFACES

15.1 Design / Construction Interface Management Plan

- a. The Project includes other contractors working at the Site, in particular LOT 2: Electrical and Mechanical Equipment, for the execution of various other Works which will be performed concurrently with the Works under this Contract.
- b. A number of interfaces exist within the Project between this LOT 1 or LOT 2 and the other contractors and their subcontractors and suppliers. In the course of complying with the provisions of the Contract, various physical and performance interfaces of the Contractor's developed construction methods and procedures may depend on facilities, equipment or services of organizations not under the Contractor's control, such as but not limited to:
 - Design interfaces with the LOT 2 contractor or with LOT 1 Contractor, as the case may be.
 - Site facilities and access.
 - Construction, installation and erection interfaces.
 - Time and programming interfaces.
 - Testing and commissioning interfaces, continuous 72 hours successful trial run for each unit.
 - After successful testing and commissioning of all the units, 15 days of successful test generation and delivery of electricity, to Nepal Electricity Authority (NEA) by the project for the first time for issue of COD (Commercial Operation Date).
 - Completion and Taking-over interfaces.
- c. The Contractor shall identify all interfaces which may affect organizations not under its control, but which may affect his construction or installation work. These external interfaces shall be included in a document suitable for obtaining approval of the affected interfaces and shall be furnished to the Employer for his review and approval.
- d. Where coordination with an affected organization by the Contractor is necessary, such coordination shall be through the Employer. The Contractor is specifically prohibited from making direct contact with other entities for purposes of making interface agreements without the specific approval of the Employer.
- e. Consequently, the Contractor shall, within one hundred and twenty (120) days from the Notice of Commencement, shall prepare and submit to the Employer, for his review and approval, a Design/ Construction Interface Management Plan detailing the interfaces of this LOT 1 or LOT 2 Contract with other contracts being implemented under this Project. It shall be periodically reviewed to take care of any missing links/ discrepancies during execution when other contractors/ sub - contractors are mobilized.
- f. The Design/ Construction Interface Management Plan shall give guidance for identifying each specific interface and provide the procedure to be implemented by the Contractor by which each interface will be defined and accommodated. Updates shall be provided by the Contractor when significant design or construction program changes are made.

- g. It is necessary that the Contractor identifies all interfaces to ensure that the design at the interface is understood by affected parties, and changes to one side of the interface are accepted and accommodated by the opposing interface. The Contractor shall include in his Design/ Construction Interface Management Plan the process by which interfaces are identified and controlled.
- h. The Design/Construction Interface Management Plan shall include interface control documents that shall be developed by the Contractor and approved by the Employer. These interface control documents shall be maintained current throughout the Contract period and be included as design data at all design reviews. Upon approval of any construction method statement, the interface control documents shall be subject to amendment as necessary, or as instructed by the Employer.
- i. The Employer' Representative will chair regular interface meetings with all concern parties during the detailed design, construction and installation stages to assess the progress of the Works or to resolve interface issues.
- j. Such general cooperation shall be foreseen and provided for in the Contractor's programming and is deemed to be included in the Contract Price.
- k. No claim for delay arising from interfaces between the Contract and other contracts shall be admissible unless the Contractor can demonstrate that the Contractor has attempted to provide all reasonable liaison and coordination but that nevertheless unavoidable or unreasonable delays with respect to the progress of the Works have been incurred by the Contractor as a direct result of the actions or omissions of the other contractors.
- l. In the event that the Contractor fails to coordinate its works with the other contractors, the Employer shall have the right to claim from the Contractor, the amount of any claim from the other contractors, as a result of such failure to coordinate.

15.2 Management of Interfaces

- a. Not later than 30 days after the Commencement Date, the Contractor shall submit details of his nominated senior engineer for the position of Interface Manager to the Employer for approval. The Contractor's Interface Manager shall have had similar interface management experience on hydropower projects and shall be available for the entire Contract Period, initially at the Contractor's head office and subsequently, immediately after the Contractor has mobilized to Site, on Site.
- b. Not later than 60 days after the Commencement Date of LOT 1 and/or LOT 2 Contract whichever is later, the Interface Manager of the Contractor, together with the other Employer's contractors, shall establish an Interface Committee under the chairmanship of the Contractor for the LOT 1 Contract. The purpose of the Interface Committee shall be to ensure that all interface requirements between the LOT 1 and LOT 2 Contracts are satisfied and that potential interface problems are identified early and avoided in order to remain within the approved construction program. All records of meetings or other communications between Interface Committee members shall be copied immediately to the Employer.
- c. The Employer is to be notified sufficiently in advance of any meetings of the Committee and shall have the right to attend all such meetings as an observer.
- d. Prior to the mobilization of the Contractor for either the LOT 1 or LOT 2 Contracts to Site, the meetings of the Interface Committee shall take place on Site at intervals and times to be agreed with the Employer, and whenever required to

discuss current interface issues but, in any case, not less frequently than every three months. Following the mobilization to Site of the Contractors of LOT 1 and LOT 2 Contracts, the meetings of the Interface Committee shall be held not less frequently than every month.

- e. The Interface Committee, under the responsibility of the Contractor for the LOT 1 Contract, shall prepare a monthly report on all interface matters which are to be included within the monthly progress reports submitted to the Employer under the Contract. Current interface matters shall also be notified by the Contractor in advance as items for the agenda of the regular progress meetings to be held with the Employer's Representative in accordance with the Contract.

15.3 Major Areas of Interfaces

15.3.1 Powerhouse, Remote Sites (Intake and PPV) and Takeoff Yard

- a. The powerhouse layout and dimensions shall be finalized by the LOT 2 Contractor, and its excavation and support shall be carried out by LOT 1 Contractor. The first civil works after completion of the powerhouse excavation and support will commence after the laying of the earthing mat, which will be followed by preparation of the foundations for the tailrace structure and distributor pipes for the three turbines and generators, embedment of the main inlet valves, EOT crane, transformers, GIS, SCADA system between headworks and powerhouse, etc. and for concrete embedment of these components for their installation by the LOT 2 Contractor. Transformer rails in machine hall (operating floor), transformer hall and connecting gallery shall be supplied by the Lot 2 and installed by the LOT 1 Contractor. All civil works related with surface outdoor yards, including laying of underground earth mat and other associated civil works of foundation, control building, DG set, fencing, gates etc.
- b. The civil works after excavation of valve chamber to be completed after laying of earth mat followed by embedment for PPV, EOT crane. The earth mat shall be at powerhouse and takeoff yard shall be supplied by Lot 2 Contractor and installed by Lot 1 Contractor.
- c. Thereafter, all main concrete works in the powerhouse shall be performed as a partly intermittent and partly continuous activity with required interface activities. Before the turbine and generator and its accessory erection continues, the LOT 1 Contractor complete all concrete structures in the powerhouse, only leaving block-outs and other erection space as necessary for installation of mechanical, electrical and other equipment. In addition, surface treatment including the first cover of paint shall be completed in order to reduce the extent of spoil and dust and other inconveniences for the installation works. Necessary provision for non-shrink grout for equipment foundation shall be made by the Lot 1 Contractor. The crane beam in service bay and surroundings of service bay is to be sufficiently completed by LOT 1 Contractor, on priority, so that a clean atmosphere and handling facility is available for unloading and assembly of the turbine, generator and other accessories prior to installation. Similarly, the crane beam for the GIS room is to be built in the transformer gallery for handling of equipment.
- d. The LOT 1 Contractor shall maintain a follow up concrete team in the powerhouse for performing step-by-step secondary concrete at the LOT 2 Contractor's request subsequent to the erection.

15.3.2 Erection of Electrical and Mechanical Plant and Equipment

- a. For coordination with and provision of information to the LOT 1 Contractor, the LOT 2 Contractor shall prepare a detailed plan for transport and storage of all major components, including the space occupied in the Service Bay and Machine Hall floor until placing in final position. The LOT 1 Contractor's works may temporarily restrict transports for other contractors. This applies specifically to concreting of the invert in the main access to the powerhouse. The LOT 1 Contractor shall adopt his detailed work plan for such works so that transport conditions are not affected in a way that may delay the LOT 2 Contractor's or others erection programs.
- b. After the initial installation of Turbine casing, the main installation of the three generating units shall start and completed, with less than two months interval between the first and the second units and not more than 1.5 months between the second and the third units. The LOT 2 Contractor shall plan and execute his works within the timelines specified.

15.4 Completion Dates

- a. Under each of the contracts, specific progress milestones which are to be achieved by the respective contractor have been defined in order to achieve the timely completion of the Works and to enable each contractor to plan, coordinate and manage the interfaces with the other contractors. Failure to achieve these Section/Milestone Completion Dates by any of the contractors may result in the deduction of damages from payments due to that contractor under his contract with the Employer.
- b. The Milestone Dates which shall apply to this Contract are described in the Conditions of Contract.

15.5 Areas of Responsibilities

- a. The areas of particular interface requirements between LOT 1 and the LOT 2 Contractors are indicated on Table 15-1; however, as this table is not all inclusive, the Contractor shall allow for all interfaces required:
- b. The following nomenclature is used in Table 15-1:

GA	General arrangement drawing or 3D model showing physical size and position and clearance dimensions
MIV	Turbine Main Inlet Valve
PPV	Penstock Protection Valve
CWS	Cooling Water System
SBG	Emergency Standby Diesel Generator
GVE	Generator Voltage Equipment (Excitation, AVR, GCB, Bus Bar, ...)
GCB	Generator Circuit Breaker
CSB	Common Services Board (LV Electrical, Particular Main DB)
GPO	General Power Outlet
FOC	Fiber-Optic Cable
HOC	Headworks Operations Center

LCU	Local Control Unit (typically SWB, Local Control HMI, Comms Panel)
DB	Distribution Board (Electrical Power)
OLTE	Optical Line Terminal Equipment
SWB	Switchboard

The power station comprises the powerhouse cavern, transformer cavern, bus duct tunnels, cable-cum-ventilation tunnel, access tunnel, service building, workshop, standby generator, take-off yard and tailrace outlet.

Table 15-1: Interface responsibilities

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
General	- Designing and sizing all caverns, tunnels and buildings to accommodate installation, operation and maintenance of all plants including LOT 2 supply. - Construction of civil works, manufacturing and installing the hydro-mechanical equipment, including electrical part of equipment, and incoming cables from specified source to Motor Control Centre (MCC). - Providing sufficient space for erection, operation and maintenance of LOT 2 electrical and mechanical equipment. - Delivery, installation and certification of suspension rock anchors/ bolts/ lugs for lifting and pulling according to specifications from LOT 2 Contractor. - Installing embedded concrete bolts and first stage embedded parts. - Providing lifting points in concrete or rock. - Supply, installation and monitoring instrumentation for the project. - Building finishes, temporary lighting inside and outside areas at power house, weir and lighting in adits, - Necessary provisions (required by LOT 2 Contractor in civil works) for installation of firefighting and fire detection systems, fire extinguishers, lighting and small power, lightning protection and earthing system in the service building, at the weir, powerhouse adit and at the emergency valve chamber including HVAC system. - Water supply and waste sanitary water systems for the project. - Civil works for installation of all equipment/ items covered in LOT 2 Contractor's scope. - Lighting on the deck along with operating arrangement for the gates at weir and tailrace. - Designing and supplying intake trash rack having clear opening size fixed as per LOT 2 turbine manufacture design requirements	- Preparation of drawings showing all LOT 2 electrical and mechanical equipment and items to be delivered and erected, with dimensions of all equipment and items including space required for safe operation and maintenance. - Providing LOT 1 Contractor with LOT 2 requirements for earthing at the powerhouse, PPV chamber and diversion weir area. - Provide information on space required for transportation equipment into and out from the Site during erection period and during overhaul and maintenance of equipment. - Advise, and show on LOT 2 drawings, locations of all necessary lifting points for installation and maintenance. - Specify locations and capacities of suspension rock anchors/ bolts/ lugs required for lifting and pulling for moving and erection of LOT 2 equipment. - Specify required concrete outline and block-outs. - Specify all static and dynamic design loads that must be supported by the concrete. - Supply templates and bolts for embedding in concrete - Design and install heating, ventilation, air-conditioning, fire-fighting and fire detection systems, fire extinguishers, lighting and small power, lightning protection and earthing system in the service building, at the weir, powerhouse, adit and the emergency valve (PPV) chamber. - Supply and install elevator for powerhouse. - Provide, well in advance, necessary drawings showing requirement of civil works for all equipment/ items covered in LOT 2 scope, which may include any minor chipping, etc. - Provide trashrack clear spacing requirements.
Power station size and design	- GA of drainage system including sewerage - Coordinated (LOT 1 and LOT 2) design of power station including powerhouse, transformer hall, access tunnel, IPBD tunnels, service building, SBG foundation, box conduit between cable-cum-ventilation tunnel portal and Takeoff	- Drawings showing GA, dimensions, forces, frequency and weights for all main equipment to be supplied. - Provide dimensions for distributor and turbine housing, runner, bucket, jets etc., erection procedures and other requirements - GA of turbine pipework (including drains

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	Yard.	from penstock, distributor and turbine housing, head cover, buckets, jets, etc.), turbine aeration, turbine portal handling equipment, governor oil pressure system including servomotor pipe routes, MIV, etc., including actuator and bypass dismantling joint - GA of CWS, including pipe routes - GA of compressed air systems and oil filtration system, including pipework - GA of powerhouse SBG, including fuel tank and supply cables - GA of generators, including foundations bearings, air coolers and pipework - GA of all GVE, including bus ducts to the power transformers - GA of auxiliary/ distribution transformers, CSBs, supply and connecting cabling; routes, trays and supports - GA of DC cubicles and battery room - GA of power transformer bays, GIS and HV interconnections, including foundation requirements - GA of HV cables and supports from GIS to take-off yard - GA of take-off yard - For all plants, in-service loads, thrusts and masses to be supported - Access and clearances required for dismantling and reinstatement, safe operation, etc. - GA of ventilation supply and exhaust fans, filters and ducts - GA of water supply system, including distribution - GA of firefighting and fire detection system - GA of lighting and GPO distribution - GA of cable tray routes, trays and supports, including supply, installation and connection, of all type of cables included in scope.
Construction services	- Providing and maintaining supply of electrical power and water, ventilation and dewatering at headworks, headrace tunnel and powerhouse sites for both LOT 1 and LOT 2 Contractors during construction, erection and operation of equipment. - All works involved in preparing the site establishment area in locations allocated by the Employer to LOT 2 Contractor, including earthworks, landscaping, road works, fencing and supply of services, including electric power, water supply, sewerage, telecommunication etc., to the agreed delivery points.	- Providing, under their own contracts, specific site installations required for their personnel or in connection with construction of the works and fulfilment of their obligations under the LOT 2 Contract - Cable extensions for electricity supply for own use from central distribution cabinets provided by LOT 1 Contractor at erection sites. - Water supply for own use from central distribution locations provided by the LOT 1 Contractor at erection sites. - Providing working/task lighting for own

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	Providing all construction electrical power and water at headworks and power station for both LOT 1 and LOT 2 Contractors.	erection work.
Embedded parts		
General	- Installing all embedded parts in first stage concrete. - Delivery and installation of all rock bolts and foundation plates in primary concrete, including calculation of bolt dimensions based on information on forces provided by LOT2 Contractor. - Embedment of structural parts, in close cooperation with LOT 2 Contractor. - Embedment of rock bolts/ plates, foundation bolts and construction parts in accordance with LOT 2 drawings.	- Providing LOT 1 Contractor with details of all embedded parts to be installed. - Supplying all embedded parts on time. - Installing all embedded parts in second stage concrete. - Providing drawings showing locations of rock bolts required, embedded plates and foundation bolts in primary concrete as anchoring and foundation of equipment - Providing drawings of bolt locations shall show all forces to be transferred to the foundation and/or primary concrete. - Electrical and mechanical equipment to be anchored and fixed to bolts, all welding shall be done by the LOT 2 Contractor.
Embedded parts	- Follow any embedding procedures stipulated by the LOT2 Contractor. - Final detailed drawings prepared by LOT2 Contractor showing rock and foundation bolts and structural construction parts to be embedded shall be issued to LOT1 Contractor as construction drawings. - Control rise speed of concrete during pours for the embedment of LOT 2 equipment so as not to exceed the allowable rise speed limits or not in more than 0.5 m thick concrete lifts.	- Calculation, supply and installation of all foundation bolts, steel beams for connection to the bolts and construction parts to be embedded. - Necessary anchoring to bolts and stiffening of LOT 2 equipment in connection with their embedment with concreting by LOT 1. - Design LOT 2 equipment as per allowable rise speed of concrete during pours in embedment forms. - Issuing OK card before concreting. - Monitoring and advising during embedment.
Powerhouse/ PPV Chamber/ GIS cranes, trolley bridge and track		
Main crane railway	- Embedment of anchor bolts and associated parts for crane rail as per details and materials supplied by LOT 2 Contractor. - Construct block-outs. - Install embedded concrete bolts. - Provide clear level area for crane erection. - Provide temporary crane power supply. - Grout sole-plates and track rails with expanding mortar after installation.	- Provide all design load considerations to LOT 1 Contractor for design of crane beam. - Specify block-outs. - Supply crane, including sole-plates, rails and anchor bolts. - Supply and erect crane on to the crane railways. - Conduct load test. - When installed, shim the crane rails by means of flat steel and fix them to concrete with bolts. The position of crane rails shall be adjustable on the foundations to compensate for up to 50 mm gradual inward deformation of powerhouse walls.
Main crane installation	- Provide access and clear level area for crane erection. - Supply, install lifting, pulling anchors.	- Define requirements for crane erection, including lifting point locations and capacity. - Assemble and erect the crane. Supply power from temporary source for

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
		operation till availability of permanent source.
Main crane usage during construction		• Use crane for erection of distributor and turbine housing • Use crane for all other LOT 2 plant installations • Provide and connect permanent crane power supply, commission test and handover crane on completion.
Turbine		
General	• Design anchor bolts for anchoring the turbine equipment and all turnbuckles, jacks and eyebolts according to forces provided by LOT 2 Contractor. • Supply and install anchor bolts.	• Provide full details of all loads and forces imposed by turbines equipment needed for design of foundations. • Provide full details of anchor bolts for the turbine equipment, all turnbuckles, jacks and eyebolts for site positioning and aligning all turbine parts/ base plates, which require anchoring in rock or placing in concrete. • All welding on anchor bolts
Distributor and turbine housing, buckets, jets and drain pipes	• Design and construct as per LOT 2 design, accommodating the LOT 2 installation and erection sequence. • Construct concrete foundations and install the bolts in them according to drawings supplied by LOT 2 Contractor. • Supply and install all anchors required for installation, including for lifting, hauling, hold-down and support. • Install all anchor bolts in rock for transfer of uplift forces due to buoyancy during concreting. • Supply and install drainage pipework. • Embed distributor and turbine housing in second stage concrete.	• Specify in-service design loads to be supported by concrete. • Define installation and erection sequence, clearances, requirements and procedures. • Define first stage concrete outlines and block-outs, • Specify location and capacity of anchors required for installation, including those for lifting, hauling, hold-down and support. • Erect, align and fix tailrace structure and distributor casing, including all anchorages, supports and protection required during subsequent embedment. • Perform weld, leak and pressure testing required prior to embedment. • Monitor and advise during embedment
Distributor	• Construct concrete foundations and install the bolts in them according to drawings supplied by LOT 2 Contractor. • Install all anchor bolts in concrete for transfer of uplift forces due to buoyancy during concreting.	• Install steel bearing plates in concrete foundations and install distributors prior to embedding. • Provide information on forces from distributor acting on concrete foundation.
Inspection platform/ grating	• Supply and instal concrete foundation and anchor bolts.	• Supply and install girder for inspection platform/ grating.
Pit liner	• Design and construct civil works according to intent of the specified arrangement. • Supply and install concrete foundation and anchor bolts for erection of liner as per drawings supplied by LOT 2 Contractor. Embedding shall be performed in cooperation with LOT 2 Contractor. • Install embedded concrete bolts.	• Specify plant arrangement details and all loads to be supported by concrete. • Define concrete outline, block-outs required for grouting and services (pipes, cables, ducts). • Supply bolts for embedding in concrete. • Provide scaffolding and supports for installation and internal support prior to embedding.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	Grout block-outs.	
Inlet Valves: MIV, PPV	- Construct concrete foundations and install bolts according to drawings supplied by LOT 2 Contractor. - Construct anchored concrete pedestal and block-outs. - Install embedded concrete bolts. - Grout block-outs. - Grout soleplates. - Grout steelwork with expanding/ non shrinking mortar after installation.	- Specify MIV / PPV mounting requirements including foundation loads, concrete pedestal and block-outs for soleplates. - Provide bolts design loads. - Supply and install soleplates. - Install steelwork on concrete foundations. - Upstream and downstream welding of penstock for PPV.
Inlet Pipes	Embed pipes in cooperation with LOT 2 Contractor.	- Supply a skid rail system for positioning and fixing of inlet pipe and cone. - Install inlet pipe in its correct position and fixed ready for embedment.
Penstock closing	Install penstock to position and align with trimming allowance of not less than 300 mm.	Contract interface shall be till upstream connection pipe from upstream line of MIV, including edge preparation and welding of pipe with penstock.
Chequered plates, access ladders, handrails, guards, trenches etc.	- Provide trenches in turbine floor according to drawings supplied by LOT 2 Contractor. - Embed frames after installation. - Construct/ provide trenches required by LOT 2 Contractor between the oil pressure unit, electronic cabinet, inlet valve control cubicle and deflector servomotor for each turbine.	Provide all necessary chequered plates, handrails, guards, etc. to permit comfortable and safe access to turbine covers and equipment to be inspected (shaft seal, turbine bearing etc.) and, in particular, handrails around turbine shafts at the turbine floor and gratings above oil pipe trenches. Necessary embedded frames shall be included.
Potable water, fire water and sanitary water in the powerhouse	- Construct water tanks and provide all block-outs for LOT 2 installations. - Supply and install water distribution system from water tanks. - Provide LOT 2 Contractor with required supply side capacity data for water tanks.	- Install pipes, pumps and water treatment plant, etc., and supply water tanks. - Install all level measuring equipment in water tanks.
Fire protection system	- Make provisions for firefighting system according to GA and civil interface requirements provided by LOT 2 Contractor - Provide necessary block-outs / cutouts in floors and walls according to drawings from LOT 2 Contractor.	- Prepare circuit diagrams and arrangement drawings, and deliver diagrams, drawings and all necessary information on fire protection system and its power supply and measurement/ control signal interfaces. - Supply and install measurement/ control signal cabling from interface at fire protection system control unit to power station control system, and manage relevant signals within the control system itself. - Provide GA of firefighting system along with civil interface requirements to LOT 1 Contractor.
Unit cooling water system		
Embedded pipe-works (into draft tubes)	Install embedded CWS pipe work through into powerhouse.	Provide design and pipe work to be installed through into powerhouse.
Header tank access	Design and construct a CWS header tank maintenance access platform.	Specify CWS header tank maintenance access requirement.
Cooling water	Provide necessary block-outs and	Supply drawings showing all block-outs

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
system	trenches in floors and walls according to drawings from LOT 2 Contractor. Perform embedding of block-outs after installation in cooperation with LOT 2 Contractor.	and trenches in walls and floor for piping to be routed. - Supply and install all pipes and equipment including anchor bolts. - For pipes to be installed through the walls and floors of the cooling water tank, supply preformed pipe sections with external sealing ribs for installation by LOT 1 Contractor. - Furnish embedded pipes through recesses with external protection prior to embedding. The protection shall allow for expansion of the pipes.
Fire water system	Design and construct water storages at the services building and in the transformer hall, including supplies to the tanks.	Design and construct fire-fighting water supply system downstream of the LOT 1 storage tanks.
Cables and cable pipes, ducts, routing ways and conduits	- Design, and construct surfaces for mounting cables/pipes/ducts. - Construct all wall and floor penetrations/ openings. - Install culverts, pipes, ducts, routing ways and conduits for cables in accordance with drawings and information supplied by LOT 2 Contractor. - Embed high voltage cables in lean concrete or an approved sand material according to instructions of LOT 2 Contractor. - Excavate and backfill all cable trenches in accordance with instructions of LOT 2 Contractor. - Where instructed by the Employer/ Employer's Representative, make fire protection sealing in block- outs and install protection materials under direction of LOT 2 Contractor.	- Define mounting surface requirements for cable and pipe supports. - Define all required wall and floor penetrations and sealing requirements. - Fill/ seal penetrations as required following pipe/ cable installation. - Prepare drawings showing locations and dimensions for culverts, pipes, ducts, routing ways and conduits for cable pulling and cable installations. - Provide fire protection sealing in block-outs after the cable pulling is finished. - Prepare drawings for all outdoor cable trenches (plans and sections). - Place cables and provide all cable protection material, such as spacer blocks, plastic shields and warning tape, as well as clamps and fixing details.
Buried and embedded conduits	Define buried and embedded conduits and cable pulling pits required.	Design, supply install and construct buried and embedded conduits and pits.
Cable ladders	- For cable ladders to be installed along unlined rock walls, install rock bolts as supports for the cable ladders. - Provide block-outs for cable ladders in walls and floors as per requirement of LOT 2 Contractor.	- Prepare drawings showing locations and dimensions for block-outs for cable ladders in walls and floors. - Provide fire protection barriers in block-outs for cable ladders in walls and floors. - Supply and install cable ladders for LOT 2 cables. Ladders shall have sufficient space for laying of all other contractors' cables, in accordance with their specifications. - Supply and install fixing bolts for ladders and racks.
AC Generators		
Stator sole plates, lower bracket sole plates	- Design and construct generator concrete foundations including block-outs, barrel housing, etc - Install embedded concrete bolts.	- Define generator stator and lower bracket sole plate static and dynamic loads, levels and block-outs. - Supply bolts for embedding in concrete.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	- Grout sole plates. - Carry out embedding and grouting of foundation bolts and foundation details in accordance with instructions from LOT 2 Contractor.	- Supply, install, align and fix sole plates. - Supply and install generators including auxiliary equipment. - Supply drawings and descriptions of block-outs in concrete, foundation details and foundation fixing bolts, including barrel enclosure. - Deliver to site all foundation details and bolts intended for embedding in time for the LOT 1 Contractor to carry out his work. - Specify all static and dynamic forces, and supply this information to LOT 1 Contractor in time for the latter to be able to complete foundation design.
Generator enclosure door frame and cover plate frame.	Install and grout.	Supply
Generator frame earthing	Provide earthing tails at nominated locations.	Nominate locations for each tail from embedded earthing system.
Generator bus ducts		
Bus duct supports, anchorage	- Construct concrete mounting surfaces. - Install embedded concrete bolts.	- Define mounting surface and embedded anchorage requirements for bus duct supports. - Supply bolts for embedding in concrete
Bus duct penetrations through walls of power transformer cells	Construct the block-outs.	- Define block-outs. - Fire block all penetrations after bus-duct installation
Neutral grounding resistor		
Neutral transformer earthing	Provide earthing tails from embedded earthing system at defined locations.	Define the required earth tail location and cubicle grouting details
Generator voltage equipment		
Transformer and reactor supports and anchors	- Construct block-outs. - Provide required embedment in concrete, underneath oil collection pit, drainage arrangement, etc. as required by LOT 2 Contractor. - Grout block-outs after installation.	- Define block-outs. - Supply bolts for earthing in concrete. - Provide foundation details including embedment in concrete, underneath oil collection pit, drainage, etc.
Control and Instrumentation		
Water level signal	- Provide water level digital signal (x3) transmittal from the HOC and tailrace outlet. - Provide headworks remote monitoring/ control digital signals transmittal from the HOC. - Provide tailrace gate remote monitoring and control digital signal from a tailrace outlet LCU.	- Obtain water level signals from HOC and tailrace. - Obtain remote monitoring and control signals from HOC and from tailrace outlet LCU.
LV AC distribution (powerhouse and Takeoff yard)		
Powerhouse diesel generator	- Design and construct SBG foundation to achieve intent of LOT 2 design. - Install embedded concrete bolts. - Grout block-outs after installation.	- Provide GA of SBG and diesel tank foundations, including block-outs. - Supply bolts for embedding in concrete. - Install SBG, fuel tanks, cable supports.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
400 V supply cables from both SBG and distribution transformer to Takeoff yard (electrical service area) and from takeoff yard station to powerhouse (electrical services area) via CVT and surface cable tunnel	Design, supply, install and construct buried and embedded conduits, pulling pits, along with mounting provisions for cable supports as per the intent of the defined design.	- Define cable route, support mounting provisions and required buried conduit and pulling pits. - Supply/ install cable supports.
Takeoff yard		
11 kV cabling from powerhouse (electrical services area) into Takeoff Yard (electrical service area) via CVT and surface cable tunnel up to Takeoff Yard/ 11 kV T/L poles (as required)	Design, supply, install and construct buried and embedded conduits, pulling pits, including mounting provisions for cable supports, as per intent of the LOT 2 design.	- Define cable route, support mounting provisions, buried conduits and pulling pits required. - Supply/install cable supports.
11 kV supply from powerhouse services building SWB to headworks, surge shaft/ PPV chamber, tailrace	Supply and install embedded and buried conduits and pits within buildings, CVT, cable trench and under LOT 1 landscaped or hard-surfaced areas.	- Define arrangement of conduits and cable pulling pits. - Extend (supply/ install) buried conduits/ cables to T/L poles. - Supply and install poles and cables. - All works related with supply and installation of overhead 11 kV T/L along with mounting of ADSS cable for communication between powerhouse and remote sites (headworks and PPV chamber), including distribution transformers at two locations.
Headworks main DB and standby generator (SBG)	- Specify Main DB function and capacity requirement. - Design and construct SBG foundation to achieve intent of LOT 2 design. - Install embedded concrete bolts. - Grout block-outs after installation. - Build HOC to house the main DB and MCC for headworks equipment operation and control. - Supply and install 400 V power cables for connection to MCC from main DB.	- Design/ supply/ install a distribution transformer, main DB and SBG, as per LOT 1 function and capacity requirement, including auto transfer switch for SBG. - Supply and connect power supply cables to main DB, including incoming power cables from SBG. - Provide GA of SBG and diesel tank foundations, including block-outs. - Supply bolts for embedding in concrete. - Install SBG, fuel tanks and cable supports.
HOC and Penstock protecting valve chamber 400V power supplies	- Built HOC control room to house MCC (LOT 1) and main DB for operation and control of gates and associated equipment supplied by LOT 1 Contractor. - Build PPV chamber to house main DB and MCC for operation and control of PPV and associated equipment.	Design/ supply/ install a distribution transformer, main DB as per LOT 1 function and capacity requirement, including incoming cable from distribution transformer.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	Supply and install 400 V power cables for connection to MCC from main DB.	
Tailrace gate 400 V power supplies	- Construct foundations/ supports for 400 V DB. - Supply and lay cables, buried conduits for cables.	Supply and install 400 V DB with appropriate IP rating.
Power transformers		
Power transformers/ transformer hall rails	- Supply and install 52 kg, broad gauge rails for transformer movement (up to its place of installation). Install pulling hooks and rails in accordance with instructions of LOT 2 Contractor. - Construct transformer pit and oil sump in accordance with LOT 2 Contractor's GA drawings, including grating over pit for placing +40 mm crushed stones, etc. - Supply and install measuring, alarm and drainage systems for supervision of liquid level in oil sumps. - Construct block-outs as per LOT 2 design.	- Define the rails, provide transformer loads, - Supply and install main transformers and all ancillary equipment. - Supply GA drawings and installation instructions for pulling hooks and rails to be embedded in concrete by LOT 1 Contractor
Foundation of spare transformer	Construct foundation of spare transformer with oil collection pit underneath to take care of any unforeseen spillage of oil, etc.	Supply GA drawings and installation instructions for pulling hooks, and rails to be embedded in concrete by LOT 1 Contractor
River stones for quenching pits	Supply and install.	
Redundant UPS/DC system, RTU, VSAT, etc		
Redundant UPS/ DC supplies at HOC, penstock protection valve chamber.	- Supply/install MCC as required including incoming cable from Main DB (by LOT 2) 400 v switchgear. - Derive redundant control DC supply from redundant UPS provided by LOT 2 Contractor. - Provide civil works as per requirement of LOT 2 Contractor. - Provide instrumentation and control cable, up to RTU supplied by LOT 2 Contractor, for equipment supplied by LOT 1 Contractor.	- Design, supply and install redundant UPS system, RTU, MDB, VSAT, etc. - Supply and install cables and other accessories required to complete and successfully operate all systems.
Earthing system		
Embedded and buried earthing conductors	- Install earth conductor surface plates at designated locations. - Design, construct all embedded and buried earths and surface connections to all LOT 1 metal work.	- Show required locations for surface plates of LOT 1 buried/ embedded earthing conductors. - Design and construct all surface earth connections from surface plates to all LOT 2 metal work and electrical equipment earths.
Power station automation and control	- Civil works related to VSAT and other equipment supplied by LOT 2 Contractor at Takeoff yard, powerhouse, HOC and PPV chamber - Provide upper headrace water level signal on RTU terminals of fibre-optic carrier network between headworks and powerhouse.	- Design, supply and install RTUs, fiber optic (ADSS) network, VSAT and associated equipment between Takeoff Yard, powerhouse, PPV chamber and HOC. - Integrate signals from HOC, PPV chamber and tailrace with power station automation and control.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
Penstock protection valve and tailrace outlet gate	Install all local station instruments and devices required for remote monitoring and control of valve/gate.	- Install all remote station requirements for remote monitoring and control. - Supply and install fibre-optic cabling required for remote control at each (valve or gate) LCU and VSAT.
Penstocks/ inlet pipes	- Supply and install trifurcation or manifold bifurcations (unit penstocks) into penstock tunnel. - Supply, install and embed branch pipes from each bifurcation to the powerhouse wall, adjusting and securing the pipes to their final position according to the requirements of LOT 2 Contractor. - Chamfer downstream end of pipes according to weld groove designed by LOT 2 Contractor.	- Supply, install and adjust at site the inlet pipes and design the weld groove for welding connection between penstock and inlet valves in power station. - Supply inlet cone/pipe with 200 mm over-length and adjustment of length to fit previously embedded branch pipes. - Perform and test weld seam branch pipe linings and turbine inlet pipes. - Blast clean weld seams between penstock and turbine inlet pipes and cones down to upstream side of the turbine inlet valve, after all concreting work and all transportation through steel linings is completed. - Paint weld seam and inlet pipes.
Penstock connection	Align, fix and embed penstock distributor outlets into position within specified tolerances.	Trim and install (weld) closing pieces to join penstock distributor outlets to turbine inlet valves.
Indoor 220 kV switchgear (GIS) located at underground powerhouse		
	- Construct foundation to specification including block-outs. - Install embedded requirements. - Grout block-outs. - Provide floor/ wall cut outs as required by LOT 2.	- Supply all embedded requirements; bolts and mesh. - Specify mounting requirements including: - block-outs and/or embedded bolts. - Weights to be supported. - Mesh embedded in floor for earth screening if required.
	Install earthing and screening mesh in accordance with LOT 2 Contractor's instructions.	- Design and supply earthing and screening mesh to be embedded in the floor, and provide instructions LOT 1 Contractor for installation and embedding. - Supply and install complete switchgear including local control cubicles.
	Install foundation frames and fixing bolts embedded in concrete in accordance with instructions of LOT 2 Contractor.	- Supply foundation frames and fixing bolts to be embedded in concrete, as well as instructions for installation and embedding. - Provide information on all static and dynamic foundation forces for the Employer to be able to complete the foundation design.
Ghunsa Khola Takeoff yard 220 kV yard and EHV/HV/ LV/ control/ fibre cables, etc.		
All cables EHV/HV/LV/ control cable/ fibre cable, etc. from powerhouse to Takeoff yard (via underground powerhouse/ bus duct tunnel/ GIS	Design, supply, install and construct buried and embedded conduits, trenches, surface cable trench and pulling pits; including mounting provisions for cable supports as per intent of design.	- Define route, cable support mounting provisions, buried trenches, surface trenches, conduits and cable pulling pits required. - Define different cable requirements. - Supply/install cables, supports, accessories, etc.

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
cavern/ CVT/ cable trench, etc.)		
Yard preparation and DG set foundation etc	Design and construct, take-off yard including buried earthing grid, perimeter kerb and fencing, drainage, slope batter stabilization, surface finish material, gravel/bluestone.	Define required size, orientation and layout of take-off yard and associated equipment, DG set, distribution transformer, etc.
Structures and supports	- Design and construct concrete foundation blocks for all take-off yard structures and equipment. - Design and construct cable trenches in take-off switchyard.	- Define structures and equipment foundation requirements and loads. - Design, supply and install all structures.
Line terminations	Provide required inserts/ hooks, on building structure, for termination of line conductors/ OPGW/ earth wires from dead-end tower.	- By Lot 3 Contractor: terminate OPGW to FDP (termination enclosure) mounted on gantry/ building structure. - By Lot 3 Contractor: terminate OH line conductors on gantries/ building structure and further connect through droppers to surge arrestors and cable to air terminations - Define requirement of inserts/ hooks, on building structure for termination of line conductors/ OPGW/ earth wires from dead end tower.
Take-off outdoor yard/ pothead yard	- Design and construct take-off arrangement for conductors of various OH lines, civil works associated with earthing grid, cable channels/ trenches, all footing and foundations, DG set foundation, approach roads, fencing, gates, surface gravel, etc. in accordance with LOT 2 Contractor's instructions. - Design and construct in-ground cable-ways required within, to and from the take-off yard and CVT portal. - Design and construct footings/ foundations of EHV equipment lattice support structures supplied by LOT 2. - Facilitate excavation and backfill on earthing grid in accordance with instructions of LOT 2 Contractor.	- Design and prepare electromechanical layout and provide required information to LOT 1 for construction. - Supply and install all control, protection and automation system equipment, fire detection and protection system, cabling, etc. in Takeoff yard - Supply and install all steel structures and cable termination equipment. - Design and supply buried earthing grid and carry out instructions for installation. - Prepare foundation plan and deliver foundation bolts and templates for embedding. - Provide information on all static and dynamic foundation forces to LOT 1 Contractor.
Heating, ventilation and air conditioning system (HVAC) for powerhouse		
	- Provide required openings in wall/ floor for ducts, cables, foundations for AHU, switchgear, etc. - Design and construct foundation to achieve intent of LOT 2 design. - Install embedded concrete bolts. - Grout block-outs after installation.	- Provide electrical power supply and ACSA interface. - Supply and install complete HVAC system. - Design, supply and install low voltage switchgear, motor starters, power cables and control cables in accordance with drawings and documents provided by LOT 2 Contractor. - Prepare and deliver all information, circuit diagrams and GA drawings to provide details for interface for power supply and measuring/control signals to the station control system. - Provide GA of equipment including block-

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
		outs. • Supply bolts for embedding in concrete.
Lighting foundations		
	Design and construct the lighting post/ poles foundations in accordance with the directions of the LOT 2 Contractor.	Prepare drawings and loading information for the lighting post/ poles foundations.
Earthing		
	- Facilitate earthing network at power house, takeoff yard, valve house and intake area including a total of about 130 vertical rod ground pits (in addition to horizontal conductors) may be required. The diameter of hole (for pit) will be approx. 100 mm and depth 3/ 4 metres. - Facilitate earthing/ grounding system risers to be raised along with columns/walls from raft level/ final excavation level for formation of grounding bus at upper floors and embedding of ground grid in upper floor slabs. The risers will also be used for grounding of noncurrent carrying parts/ metal enclosures of various equipment, neutrals of generators and transformers, lightning arrestors, grounding of structures etc. - Facilitate installation of the embedded main earthing electrodes in accordance with the directions of the LOT 2 Contractor. - Design, construct all embed and buried earths and surface connections to all LOT-1 metalwork. - Install earth conductor surface plates in the nominated locations.	- Prepare the design of the main earthing electrode system as well as the equipotential grid for the earthing and lightning protection of all parts, as necessary, of the Plant and takeoff yard. - Provide and install the earthing grid materials and give instructions for installation of main earthing grids/ rod electrodes as required to LOT 1 Contractor. - Advise all about particular earthing requirements - Provide the fault current data for all LOT 2 equipment areas. - Design, construct all embed and buried earths and surface connections to all LOT-2 metalwork. - Design and construct the interconnected earthing system for all of power station including the Takeoff yard. - Show required locations for surface plates to be provided by Lot-1 for buried/ embedded earthing conductors.
Power Supply from Station Service Board (SSB) to LOT 1/LOT 2 Consumers and Control Cables and Signals from Equipment to Central Control Room (CCR)		
	Design, Procurement, Delivery, Installation, Testing and Commissioning of the Power, Control and instrumentation cables as required for interconnection of Electro-mechanical Equipment supplied by LOT 1 contractor as well as cabling required between Lot -1 and Lot-2 supplied equipment at Powerhouse. This should serve the connection between LOT 1 supplied equipment and LV Distribution Board for Power Cables and LOT 1 supplied equipment and Remote Terminal Unit/Remote Terminal Boards for control/ instrumentation cables (fully satisfying the purpose). The cables should meet the technical standards and fully comply with the technical requirements of the Project.	Facilitate Lot-1 for connection of the Power, Control and instrumentation cables as required for Electro-mechanical Equipment supplied by LOT 1 at Powerhouse.
Measuring Instruments such as water level/ silt level/ encoders etc		

Location/ Detail	LOT 1 Contractor	LOT 2 Contractor
	Supply and install specified/ required water level measuring instruments and associated SS pipes and other measuring instruments providing 4-20 mA or 0-10V signals for control and monitoring. Provide necessary information to Lot-2 about measuring/ status instruments. Provide all necessary piping, required electrical equipment and cabling from measuring instruments to RTU panel/ cubicles of Lot-2. Provide insert etc. and Facilitate Lot-2 for erection of water level measuring instruments (supplied and erected by LOT 2) at designated upstream and tail race locations.	Provide all necessary information and facilitate Lot-1 for connection of cables as required. Prepare and supply all information, circuit diagrams and arrangement drawings in order to provide details for interface for power supply and for measuring/control signal to the station control system. Supply and install specified/ required water level measuring instruments and associated SS pipes providing 4-20 mA or 0-10V signals for control and monitoring and connect them to RTU panel/ cubical at HOC control room.
Monitoring for HOC		
	Control and Instrumentation cables from LOT 1 Contractor supplied MCC, hoist equipment/ sensors, etc. up to RTU panel (supplied and erected by LOT 2 Contractor for monitoring at powerhouse).	Prepare and supply all information, circuit diagrams and arrangement drawings to provide details for interface for power supply and for measuring/ control signal to the station control system
Lighting and small power for plant / units		
Powerhouse, transformer hall, access tunnel and portal, services building, workshop, SBG room/ building, take-off yard and CVT portal	Provide appropriate, secure and protected location for LOT 2 equipment, including cable routes to and from.	- Design lighting system. - Supply, install and connect: - GPO's fittings, fixtures, poles. - Cables. - L&P DBs..
Headworks including HOC, weir, desilting caverns, access tunnels, gate chambers Headrace access tunnel Penstock protection valve Tailrace outlet	Provide appropriate, secure and protected location for LOT 2 equipment, including cable routes to and from.	- Supply and install 400 V DB - Design lighting system. - Supply, install and connect: - GPO's fittings, fixtures, poles. - Cables. - L&P DBs. - Cables from 400 V DBs - Dedicated lighting of equipment.
CW pump monorails, turbine pit monorails	- Design and construct building (structure) to support crane/host. - Construct block-outs. - Install embedded concrete bolts.	- Define loads and mounting requirements for crane rail/ beam support brackets and anchors. - Supply bolts for embedding in concrete. - Supply and install all mounting brackets, beam, run ways.
Workshop and service equipment		
Workshop building	Design and construct workshop as per intent of LOT 2 design.	Design a workshop to house and permit effective use of workshop tools and equipment.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION II
GENERAL TECHNICAL REQUIREMENTS

CHAPTER 16
MANUFACTURING

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CHAPTER 16 – MANUFACTURING

16.1 SURFACE TREATMENT AND PAINTING

16.1.1 GENERAL

The Contractor shall provide complete and reliable surface treatment and protection against corrosion of the furnished equipment. Such works shall include workshop painting and coating and paint “touch-ups” and finishing at construction site. The protection shall be applied, as much as practicable, in the workshop.

Unless otherwise specified, coating and painting shall be carried out in accordance with these General Technical Specifications and DIN 55928, "Protection of steel structures from corrosion by organic and metallic coatings", or another equivalent standard.

In all cases, the Contractor shall, however, fulfil the requirements imposed by the onsite conditions – water quality, climatic conditions, environmental conditions, etc. – that may, in many ways, affect the quality and suitability of the surface protection. The surface protection shall ensure lifelong protection of the equipment and minimize its maintenance.

The Contractor shall submit, for the Owner's review and comments, anti-corrosion protection procedures with full details regarding the preparation, type of materials, methods and sequences of application the Contractor intends to use for the protection of structures, machinery and equipment during transport, site storage, building, concreting, erection and operation.

The Contractor shall ensure that his proposed materials, methods and sequences comply with relevant safety rules and health standards, and do not contaminate the environment.

Coating materials shall be standard products from reputable manufacturers with suitable experience in the field of corrosion protection for the type of equipment to be supplied. Coating materials shall be adapted to the quality of fluid in its most severe condition. The Contractor shall justify his use of the proposed product according to the proposed procedure.

In general, stainless-steel components, as well as machined surfaces, shall not be painted or galvanized. Machined surfaces shall be protected against corrosion during transportation and storage by an easily removable varnish.

The painting materials of each individual painting system will be of the same manufacturer and will be compatible.

16.1.2 STEEL STRUCTURES AND SURFACE PROTECTION SYSTEMS

- **System No. 1 – Surfaces in Contact with Water:**

- Step 1: Perfect cleaning of all surfaces by blasting to ISO 8501-1, Grade Sa 2.5 according to Swedish Standard SS 05.59.00. (see also clause 5.4.4 below);
 - Step 2: Application of a zinc-rich primer (epoxy-based) of Dry-Film Thickness (DFT) of not less than 50 microns. The primer shall contain not less than 90% by weight of metallic zinc in the dry film;
 - Step 3: Application of two or more successive finishing coats using a two-component epoxy tar-based paint, resistant to water, atmospheric agents and UV (for parts likely to be exposed to sunlight). For alternative paint systems, see below;
 - Following Steps 2&3, the total DFT shall be not less than 350 microns;
 - Alternatively, the first coat of coal-tar paint or two-component epoxy tar-based paint may be applied directly on the steel surface without the zinc-rich primer, if recommended by the paint manufacturer and review by the Owner;
 - Surfaces in contact with concrete shall receive only the primer coat; and
 - For equipment carrying drinking water or water for fish hatcheries, the paint system shall use solvent-free epoxy-based or bitumen-based paint approved and certified by an official health recognized institution as compatible for use with drinking water.
- **System No. 2 – Ladders, Stairs and Railings, as well as Outdoor Surfaces of Auxiliary Equipment:**
 - Step 1: Cleaning by blasting, as described above under Step 1 of System No. 1;
 - Step 2a: Hot-dip galvanization Unless otherwise specified, the thickness of the galvanising coating shall be in accordance with ISO 1461;
 - Step 2b: Alternatively, a gun-sprayed zinc coat on perfectly dry and dust-free sand blasted surfaces may be applied. For this purpose, 99.95% pure zinc wires shall be used. Unless otherwise specified, the thickness of the coating shall be Zn 200 in accordance with ISO 2063; and
 - Zinc-coated surfaces shall not be painted, unless specified in the Particular Specifications. If painting is specified, System No. 1 or 3 shall be applied. No welding, flame cutting, bending or any other work that will harm the zinc coating shall be applied on zinc-coated components.
 - **System No. 3 – Surfaces in Contact with Air:**
 - Step 1: Blasting to Sa 2.5, as performed for System No. 1;
 - Step 2: Application of a suitable zinc-oxide or ferro-oxide primer according to the manufacturer's specification;

- Step 3: Application of two successive finishing coats of chlorinated rubber or epoxy based paint. The total DFT shall be not less than 150 microns; and

Paint based on synthetic resin may be applied only upon agreement by the Owner.

- **System No. 4 – Surfaces in Contact with Oil (internal oil tank):**

- Step 1: Blasting to Sa 2.5, as performed for System No. 1;
- Step 2: Application of a suitable zinc-oxide or ferro-oxide primer according to the manufacturer's specification;
- Step 3: Application of two successive finishing coat of epoxy-based oil-resistant paint. Total DFT shall be at least 100 icrons; and
- Paint based on synthetic resin may be applied after agreement by the Owner.

The superior coatings will be compatible to use in oil hydraulic system such that no harm will be caused by the oil to the paints and vice versa.

16.1.3 PROTECTION OF AUXILIARY EQUIPMENT

The protection system of the auxiliary equipment shall be in accordance with the protection scheme described above. However, the standard system from the component supplier can be proposed to the Owner for his review, as an alternative, with the submission of complete documentation.

16.1.4 SURFACE PREPARATION AND PAINTING

Before any coat is applied, surfaces shall be properly prepared. For removing rust and mill scales, blasting shall be carried out down to clean bare metal, according to ISO 8501-1, Grade Sa 2.5. The average surface roughness after blasting shall not exceed 50 microns. Sandblasting or grit blasting shall be performed by dry compressed air or rotating wheel. If the blasting material is recuperated it shall be thoroughly cleaned before reuse.

Blasting and coating shall, as far as possible, be performed after the structures and components are welded and machined. Equipment that cannot be blast-cleaned after the last machining shall be blasted, primed and given one topcoat prior to machining.

Painting will be carried out as much as possible immediately after completion of surface preparation.

Parts that cannot be blast-cleaned, such as pipes, shall be cleaned by power-tool and chemical agents.

All equipment parts shall be blasted in the manufacturer's shop unless otherwise specified or agreed by the Owner. The blasted surfaces shall receive a primer coat within

a limited time after sandblasting. All work shall be executed under acceptable climatic conditions and with efficient ventilation for removing dust and thinner vapours.

16.1.5 CLEANING AND WELDS

Erection welds and their heat-affected zones created during erection, which have already been blast-cleaned and painted, shall be re cleaned by sandblasting to Sa 2.5 on an area of at least 100 mm on each side of the weld and repainted.

16.1.6 PAINTING AND MARKING

Paints shall preferably be applied by means of airless equipment. Areas difficult to reach may be brush-coated or coated using a glove. Other application methods require agreement by the Owner.

Coating of any surface shall not take place unless the temperature and humidity conditions are such that a perfect result may be expected. Steel temperatures shall always be at least 3

°C higher than the dew-point temperature of the ambient air. Painting works shall not be carried out on surface temperatures below +5 °C or above +35 °C, unless agreed by the

Owner. During painting works, the ambient air temperature shall be kept within the limits recommended by the paint manufacturer. Application of paint shall never be undertaken under conditions where dust, sand, etc., can settle on the wet paint film.

Care shall be taken to maintain full paint thickness at all chamfers, corners and edges, and special attention shall be paid to the application of protective coatings over welds, mitre joints, etc.

Each coat shall be free from runs, drops, pinholes, waves, laps, sags and unnecessary brush marks, and shall be allowed to dry or cure before the succeeding coat is applied, the period of time not more and not less than instructed by the paint manufacturer.

Shop coats shall be checked for good quality and, where necessary, before proceeding with onsite painting or coating operations, the Contractor shall clean and repair all shop coats that are defective or damaged.

The Contractor shall consider that damage to paint work during shipment, storage and erection is unavoidable, and the application of all protective treatments shall be programmed accordingly. All parts subjected to mechanical machining such as guides, slides, tools etc. shall be protected by soluble, high intensity substances to ensure protection during sea transportation and lengthy storage.

Painting repair shall be done at site after installation.

All paints and primers shall be handled and delivered to the painting site according to manufacturer's instructions and in sealed containers packed by the manufacturer. The

manufacturer's instructions for preparation and application of all painting and protective coats shall be strictly followed.

Each paint shipment will be accompanied by the manufacturer's certificate of date of manufacturing. Storage period of paints will be as short as possible. Paints whose storage period has passed the manufacturer's recommendations will not be used and be withdrawn from the site.

It is forbidden to store paint containers with the cover upside down.

Painting parameters – temperature, hygrometry, dew point, product batch number, coat thickness, etc. – shall be recorded in a painting record sheet to be established for each painting operation carried out in workshop and site and submitted during component inspection.

16.1.7 QUALITY CONTROL

The first and each successive coat shall not be applied without inspection and approval by the Employer.

The minimum dry-film thickness prescribed in these Specifications shall be observed. Not more than 3 spots on average per 1m² painted surface will be measured for dry-film thickness. No measured thickness shall be less than the specified thickness. Where the minimum thickness is not achieved, the coat shall be repaired to reach the specified minimum dry-film thickness.

The dry-film thickness shall be measured by approved gauges. During the entire erection period the Contractor shall make available two sets of electronic paint thickness gauges.

For checks on porosity, the Contractor shall furnish a DC variable high tension test instrument with built-in pore counter. The test voltage shall not exceed 2000V. The tests shall not be performed within 0.5m distance from uncovered, corrosion resistant surfaces.

Upon completion of each coat, the painter shall make a detailed inspection of the painting finishing and shall remove from adjoining work all spattering of paint material. He shall make good all damages that can be caused by such cleaning operations.

A detailed inspection of all painting work shall likewise be made, and all abraded, stained, or otherwise disfigured portions shall be touched up satisfactorily or refinished as required to produce a first-class job throughout and to leave the entire work in a clean and acceptable condition.

16.1.8 WARRANTY

The guarantee period for all corrosion protection work shall be 1820 days, starting from the date of the issue of the "Taking-Over Certificate". This guarantee period shall be effective regardless of any other guarantee periods for the project or parts of the project,

or any "Defects Notification Period" or even "Performance Certificate", issued prior to the elapse of the painting guarantee period.

The Contractor shall perform requested painting repair work at no charge for the Employer if the painting quality guarantee is not met.

At the end of the guarantee period the corrosion protection may show a degree of rusting not higher than RE 1 (one) on the European scale of degree of rusting for anti-corrosive paints, (the corrosion committee of the Royal Swedish Academy of Engineering Sciences, Stockholm).

16.1.9 GALVANISING

Unless otherwise specified, all structural steel and all exterior and interior steel surfaces of outdoor equipment, as well as bolts and nuts associated with galvanised parts shall be hot-dip galvanised, electro galvanised or sherardised, as may be appropriate to the particular case.

Galvanising shall be performed in accordance with DIN ISO 1461 and EN 50341.

Material: For galvanising, only original blast-furnace raw zinc shall be applied, which shall have a purity of 98.5%.

The cover of the zinc coat shall be:

For bolts, nuts, and all other parts, except for hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 500 g/m²,

For hydraulic steel structures or parts intermittently or permanently submerged in water, approx. 1000 g/m².

Cleaning: All material to be galvanised shall be carefully cleaned of rust, loose scale, dirt, oil, grease, and other foreign matters. Particular care shall be taken to clean slag from welded areas.

In case pieces are of such dimensions that they cannot be dipped in one operation, great care shall be exercised to prevent warping.

Finished compression members of steel structures shall not have lateral variations greater than one-thousandth of the axial length between the points which are to be supported laterally. Finished tension members shall not have lateral variations exceeding 3mm for each 1.50m of length. Materials with sharp kinks or bends shall be rejected. All holes in material shall be free of excess spelter after galvanising.

Galvanising of hardware: Bolts, nuts, washers, locknuts and similar hardware shall be galvanized in accordance with the relevant standards. Excess spelter shall be removed by centrifugal spinning.

All plates and shapes which have warped during the galvanising process shall be straightened by re-rolling or pressing. The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. Materials that have been harmfully bent or warped in the process of fabrication or galvanising shall be rejected. Repair of galvanising: Material on which galvanising has been damaged shall be re-dipped unless the damage is local and can be repaired by soldering or by applying a galvanising repair compound; in this case, the compound shall be applied in accordance with the manufacturer's instructions.

Soldering shall be done with a soldering iron using 50/50% solder (tin and lead). Surplus flux or acid shall be washed off promptly and the work shall be performed so as not to damage the adjacent coating or the metal itself. Any member on which the galvanised coating becomes damaged after having been dipped twice shall be rejected.

16.2 WELDING

16.2.1 GENERAL

All welds shall be as shown in the detailed drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum.

The Bidder shall submit with his Bid adequate information concerning the proposed:

- Extent to which automatic welding techniques will be applied;
- Extent to which manual welding techniques will be applied;
- Extent to which it is the Tenderer's intention to use pre-weld heat treatment, post-weld stress relieving, full annealing or normalizing consistent with the thicknesses and types of material proposed;
- Welding electrodes, welding wire and flux which will be used with the selected plate material or materials; and
- Standard tolerances for the deviations of mating weld profiles.

16.2.2 PREPARATION FOR WELDING

All welds shall be performed as shown in the detailed drawings and shall be made in such a manner that residual stresses are reduced to a minimum. Weld seams shall, as far as possible, be positioned outside zones of stress concentration.

Full information and specifications of all principal weld seams shall form part of the design drawings. The drawings shall indicate the type of weld and the choice of electrodes, wires and welding powders to be used. The number of welding passes shall be made in relation to the thickness of the plate. Each pass shall be thoroughly de-scaled before the next pass is applied.

Members and sections to be joined by welding shall be cut accurately to size, with their edges ground or machined to suit the required type of welding, and to allow full penetration and fusion of the weld with the base material.

The surface of members or sections to be welded shall be free from rust, grease, mill scale, and other foreign matter for a distance of at least 30 mm from the edge of the weld. All paint materials shall be removed well back of the heat-affected zones. Welding over zinc primers shall be avoided.

16.2.3 WELDING PROCEDURE

All welding shall be performed by the electric-arc method, and according to relevant standards, unless otherwise agreed by the Owner.

The welding works for main structures and components shall be in accordance with the requirement of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, and performed according to Welding Procedure Specifications (WPS) and Procedure Qualification Reports (PQR) established according to ASME Section IX and AWS code ("Standard Qualification Procedure").

WPSs and PQRs shall be submitted to the Owner for review and comments and shall be issued with full information on all factors set forth in the respective welding forms according to the actual standard, e.g., QW-482 and QW-483 of ASME Section IX.

The welding procedures shall be selected in consistency with the composition and properties of the base material, type of weld and working stresses of the welded joint. Whenever required and in accordance with the requirement of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, preheating and heat treatment of the welding seam shall be applied.

The mechanical properties of the weld shall conform to the base material, as specified in the respective standards, and shall be confirmed by mechanical test on a sample during the qualification procedure phase.

All joining of plates in the principal stress direction shall be carried out using either single-welded or double-welded butt joints. Adjacent plates, carrying high stresses, shall in general not differ more than 3 mm in thickness. If the difference is greater, the thicker plate shall be chamfered at a maximum of 1:4.

Principal welds shall be ground as specified in the welding procedure. In addition, all welds exposed to water having a velocity of 4 m/s or more shall be ground flush with the plates, unless otherwise agreed by the Owner.

In order to prevent the presence of residues in double-welded butt joints, the root shall be completely removed by grinding or back-gauging before proceeding with welding on the other side.

Welding of auxiliary structural members to components of the Plant for the purpose of assembly and installation works is completely prohibited, especially on high-grade material (e.g., the stay ring of the turbine). In extreme cases when it is allowed by the Owner, once the installation has been completed, auxiliary structural members shall be removed by burning them off, followed by grinding the affected areas flush with the plate, without

introducing additional local thermal stresses. At a minimum, dye penetrant checks shall be performed on restored surfaces. Knocking off of such members shall not be permitted.

The electrodes for arc welding shall be classified on the basis of mechanical properties of the as-welded deposited weld metal, type of covering, hydrogen absorption, welding position of the electrodes and type of current.

Electrodes shall be used only in the positions and under the conditions of intended use in accordance with instructions of each container. Electrodes for manual welding shall be suitable for welding in any position.

During welding operations, electrodes shall be stored and dried in electric heating furnaces prior to welding, according to manufacturer's instructions.

16.2.3 WELDING REPAIR

In all welded assemblies, defects beyond the criteria of acceptance shall be eliminated. Depending on the size and number of defects to be eliminated, the Contractor retains responsibility for choosing between performing more or less numerous and important local repairs and that of a new assembly after cutting or entirely gouging the concerned weld. The Contractor's choice is subject to the agreement of the Owner.

If the extent of repairs of a weld performed by an automatic process is likely to extend beyond one-fifth of its length at least its total thickness, the weld shall be redone and controlled once again.

For all welding repairs, the x-ray films or the results of the ultrasonic control revealing one or more defects of origin shall be submitted by the Contractor for Owner's review.

All repairs shall be performed either according to the qualified welding procedure for the execution of the welds, or according to the qualified repair procedure. Welding repairs either in manufacturers' premises as well as on site shall be carried out by qualified welders as well as all current welding works.

However, if the defects, at the origin of one or more repairs, do not bring into question the qualified welding procedure followed during construction, and, if the Contractor decides to apply this procedure to perform the said repairs, no qualification test will be imposed. The repair shall be performed by a qualified welder or operator.

All repair operations shall include the following:

- Verification of elimination of defects
- Non-destructive control of the zone repaired
- New heat treatment (local or global), unless justifications are brought by the Contractor and agreed by the Owner.

At the same location, only two repairs by welding are allowed. The Contractor shall not continue beyond that before having submitted a report analyzing the reasons for these successive repairs and receiving authorization from the Owner.

16.2.4 HEAT TREATMENT

The need and method for heat treatment shall be determined in accordance with the agreed design standard and ASME Boiler and Pressure Vessel Code, taking into account the stress levels, design temperatures, material properties (notch toughness, material thickness, etc.) and forming, welding and inspection procedures. Shop heat treatment of welded components shall be performed prior to final machining.

Procedures for heat treatment shall be submitted to the Owner for review and comments.

Site welding heat treatment shall be performed according to the specifications of welding procedures for the corresponding parts, which shall be submitted to the Owner for review and comments.

16.2.5 WELDER'S QUALIFICATIONS

Welding shall be carried out only by experienced qualified welders. Welder qualification tests shall conform to ASME Code – Sections VIII and IX, or AWS B3.0.

All welders' and welding operators' test certificates shall be submitted to the Owner upon request. Welders for onsite work shall be tested no earlier than three (3) months prior to commencing onsite work operations.

16.2.6 QUALITY AND PROCEDURE CONTROL

- Quality control methods, e.g., non-destructive examination, radiographic examination, ultrasonic examination, dye penetration test etc., shall be done in accordance with the appropriate manufacturing code. However, the Tenderer shall indicate clearly in the Technical Data Sheets the extent to which these methods shall be used.
- Additional non-destructive examinations can be required when it is desired to examine the acceptability of any welds when, in the opinion of the Employer, serious doubt exists as to their quality; in this case, the expenses for this examination shall be borne by the Contractor.

When required in the Particular Technical Specifications, the detailed description of welding procedure (including type of welding electrodes, sequence of welding seams, etc.) for certain parts of the delivery shall be submitted to the Employer before commencement of manufacture.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**INTERNATIONAL COMPETITIVE BIDDING (ICB)
[Single Stage Two Envelope Bidding Procedure]**

**VOLUME – 2 of 5
EMPLOYER’S REQUIREMENTS**

**SECTION III - STANDARD TECHNICAL REQUIREMENTS
FOR
CIVIL WORKS**

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
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LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
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**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 1
GENERAL**

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CHAPTER 1 - GENERAL

1.1 GENERAL

- (a) This Volume 2 – Section III of the Employer's Requirements covers the Standard Technical Requirements for all of the civil works for the Facility.

1.2 DRAWINGS

- (a) For the purpose of this Contract, "Drawings" means the drawings included in the Employer's Requirements prior to the Contract Date and drawings in the Contractor's Specification and/or Approved Contractor's Documents (as appropriate) on and after the Contract Date. Where "Drawings" has been referred to in the Employer's Requirements but no drawings or details exist prior to the Contract Date, then the details specified in the Employer's Requirements shall be shown on drawings included in the Approved Contractor's Documents. Such definition does not void the use of any other drawings included in the Employer's Requirements for the purpose of evaluation of the Contractor's compliance with its obligations under the Contract.

1.3 CONFORMITY OF MATERIALS WITH SPECIFICATION

- (a) All materials that will become part of the Permanent Works shall be new and shall conform to these technical requirements. Where the requirements for any materials are not stated in these technical requirements, the material shall conform to such other specifications as the Employer may approve.

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**CHAPTER 2
SURVEYING**

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CHAPTER 2 - SURVEYING

2.1. GENERAL

2.1.1. Scope

- (a) The Contractor shall render all services for topographical survey and measurement required for the performance of the Works.
- (b) These services cover in general the establishment of axis centrelines, alignments of project structures and features; the setting out for construction thereof; the control surveys for correct locations, dimensions and elevations as well as the necessary surveys for measurement to permit quantity calculations for accompanying invoicing.
- (c) Such surveys shall be based on and/or referred to a basic survey grid of control points and benchmarks extended adjacent to the Works in the project area. This grid shall be the sole basis of reference for all survey work and measurement.

2.1.2. Submissions

- (a) At least Fourteen (14) days prior to commencing survey work, the Contractor shall submit to the Employer for his approval a proposal of the purpose and the sequence of the survey works to be performed, the area to be surveyed, the bio-data of the key personnel in charge of survey works, the list of survey equipment and instruments which the Contractor will have available at the site, and a brief outline on methodologies of survey works applied for the various types of survey.

2.2. MATERIALS AND INSTRUMENTS

- (a) The Contractor shall provide, maintain and operate suitable and appropriate equipment, instruments, materials and auxiliary equipment, commensurate with the various tasks and precision requirements of the survey works.
- (b) Type and accuracy of the survey equipment to be used by the Contractor shall correspond to the nature of the construction/erection works and the construction technique.
- (c) All equipment, instruments, materials and auxiliary equipment shall be in perfect operation condition. Prior to the start of survey activities, equipment, instruments, etc., shall be checked as to their proper functioning and accuracy.
- (d) During the construction period the survey instruments shall be checked and adjusted at regular time intervals.
- (e) Instruments and equipment, which have suffered from damage or accidents to a degree making them unfit for further use at the site shall be removed from the site and replaced immediately.
- (f) The number of sets of instruments shall be sufficient to meet the requirements of the construction time schedule.

2.3. EXECUTION

2.3.1. General

- (a) For the execution of the survey work, the Contractor shall employ and provide experienced professionals and auxiliary staff.
- (b) The Contractor shall provide, maintain, adjust when necessary and operate the required survey and auxiliary equipment for the performance of the Works.
- (c) All survey and measurement activities shall be recorded in maps and field books where required, the production of drawings and maps shall be deemed to be part of the Works.
- (d) The Contractor shall keep and maintain professional records of all field surveys and measurements, the related computations and calculations, manuscripts, plans, drawings and maps, and shall make them available to the Employer whenever requested.
- (e) If, in the opinion of the Employer, deficiencies and/or inaccuracies in field and office work have been found, such work shall be repeated and made good to the satisfaction of the Employer.

2.3.2. Preparatory Works

- (a) Prior to starting the survey works, the surveyors shall make adequate terrain investigations with respect to sightings, vegetation to be removed, placement of monuments, taking into consideration future construction work, which may affect the survey points, monuments and benchmarks.
- (b) In case the survey work have activities on lands not owned by the Employer, the prior consent of the land owners shall be obtained and adequate compensation payments shall be made by the Contractor at his own expenses.

2.3.3. Handing-Over of Basic Survey Data

- (a) General Requirements
 - Prior to the commencement of the survey work, the Employer shall hand over to the Contractor all information and data of the basic survey grid and benchmarks to which the Contractor's survey work shall refer. Upon handing-over the Contractor shall review this information and data and shall check the existence of the control points and benchmarks. Furthermore, the Contractor shall take responsibility for the maintenance and protection of these basic datum points and benchmarks.
 - Should field checks reveal that points and benchmarks have been damaged, displaced or destructed, the Contractor shall inform the Employer of this fact, and the Employer shall give instructions regarding the re-establishment of such datum points and benchmarks.
 - Should it become necessary that basic control points and benchmarks be removed because of foreseeable construction works, the Contractor shall inform the

Employer of the need thereof and obtain approval and instruction for the establishment of new basic control points and benchmarks and/or auxiliary points.

- If, within 3 months upon handing over, inconsistencies within the basic survey grid the Contractor should inform to the Employer immediately thereof and produce the evidence. The Employer shall subsequently inform and instruct the Contractor on remedial measures to be taken. Any survey work, setting out or measurement already taken or performed prior to the detection of such inconsistency shall be rechecked and corrected by the Contractor.
- Additional basic control points and benchmarks established by the Contractor for the convenience of his work shall have at least the same quality and durability as those of the existing points, and meets the accuracy requirements.

(b) Coordinate and Elevation

- Coordinates and elevation of national control points are listed below as standard points for survey works of the Project.

Co-ordinates and Elevation of Established Benchmark

SN	Station	Order	Easting (m)	Northing (m)	Elevation (m)
1	Trig. 4440	Fourth	580,771.96	3,047,882.91	-
2	Trig. 4441	Fourth	580,258.05	3,047,870.22	-

- List of the basic control points established by the Employer within the Project area based on the national control points are given in the table below:

List of Basic Control Points at the Project Area (Basic Survey Grid)

SN	Station	Location	Coordinates (m)			Remarks
			Northing	Easting	Elevation	
1	GK1	Sekathum	3046447.170	579758.631	1576.709	Permanent point (200 × 200 × 500 mm pillar)
2	GK2	Japantar	3046721.402	580110.057	1552.134	
3	GK3	Lai Gyap Bheer	3046871.672	580081.383	1702.028	
4	GK4	Phedi,	3049158.663	584099.818	1973.549	
5	GK5	headwork area	3049256.536	584160.254	1976.633	

- List of the permanent control points established by the Employer within the Project area are given in the table below:

List of Permanent Control Points in the Project Area

SN	Station	Location	Coordinates (m)			Remarks
			Northing	Easting	Elevation	
1	TP1	Lai Gyap Phedi	3046844.244	580167.952	1630.708	Permanent points on boulder
2	TP2	Vhedi chowk	3047537.052	581037.711	1754.235	
3	TP3	Jongim	3048099.609	581938.565	1757.370	
4	TP4	Jaubari	3048368.889	582793.149	1837.888	
5	TP5	Lamatar	3048664.548	583477.072	1917.174	
6	TP6	Lamatar	3048754.864	583632.177	1924.419	
7	TP7	Amjilosa Phedi	3049305.876	584136.797	2001.430	

(c) Verification of Survey Grid

- The Contractor shall verify the reliability, the accuracy and the acceptability of the basic survey grid, and data for further surveys.
- All coordinates and elevations to be shown on the Drawings shall be based on the basic survey grid. If, after having executed the verification, the basic survey grid reveals inconsistencies which may affect the location, alignment and elevation of structures of the Project, the Contractor shall forthwith inform the Employer of these inconsistencies.
- The Contractor shall record all calculations, control surveys, setting out and check surveying in a suitable permanent form for verification, which shall be available to the Employer on request at all times. The Contractor shall supply two (2) copies of any such calculations to the Employer on his request.

(d) Augmentation of Basic Survey Grid

- ◆ Existing control points and benchmarks closely located to the permanent structures may be endangered by construction activities. The Contractor shall therefore in due time establish additional control points at safe locations and elevations to augment or extend the basic survey grid.
- ◆ The new control points shall be of permanent nature and shall be constructed as directed by the Employer.
- ◆ The Contractor shall also establish reference monuments for centerlines and line control of structures, which need frequent and extended control surveys of embankment axis, tunnel alignment, etc.
- ◆ New control points, reference monuments and benchmarks shall be protected and maintained in the same way as the original grid points.

(e) Survey of Ground Profiles

1. Original Ground Profiles

- Before commencing any work, the Contractor shall survey the original topography over the entire area to be occupied or disturbed. The information so obtained shall be recorded by the Contractor on a drawing or drawings, which shall be signed by both the Contractor and the Employer. The Contractor shall then provide the Employer with a reproducible copy of each drawing to serve as a permanent record of earthworks carried out in the construction of the permanent structures, and the extent to which temporary works shall be removed or temporary excavations shall be refilled upon completion of the works.

2. Excavated and Final Profiles

- The Contractor shall survey all excavated and final surfaces for the purpose of recording as-built details, and for the measurement of quantities:
 - I. on completion of common excavation and prior to commencement of

rock excavation;

- II. on completion of excavation and prior to commencement of embankment, banking, placing concrete or other work;
- III. on completion of embankment, banking, placing concrete or other work. The survey results shall be recorded and agreed as set out in sub-clause a. above.

(f) Tunnel Alignment and Gradients

- The Contractor shall establish and maintain at suitable distances of any tunnel portal at least two (2) reference monuments and benchmarks on the extended tunnel axis/alignment, to warrant that control surveys during tunnel construction can always be referred to such reference monuments.
- Auxiliary fixed points permitting the location control of the reference monuments in case these have suffered from damage during tunnel excavation periods shall secure them.
- Underground alignment and level survey and control thereof shall be performed by the use of suitable precision instruments preferably of the pulsed laser type or equivalent instruments and auxiliary equipment.

2.3.4. Accuracies and Tolerances

(a) Accuracies

- Accuracy of survey work shall be within the following tolerances: Triangulation:

I. Allowable Error of Closure

- Average not to exceed 5 seconds
- Maximum not to exceed 10 seconds

Traversing:

- Allowable error of closure: 1/3,000
- Allowable error of distance: 1/5,000

Leveling:

- Allowable error for 1 km: 10 mm (Measured forward and backward)
- Allowable error for closure: 10 mm

II. Tolerances

- The tolerances given above shall be the maximum permissible deviations from the specified dimensions, levels, alignments, positions, etc. as shown on the approved Drawings of the structures or structural elements.
- In addition, at the interfaces with mechanical components, concrete surfaces shall be finished flush and shall also meet any additional tolerances required by the mechanical designs or works, respectively.

- Where the tolerances overlap, the severer tolerance shall apply.

Foundations and General Structures:

- Plan position ± 20 mm
- Direction ± 1 degree
- Level ± 20 mm

Tolerance for setting out centerline for shaft excavation: ± 25 mm maximum deviation from alignment.

Determination of centerlines for alignment of tunnels shall meet the following criteria:

- Plan position of centerline ± 10 mm
- Elevations ± 10 mm

Rock bolts:

- Position ± 150 mm
- Deviation from direction ± 5 degree

Project Service Roads:

- Position ± 50 mm
- Gradual Irregularity 10 mm per 3 m

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**CHAPTER 3
DETAILED DESIGN BY THE CONTRACTOR**

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CHAPTER 3 - DETAILED DESIGN BY THE CONTRACTOR

3.1. GEOLOGICAL AND OTHER INFORMATION

- (a) Geological and/or geotechnical information and any other information given in "Volume 4, Part B: Project Description". The information provided in this chapter are informative only to assist the Contractor in preparing the bid and the design.
- (b) The Contractor shall be responsible for the interpretation of the data provided by the Employer.
- (c) The Contractor shall conduct further geological and geotechnical investigations and laboratory investigations necessary for his design and construction materials. The program of investigations shall be transmitted for information to the Employer.

3.2. DETAILED DESIGN OF PERMANENT CIVIL WORKS

- (a) The drawings attached in the bidding document were prepared at the basic design level. The Contractor shall prepare detailed design of the Permanent Civil Works to be constructed by him under the Contract, for the purpose of preparation of working drawings for construction detailed in Clause (b) below, as required for execution of the civil works. The Contractor shall submit such working drawings of a part of the civil works to the Employer for approval, after his obtaining the Employer's approval to the detailed design of the said part.
- (b) Detailed design shall include, but not limited to, the following for the Permanent Civil Works:
 - i. Review of design parameters and drawings provided in the bidding document;
 - ii. Revision of geological map of headworks, waterway and powerhouse area;
 - iii. Revision of geological plans, profiles and sections of each structure;
 - iv. Preparation of design criteria for the Permanent civil works;
 - v. Stability analysis on each civil structure;
 - vi. Stability analysis on head works and powerhouse;
 - vii. Finalization of supporting works of tunnel;
 - viii. Stress analysis on each concrete structure and determination of reinforcing bars arrangements;
 - ix. Stress analysis on steel structures and determination of each steel members;
 - x. Hydraulic calculations on head losses with revised designs of waterway and confirmation of no change of the maximum and rated installed capacity;
 - xi. Hydraulic calculations of river water levels for design of slope protection on the river side;

- xii. Design of utility works including plumbing system, ventilation and air conditioning system, illumination system, fire alarm system, telecommunication system and grounding and lightening system in the headworks, powerhouse and in the outgoing terminal; and
 - xiii. Design of architectural work (finishing, doors and windows, etc.) for the powerhouse and the outgoing terminal.
- (c) Regardless of the information provided above and the approval by the Employer of the Contractor's designs, the Contractor shall be solely responsible for designing the Works and all facilities that meet the specified requirements of the Contract.
- (d) The Contractor shall proceed with the detailed design in consideration of his construction schedule, to prevent him from causing delay due to late design progress. The Detailed Design of each component or structure of the Permanent Civil Works shall have been approved by the Employer at latest by the commencement of construction works for any part of the said component or structure, unless otherwise the Employer accepts the commencement of the construction works of the said component or structure before approval of all of its detailed designs.

3.3. DESIGN CONDITIONS GIVEN BY HYDROMECHANICAL AND ELECTROMECHANICAL MANUFACTURER/SUPPLIER

As specified in Volume 2, Section II General Technical Requirements, Chapter 2, the Contractor;

- I. shall incorporate, into Detailed Design of Permanent Civil Works, Hydromechanical Works' and Electromechanical Works' design data,
- II. may assume them in an appropriate manner to execute the said part of the Civil Works, if some of such data have not been fixed during the detailed design of a part of the Civil Works and the approval by the Employer of the Contractor's designs of the said part, the Contractor shall be solely responsible for designing the part, and
- III. shall revise his design and drawings of the said part after the data have been fixed and final and submit the revisions to the Employer's approval.

3.4. REVISIONS AND ADDITION OF DESIGN AND DRAWINGS

- (a) The Contractor shall revise his detailed design and drawings from time to time due to various reasons such as the conditions mentioned in Sub-clause 3.3 above, issue of a variation order for a part of the Works by the Employer, etc. regardless of his discretion or the Employer's instruction, and submit the revisions to the Employer for approval.
- (b) The Contractor shall prepare new detailed design and drawings as required by the Employer and submit them to the Employer for approval.

3.5. APPROVAL PROCEDURE OF DETAILED DESIGN

- (a) The Contractor shall furnish copies of detailed design documents and drawings in accordance with relevant clauses in the Specifications.
- (b) Within Thirty (30) days, unless otherwise specified elsewhere in the Specifications, of the receipt of the Contractor's drawings, the Employer shall have reviewed and notified the Contractor of its review by returning one copy of the drawings together with any comments as applicable. The 30- day period counts from the receiving date of the drawings by the Employer through the sending date of the copy of drawings to the Contractor. The returned drawing(s) shall be clearly marked with one of the following notations:
 - I. "Approved",
 - II. "Approved Except as Noted",
 - III. "Returned for Corrections" and
 - IV. "Approval not Required".
- (c) In the cases of (II) and (III) of the above, the Contractor shall respond to the instructions noted on the documents and/or drawings and resubmit the modified documents and/or drawings within Thirty (30) days, unless otherwise specified elsewhere in the Specifications, after receiving the drawings from the Employer.
- (d) The Contractor shall be solely responsible for recovery of the delays incurred by late drawing or design submittals or incurred due to rejected submittals. The Contractor shall not be entitled to a time extension based on the rejection of designs or drawings.
- (e) No revision affecting the design shall be made after drawing has been "Approved" without resubmitting the drawing for the approval to the Employer.
- (f) Should an error be found in a Contractor's drawing during the manufacture of Plant or construction of Works, the correction including any changes found necessary on the Site, shall be noted on the drawing and it shall be re-submitted for approval.
- (g) When prints of drawings have been marked "Approved Except as Noted" or "Returned for Corrections", the Contractor shall make the necessary corrections and resubmit the drawings with comments sheets that describe all corrections made by the Contractor and response toward the Employer's comments. Every revision shall be shown by number, date and subject in a revision block. In addition, each revised drawing shall have its latest revision clearly indicated by arrows or other means.
- (h) When prints of drawings have been marked "Approved Except as Noted", the Employer may give comments on the revised drawings re-submitted by the Contractor in any portion including the portion not commented in previous version of the Drawing. The Contractor shall not have any right to claim on additional comments by the Employer.

- (i) The approval of the detailed design by the Employer shall not be understood as a complete check but will only indicate that the general method of construction and detailing are satisfactory.
- (j) Approval of Contractor's detailed design shall not release the Contractor from any part of the Contractor's obligations to meet all the requirements of the Contract Documents or of the responsibility for the correctness of the Contractor's drawings or Equipment involved, or for consequences of error and/or omissions, or for any faults or defects, or for failure in the matter of guarantee, which might become evident during erection or subsequent operation, or for correct fit of assembled parts in final position, or in general for the adequacy of the Works supplied by the Contractor.

3.6. AS-BUILT DRAWINGS

- (a) Chapter 4: Documents and Drawing, Sub-clause 4.7.5 hereunder shall be applied to stipulations for as-Built Drawings of the Contractor's detailed design drawings.

3.7. METHOD STATEMENT OF DETAILED DESIGN OF PERMANENT CIVIL WORKS

- (a) The Contractor shall submit to the Employer for his approval the Method Statement of Detailed Design of the Permanent Civil Works within Thirty (30) days after the Commencement Date. The said method statement shall cover, but not limited to, an organization for the design, design standards to be applied to the design, list of detailed design drawings, design schedule including drawings and documents submission schedule, coordination method with relevant owners who are responsible for designs of the Hydro mechanical Works and Electromechanical Works, etc.
- (b) The Employer's and the Employer's comments on the method statement in this regard submitted with the Contractor's bid shall be incorporated into the said method statement.

3.8. APPLICABLE STANDARDS AND CODES FOR DETAILED DESIGN

- (a) The Contractor shall propose, in the method statement for the detailed design, standards and codes to be applied to his detailed design, as stated in General Technical Requirements; Section II; Volume 2.

3.9. ANALYSIS FOR DETAILED DESIGN

- (a) The Contractor shall conduct at least the following analyses by using mathematical models during detailed design:
 - I. Stability analysis, structural analysis and detail design of headworks;
 - II. Structural analysis and detail design of Headrace tunnel and portals areas;
 - III. Stability analysis and detail design of surge shaft;

- IV. Structural analysis and detail design of valve chamber;
- V. Structural analysis and detail design of drop shaft and pressure tunnel;
- VI. Stability and structural analysis and detail design of Powerhouse building; and
- VII. Stability and structural analysis and detail design of tailrace conduit.

The Contractor shall also conduct physical modelling of the headwork's during detailed design.

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**CHAPTER 4
DOCUMENTS AND DRAWINGS FURNISHED BY THE
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CHAPTER 4 - DOCUMENTS AND DRAWINGS FURNISHED BY THE CONTRACTOR FOR CONSTRUCTION

4.1. GENERAL

- (a) The Contractor shall submit the following documents, drawings and data sheets on or by the specified dates, but not being limited to hereunder mentioned, stipulated in the Contract.
- (b) The Contractor shall also provide a method statement including means of construction of the Civil Works shown on the contractor's drawings in accordance with this clause and elsewhere in Technical Specification of the Civil Works.
- (c) All catalogues, manufacturer's specifications, pamphlets, instruction manuals and similar material required to be submitted under the Contract shall be clearly readable prints, photocopies, or typed or printed originals. All documents shall be in English. If the documents are not published in English, copies of the certified English translation of the same shall be provided.
- (d) Submission of such documents and drawings to the Employer shall be made with formal transmittal letters.

4.2. DESIGN AND DRAWINGS OF THE TEMPORARY CIVIL WORKS

- (a) The Contractor shall submit for the Employer's approval the design of each facility of the Temporary Civil Works in sufficient time for the approval thereof. The necessary drawings adequately scaled and a method statement including means of construction of the facility shall be included.

4.3. METHOD STATEMENT

- (a) Before the commencement of the various parts of the Civil Works and the commencement of the various categories of the works, the Contractor shall submit for the information of the Employer a detailed description of his proposed method of carrying out the various categories of the works. Whenever the execution of the works implicates engineering aspects, Employer's approval shall be required. The Contractor shall provide full particulars of the method and sequence of the works including excavation, the drilling and blasting system, support of excavation above ground and underground, pumping (dewatering) systems, methods for formwork, reinforcement cages and placing of concrete, equipment used, safety measures and other auxiliary and associated activities.
- (b) All such information shall be provided at least Thirty (30) days before the commencement of the said part or category of the works so as to permit approval, necessary correction and approval after correction to be accomplished sufficiently in advance of the programmed commencement of construction of the various categories of the works.

4.4. SPECIFICATIONS, PAMPHLETS AND DATA

- (a) The Contractor shall submit to the Employer for his approval two (2) sets of manufacturers' specifications, drawings, catalogues, pamphlets, cuttings, diagrams and other descriptive data for all materials and equipment to be furnished under the Contract at least Sixty (60) days prior to purchasing them. The approval of such specifications, drawings, catalogues, pamphlets, cuttings, diagrams and other descriptive data by the Employer shall not relieve the Contractor of any of his responsibilities under the Contract.

4.5. INSTRUCTION MANUALS FOR INSTALLATION, OPERATION AND MAINTENANCE

- (a) The Contractor shall submit in draft form, three (3) sets of instruction manuals concerning the correct manner for installing the permanent equipment at least Ninety (90) days before such items are shipped to the Site, and the instruction manuals for the operation and maintenance of the installed equipment in draft form within Ninety (90) days after shipment is effective.
- (b) The instruction manuals shall describe in detail the methods and procedures to be followed and the use of all erection equipment, measurement devices or other items to be used in the installation/erection and in the operation and maintenance of the equipment supplied by the Contractor. The procedures for assembling, adjusting, operating and dismantling of each component system, machine or equipment shall be clearly described and illustrated and where applicable flow diagram shall be provided. The maintenance to be performed for these items shall be described in detail including the recommended frequency of inspections and lubrication.
- (c) The instruction manuals shall include diagrammatic drawings of the equipment to facilitate understanding the descriptive information.
- (d) The instruction manuals shall include a complete list of all applicable drawings, spare parts lists, and a parts list for each component of each item of equipment. The parts list shall include the manufacture's code, serial numbers and ordering instructions and any other details for the equipment supplied.
- (e) Final O & M manuals shall be submitted in five (5) copies. The Employer shall define color code type for the binding containing O & M manual.

4.6. TEST PROCEDURE INSTRUCTIONS

- (a) At least Sixty (60) days prior to the test following the submission of equipment drawings, the Contractor shall submit to the Employer for approval, test procedure instructions describing any test which may be required during manufacture and/or tests which may have to be performed on completion.
- (b) Such instructions shall define the sequence of tests, equipment preparation, operation procedures to be followed and the detailed procedures for conducting the tests. Further details listed in the Technical Specifications which pertain to test

procedure instructions and types of tests to be performed shall be complied with.

4.7. DRAWINGS FOR CONSTRUCTION

4.7.1. General

- (a) The Contractor shall prepare the Construction Drawings for construction purpose based on his detailed design drawings approved by the Employer and submit to the Employer five (5) copies of all Construction Drawings, documents and supporting calculation sheets for which the Employer's approval is required. All drawings prepared by the Contractor shall be supported by calculations sheets to demonstrate the suitability and adequacy of the design. Such drawings shall show types of materials to be used, grades, locations, exact dimensions and any other details, which may be required.
- (b) Unless otherwise specified, all drawings, which require the approval of the Employer, shall be submitted to the Employer for review or approval at least Sixty (60) days prior to the commencement of fabrication or execution of the work concerned with the particular drawing.
- (c) If the Construction drawings and documents are not submitted within the stipulated time limits, the Contractor shall be held responsible for all costs involved for consequent delays and damages to all parties concerned on the Project resulting therefrom.
- (d) The Contractor shall not execute any part of the Civil Works shown on the drawings supplied by the Contractor without prior approval by the Employer.
- (e) The procedure for approval by the Employer, drawing identification and size, title block and others shall comply with Volume 2, Section II - General Technical Requirements.

4.7.2. Lift and Placement Drawings

- (a) At least Thirty (30) days prior to starting construction of any concrete lift or other placement, the Contractor shall submit lift or other placement drawings to the Employer for information. Lift or other placement drawings shall be to such scale as to show clearly all recesses, opening, and embedded work, including embedded structural, mechanical, and electrical items in each lift in sufficient detail for proper installation of the work.

4.7.3. Fabrication Drawings

- (a) The Employer's representative will not normally require copies of detail fabrication drawings, but the Contractor shall make these available to the Employer's representative if so required.

4.7.4. Other Drawings

- (a) Drawings showing methods of construction and other drawings additional to those referred to hereinabove and required by the Specifications shall also be submitted by the Contractor to the Employer for his information.

4.7.5. As-Built Drawings

- (a) Through the period of construction, the Contractor shall prepare As-Built Drawings for the various items of works, which have been completed. Such drawings shall show any authorized change, which may have been made in the Construction Drawings, to the extent that they correctly portray the true "as-built" condition of each item of the Permanent Works. The format of the As-Built Drawings shall be as approved by the Employer.
- (b) As-Built Drawings shall be subject to an inspection at the Site by the Employer and if found unsatisfactory and not up-to-date, shall be re-checked within Seven (7) days later. As each of the Permanent Works delineated on the Construction Drawings is completed, the Employer and the Contractor or their representative shall mutually sign all As-Built Drawings, after approval by the Employer.
- (c) Seven (7) days prior to the notice which gives to the effect of substantial completion of work and deemed to be a request by the Contractor for the Employer to issue a Taking – Over Certificate as per Clause 76 of the Conditions of Contract, the Contractor shall furnish to the Employer.
 - I. One set of all as-built drawings and documents in electronic media for the Employer and Employer's representative each.
 - II. One set of all as-built drawings and documents for the Employer in high quality reproducible material from which clear copies can be made.
 - III. Five sets of copies of all approved as built drawings and documents for Employers use.

4.8. FINAL DOCUMENTS TO BE SUBMITTED

The final documents such as as-built drawings, approved O&M manual, design calculations and commissioning documents shall be submitted by the Contractor before the issuance of the Taking over Certificate.

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**CHAPTER 5
RIVER DIVERSION AND CARE OF WATER OR
DEWATERING**

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CHAPTER 5 - RIVER DIVERSION AND CARE OF WATER OR DEWATERING

5.1. RIVER DIVERSION

This Chapter covers work to be performed by the Contractor for river diversion. The Contractor shall design, construct and maintain the diversion works in accordance with requirement stated in the Drawing or as instructed by the Employer. The Contractor shall be responsible for the construction, restoration, maintenance and repair of all the damages to the coffer dams and structures during the entire construction period. The Contractor shall also perform the care of other small streams/drains considered to affect the works during construction in a manner, which shall be subject to the approval of the Employer.

In between and after monsoon seasons and before handing over the work, any sediments or debris shall be removed from the constructions such as stilling basins, intakes, culverts, etc. After having served their purpose, all cofferdams and other temporary protective works shall be removed or leveled so as not to interfere in any way with the operation or usefulness of the works and in a manner satisfactory to the Employer. Surplus material shall be transported to approved spoil areas. In case of reinforcement bars or nets are exposed to water flow, they shall be protected against fatigue due to vibrations caused from flowing water and bed load.

5.1.1. Stage Wise Diversion

The river diversion and construction works are to be done in two stages. In the first stage of works, the construction will start from the right bank. The river will be allowed to flow in its natural path on the left bank. A cofferdam will be built along the thalweg of the river to protect the construction area from flooding. In the second stage, u/s and d/s cofferdams will be built on the left bank of the river connecting with the walls of the sluice ways, thus diverting the river flow through the intake and sluice ways.

5.1.2. Cofferd Dam

The cofferdams shall be founded on the river alluvium and will be constructed during a low-flow period. The Contractor shall include the cost for the construction, maintenance and restoration of the coffer dam for the entire construction period in its Price Proposal. The Contractor shall not be entitled for any claim due to the failure and break of the cofferdam. The Contractor shall be fully responsible for repair and maintenance of the Cofferdam as well as structures during the entire construction period as required. There shall be no any extra payment to the Contractor for the same.

5.1.3. Removal of Cofferdam

After having served the purpose, the cofferdam, all temporary diversion and protective works shall be removed and disposed of or shall be levelled in a manner to give a slightly appearance, and so as not to interfere in any way with the operation or usefulness of the Works. Areas affected by such works shall be reinstated, unless otherwise approved by the Employer, in accordance with the contract.

5.2. DEWATERING

The specifications described hereinunder relate to the work of dewatering, drainage and pumping along with the cleaning of open drains and the repairing of subsoil (Sub surface) drainage to be carried out by the Contractor, which shall include supply of all labor, construction plant and materials and performance of all services required to remove service water and natural surface flow or ground water seepage under all conditions including rain and flood water from the working areas on the surface as well as from the underground sites for the construction of various structures covered under the contract. It also covers the clearing of existing culverts, including amongst others the removal of all undesirable materials that have accumulated in and around Inlet and Outlet Structures and in the barrels of the Culverts.

The Contractor shall design, furnish, build, install, operate, maintain and remove all the temporary dewatering facilities as specified herein or as required by the Employer.

5.2.1. SUBMITTALS

- I. Within 4 (Four) weeks from the commencement date, the Contractor shall submit, to the Employer, the detailed design of dewatering system which shall include the minimum of following:
 - a. Design assumptions and calculations.
 - b. Layouts of drainage facilities.
 - c. Layout and capacity of pumps and pipes, sumps, drains both open and covered, well points etc. and details of standby dewatering arrangements.
 - d. Any other arrangements or installation, the Contractor may propose for dewatering of the working areas both in open and underground Construction sites.
- II. At least 4 (Four) weeks prior to the scheduled construction of the particular work, the Contractor shall submit, to the Employer, full details of the equipment to be installed and all necessary construction details required for dewatering purpose.
- III. The Employer reserves the right to require any additional information deemed necessary to be included in the submitted documents.

5.2.2. DEWATERING

- I. Dewatering of the surface as well as the underground Construction sites shall be undertaken by gravity, wherever possible. Where, however, dewatering by gravity is not practical, pumping shall be resorted to after this mode has been approved by the Employer.
- II. Where, in the opinion of the Employer, water inflows or potential water inflows into the excavation are to be reduced or controlled by grouting, the Employer may direct that these inflows be grouted in advance, in accordance with the provisions set out under Chapter of "Drilling and Grouting".

- III. Whenever more than one agency is working in the same or adjacent areas, the Contractor, who has already provided the drainage facility, shall extend this facility to the other agencies also, who shall pay for such facility at mutually agreed rates. In case of dispute, the apportioning of such expenditure shall be decided by the Employer, whose decision shall be final. In no case shall any Contractor be permitted to stop the drainage system.
- IV. Unless specifically authorized in the Contract, significant lowering of the natural groundwater tables shall be avoided or mitigation measures shall be adapted.
- V. In case there is flow of water passing through the sites of two or more agencies, the drainage shall be attended to the extent directed by the Employer by the agency in whose site the origin of the water is located. Out of the sites of both the agencies, the agency working on the upstream side of the flow shall attend to the drainage as directed.
- VI. The pumped water carried in pipes or flumes shall be discharged at point sufficiently away from the edge of foundation excavation as directed by the Employer. Care shall be taken to ensure that there is no seepage and flow of water back to the pit working area.
- VII. Where required to measure the flow from the tunnel the Contractor shall furnish a measuring weir and continuous stage recorder or other types of measuring devices to be utilized in measuring tunnel water at each construction portal with pumped water outlet. The accuracy of the measuring devices shall be ± 5 percent. Drawings and data of the measuring devices shall be submitted for approval of the Employer.
- VIII. Power for operating the dewatering system shall be arranged by the Contractor at his own cost.

5.2.3. DEWATERING FOR CONSTRUCTION OF SURFACE STRUCTURES

GENERAL

The Contractor shall perform all works necessary to drain the surface construction sites of rain, flood water, ground water and service water. The Work shall include, but not be limited to the following:

- Design and construction of drainage, ditches, pits, dykes/bunds and pump sumps.
- Design, furnishing, operation and maintenance of dewatering equipment.
- Relocation of dewatering facilities required for the performance of other Works.
- All auxiliary Works required for safe and continuous dewatering of the construction sites.

Dewatering of surface construction Sites located near and above a river/stream shall be done up to the existing water level in the river / stream by gravity as directed by the Employer. Suitable drainage shall be made joining the course downstream of the construction Site to provide required gradient to facilitate proper and efficient dewatering. Below the water level of the stream, dewatering shall be done by pumping water collected in the sumps and discharging the same into course of the river/stream downstream of the construction Site.

The dewatering arrangement shall have provision of settling tank before disposal in to natural drain /river to ensure clear water discharge. The water so collected in the settlement pond shall be treated, if deemed necessary, as per the instruction of the Employer before discharging it to the natural water courses. The outflow from the ponds shall ensure that no oil leaves the pond.

Dewatering operations shall not be discontinued until approved by the Employer. No concrete shall be placed in water or upon waterlogged material.

REQUIREMENT AND DESIGN

- i. The Contractor shall design and install complete facilities at the surface construction Sites.
- ii. The surface water dewatering systems shall be designed to accommodate, without undue disruption to the work, any rainfall event and taking into account the extent of the Sites to be dewatered and the dewatering arrangements proposed.
- iii. Claims for extension of time due to delays caused by unfavorable weather conditions will not be considered.
- iv. The Contractor shall provide adequate pumping capacity, including standby units, to handle all water entering into any of surface construction Sites. In addition, he shall provide sumps and pumps and or well points in the immediate vicinity of the structure foundations using such water conductors as are necessary to conduct the water away from the excavation and concrete placement operations in an approved manner, so that such operation shall be kept free from standing or running water.
- v. The Contractor shall ensure that all drainage water is disposed off without causing interference to his own or other Contractors' operations elsewhere on the Site and that no drainage water runs into adjacent Works.
- vi. The dewatering systems shall be designed and installed in such a way that modifications and extensions to the systems are possible while they are in full operation.
- vii. All the components of the dewatering systems shall be installed and operated in accordance with the approved method and the construction time schedule, or approved modification thereof.
- viii. The approval by the Employer of the dewatering system shall not relieve the Contractor from being fully responsible for the design, construction, operation, maintenance, safety and removal of the facilities provided for the dewatering system and he shall be liable for any damage or delays caused by its failure.

MATERIAL AND EXECUTION

- i. Drainage ditches shall be excavated along the top of excavated slopes and on the berms. Such ditches shall be kept well back from the excavation edges in order to prevent saturating the upper part of the slopes. The ditches shall be regularly cleaned out of all accumulated silt and other matter so that water may flow freely at all times.
- ii. Where excavation is to be made below the ground water table, the Contractor shall lower the water table sufficiently below any working surface by means of properly screened wells and/or ditches to ensure that the foundation surfaces remain free of standing water and undamaged by the passage of construction traffic. All ditches shall be outside the foundation areas. The water shall be collected and removed by pumping, if no outflow by gravity is possible.
- iii. Where concrete is to be placed, the water table shall be maintained below the lowest part of the finished excavation for minimum one day following the raising of structure above the natural ground water table, and for such additional time as may be necessary to preclude damages to structure foundation.
- iv. In trenches and foundations, the dewatering shall at all times enable to carry out the excavation Work in dry, and in a manner that will prevent loss of fines from the foundation.
- v. Upon completion of dewatering, temporary pipes and pump sumps beneath permanent structures shall be closed off and completely filled with grout, mortar or concrete as required by the Employer.

5.2.4. DEWATERING OF UNDERGROUND CONSTRUCTION SITES

General

The Contractor shall perform all works necessary to collect and drain service and infiltrating ground water and flood water entered into the underground construction sites (if any), convey it to main conduits and lead it out from underground works such as tunnels, shafts, etc. The dewatering arrangement shall have provision of settling tank before disposal in to natural drain / river to ensure clear water discharge. The water so collected in the settlement pond shall be treated, if deemed necessary, as per the instruction of the Employer before discharging it to the natural watercourses. The outflow from the ponds shall ensure that no oil leaves the pond. The work shall include, but not be limited to, the following,

- Design and construction of pits and trenches, flood protection walls at the entrance/exit portals of tunnels/adits.
- Design, furnishing, operation and maintenance of dewatering equipment.
- Design, furnishing, operation and maintenance of dewatering equipment for dewatering under geo-thermal conditions when the water temperature is higher than fifty (50) degree celsius.

- Relocation of dewatering facilities required for the performance of other underground works.
- All auxiliary works required for the safe and continuous dewatering of the underground sites.

Probe holes, as specified in Chapter of "Underground Excavation" shall be drilled to provide information on the inflow of water into the tunnel as the excavation proceeds. Where the indications are that flows are likely to be large, grouting to seal off the water flows and drilling of drainage holes may be ordered by the Employer.

Dewatering operations shall not be discontinued until approved by the Employer and no tunnel or water conductor system shall be inundated with water.

Requirements and Design

- i. The Contractor shall design and provide a complete dewatering system for all underground construction sites.
- ii. All excavated areas shall be drained off all service and ground water. In order to keep the construction areas free from water, the dewatering systems shall be able to operate at any time during the whole construction period in any part of the works at the required design capacity.
- iii. The Contractor shall provide adequate pumping capacity, including a sufficient number of standby pumping units, to handle all water entering including sudden gush of water / flowing ground water condition/ flood water into any portion of Underground works. These units shall be connected to the dewatering systems in such a way that proper and uninterrupted drainage is guaranteed throughout the entire construction period.
- iv. The Contractor shall make arrangement for sufficient stand-by power at his own cost to carry on the works during any interruption of power. The standby power supply shall undergo weekly trial runs.
- v. All components of the system shall always be maintained in ready for service condition and all access to pumps and other equipment shall be kept in good condition under the most adverse conditions.
- vi. The Contractor shall ensure that all drainage water is disposed off without causing interference to his own or other Contractor's operations elsewhere on the site, and that no drainage water runs into adjacent works.
- vii. The dewatering system shall be designed and installed in such a way that modifications and extensions to the system are possible while they are in full operation.
- viii. All the components of the dewatering system shall be installed and operated in accordance with the approved method and the construction time schedule, or approved modification thereof.

- ix. The approval by the Employer of the dewatering system shall not relieve the Contractor from being fully responsible for the design, construction, operation, maintenance, safety and removal of the facilities provided for the dewatering system and he shall be liable for any damage or delays caused by its failure.

Material and Execution

- i. The Contractor shall construct the drainage trench in the access adit(s) and invert of the tunnel as required at site and approved by the Employer.
- ii. After the excavated profile has been checked, the ground water which runs or drips into the excavated space shall be diverted into the drainage trench by means of water collectors and pipes for collecting the seepage water from rock surfaces or steel laggings. Damp surfaces or seepage areas with low volume inflows can be sealed off with a quick setting-sealing compound.
- iii. Special care shall be exercised where excavation passes through material, which is liable to soften or swell when it comes in contact with water. In such locations, water entering the excavated space shall be collected as soon as possible and conveyed away / disposed of in such a way that the water does not come in contact with such material. Should the Contractor neglect to observe this requirement and a deterioration of the excavated surface of tunnel invert results from water being allowed to flow over or stand upon the sensitive or swelling material, the Employer may order the removal of the material from affected surface and its replacement with concrete. The Employer may order installation of additional rock supports in connection with such remedial work at the cost of the Contractor.
- iv. If any water from another portion of the underground works flows into a lower section where concreting is being done, which is likely to be affected by water, all such water shall be diverted past this area in such a way that no damage occurs to the concrete. The length of the affected sections over which water has to be diverted shall be ordered by the Employer.
- v. The Contractor shall perform regular checking and cleaning of the drawing trench and all dewatering equipment and accessories during the construction period.
- vi. The dewatering facilities shall be kept in operation according to the approved schedule, which shall be related to the progress of the work. No pumps shall be stopped, no pipes, ducts, trenches, etc. shall be taken out of service without the permission of the Employer.
- vii. Any openings such as pipes, boreholes, ducts, pumps, sumps etc. used for temporary drainage purposes in any part of the work shall be completely sealed by filling with grout, mortar or concrete when no longer required, unless otherwise directed by the Employer in writing. The Contractor shall notify the Employer in writing before any such openings are permanently closed.

5.2.5. EMERGENCY EQUIPMENT

In order to be able to continue water drainage work in the event of power failure, diesel driven emergency units might be made available. These units shall undergo every week at least one trial run lasting 30 minutes, if provided. Stand-by pumps might be provided so that safe dewatering can be ensured. The Contractor shall be held responsible for any damage due to the failure of the dewatering system.

5.2.6. DEWATERING AND POLLUTION CONTROL

(1) Dewatering

- (a) The duration of dewatering will be determined according to the construction time schedule and to other factors, e.g., other Contractors' work that has to be carried out under the protection of this dewatering system.
- (b) The dewatering system shall be designed and installed in such a way that alterations and extensions of the systems during operations are possible, if so required.
- (c) Pump operations shall not be stopped, and pipes, channels and equipment for dewatering shall not be removed or altered in any way, except with the permission of the Employer. Until then, the dewatering systems shall be kept in proper working order.
- (d) The Contractor shall maintain ready-for-service and shall regularly clean all dewatering equipment and accessories so that they can immediately and safely be used without risk of accident.

(2) Pollution Control

- (a) Before any work is carried out in any area of the site, all specified or directed or approved pollution control measures shall be in place and operational.
- (b) Any water shall not be discharged directly into rivers without being disposed of through the water treatment system.
- (c) Particular attention shall be paid to possible pollution from oil or solvents coming into contact with the water prior to its disposal. Oil separators shall be provided within the dewatering system, if such cases arise.

(3) Removal of Dewatering and Pollution Control System

- (a) Upon completion of dewatering work, the Contractor shall remove all installations for the dewatering and pollution control systems, and fill in all excavated areas such as sumps, channels, etc. to the lines and grades of the finished works as shown on the Drawings approved by the Employer.
- (b) Upon completion of dewatering work, all pipes shall be closed off and the pump sumps shall be removed and tightly filled by injection of cement mortar or by underwater concreting.

(4) Emergency Dewatering System

- (a) The Contractor shall take into account the possibility of a temporary power failure. So that emergency power units shall be installed with sufficient capacity for dewatering units during the failure. There shall be neither time extensions nor additional compensation granted to the Contractor in case of failure of the power supply.
- (b) The emergency power unit shall be tested at least once a week by trial run of at least 30 minutes duration.
- (c) In case of emergency, the Contractor shall furnish, install and maintain the adequate dewatering system as specified in Sub-clause 5.2.6 (1).
- (d) The costs for mounting and removal of the emergency generating set and stand-by equipment, including all necessary connections, switches and electrical auxiliaries and controls as well as trial runs shall be part of the entire dewatering system.

(5) Interference with Rivers and Streams

- (a) The Contractor shall not interfere with the natural flow of rivers or streams on the site for any purpose without prior approval from the employer.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 6
SURFACE EXCAVATION AND EARTHWORKS**

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CHAPTER 6 - SURFACE EXCAVATION AND EARTHWORKS

6.1. GENERAL

6.1.1. Scope

This Chapter covers all surface excavation work including common excavation and rock excavation, as well as earthworks including clearing, grubbing, stripping and backfill, as shown on the drawings approved by the Employer.

6.1.2. Definitions

1) Common Excavation

All soil, overburden, weathered and shattered rock, colluviums and residual soils or cemented sand in river terrace area and other material which can be removed by hand, by single shank ripping and bull- dozing with a track mounted tractor at least equivalent to a caterpillar D8N or, in confined areas, by a mechanical excavator equivalent to a caterpillar 225 (output 95 kW) fitted with a rock bucket of 1 m³ capacity.

2) Rock Excavation

Rock and artificial hard materials, which cannot be removed effectively by the methods described above and which normally require recognized rock excavation methods such as drilling and blasting or use of hydraulic breakers.

3) Clearing

The removal and disposal of materials above ground level including overhanging branches except those things the Employer directs area to be left undisturbed. The material to be cleared shall include, but not necessarily be limited to, trees, stumps, logs, logs, undergrowth, grass crops, loose vegetable matter, structures and other objectionable materials.

4) Grubbing

The removal and disposal of buried logs, stumps, roots and all unsuitable obstacles to a depth beneath the original ground surface.

5) Stripping

The removal and disposal of topsoil to a depth beneath the original ground surface.

6) Topsoil

The surface or top layer of soil, including fine roots, the herbaceous vegetation and grasses being characterized by the presence of organic material.

7) Scaling

Scaling of rock faces or surfaces including the removal of all loose, shabby, broken, altered or unsound rock.

8) Dental Excavation

Removal of loose, friable or weak materials encountered after exposure to rock excavation faces.

9) Perimeter Holes

A row of holes neatly and uniformly drilled along the excavation line.

10) Controlled Blasting

Controlled Blasting requires special drilling and blasting methods to produce smooth rock faces conforming to the prescribed neat excavation lines and to minimize blasting-induced fractures in the rock outside the excavation lines. These methods include pre-splitting, smooth blasting, line drilling and cushion blasting.

i) Pre-splitting

Pre-splitting consists of drilling a single row of closely spaced perimeter holes, loading all the holes lightly and continuously, stemming the entire length of each hole and then firing them as a completely separate operation before any adjoining main excavation area is blasted, to produce a crack along the line of split holes which a subsequent primary blast can break. Completion of blasting to remove the adjoining rock requires an accepted burden/spacing ratio, a reduced explosive charge in the line of holes nearest the split line, and a limit on the distance between these lines.

ii) Smooth Blasting

Smooth blasting consists of drilling a single row of closely spaced perimeter holes with an accepted burden/spacing ratio, loading all the holes lightly and continuously, stemming all holes and then firing them as the last or intermediate delay period in the round.

iii) Line Drilling

Line drilling consists of drilling a single row of very closely spaced perimeter holes, not loading the holes except for the possible use of special explosive to split the rock webs between adjacent holes, having an accepted burden/spacing ratio, and a reduced explosive charge in the line of holes nearest the line drill holes and a limit on the distance between these lines.

iv) Cushion Blasting

Cushion blasting consists of drilling a single row of closely spaced perimeter holes with an accepted spacing/berm width ratio, loading all the holes lightly and continuously, stemming the entire length of each hole and then firing them to remove the berm left in place from the previous primary blast.

11) Bench Lift

The vertical depth of rock loosened by anyone blasting cycle.

12) Blasting Consultant

Blasting expert to be engaged by the Contractor.

6.1.3. Submissions

1) Surface Excavation

(a) General

Not less than Thirty (30) days prior to commencement of excavation, the Contractor shall submit to the Employer for information, his detailed plans of proposed excavation methods and sequences, together with pertinent data for each stage of excavation in each work area.

The proposed plans for the excavation shall also include the detail of balancing of material from the required excavation: i.e. excavation and embankment schedule, stockpiling, reloading, disposal of waste and excess material and the drainage plan within the excavated area.

(b) Common Excavation

Within Thirty (30) days of the Commencement Date under the Contract, the Contractor shall submit plans and descriptions of methods and sequences for common excavation of the areas.

(c) Rock Excavation

Not less than Thirty (30) days prior to commencement of blasting on site, the Contractor shall submit:

- Name and qualifications of Blasting Consultant to be retained by the Contractor.
- Copies of valid Blaster's Certificates for Contractor's Blasting Supervisor and Blasters.
- Preliminary design and procedures for blasting and blast monitoring. Submittals shall include all essential blast design, elements of drilling, charging, delay patterns and weight of explosive detonated per day.
- Commercial description and technical information for the blasting products (explosive, detonator, fuses, etc.) proposed.
- Location, design and capacity of explosives and detonator magazines.

(d) Stockpiling

Not less than Thirty (30) days prior to commencement of stockpiling of excavated materials, the Contractor shall submit to the Employer for approval, detail of the source, type and end uses of materials to be stockpiled. The details to be submitted include the area to be occupied, height, side slopes, access requirements, programming of end use, erosion protection measure, drainage and other pertinent details.

(e) Shift Reports

For each area of the work, the Contractor shall submit to the Employer shift reports giving details of all drilling, blasting and excavation activities. These reports shall be signed jointly by the Contractor and the Employer and shall be submitted within 24 hours of shift completion.

2) Clearing

Not less than Thirty (30) days before the beginning of the works, the Contractor shall submit to the Employer for information, a program of work he intends to carry out, area by area, to enable the Employer to assess the consequences of the clearing work, as regards to the relevant authority.

3) Grubbing

Not less than Thirty (30) days before the beginning of the works, the Contractor shall submit to the Employer for information, a program of work he intends to carry out, area by area, to enable the Employer to assess the consequences of the grubbing work, as regards to the relevant authority.

4) Stripping

Not less than Thirty (30) days before the beginning of the works, the Contractor shall submit to the Employer for information, a program of work he intends to carry out, area by area, to enable the Employer to assess the consequences of the stripping work, as regards to the relevant authority.

5) Banking and Backfill

Not less than Thirty (30) days prior to the commencement of each work, the Contractor shall submit to the Employer for information, details of the materials to be used therein, including description of the material and proposed use, source and requirement for the results of testing carried out on the proposed materials.

6) Gravel Bedding and Gravel Fill

Not less than Thirty (30) days prior to the commencement of each work, the Contractor shall submit to the Employer for information, details of the materials to be used therein, including description of the material and proposed use, source and requirement for the results of testing carried out on the proposed materials.

6.2. EXECUTION

6.2.1. Clearing

1) Areas to be Cleared

- (a) The Contractor shall clear the areas to be occupied by the Works of all trees, stumps, roots, brush, rubbish and other objectionable matter. Felling of trees shall be restricted to the minimum practicable for the execution of the Works and within approved limits. Felled timber shall be removed from the site in accordance with Sub-clause 6.2.1 4) of this Chapter.

2) Method of Clearing

- (a) Trees and saplings which are more than 3 m in height or more than 250 mm in girth, measured 1 m above the ground, shall be felled in such a manner that the height of the stumps above the ground, measured on the uphill side of the stump, does not exceed 500 mm. Roots and stumps less than 500 mm high within the disposal areas and beyond the limits of surface excavation shall be left in the ground. Felling or removal of trees with explosives will not be permitted.
- (b) In areas from which removal and stockpiling of topsoil is required clearing shall be effected in such a manner as to prevent, as far as possible, the loss of topsoil.
- (c) Clearing shall be completed as early as possible to permit the maximum drying period, during the driest months of the year, before burning.

3) Disposal of Material

- (a) All usable timber greater than 750 mm in girth, measured 1 m above the ground, shall belong to the Government of Nepal and shall be prepared, transported and stockpiled in accordance with Sub-clause 6.2.1 4) of this Clause.

4) Clearing Portion of the Project Area

- (a) The Contractor shall clear the Project area as required.
- (b) Tree stumps and roots are to be left firm in the ground. All timber greater than 750 mm in girth, measured 1 m above the ground, or otherwise deemed usable timber by the appropriate Agency shall be trimmed of all branches and transported and neatly stockpiled at locations acceptable to the Employer.
- (c) All fallen timber less than 750 mm in girth or otherwise not deemed usable timber by the appropriate Agency and all branches, saplings, brush and rubbish shall be disposed of as provided above.
- (d) The use of tracked or wheeled vehicles will be permitted in the area only along roads and tracks which are approved for this purpose. The Contractor shall conduct the clearing operations in such a manner that any disturbance of the original surface conditions in the cleared area shall be avoided or kept to a minimum.

5) Protection of Other Areas

- (a) The Contractor shall ensure that trees and other vegetation outside the areas of the permanent works and the minimal areas required for temporary works including access roads are protected and preserved from damage.
- (b) The Contractor shall clear the areas to be occupied by the Works of all trees, stumps, roots, brush, rubbish and other objectionable matter. Felling of trees shall be restricted to the minimum practicable for the execution of the Works and within approved limits. Felled timber shall be removed from the site in accordance with Sub-clause 6.2.1 4) of this Chapter.

6.2.2. Stripping

1) General

- (a) Immediately after clearing operations and before excavation commences, the Contractor will strip from the surface of all required excavations and borrow areas the surface layer of soil including herbaceous vegetation, overlying grass and organic matter. Such stripping shall extend for 2 m outside the limits of required excavation and the surface shall not be disturbed beyond these limits.

2) Disposal

- (a) All materials removed by stripping operations shall be disposed of in the designated area or the area approved by the Employer.

6.2.3. Removal and Stockpiling of Topsoil

1) General

- (a) Immediately after clearing operations and before excavation commences, the Contractor shall remove the topsoil layer in accordance with Sub-clause 6.2.2 1).

2) Stockpiling and Soil Conservation

- (a) Topsoil so removed shall be stockpiled at convenient approved locations adjoining the area from which such topsoil was removed. Compaction of the soil during stockpiling shall be avoided. Stockpiles shall be stable and smoothed and shall be protected by appropriate soil conservation measures if they are to be left exposed for longer than Sixty (60) days. The stockpiled soil shall be used for soil conservation measures and landscaping as required for the Works.

6.2.4. Surface Excavation and Earthworks – General

1. General

- (a) Suitable material from surface excavations shall be used in the Works to the maximum practicable extent. The Contractor's blasting and other operations in the excavations shall be such that the materials excavated will yield as much required suitable materials as practicable. Where practicable, materials suitable for use in the Works shall be excavated separately from materials to be wasted. Approved material shall be segregated by loads during the excavation and shall be placed in the designated final locations or shall be placed in stockpiles and later placed, or processed and placed, in the designated final locations, in accordance with the provisions of the Employer's Requirements.
- (b) Material obtained from required excavations for use in the Works shall comply with the appropriate provisions of the Employer's Requirements for the location where it is to be used.
- (c) Any and all over-excavation performed by the Contractor for any purpose or reason shall be backfilled with approved material from required excavations or concrete, as appropriate.
- (d) Excavated materials to be wasted from all surface excavations shall be disposed of in accordance with the appropriate provisions of the Employer's Requirements.

2. Shape of Excavation

- (a) All surface excavations shall be made to the lines, grades and dimensions shown on the Drawings.

- (b) The Contractor shall perform core drilling as required to determine the expected depth of excavation required.
- (c) The Contractor may perform excavation in successive stages until a suitable foundation or surface is reached.

3. Seams, Cavities and Other Defects in Rock

- (a) The exploratory investigations of the foundations, slopes and other areas to be excavated are not sufficiently complete to disclose all seams, cavities and other defects that may exist in the rock. It is expected that there may be depressions, fissures, faults, seams, cavities, caverns and bands of soft disintegrating rock running in various directions in the materials to be excavated and in the foundations, slopes and other areas. The geotechnical investigations shall therefore not be interpreted as indicating with any degree of accuracy the final or actual excavation lines or that no defects exist.
- (b) Where such seams, cavities or defects occur they shall be corrected by local surface excavations, below the general surface of excavation to the approved lines, depths and dimensions. For concrete structures placed against rock these local surface excavations shall be solidly backfilled with concrete or covered by shotcrete. Seams and other defects below the general level of the foundations for the weir shall be treated as specified in the relevant Chapters of Standard Technical Requirements.
- (c) Certain surfaces may need to be protected and/or supported in accordance with the relevant Chapters of Standard Technical Requirements or by other appropriate means.

4. Excavation Precautions

- (a) All necessary precautions shall be taken to preserve, in the soundest possible condition, the material below and beyond the lines of all excavation. Any damage done to the Works by blasting, including the shattering or loosening of the material beyond the required excavation lines, shall be repaired by the Contractor in accordance with the requirements of this Technical Requirements.
- (b) The Contractor shall exercise special care to avoid damage to concrete, shotcrete, rockbolts, pressure grouting or any other work already completed. Delay-blasting shall be used to reduce shock waves. The Contractor shall implement monitoring and testing procedures to verify that concrete, shotcrete, rockbolts, pressure grouting and any other works have not been damaged by blasting. The results of such monitoring shall be submitted to the Employer on a daily basis.
- (c) The Contractor shall periodically remove loose material from excavated batters to maintain them in a safe condition. All berms shall be maintained with the clear width of passageway of not less than 3 m or as approved. The drainage system provided on the berms shall be maintained to ensure it is effective at all times.
- (d) All planking, strutting and supports necessary to retain the sides of the excavations shall be provided, erected and maintained in a safe condition by the Contractor.

- (e) Contractor shall be responsible for any temporary slope protection works during the excavation and stabilisation both temporary and permanent protection of the cut slope and surrounding areas by approved means.

5. Pre-splitting Technique

- (a) Where blasting is required to produce excavated surfaces to the lines and grades shown on the Drawings, the Contractor shall use the pre-splitting technique to ensure that a fracture plane is established along the required final excavation surfaces before excavation of the main body of rock, thus minimising damage to the rock beyond the required final excavation surface.
- (b) The Contractor shall submit to the Employer a description of the proposed method and procedures of excavation in accordance with the requirements for Contractor's Documents to allow for the initial review period prior to starting excavation in any section of the work requiring the use of the pre-splitting technique specified in this Subclause. The spacing and diameter of pre-splitting holes and the arrangement of the explosives in each hole shall be varied to suit the hardness of the rock and be chosen to provide the best practical excavated surface after blasting.
- (c) Before commencing excavation by blasting, for each structure, the Contractor shall establish, by field trials in an approved area, its blasting technique to produce a minimum of overbreak and fracturing of the rock outside the excavation lines of the areas required to be pre-split. These trials shall be performed by varying the diameter, depth and pattern of holes, the type and quantity of explosive, the blasting sequence and delay pattern.

6. Blasting Techniques

- (a) All blasting techniques, including the depth and size of holes and the size and characteristics of charges, shall be such that blasting will neither open seams nor crack nor damage rock outside the prescribed limits of excavation. As the excavation approaches its final lines, the depths of the holes for blasting and the amount of explosive used per hole shall be reduced progressively. Wherever further blasting may damage the rock, the use of explosives shall be discontinued and the excavation shall be completed by other approved means.

7. Rock Classification

- (a) The rock classes which have been identified are independent of rock type and are:

Class I	Fresh rock, high to very high substance strength with clean, apparently tight, moderately to widely spaced defects.
Class II	Slightly weathered rock, high substance strength, with local zones of apparently slightly open moderately spaced defects.

Class III	Moderately weathered rock, low to medium substance strength, with some local highly weathered zones and moderately spaced slightly open defects with some zones of closely spaced defects which are clay coated.
Class IV	Highly weathered rock, very low to low substance strength, with closely spaced clay filled defects.
Class V	Completely weathered rock-soil, either residual or colluvial.

(b) Rock weathering definitions are given below:

Fresh Rock (Fr)	Rock which exhibits no evidence of chemical weathering. Joint faces may be clean or coated with clay, calcite, chlorite or other minerals.
Fresh with Limonite Stained Joints (Fr St)	Joint faces coated or stained with limonite but the blocks between joints are unweathered.
Slightly Weathered Rock (SW)	Rock which exhibits some evidence of chemical weathering, such as discolouration, but which has suffered little reduction in strength. Except for some inherently soft rocks, slightly weathered rock rings when struck with a hammer.
Moderately Weathered Rock (MW)	Rock which exhibits considerable evidence of chemical weathering, such as discolouration and loss of strength but which has sufficient remaining strength to prevent dry pieces about the size of 50 mm diameter drill core (of inherently hard rock) being broken by hand across the rock fabric. Moderately weathered rock does not ring when struck with a hammer.
Highly Weathered Rock (HW)	Rock which is weakened by chemical weathering to the extent that dry pieces about the size of 50 mm diameter drill core can be broken by hand across the rock fabric. Highly weathered rock does not readily disintegrate when immersed in water.
Completely Weathered Rock (CW)	Rock which retains most of the original rock texture (fabric) but the bond between its mineral constituents is weakened by chemical weathering to the extent that the rock will disintegrate when immersed and gently shaken in water. In engineering usage this is a soil.

6.2.5. Excavation for Trenches, Pits and Footings

- (a) Excavation for trenches, pits and footings shall be performed in such a manner as to prevent shattering of the sides and bottom of the excavation.
- (b) All planking, strutting and supports necessary to retain the sides of the excavation shall be provided, erected and maintained by the Contractor.

6.2.6. Clean-Off of Foundation for Inspection

- (a) The Contractor shall clean-off foundations for inspection by the Employer with an air and water jet under high pressure, before placement of embankment materials, concrete or shotcrete.
- (b) The Contractor shall clean-off foundations for inspection after each successive stage of excavation for foundations to determine whether any unsound or unsuitable material is present in the foundation.

6.2.7. Random Backfill

1. General

- (a) The Contractor shall furnish, place and compact random backfill in the approved locations and to the lines, grades and dimensions shown on the Drawings.
- (b) Random backfill shall be obtained from required excavation and other approved sources. Random backfill shall be free from stumps, roots, rubbish, topsoil and other objectionable matter. Random backfill placed within 1 m of structures shall be selected material containing rocks not larger than 75 mm in maximum dimension and shall be placed carefully so as not to damage the structure.

2. Placement

- (a) Random backfill shall be deposited in horizontal layers not more than 150 mm thick after being compacted and shall be brought to the moisture content required for the purpose of compaction, and the moisture content shall be uniform throughout each layer. The density of compacted random backfill shall not be less than ninety (90) per cent of the maximum dry density for cohesive materials tested in accordance with ASTM D698 or where the backfill is a cohesionless, granular material, to not less than seventy (70) per cent density index as defined in ASTM D4253 and D4254, if appropriate, or to a density to not less than 1.85 t/m³ as measured in accordance with ASTM D5030.

6.2.8. Free-Draining Backfill

1. General

- (a) The Contractor shall furnish, place and compact free-draining backfill in the approved locations and to the lines, grades and dimensions shown on the Drawings.
- (b) Free-draining backfill shall be obtained from required excavation and other approved sources. Free-draining backfill shall be well graded with a maximum dimension of 200 mm, and not more than five (5) per cent smaller than 0.075 mm. Free-draining backfill placed within 1 m of concrete structures shall not contain rocks larger than 75 mm in maximum dimension and shall be placed carefully so

as not to damage the structure.

2. Placement

- (a) Free draining backfill shall be placed in accordance with the following requirements:
 - ◆ Free-draining backfill shall be deposited in horizontal layers not more than 300 mm thick after being compacted, and shall be thoroughly wetted for the purpose of compaction and the moisture content shall be uniform throughout the layer.
 - ◆ Free-draining backfill shall be compacted to a density not less than 1900kg/m³ as measured in accordance with ASTM D5030.

6.2.9. Gravel Fill

1. General

- (a) The Contractor shall place gravel fill in the approved locations and to the lines, grades and dimensions shown on the Drawings.
- (b) The gravel shall be obtained and comply with the provisions of this Technical Requirements for aggregates for concrete with a maximum size of 20 mm and nominal size range 9.5 to 19.0 mm.

2. Placement

- (a) Where concrete is to be placed on gravel, the gravel shall be covered with either building paper, polyethylene sheet, or a thin concrete screed.
- (b) Where fill is to be placed on the gravel, the gravel shall be covered with either galvanised iron or polyethylene sheets.

6.2.10. Riprap

1. General

- (a) The Contractor shall furnish and install riprap where required and approved.

2. Materials

- (a) Material for riprap shall consist of hard, dense and durable rock and shall be obtained and selected from required excavations or other approved sources.

3. Grading

- (a) Material for riprap shall be well graded within the following limits:
 - ◆ The maximum rock size shall be not greater than that which can be encompassed in the specified layer thickness.
 - ◆ Not less than twenty five (25) per cent of the material shall consist of rock having an average dimension greater than 600 mm or such larger size as determined by design requirements.
 - ◆ Not more than forty (40) per cent of the material shall consist of rock having an average dimension of less than 100 mm.

4. Gravel Bedding

- (a) The Contractor shall place gravel bedding beneath riprap.
- (b) Where riprap is to be placed against an earth, gravel or weathered rock foundation which is not suitable for bedding for riprap, the riprap shall be bedded on a 300 mm thick continuous layer of gravel bedding.
- (c) The rock used for gravel bedding shall be hard, dense and durable. The inclusion of earth or organic materials will not be permitted.
- (d) The material shall be well graded within the limits specified for coarse aggregate for concrete in Chapter 11 of the Standard Technical Requirements and shall be graded to provide a filter between the underlying material and the riprap.
- (e) The gravel bedding shall be placed wet and compacted to the approved lines, grades and dimensions.

6.2.11. Disposal and Stockpiling of Materials from Excavation

1. General

- (a) The Contractor shall dispose of excavated materials which are unsuitable for or which are not required for construction in approved disposal areas. Not less than Thirty (30) days before the need for each disposal area, the Contractor shall submit to the Employer, for approval, a detailed plan for each proposed disposal area indicating location, topography, drainage and clearing requirements, quantity of material to be disposed and finished treatment of the area.
- (b) Such excavated materials shall be stockpiled or disposed of so as not to interfere with the operation of any facilities or any water courses, and disposal areas shall generally be levelled and trimmed to reasonably regular lines to the approval of the Employer.
- (c) The finished outer slopes of the disposal areas shall not be steeper than 1 vertical to 3 horizontal.
- (d) Excavated materials suitable for use in construction which cannot be used immediately shall be stockpiled within approved stockpile areas. Not less than Thirty (30) days before the need for each stockpile area, the Contractor shall submit to the Employer, for approval, a detailed plan for each proposed stockpile area indicating location, topography, drainage and clearing requirements, quantity of material to be stockpiled and finished treatment of the area.

2. Composition of Disposed Material

- (a) Material placed in disposal areas shall be dumped, spread in layers and compacted by the controlled passage of haulage equipment over the surface of each layer.

3. Treatment of Surfaces

- (a) The Contractor shall grade the top surfaces of all material placed within disposal and stockpile areas and shall construct permanent drains and other protective works, sufficient to ensure that surface run-off will not erode the surfaces of stockpiles and/or disposal areas or the material placed therein.

- (b) The finished surfaces of disposal areas shall be covered with 100 mm of topsoil and grassed in accordance with the provisions of this Technical Requirements.

6.2.12. Compacted Tunnel Spoil

1. General

- (a) The Contractor shall furnish, place and compact approved tunnel spoil in the approved locations, including the Switchyard and Services Buildings, and to the lines, grades and dimensions shown on the Drawings.
- (b) Approved tunnel spoil shall be obtained from required underground excavation and of a type and grading suitable for compaction and for the foundation of the structures for which it shall be used. The tunnel spoil shall be free from stumps, roots, rubbish, topsoil and other objectionable matter. Tunnel spoil placed within 1 m of structures shall be selected material containing rocks not larger than 75 mm in maximum dimension and shall be placed carefully so as not to damage the structure.

2. Placement

- (a) Tunnel spoil shall be deposited in horizontal layers not more than 150 mm thick after being compacted and shall be brought to the moisture content required for the purpose of compaction, and the moisture content shall be uniform throughout each layer. The density of compacted tunnel spoil shall not be less than ninety five (95) per cent of the maximum dry density for cohesive materials tested in accordance with ASTM D698 or where the backfill is a cohesionless, granular material, to not less than seventy (70) per cent density index as defined in ASTM D4253 and D4254, if appropriate, or to a density to not less than two (2) t/m³ as measured in accordance with ASTM D5030.

6.2.13. Landscaping and Grassing

1. General

- (a) The works under this Clause shall cover, but are not limited to the landscaping and restoration of the
- site installation area;
 - temporary deposit and spoil area, as required;
 - project site in the boundaries as shown on the drawings.

2. Shaping

- (a) Excavation and fill for temporary works, spoil dumps and other areas shall be formed in such a manner that the final profile shall appear as a natural extension of the adjacent undisturbed ground profiles.

3. Trimming

- (a) Trimming shall consist of bringing the existing or previously shaped ground to a smoothly flowing surface with the final levels generally following the original surface. Trimming shall normally be done by means of a grader or in more confined or steep areas by bulldozer. Where machine operations are not practicable, because of confined space or steep slopes, trimming shall be done

manually.

- (b) Trimmed surfaces shall be left slightly rough to facilitate binding with topsoil or the natural establishment of vegetation.
- (c) Trimming of any areas requiring to be planted to grass shall be done to levels such that, after cultivation and application of any topsoil, the finished surface of the area shall be approximately 25 mm below the toe of adjacent kerbing, channelling or pavement. All stones in excess of 50 mm in size shall be removed.

4. Preparation of Areas for Grassing

- (a) In case it is required or instructed by the Employer to plant grass in any areas, these areas shall be prepared as follows:

- **Areas Not Requiring Topsoil**

Where the areas to be grassed consist of organically suitable material, they shall be scarified to a minimum depth of 150 mm.

- **Areas Requiring Topsoil**

Where areas to be grassed consist of organically unsuitable material, the surface shall be roughened to ensure a proper bond between the topsoil and the subsoil. Hardened surfaces shall be broken off by ripping or scarifying.

Topsoil shall be placed on the prepared surfaces and be trimmed to a uniform thickness of 150 mm and as set out in the following clauses by means of hand raking or mechanical blading.

- **Fertilising**

The Contractor shall have the top 150 mm of the prepared surfaces tested to determine the amount and type of fertiliser required for establishing proper growth conditions for the grass. The fertiliser shall be evenly applied over all surfaces where grass is to be planted and shall then be thoroughly mixed with the soil to a depth of 150 mm either mechanically or manually.

The nominal application rate for monophosphate fertiliser to be used with an anti-erosion compound shall be 150 kg/ha.

5. Grassing

In areas to be planted the method of establishing grass shall depend on the circumstances relating to each case. Following methods is to be used.

- (a) **Sodding**

Areas to be grassed by sodding shall be given a layer of topsoil at least 75 mm thick unless, due to the presence of suitable subsoil, the topsoil be omitted. The areas to be sodded shall be thoroughly watered beforehand so that they are wet to a depth of at least 150 mm when sodding is done. The surface shall be made slightly rough to ensure a good penetration of roots into the soil. Sods shall be protected against drying out and shall be kept moist from the time of harvesting until finally placed.

The first row of sods shall, where it is possible, be laid in a straight line and, if on a slope, starting at the bottom of the slope. The sods shall be butted tightly against each other, care being taken not to stretch or overlap sods. Where a good fit cannot be obtained, the intervening space shall be filled with topsoil. The next row shall be placed in the same manner tightly against the bottom row with the joints staggered and so on until the full area is covered with sods.

On steep slopes, the sods shall be held in position by sufficient wooden stakes approximately 300 mm long by 20 mm in diameter.

The Contractor shall water the sods directly after placing to prevent undue drying out. As sodding is completed, each section shall be lightly rolled or stamped into place and thoroughly watered.

(b) Seeding

Areas to be grassed by seeding shall be given a layer of topsoil at least 150 mm thick unless, due to the presence of suitable subsoil, the topsoil be omitted. The surfaces of the topsoil shall be raked, sown with grass seed by drill seeding or hand seeding and lightly rolled. The seed mix and the rate of application shall be subject to the approval of the Employer. The rate of application shall be not less than 32 kg/ha.

(c) Spring Planting

Areas to be grassed by planting sprigs shall be given a layer of topsoil at least 150 mm thick unless, due to the presence of suitable subsoil, the topsoil be omitted. Prior to planting the topsoil shall be raked, and rooted sprigs of the approved grass type shall then be planted at spacing not exceeding 200 mm in lines not more than 200 mm apart.

6. Establishment and Maintenance of Grass

(a) Watering, Weeding, Cutting, and Replanting

All seeded, sodded and grassed areas shall be adequately watered at regular and frequent intervals to ensure the proper germination of seeds and growth of grass until the grass has established an acceptable cover and thereafter as required to sustain growth to the end of the Period of the Contractor's Liability for Maintenance of Grass as defined in (c) below. The amount and frequency of watering shall be agreed by the Employer.

The Contractor shall mow the grass on all areas that have been grassed until the end of the Period of the Contractor's Liability for Maintenance of Grass. All grass cuttings shall be collected and disposed.

Weeds shall be controlled by pulling, cutting or other approved means. Any bare patches where the grass has not taken or where it has been damaged or has dried out shall be recultivated, planted or sodded without any additional payment.

(b) Acceptable Cover

An acceptable grass cover shall mean that not less than 75% of the area planted shall be covered with grass and that there shall be no bare patches of more

than 500 mm in maximum dimension. In the case of sodding, acceptable cover shall mean that the full area shall be covered with live grass three months after sodding.

(c) Period of the Contractor's Liability for Maintenance of Grass

The Contractor's liability with regard to the maintenance of planted grass shall be 11 months and shall commence when an acceptable cover as defined in (b) above has been established over the whole of all the areas specified or instructed to be planted to grass. The Period of the Contractor's Liability for Maintenance of Grass could therefore commence earlier or later than the Defects Liability Period for the Contract.

(d) Maintenance of Areas Subject to Natural Establishment of Local Grasses

On areas on which topsoil has been placed, but which are not to be planted to grass, the Contractor shall maintain conditions which encourage the establishment of local grasses by natural processes. These areas shall be watered as required, depending on the nature of the topsoil to maintain adequate soil moisture for grass establishment.

The Contractor shall ensure that these areas are protected from damage or interference from site activities and if any such damage occurs shall reinstate the topsoil and specified conditions without any additional payment.

The Contractor's liability with regard to the maintenance of topsoil but not grassed areas in accordance with this clause shall be until the end of the Defects Liability Period for the Contract.

7. Trees and Shrubs

(a) Positions of Trees and Shrubs

The position in which trees and shrubs are to be planted shall be as directed by the Employer.

(b) Preparation of Holes

Holes shall be placed and prepared as follows and as shown on the drawings:

- All holes shall be square in plan.
- For shrubs the holes shall be at least 500 mm square by 600 mm deep. The shrubs shall be planted in any case not closer than 1.5 metres apart. The bottom surface of the planting hole shall be broken up to provide improved local drainage beneath the shrub.
- For trees the holes shall be at least 1000 mm square by 1000 mm deep. The 300 mm of soil beneath the bottom surface of the planting hole shall be broken up to provide improved local drainage beneath the tree.
- The planting holes shall be refilled with plant mix comprising selected and approved topsoil thoroughly mixed with manure or compost (one heaped spadeful added to every plant hole). For each shrub 3 planting tablets, and for each tree 6 planting tablets, shall be buried in the soil spaced equally around the root ball at not less than 200 mm below the top of the hole backfill.

- The holes shall be thoroughly watered before planting.

(c) Planting

Directly after the planting, each plant shall be watered well to establish the plant firmly in the soil. After the soil is set, additional plant mix soil shall be added where necessary to bring the hole backfill to 150 mm below the top surface of the local topsoil. The topsoil removed from the area of the planting hole shall be piled locally to a depth of 100 mm on top of the topsoil around and adjacent to the hole, in order to form a water retaining basin around the plant. A 75 mm thick layer of stone mulch shall then be placed on top of the hole backfill soil to minimise evaporation.

Two 50 mm diameter and 2800 mm long creosote-treated timber stakes shall be driven firmly 300 mm into the ground below the broken soil layer at the bottom of the planting hole on either side of the tree, care being taken not to touch the root ball of the tree with the stake. The tree shall be tied for support to the stakes by means of a double wire protected with rubber hose at two levels.

(d) Maintenance of Trees and Shrubs

The Contractor shall be responsible for watering the trees and shrubs and for keeping the plants free from weeds and pests.

Every tree or shrub that is not healthy or shows unsatisfactory growth shall be replaced by the Contractor at his own expense before the end of this period.

8. General

(a) Time of Planting

- The planting of grass, trees and shrubs shall be carried out during periods of the year most likely to produce beneficial results with regard to the seasonal variations in the prevalent climatic conditions. The Contractor shall make every effort to programme his operations in such a manner that this is done as far as possible.

(b) Rehabilitation Concurrent with Construction

- Rehabilitation measures shall be carried out concurrently with construction of the Works. In particular, spoil dumps shall be rehabilitated in stages. To facilitate maintenance, suitable benches shall be formed as the spoil dump is constructed.

(c) Traffic on Grassed Areas

- The Contractor shall not spread topsoil or plant grass until all operations which may require construction equipment to be taken over the areas concerned have been completed. No construction equipment, trucks or water carts shall be allowed onto areas which have been topsoiled or grassed with the sole exception of equipment required directly for the preparation of areas, application of fertilizer and spreading of topsoil.

(d) Erosion Control

- During construction the Contractor shall protect all areas susceptible to erosion by installing all the necessary temporary and permanent drainage works as soon as possible. He shall also take such other measures, such as the construction of gently sloping mounds approximately 200 mm in height, as may be necessary to prevent the concentration of surface water and scouring of slopes, banks and other areas.
 - Any runnels or erosion channels developing during the construction period or during the period for which the Contractor is liable for maintenance as defined shall be backfilled and consolidated, and the areas restored to their proper condition. The Contractor shall not allow erosion to develop on a large scale before effecting repairs and all erosion damage shall be repaired as soon as possible and, in any case, not later than three months before the termination of the Contractor's liability for maintenance. All topsoil or other material accumulated in side drains shall be removed at the same time. Topsoil washed away shall be replaced.
 - The Contractor shall ensure that erosion to rehabilitated areas is not caused by pedestrian access.
- (e) Responsibility for Establishing an Acceptable Cover
- Wherever planting of grass is specified or instructed by the Employer, the Contractor shall be solely responsible for establishing an acceptable grass cover and for the cost of replanting grass where acceptable cover is not obtained. Where however, in the opinion of the Contractor, it is doubtful from the outset whether it will be possible to establish an acceptable cover he may inform the Employer of his reasons for this, and the Employer shall, if he agrees, either agree to adopt another method of grassing, or accept whatever cover can be obtained provided that all reasonable efforts shall be made to establish a good grass using the method proposed, or else agree to adopt a method of allowing the establishment of local grasses by natural processes.
- (f) Protection of Planted Areas
- Where temporary or site fencing is to be removed in the terms of the Contract, that fencing shall not be so removed until all grass, bushes or trees planted within such fenced area is established and the period of maintenance required has expired.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 7
UNDERGROUND EXCAVATION**

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CHAPTER 7 - UNDERGROUND EXCAVATION

7.1. GENERAL

7.1.1. Scope

- a) Underground excavation as specified here under shall include all excavation performed by drilling and blasting methods or any other methods stipulated in the Specifications.
- b) Temporary and permanent support shall be furnished and installed as shown in the Drawings approved by the Employer.
- c) During construction, tunnels and other underground structures shall be drained, illuminated and ventilated as specified hereunder.
- d) If any particular operation or activity necessary for the proper performances of the work has not specifically been mentioned in this specification, it shall be deemed to have been included in the unit prices for underground excavation.
- e) Underground excavation includes all excavation for the tunnels, adits, portals, drop shaft, surge tank and other underground structures. The excavation and support of underground excavations shall be carried out in accordance with the principles of the New Austrian Tunnelling Method (NATM) around which this Technical Requirements is based. The rock surrounding an underground opening is considered to be part of the support system for that underground opening. It is, therefore, essential that construction methods and operations are, as far as possible, such that the integrity and bearing capacity of the rock surrounding an opening are maintained.
- f) The Contractor shall retain at least one qualified engineer (as nominated in the Contract), expert in NATM who shall be resident permanently on the Site during all underground excavation work. The curriculum vitae of such engineers shall be submitted to the Employer.
- g) The Contractor shall retain at least one qualified engineer (as nominated in the Contract) experienced in controlled blasting techniques on Site for the duration of the underground excavation to provide expert construction advice on controlled perimeter blasting and rock reinforcement methods required by this Technical Requirements. This engineer shall have had at least five years' relevant experience.
- h) The Contractor shall ensure at all times that all aspects of its excavation methods and equipment comply with the regulations of the relevant Agencies and this Technical Requirements.
- i) The Contractor shall submit detailed working drawings with pertinent descriptions, schedules and operations, equipment to be utilized and methods of construction to the Employer. Items shall include drilling, mucking, transporting and hoisting equipment; types of underground excavation machines if applicable; methods of disposal; underground ventilation; lighting and drainage; groundwater control methods; support and shotcrete placement details. Such details and information for each underground feature shall be submitted to the Employer for review in accordance with the requirements for Contractor's Documents to allow for the initial review period prior to the commencement of the relevant underground excavation.
- j) The Contractor's blasting supervisors shall have a Nobel Blasters Certificate First Class or equivalent, have a minimum of five (5) years' experience in supervising the loading

and firing of charges for tunnel excavation and shall have all necessary licenses and permits required by appropriate Agencies or others having jurisdiction.

- k) Only wet drilling shall be used.
- l) Adequate dewatering and clean access during the underground excavation shall be designed, constructed and maintained by the contractor during the execution of all tunnelling works.
- m) Good ventilation and lighting systems shall be designed, constructed and maintained by the contractor during the execution of all tunnelling works.
- n) The contractor shall be fully responsible for the excavation in lines, levels as specified in Employers' Requirements. There will be no separate provision of normal overbreak and geological overbreak consideration.

7.1.2. Definitions

1. Tunnel and Tunnelling

The terms tunnel and tunnelling shall, depending on the context, refer to underground structures including tunnels, shafts or other type of structures and underground excavation, respectively.

Specifically, the following terms shall be defined as below.

I. Tunnel Excavation

Tunnel excavation means, in general, both horizontal and inclined underground excavation.

II. Shaft Excavation

Shaft excavation means tunnel excavation in vertical alignment such as for surge tank and drop shaft.

2. Cycle Time

Cycle time means a required time for one round of tunnel or shaft excavation including drilling, blasting, mucking and rock supporting works.

7.1.3. Submissions

1. General

Not less than Sixty (60) days prior to commencement of the work, the Contractor shall propose to the Employer for his approval the following subjects, however, not being limited to them. The Employer's approval shall in no way relieve the Contractor from his responsibility for the works.

- I. Schedules of advance and cycle times for underground excavation including rock supporting work
- II. Setting-out methods for alignment and slope of tunnels and axes of all underground structures
- III. Type and amount of rock support, including type and location of cross

section

- IV. Safety measures
- V. All permanent materials and equipment to be part of the works as well as temporary materials and equipment including conditioning systems such as ventilation, illumination, communication, firefighting and drainage to be used by the Contractor
- VI. Date of removal of such conditioning systems
- VII. Blasting techniques, blasting patterns and commencement of blasting to be applied for all underground excavations
- VIII. Details of mucking operations, including temporary stockpiling and final disposal, and use of muck for the execution of other works
- IX. Design calculations for conditioning systems like ventilation, illumination, drainage and others
- X. Additional excavations to be made for the Contractor's convenience, if any.

2. Drawings

Where applicable, not less than Sixty (60) days prior to commencement of the work, the Contractor shall submit shop and fabrication drawings related to detailed construction drawings and construction method drawings showing plant details, diagrams and details of all layouts, material handling operations, etc. and calculations as stipulated in the following.

- I. Details of the proposed setting-out methods before commencing the work and at such stages during the progress of the work as the Employer may require, together with a copy of all instructions given to the Contractor's superintending staff and others concerning the maintenance of the correct line and level of the underground structures
- II. Drawings of and calculations for all temporary rock supports and methods to be used during excavation prior to completion of the permanent rock support
- III. Drawings of and calculations for any temporary shafts or tunnels required by the Contractor, and of the proposed construction methods thereof
- IV. Drawings, diagrams and details of all proposed site layouts and materials handling operations
- V. Drawings of and calculations for groundwater lowering and groundwater control proposals, and details of associated plant.
- VI. Details of all proposed measures for compliance with environmental control requirements

3. Reporting

A daily report, incorporating a blasting journal, shall be submitted to the Employer each day covering the previous day's work. This report shall include:

- I. Advance for face.
- II. Location of face at the start and the end of rounds.
- III. Complete descriptions of each blast round used, including:
 - date, time and limits of blasting by chainage
 - amount of explosives

- Number of detonators and delay series
- IV. Details of ground support installed, including rockbolts, wire mesh, lattice girders, steel ribs, shotcrete, forepoling, reinforced concrete and any other materials used.
- V. Elapsed time for moving and setting up, drilling, loading, blasting, ventilation/defuming, scaling, mucking, installation of supports, excavation and non-productive work.
- VI. Unusual occurrences, rock falls, zones of instability, inflows of water, occurrence of gas, and details of any accident sustained by workmen.
- VII. The Contractor shall maintain qualified geologists (as nominated in the Contract) on Site with experience in underground works in sufficient number to do fully detailed geological mapping of all underground excavation which will be submitted to the Employer on a daily basis.

7.1.4. Supervision

The underground works shall be carried out under the full-time technical supervision of engineering personnel experienced in this particular work and capable of directing the work in matters of technique so as to ensure maximum effectiveness and compliance with the requirements of these Technical Requirements.

7.1.5. Shape and Limits of Excavation

- a) All underground excavation shall be made to the design lines, grades and dimensions shown on the Drawings.
- b) The minimum excavation lines for each rock support classification and each underground structure are lines within which no unexcavated material of any kind will be permitted to remain.
- c) The nature of the materials being excavated could, for existing and/ or subsequent excavation, make it necessary to move the minimum excavation line to provide for increased thickness of shotcrete or concrete.
- d) Any and all over-excavation performed by the Contractor for any purpose or due to any reason shall be backfilled with shotcrete and/ or concrete unless otherwise approved.
- e) The overall alignment of each underground work shall be in accordance with the tolerances shown on the Drawings.

7.1.6. Ground Support

- a) Primary support is defined as that support which is installed systematically as close to the face as possible, order to ensure the short-term integrity of the underground excavation and safety of personnel during excavation. The installation of primary support is an essential part of the excavation cycle. Lattice girder, first layer of wire mesh and first layer of shotcrete are to be installed at the face round. The second layer of wire mesh and second layer of shotcrete are to be installed one round behind the face round. The rock bolts are to be installed latest two rounds behind the face round.
- b) The class of ground being excavated can be categorized in terms of ground conditions and the extent of primary support required in accordance with the following classes:

Class I	Fresh rock with high to very high substance strength and a very high modulus. Negligible deformation in the rock mass is expected. Defects are moderately to widely spaced, clean surfaces and tight. This rock mass is essentially sound, and will stand unsupported, except for random/spot bolting and/or random/minor application of unreinforced shotcrete.
Class II	Fresh rock with high or better substance strength and high modulus. Minor local deformation in the rock mass is expected. Defects are locally moderately spaced and may be slightly open. This rock is jointed such that the crown, and locally the tunnel walls, need to be systematically supported with pattern rock bolts and a single layer of unreinforced or reinforced shotcrete.
Class III	Fresh rock, locally slightly weathered and some moderately-highly weathered along defect surfaces. Medium to high substance strength. Defects are moderately spaced, slightly open in places with some zones of closely spaced defects which may be clay coated. This rock requires a systematic pattern of rockbolts to support the crown, and the walls, together with reinforced shotcrete.
Class IV	Fresh to variably weathered rock mass with some zones of moderately to highly weathered, associated with defects. Low to medium substance strength. Defects are closely spaced, with sheared zones and seams of varying condition. Potentially clay filled defects. This blocky and seamy rock mass requires full perimeter support. Closely spaced pattern bolting and shotcrete with wire mesh or steel fiber in the crown, walls and invert are required. Steel rib support will be required locally, with application of forepoling/spilling to support ground during advance.
Class V	Variably weathered rock from fresh to moderately weathered, zones of highly to extremely weathered associated with defects. Generally low to very low substance strength and highly deformable. Defects are closely to very closely spaced, with sheared zones and seams, potentially clay filled defects. This very poor, blocky and seamy rock mass requires support with steel ribs. There may be application of lattice girders and forepoling/spilling, with crown and sidewall support by pattern rock bolting and layers of reinforced shotcrete. A small heading of approximately 5 m height and supporting core may be required.
Class VI	Rock mass totally affected by sheared and seams and very closely spaced defects, commonly clay filled. Loose rock mass subject to extensive deformation. Will require staged heading. A small heading of approximately 5 m height and supporting core will likely be required. Requires support with steel ribs. There may be application of lattice girders and forepoling/spilling, with crown and sidewall support by pattern rock bolting (optional) and two layers of reinforced shotcrete.

- c) The support requirement specified here subject to vary as per rock support design requirement based on input parameters such as in situ and induced stresses, rock

mass properties, time of support application, time dependent behaviour of rock mass, etc.

- d) Rock mass Classification shall be done using Rock Mass Quality Index, Q (Barton et al. 1974). For estimating rock support during construction, the rock mass shall be classified into eight classes mainly based on the Q-value. Rock Mass Rating (RMR) and Geological Strength Index (GSI) may be used with reference to the Q-value. GSI may be used in computation.

Q value	Rock mass Class	Rock mass quality
>40	Class I	Very good
10 - 40	Class II	Good
4 - 10	Class III	Fair
1 - 4	Class IV	Poor
0.4 - 1	Class V	Very poor
0.1 – 0.4	Class VI	
0.1 – 0.01	Class VII	Extremely poor
< 0.01	Class VII	Exceptionally poor

- e) In nominally unlined underground excavations, which include the headrace tunnel, power caverns and access/maintenance adits, the primary support will form part of the permanent support and lining and should be installed to the requirements of permanent support (e.g. fully grouted rockbolts with corrosion protection).
- f) Extensive secondary support, such as additional rockbolting, shotcrete protection of erodible seams and local shotcrete or concrete lining may be required in order to provide for the long-term integrity of the tunnels and shafts in their final operational condition.
- g) In lined tunnels and shafts, primary support need only be considered as temporary support.
- h) The Contractor shall design and install the support required and shall satisfy itself at all times as to the adequacy of any ground support to ensure the long-term stability and safety of the Works.

7.1.7. Drilling and Blasting

- a) When carrying out blasting operations, the Contractor shall use the standard blasting warning code, on which prior approval has been obtained in writing, take all precautions for the protection of persons, the Works and all property, and shall be responsible for any injury caused to or death of any person, or damage done to the Works or to property by blasting. The Contractor shall fully inform the Employer of the times it intends to carry out blasting from any portals up to 20 m underground. Protected detonators shall be used in all blasting operations which use electric firing. The location and design of powder magazines, methods of transporting explosives, use of explosives and, in general, the precautions taken to prevent accidents shall be in accordance with all statutory regulations and with BS 5607 and BS 6656, and the "Safety Regulations for Sensitized Ammonium Nitrate Blasting Agents" (United States Department of the Interior, Bureau of Mines), and such other precautions as the

Employer may reasonably require with special reference to the presence of high-voltage electric power transmission lines and substations near sections of the Works; nevertheless the Contractor shall assume any liabilities resulting from injuries to, or deaths of persons or damage to property caused by blasts or explosions.

- b) Drilling, blasting and charging patterns shall be designed by the Contractor to produce the minimum amount of disturbance to the rock mass surrounding the excavation in order to preserve its inherent quality, to minimize overbreak and to provide an effective, sound substrata for the excavation lining or final excavated surface.
- c) Controlled perimeter blasting such as pre-splitting or smooth blasting shall be used. This involves careful drilling of closely spaced perimeter holes with a suitable ratio of burden to spacing, loading all perimeter holes with the minimum effective quantity of explosives and either detonating them simultaneously prior to the rest of the round to produce a pre-split or as the last delay period in the round so that they have free burden at the moment of detonation.
- d) Following each blast, full re-entry procedures should be followed. Re-entry into the works should be delayed until all blasting fumes have been removed by the ventilation system. The shot firer is then responsible to ensure that the works are safe prior to allowing any other personnel into the face; this includes checking for misfires and dealing with any unexploded explosive, testing for gas and checking for any loose rocks on the crown or sub walls. The crown and walls of the excavation shall be tested by experienced and suitably equipped scalers whose duty shall be to dislodge and remove loose or shattered rock which is liable to fall. Previously excavated and supported portions shall be inspected periodically for cracks in the shotcrete linings and any other signs of instability and maintenance scaling shall be carried out if the need arises. If any scaling will involve breaking loose large blocks, support may be required.
- e) All misfires shall be brought to the attention of the Employer and shall be treated in an appropriate manner.
- f) Blasting that is likely to damage the Works or adjacent structures will not be permitted. Any damage to, or displacement of, supports and any damage to any part of the Works caused by blasting or any other operations of the Contractor, shall be repaired by the Contractor in a manner satisfactory to the Employer. The Employer may require the Contractor to prove that blasting has not damaged the Permanent Works. The following criteria are presented as guidelines only and compliance with these criteria shall not relieve the Contractor from its obligation to repair damage caused by blasting. The Contractor shall provide suitable vibration monitoring equipment to verify compliance with the following limits or other limits that the Contractor proposes and therefore needs to verify.
- g) Should the Contractor's blasting methods indicate possible damage either to existing adjacent structures or the completed parts of the Works, the Contractor shall immediately modify the design of its blasting methods to prevent such damage.

Item	Peak Particle Velocity (PPV)
Temporary support	25 mm/s 50 mm/s
Structural lining	10 mm/s 25 mm/s 50 mm/s

- Support types
 - Mechanical anchor 100 mm/s
 - Resin anchor 200 mm/s
 - Grouted anchor (after 24 hours) 200 mm/s
 - Alternatively, the rock reinforcement units and shotcrete may be exposed to other ppv levels proposed by the Contractor and their effectiveness proved in controlled site trials and testing.
- h) All rock projecting inside the minimum excavation line shall be removed by the Contractor during the progress of the Works. Such rock shall be removed by non-explosive means such as wedges, barring, use of expanding grout or other suitable means.
- i) The preferred method of blast initiation is non-electric delay detonators such as Nonel (or approved equivalent) to prevent inadvertent initiation by high frequency radio transmissions, static or stray electrical energy, or impact found in normal construction conditions.
- j) For firing the following requirements are additional to the procedures laid down in BS 6657 and BS 5607 or equivalent standard.
- The firing circuit shall be desensitised by the insertion of additional resistance so that the total resistance of a series connected circuit is not less than the equivalent of 100 detonators. This resistance shall be inserted at the face terminal block of the firing cable.
 - The firing cable shall consist of twin twisted PVC insulated 250 Volt grade and PVC sheathed heavy duty flexible cord of not less than 70/0.076 cross-section.
 - The firing cable shall be terminated in approved insulated terminal blocks with interlocked covers on firing and circuit boxes.
 - The firing cable shall not be earthed at any time.
 - The firing line shall be from a totally dedicated tapping on the secondary side of the supply transformer.
 - All metal pipes, conduits and the like shall run on the opposite wall of the tunnel to the firing cables.
 - All metal pipes, conduits, rails and other metals structures continuous along the tunnel wall shall be effectively bonded together and earthed at the tunnel entrance.

- k) The adoption of any or all of the above practices and techniques shall not relieve the Contractor of its responsibility to perform the work in accordance with the Contract.
- l) The Contractor shall install outside each portal in use as access to a working face during drilling and blasting operations, an automatic lightning detector and alarm system. When atmospheric electrical activity in the vicinity of the portals reaches danger levels and the alarm is activated, all blasting operations should be suspended until such electrical activity again reaches safe levels.

7.1.8. Determination of Rock Support Classification

- a) Determination of the rock mass classification for supports assignment shall be made according to the conditions exposed in the freshly excavated opening. The geological mapping of the fresh excavated face, crown and walls will be jointly carried out after each blast and accordingly rock class will be defined. Corresponding support class as specified in the approved design shall be applied thereafter.
- b) The adequacy of the support elements will be regularly monitored by the Contractor by means of geotechnical measurements (instrumentation) and observations of tunnel behaviour, in particular daily deformation monitoring, and such measurements and observations shall be reported immediately to the Employer. In the spirit of the Interactive Observational Design Approach the Contractor shall gather from the interpretation of such monitoring data suitable elements to adjust its design or construction sequence, if required.

7.1.9. Heading and Benching Excavation

- a) Heading and benching excavation shall be carried out where necessary dependent upon the rock support classification and elsewhere to suit the Contractor's proposed operations.
- b) The Contractor shall ensure where two or more operations are being carried out in a section of the works that they are being carried out safely, that there is adequate space, lighting and ventilation to carry out both operations.

7.1.10. Safety

- a) Work shall be performed in a manner to avoid hazards and exposure to personnel and equipment to hazardous or potentially hazardous conditions.
- b) Safety in underground excavation shall be the responsibility of the Contractor. Careful scaling after each blast and continuing inspection of the walls and arches of the underground excavation shall be performed. Primary rock support shall be installed immediately after excavation.
- c) The Contractor shall take note that flammable and toxic gases may be present, and it shall take all necessary precautions to ensure that these gases do not become a danger.

7.2. MATERIALS, EQUIPMENT AND CONDITIONING SYSTEMS

7.2.1. General

- a) All materials and structural components which are permanently incorporated in the work shall be new. All materials shall comply with the relevant standards and requirements.
- b) All materials, equipment and structural components which the Contractor is to provide for the sole purpose of underground excavation in accordance with the requirements of the Contract and which are not permanently incorporated in the works may be new or used materials at the Contractor's option.
- c) Electrical, pneumatic or diesel driven equipment may be utilized for the different operations of underground excavation. In case diesel driven equipment is used, the Contractor shall provide the necessary facilities to remove all noxious gases resulting from the operation of that equipment, or the Contractor shall demand proof from suppliers of diesel-powered equipment for use in the tunnels that the proposed equipment conforms to the requirements of the internationally recognized. If the diesel gas removal system is not adequate, the Employer can request, without extra cost, the suspension of its operation or the necessary measures to correct the defects of that system.

7.2.2. Ventilation System

- a) The ventilation system shall be provided conforming to the following requirements:
 - I. The Contractor shall design, install, maintain and operate ventilation system of sufficient capacity to maintain an adequate supply of uncontaminated air in underground structures throughout the Contract period.
 - II. The ventilation system may be of the forced supply or forced extraction type, or any combination thereof including local air movers.
 - III. The design of the ventilation system shall provide for all categories of construction equipment intended to be used for underground works. Full particulars of the proposed ventilation system shall be transmitted to the Employer for information
 - IV. The ventilation system in each section of the Works shall ensure the following requirements.
 - 4.0 m³/min of fresh air for each person working in underground structures.
 - 4.0m³/min of fresh air for each kW of installed power of diesel plant or equipment being operated in underground structures, taking into account an appropriate factor of simultaneousness for the operation of different plants and equipment.
 - The ventilation system shall be arranged so that air is circulated as near to the working faces as possible. All ventilation ducts shall be maintained in an airtight condition

- The content of oxygen in the air during the underground works shall be maintained not less than 18% by volume.
 - The content of dust in the air during the underground works shall be maintained not more than 3 mg/m³.
- b) The values shall relate to average concentration over an 8-hour working shift. When dust concentration exceeds the above figure, all persons in the affected area shall be notified and be requested to wear appropriate respirators.

Noxious Gas	Max. Permissible Concentration	
	Average over 8 hours	Max. Permissible limit at any time
	Parts/ million by volume	Parts/ million by volume
Carbon dioxide (CO ₂)	5,000 ppm	15,000 ppm
Carbon monoxide (CO)	25 ppm	100 ppm
Nitric oxide (NO)	25 ppm	35 ppm
Nitrous oxide (NO ₂)	3 ppm	5 ppm
Hydrogen sulphide (H ₂ S)	10 ppm	15 ppm

$$(1\text{ppm} = 1\text{cm}^3/1\text{m}^3)$$

- The average air velocity in all excavation shall not be less than 0.2 m/sec.
 - The ventilation, and where necessary, cooling arrangements shall be designed to ensure working environment such that:
 - At anytime, the average weighted mean wet bulb temperature at all work places in any one underground structure shall not exceed 30°C.
 - The wet bulb temperature at any one workplace shall not exceed 32°C.
- c) The air in the underground works shall be controlled continuously by sampling and testing and the results shall be recorded in daily reports. The Employer may request at any time to test the equipment and to provide performance test. Should the content of gases in the air exceed the values admissible for the health of the operators, no person shall be allowed to enter or remain at such underground works, unless such person is wearing effective apparatus to protect himself against the observed gases.
- d) Instruments to register the various noxious gases and dust shall at all times be available on the site in good working order and condition. These shall be supplied and maintained by the Contractor throughout the duration of underground work.
- e) All equipment and ducting shall be maintained in sound working order at all times. Any damage to ducting shall be repaired without undue delay. Failure by the Contractor to comply with these requirements or to maintain the prescribed ventilation standards shall entitle the Employer to order a temporary halt of all work within the affected area, until the specified requirements are met, without any extension of time and any additional payment being granted.

- f) After excavation of any underground structure which shall be lined, the ventilation system used for the excavation stage may have to be modified or adjusted to allow for the concrete lining, welding works, filling with concrete and painting of steel lined sections, if any. Any such modifications or adjustments will be allowed for the Contractor in his design of the ventilation systems for the underground works. These allow access hall also be required for localized ventilation during concreting and grouting operations and during carrying out welding or painting operations in the underground works.
- g) After the lining concrete work, the ventilation system shall be operated in such a manner that satisfactory conditions for proper curing of the concrete are maintained.
- h) The Contractor shall provide evidence that these ventilation systems meet the requirements as outlined in the Specifications considering construction method, type of equipment applied, and other factors.
- i) If the ventilation systems provided by the Contractor are proved by the measurements not to meet the requirements, the Contractor shall install additional ventilation system to meet the requirements.

7.2.3. Illumination System

- a) The illumination system shall be provided conforming to the following requirements:
 - I. For each section of the Works, the Contractor shall provide a general illumination system. In addition to this general illumination system, he shall provide special illumination for the excavation work front or where it is necessary to inspect apart of tunnels. Special illumination shall consist of flood lights, or any other type approved by the Employer.
 - II. An adequate traffic light system shall be provided, maintained and operated especially at tunnel junctions or crossings.
 - III. All power and illumination wires shall be installed and maintained in optimum conditions regarding insulation and safety. Power and illumination cables shall be installed on one side of the tunnel whereas detonator wires shall be installed on the opposite side, sufficiently away from communication systems wires.
 - IV. The temporary illumination shall remain in commission until tunnel construction is completed.
 - V. Without prejudice to the liability of the Contractor under the Conditions of Contract and his responsibility to adopt all expedients for ensuring the safety of his workmen and others, the Contractor shall, in connection with any installation for illumination, power and signaling, observe the following:
 - ◆ Power supply for tunnel illumination shall be partly or wholly independent of the power supply for any plant or small tools to ensure are liability of required illumination system in an emergency.
 - ◆ All lamp holders shall be of approved nonconductive material.
 - ◆ All wiring shall be properly insulated with vulcanized rubber or other approved material, and particular care shall be taken to insulate connections.
 - ◆ All wiring shall be securely fixed clear of any moving plant, man access, and source of heat or other likely cause for damage or accident.

- ◆ All circuits shall be sub-divided and protected by fuses of low current ratings.
- ◆ Lighting in tunnels shall generally consist of not less than one 60-Watt tungsten lamp at 6 m distance, or equivalent arrangements.
- ◆ Power supply lines for plant and equipment shall be protected adequately against unauthorized use or accidental damage. All cables shall be protected against continuous immersion in water, contact with hydraulic fluid, vibration from moving machinery, heat, abrasion and mechanical damages.
- ◆ High-voltage step-down transformers including the related switch gear shall be installed in tunnel recesses outside the excavation lines.

7.2.4. Communication System

The Contractor shall provide and maintain a communication system for construction of all underground works which provides at two way telephone system adequate for the conditions in the tunnels between each working face, each fire point, manned control point, and the site offices of the Contractor, Employer.

7.2.5. Drainage System

The drainage system shall be provided conforming to the following requirements:

- I. The Contractor shall make all necessary arrangements to prevent the penetration of ground or service water into the area of adjacent works.
- II. The Contractor shall provide sumps, pumps, pipes, etc., in an adequate number and capacity for dewatering during construction to give a safe margin to meet extraordinary conditions.
- III. Water in tunnels has to be collected, pumped and piped out of the tunnels. Near tunnels' portals, the water shall be led into a collector of sufficient capacity and be de-sludged and de-oiled.
- IV. After rock support has been installed, systematic drainage shall be executed. If an unexpected high out flow of water is encountered from faults or fracture zones, it may be necessary to install enough number of drainage pumps or perform other drainage methods
- V. Methods for controlling groundwater at all sections and during all stages of tunnelling may include groundwater lowering, ground treatment, or a combination thereof.
- VI. Drain holes may be drilled on the excavated face by the Contractor at his own expense in order to facilitate the smooth advance in the excavation.
- VII. The technique adopted shall ensure stability of the tunnel and excavated face during and after construction and shall ensure that no washing out of fine materials occurs which may lead to progressive settlement or loss of stability.
- VIII. Dewatering shall be continued until the works are finally accepted by the Employer.

7.2.6. Fire Fighting

Notwithstanding the Contractor's liability under the Conditions of Contract and the requirements of the local firefighting authorities, the Contractor shall observe the following requirements:

- I. Firefighting equipment shall be in compliance with internationally recognized standards.
- II. Vulnerable areas, such as material stores, shall be provided with individual firefighting equipment.
- III. An alarm procedure shall be developed for any type of emergency.
- IV. Burning and welding underground shall be kept to a minimum and propane shall be used in preference to acetylene. Gas cylinder shall not be stored below ground and shall be removed to proper storage locations after use. Sand buckets and extinguisher shall be immediately available when cut welding is carried out.
- V. Storage of combustible materials below ground shall be limited to that required for immediately or for emergency use only. Waste shall be removed at the end of each shift.
- VI. A site firefighting squad shall be designated and trained to use the equipment, to check its readiness, and to check and report on unsafe practices.
- VII. Access to the site for emergency vehicles shall be maintained at all times.

7.3. EXECUTION

7.3.1. General

- a) The working method, technique and equipment for underground excavation shall be established by the Contractor.
- b) Survey points, benchmarks, boundary stones, etc., shall not be removed or obstructed without the Employer's written consent. Where required, additional survey points shall be provided by the Contractor. Additional benchmarks shall be marked by plates, approx. 25 cm x 25 cm in size, with benchmark inscriptions written in black letters on a light background with clearly legible weatherproof oil paint.
- c) A binding working schedule with explanatory report shall be transmitted to the Employer prior to starting any underground excavation work. The schedule shall show the quantity, type and capacity of the equipment to be used, schedule of advance and cycle times for excavation including rock supporting work, blasting pattern and charges, the working method envisaged for transportation and distribution of excavated material, and the location of stockpiles as well as the approximate number of site operators, etc.
- d) Excavation shall be made to the lines, grades and dimensions as shown on the Drawings approved by the Employer. The general dimensions, arrangements and details of typical sections of the tunnels, shafts, etc., are shown on the Drawings. The type of section to be excavated shall be established based on the daily geomechanical

survey of the head face and of the RMR. A specific section type, previously designed at detailed level by the Contractor and approved by the Employer will be implemented in accordance with the surveyed RMR and the chainage of the tunnel.

- e) The Contractor shall protect final rock surface from damage by employing controlled blasting techniques such as smooth, cushion line drilling and pre-splitting techniques.
- f) Before tunnel excavation, portals shall be installed. In case of any possibility of failure of the adjacent open slope of the portals, the Contractor shall take necessary measures timely.
- g) The Contractor shall pay extra attention to the safety of the work and provide all safety measures to avoid any danger to personnel, equipment, installations and the structure itself not only in the case of obvious danger, but also in the case of suspected danger. Once an accident happens, the Contractor shall report to the Employer as soon as possible and take necessary measures against it.
- h) The safety of the underground excavations shall, at all times, be the responsibility of the Contractor, as well as the adoption and fulfilling of all necessary measures to protect the personnel engaged in underground work from cave-ins, harmful gases or vapors, fortuitous explosions, intoxications, electric discharges, floods and all other accidents of probable occurrence in the construction of underground structures.
- i) The Contractor shall take all precautions normally adopted for this type of work. Lack of compliance with any safety measures shall be cause for the Employer to suspend the execution of the Works until the causes are remedied. In such cases the Contractor shall have no right to claim for time extension
- j) Suitable excavated material may be utilized by the Contractor in the permanent works or temporary works. All such material that is not used shall be disposed of in the disposal areas as specified.
- k) Existing bore logs and interpretative geological sections derived from former subsoil investigations shall only be taken as an indication of the type of rock/soil to be encountered during underground excavation. The Employer shall not be held responsible for the accuracy and reliability of the investigations.
- l) Arrangement of all temporary work adits deemed necessary for construction works is discretion of the Contractor. The Contractor shall design, prepare the materials, and construct the closing structure for such adits.

7.3.2. Investigation Drilling

The Contractor shall, prior to his decision regarding excavation method, technique and type of equipment, verify the geological conditions ahead of excavated face to ascertain the suitability of his excavation method, technique and type of equipment, if deemed necessary.

7.3.3. Field Trials for Drilling and Blasting Operations

- a) Prior to starting underground excavation, the Contractor shall carry out field trials to establish methods of drilling and blasting that meet the requirements of these Specification and the local rock conditions. During the progress of the excavation, these techniques shall be varied as necessary to suit rock conditions.

7.3.4. Underground Excavation

1. General

a) Talus Deposit, Weak or Weathered Rock

- The Contractor shall excavate the section of tunnels, shafts, etc., through talus deposit, weak or weathered rock by means of appropriate methods to allow a safe excavation and avoid cave-in sand slides. He shall use the excavation and transportation equipment that best suits the working conditions.
- The excavation shall be coordinated with the installation of steel support, shotcrete and rockbolts. Where it is necessary to place laggings, they shall be packed at contact with vaults and walls in such a way as to obtain a safe protection.
- The excavation shall be started using manual methods or pneumatic tools. In case that it is impossible to execute the excavation using these methods and it becomes necessary to use explosives, blasting may be carried out. If rock blocks of considerable size are found, it may be necessary to resort to line drilling to diminish any harmful effect on the remaining material from blasting.
- The Contractor shall take all necessary precautions to protect the underground structures against cave-ins produced by water seepage, etc. When the material found at the work front is saturated or has a consistency that may cause cave-ins with normal excavation operations, the Contractor shall proceed to place temporary support at the work front, drive forepoling steel bars ahead of the excavation and take all necessary precautions.
- Filling of holes or voids shall be made with concrete or shotcrete. Seepage water shall be conveyed by temporary drains through plastic pipes laid with open joints, surrounded by a gravel and sand filter or by special drain mat, where required.

b) Rock

- The Contractor shall execute the excavation through rock by means of any appropriate method. He shall use excavation and transportation equipment, which meets the requirements stated in the Specifications. Support shall be called for in sections where the quality of the rock mass requires .
- As excavation advances, the rock mass encountered shall be inspected to determine the length and number of boreholes, charge of explosive per hole and the sequence of detonation to reduce excess excavation to a minimum. If required, investigation drilling shall be executed ahead to enable the selection of any appropriate excavation and support method. A systematic and permanent inspection of the excavated surfaces shall be made to verify the quality and conditions of the rock support installed.
- All shattered pieces of rock shall be removed. Where the removal of shattered or loosened rock is not sufficient to guarantee safety, the vaults and walls shall be supported by means of shotcrete, rock bolts or steel supports. When it becomes necessary to support a tunnel section, this operation shall be

completed before continuing the excavation.

2. Rock Classification

The rock mass classification is given in "Volume 5: Basic Project Report, Part B: Project Description".

3. Excavation Requirements

- a) Drilling and blasting operations and excavations shall be carried out to meet the following requirements:
 - I. Minimum loosening of the excavation surface and tunnel walls
 - II. Minimum impact of vibration to all tunnel support or lining (especially the concrete lining), neighboring tunnels, and the surrounding rock mass and structures
 - III. The least amount of overbreak
 - IV. Minimum rock fall in fault zones
- b) Damages to or alternation of any facilities caused by improper blasting or any other improper operation executed by the Contractor shall be repaired or indemnified by him at his own expense in a manner acceptable to the Employer. Unstable or loose material appearing during excavation which may be dangerous for the personnel or for the Work shall be immediately removed.
- c) To ensure work man like driving and supporting operations and the progress of the Work to schedule, experienced supervisory staff and skilled miners shall be engaged, and the most suitable machinery and equipment shall be used.
- d) Should any excavation be made of greater dimensions than those shown on the Drawings, the overbreak shall be filled in with such material and in such a manner as the Employer may be satisfied.

7.3.5. Blasting

1. Blast Hole Drilling

- i. Holes intended to be charged with explosives for blasting shall be drilled strictly in accordance with the pattern approved by the Employer, in spacing, direction and depth.
- ii. The Contractor shall make observations during the drilling of each round to gain information on the soundness of rock about to be excavated, including the presence of any soft, decomposed or water bearing areas.
- iii. If the actual rock condition differs from the anticipated condition the Contractor shall make appropriate adjustments to the amount of explosive.

2. Prerequisites for Explosives

The Contractor shall not obtain and make use of any explosives without the written permission of the local security authorities or other authorities concerned. The Contractor shall comply strictly with the prevailing regulations regarding purchase, storage, issuance, supervision by him and security measures in use of explosives and transport of them to and from the Site. Explosives containing nitro-glycerine shall not be used.

3. Requirements for Explosives and Blasting

All pertinent specifications regarding the general requirements for storage and care of explosives shall be applicable taking in to account the following:

- I. Charges shall be prepared outside the tunnels.
- II. Blasting caps shall be separately packed in clearly marked boxes according to type and shall be sent to the work front by a car. This car shall be followed by another car carrying the explosives in open boxes. Only the necessary amount of explosives and caps shall be sent to the work front and all remaining caps and explosives shall be removed before blasting.
- III. The depth of the holes shall be checked before placing the charges.
- IV. The base wire ends of electric type detonators, which shall be prepared outside the tunnels, shall be protected with insulating caps or neoprene fittings. Such insulators shall be removed after charging the holes to make the proper connections.
- V. Each of the prepared blasting charges shall be checked by means of a galvanometer or a special ohmmeter, at an adequate distance, to verify the wiring arrangement.
- VI. The ends of the main wires shall be connected to the detonator immediately before the blasting. The initiation system shall be kept at a minimum distance of 200m from the work front and dispensable personnel shall move further back.
- VII. In case that an ignition system without electric detonators is used, the manufacturer's recommendations shall be followed.

Blasting shall be carried out carefully by experts only. The Employer shall not be liable for any claims arising out of damage or alleged damage, injury to the public, etc. due to blasting.

Blasting shall be carried out at specified times to be agreed upon between the Contractor and the Employer. Sufficient signs and notices shall be installed. Immediately before blasting is due, adequate warning shall be given. Upon completion of blasting, an "all clear" signal shall be given. This signal shall be withheld by the supervisor in charge until he is satisfied that all charges loaded have detonated and that no delay explosion or misfiring can be expected. Adequate warning, as mentioned above, shall be given and the required portion of the Site shall be cleared before electrical resistance measuring or testing of the firing lines carried out.

The Contractor shall always be sure that the rail tracks, ventilation tubes and supply lines are safely grounded so as to prevent danger to persons from lightning and to avoid the possibility of explosion of loaded or unloaded charges.

Special care shall be given to safety measures when blasting is carried out at two opposite faces which are separated only by a short length of rock. Within the last 50 meters prior to break through, people at opposite faces shall be informed of the exact blasting time at either side, in order to remove from the face to a safe location during blasting.

4. Smooth Blasting

- a) Where smooth rock surfaces are required, or where the rock cover above underground excavations are limited, the Contractor shall reduce blasting charges. The specific explosive load shall be kept as low as possible, i.e. the quantity of explosives at the outer ring shall be distributed to most of the individual length of the holes.
- b) Blast holes at the outer ring shall be charged by means of explosive cordora combination of explosive cord and normal cartridges.
- c) The booms of drilling jumbos shall be equipped with a device which automatically aligns drillholes in a direction parallel to the tunnel axis.
- d) The size of excavated rock shall be preferably 25-30 cm or less.
- e) Blasting Records
 - The Contractor shall record on agreed forms all blasting events including location, time, charge, type of explosives, detonator type and arrangement, purpose, etc. Two copies of the record shall be submitted to the Employer.

7.3.6. Mucking

- a) All muck resulting from underground excavation shall be removed from the working face as soon as practicable and be placed in stockpile areas or disposal areas as shown on the Drawings or as approved by the Employer.
- b) The Contractor may deposit materials on disposal areas only when there are no possibilities for its further use by him or by the Employer.
- c) Excavated material from the Works, which is selected by the Employer for re-use shall be placed directly in its final position, if possible. Otherwise, it may be stockpiled or deposited.
- d) Muck resulting from tunnel excavations may be crushed and stockpiled in appropriate places to be used in any Work for which it meets the specifications under this Contract.
- e) Materials which will not be used in any Work shall be placed in disposal areas in a neat and orderly manner and the complete area shall be free of potholes and unsightly humps. The disposal areas shall be sloped to drain as directed and shall be maintained and left in such condition that they present a neat and orderly appearance and a blend with the surrounding topography.
- f) The Contractor may temporarily deposit excavated materials on approved areas in order to expedite the mucking cycle and/or to use them for other purposes in an approved way.
- g) The Employer shall be the owner of the muck resulting from underground excavations, and the Contractor cannot sell or use it in works not covered by this Contract without the Employer's approval.
- h) Other entitles or persons authorized by the Employer to use materials resulting from excavations may utilize only excess material left by the Contractor.

7.3.7.DISPOSAL OF EXCAVATED MATERIAL

1. Disposal

The Contractor shall dispose of all materials from underground excavation in the approved disposal areas except selected tunnel spoil material which shall be stockpiled or used directly in the Works. Such selected tunnel spoil for use in the Works shall conform to the appropriate requirements of this Technical Requirements.

2. Stockpiling

Selected tunnel spoil material, suitable for use in the Works but not used directly therein, shall be stockpiled within the approved stockpile areas.

3. Treatment of Surfaces

The Contractor shall grade the top surfaces of materials placed within disposal areas to the approved lines and levels and shall construct permanent drains and other protective work sufficient to ensure that surface runoff will not erode the surfaces of waste material placed therein. Such disposal shall be treated in accordance with the provisions of this Technical Requirements.

7.3.8.Supporting

1. General

- a) The excavations shall at all times be properly secured by steel support, shotcrete, rockbolt to prevent movements or loss of ground outside their boundaries, settlement of or damage to property, or injury to persons. The Contractor shall make good any damage to structures, services or other property caused by such movements, loss of ground or water, and settlement/ deformation.
- b) Any face where excavation is to be discontinued shall be protected adequately. If necessary, the face of the tunnels and other underground excavation shall be supported temporarily by shotcrete or reinforced shotcrete and/ or rockbolts or other adequate support during the progress of the works.
- c) Specifically, it may become necessary to support the face on weekends and holidays or during other interruptions of work. The Contractor shall have responsibility for any damage or injury resulting from his operation. Timber shall in no case be used as support.
- d) Supports of underground excavations consisting of shotcrete, rockbolts, rock anchors and steel supports, used separately or in combination thereof, shall be installed by the Contractor based on the approved Drawings and the Specification depending upon the RMR.
- e) Basic modifications of the standard support patterns may be proposed to the Employer for his approval, depending on the results of deformation monitoring.
- f) Excavation shall be completed prior to the installation of support. However, in case of rock masses or soils behaving plastically or squeezing, excavation and support may be done almost at the same time at very small partial surfaces.

2. Temporary Support Pattern

- a) Temporary supports for tunnel and shaft excavations (bolts, shotcrete, steel ribs) shall be designed as described in "Volume 2 - Section IV - Particular Technical Requirements for Civil Works, 1.6 Underground Works Design Criteria"
- b) Temporary supports pattern shall be designed as function of the Rock Mass Class (RMR) and tunnel overburden as approved by the Employer.
- c) In addition to the support patterns designed as above, local modifications of supporting measures, such as increasing shotcrete thickness, applying additional number of rockbolts or steel ribs, increasing length of rockbolts, etc. may be required due to special geological features.

7.3.9. Access

- a) Without prejudice to the liability of the Contractor under the Conditions of Contract and his responsibility to adopt all expedience for ensuring the safety of his workmen and others, the Contractor shall, in connection with the provisions of safe access to the works, observe the following requirements:
 - I. Walkways shall be provided in all underground excavations providing a minimum clear space of 1800 mm high and 750 mm wide, with a walking surface of not less than 400 mm wide. The walking surface shall be free of irregularities and sufficiently rough to avoid slipping and sliding. Water should not be allowed to stand or accumulate to or above walkway level at any point. Any accidental spillage of spoil or other material shall be removed immediately. Walkways elevated by 1.5 m or more shall be provided with guard rail and toe boards.
 - II. Ladder access and/ or staircases shall be provided in every shaft as soon as possible and in any case not later than completion of the shaft. Landings shall be provided, preferably at 4.5m intervals with a maximum distance of 9 m, and shall be solidly constructed with handrails, guard rails and toe boards.
 - III. Openings for the lower ladder shall be as small as practicably possible and be located clear off the foot of the upper ladder. Every ladder shall be securely fixed and shall be extended by a minimum of 1.1 m above the upper landing unless another adequate handhold is provided. The foot hold of every rung shall be unobstructed. Ladder bays in shafts shall be protected by substantial barriers against swinging loads and shall be designed to minimize the risk of obstructing hoisted loads.
 - IV. Immediately after mucking out, the invert shall be levelled suitably. All groundwater and service water shall be drained off so as to make the invert suitable for the use by persons and vehicles. Any core sand barriers required shall be installed immediately.

7.3.10. Construction Control

1. Testing

- a) At the Employer's request, the Contractor shall at all times supply rock and water samples for testing purposes. Any change in rock and water conditions shall immediately be

reported to the Employer.

- b) Environmental monitoring for underground excavation shall be performed by the Contractor at a frequency as approved by the Employer depending upon the items to be measured.

2. Observation and Measuring during Underground Excavation

- a) The Contractor shall, during underground excavation, observe condition in tunnel and shaft subject to the following provisions so as to assure safety in underground excavation and judge appropriateness of construction method including method of support, and shall notify it to the Employer.

I. Geological Observation and Inspection

- ◆ The geological observation including geological mapping, description and photographing will be carried out at tunnel and shaft faces and walls exposed by the construction activities. The observation shall be on a regular basis set for this document. The Contractor shall perform the observation in parallel with their excavation work.
- ◆ The Contractor shall describe geological features appeared on excavation surfaces concretely and objectively without any geological interpretation on overbreak and/ or underbreak in underground openings. Analysis or evaluation on overbreak and/ or underbreak shall be made separately from the geological observation work. The excavation schedule shall provide time for the observation. The observation shall be carried out just after mucking out operations in underground excavation.
- ◆ The observation shall be performed by persons with training in geotechnology and with experience in underground geological mapping. The persons shall have become familiar with the regional and local geology in the project area prior to performing the observation. The Contractor shall organize adequate number of personnel who are in charge of the geological observation work so as to perform the observation completely.
- ◆ The Contractor shall perform the observation including geological mapping, recording and photographing at least every two (2) blasting cycles. When excessive overbreak and potential instability are estimated or occur at the excavation surfaces, all of observation items shall be carried out regardless of regulatory frequency.
- ◆ If primary supports are needed for safety, they may be placed prior to the observation. In addition, the area to be observed shall have adequate ventilation and illumination.
- ◆ Surfaces of the excavation may need to be cleaned by water immediately prior to the observation.
- ◆ Forms for the observation shall be proposed by the Contractor prior to the commencement of the excavation.
- ◆ Not less than Thirty (30) days prior to the underground excavation, the Contractor shall prepare a detailed plan of observation based on the provisions mentioned above and shall submit to the Employer for approval.

- II. Measuring of Convergence
 - ◆ Convergence measurements shall be recorded when deemed necessary in order to validate and/or promptly adjust the design of the temporary rock supports, previously approved by the Employer.
- III. Measuring of Displacement
 - ◆ Comprehensive geological measurements in related to rock behaviour shall be performed by the Contractor in order to judge whether or not the loosened rock zone around the cavity has reached an equilibrium state.
 - ◆ The Contractor shall provide, maintain and operate the required devices for measuring of displacement including all materials, consumable and auxiliary equipment, and shall measure, record and evaluate the results.

7.3.11. DRILLING FEELER OR PILOT HOLES AHEAD OF UNDERGROUND EXCAVATION

1. General

Where the existence of water-bearing or gas-bearing seams or strata is suspected the Contractor shall drill feeler or pilot holes ahead of underground excavation to determine in advance the nature of the materials to be excavated. The diameter of each hole shall not be less than 35 mm. The location, direction, length and number of holes shall be as necessary to ensure the safety of the work. When feeler or pilot holes are required to be drilled during the excavation, other operations shall be suspended or modified as may be necessary to permit such drilling and the Contractor should have made allowance for such disruptions and interferences. Suitable equipment shall be kept at site for such purposes and for the duration of the underground excavation work.

2. Inflows of Water

- a) If sustained inflows of water are encountered, the Contractor may need to grout feeler or pilot holes and drill and grout additional holes to limit the water inflow.
- b) Pilot, feeler and additional holes shall be fitted with stub pipes and throughway gate valves during grouting operations.

3. Grouting Equipment

At the commencement of underground excavation, the Contractor shall provide sufficient grouting units in accordance with the provisions of this Technical Requirements for the grouting of feeler or pilot holes and for grouting to reduce water inflow. Sufficient grouting units shall be available for use during the entire progress of all underground excavation.

7.3.12. SAFETY MEASURES AND SUPPORT DURING CONSTRUCTION

- a) The Contractor shall provide all safety measures and carry out the work in a manner to avoid any danger to personnel, equipment, installations and structures.
- b) The Contractor shall implement a safety plan for the underground works which shall be submitted to the Employer. The safety plan shall include provision for first aid and firefighting/prevention and evacuation procedures.
- c) The safety of the underground excavations shall at all times be the responsibility of the

Contractor, as well as the adoption and fulfilling of all necessary measures to protect the personnel engaged in underground work from cave-ins, harmful gases or vapours, fortuitous explosions, intoxications, electric discharges, floods and all other accidents of probable occurrence in the construction of tunnels, shafts, caverns, etc. The Contractor shall take all precautions normally adopted for this type of work. Lack of compliance with any safety measure shall be cause for the Employer to suspend the execution of the Works until the causes that determined the suspension are remedied, and in such cases the Contractor shall have no right to claim for time extensions or extra costs.

- d) In case of difficult rock conditions such as weak rock, fault zones, karstic areas with karstic water, gas, etc, the Contractor shall provide core drilling ahead to determine difficulties in advance and to provide all corresponding safety measures. Suitable equipment shall be kept at Site for such purposes and for the duration of the underground excavation work.
- e) Careful scaling after each blast and continuing inspection of the walls and arches of the underground excavation shall be performed. Primary rock support, shall be installed immediately after excavation. In the event of falls of ground owing to unfavourable bedding, jointing, local faults, etc, work shall be carried out with particular care and protective safety measures.
- f) The Contractor shall continually monitor the inhalant air for flammable and toxic gases and shall take all necessary precautions to ensure that these gases do not become a danger. The Contractor shall further provide such means as necessary, including the provision of self-rescuers, for all personnel in the case of an emergency should the concentration of such gases become dangerous.
- g) The Contractor shall provide such personnel protective equipment as may be required for the work and shall ensure that such equipment is used at all times. Such equipment shall include but not be limited to:
 - ♦ hard hat
 - ♦ steel toe cap boots
 - ♦ safety goggles
 - ♦ gloves
 - ♦ ear defenders
 - ♦ safety harness
 - ♦ dust masks.
- h) No smoking will be allowed in the underground Works.
- i) When underground excavations are being executed through zones of earth, earth/rock sequence, weak or weathered rock or any other zones where the rock is unstable, they shall be stabilised during construction or shall be supported permanently by means of lattice girders with forepoling placed as required by the local conditions. When the excavation is being made through sound and relatively unaltered rock, support by means of shotcrete, lattice girders or rockbolts shall be required only when the structural characteristics of the rock may cause dangerous conditions. Such support shall be installed in such a way as to allow ready inspection at any time.
- j) The stabilisation can also be executed by using, if required, special techniques such as consolidation grouting around the excavation or freezing of the saturated soil.

- k) Metallic supports shall be lattice girders, forepoling or any other appropriate method. Such metallic elements shall have physical and mechanical characteristics in accordance with the respective provisions of this Technical Requirements.
- l) Anchor and rock bolt plates shall bear flat against the rock and shall not be placed on projections, but, wherever possible, in depressions or similar areas of the rock surface.

7.3.13. INSTRUMENTATION

1. General

- I. The work specified in this Clause consists of furnishing, installing and maintaining instrumentation for the detection of ground movements and the detection of underground opening deformation during construction, including all materials, consumable and auxiliary equipment, to record and evaluate the results.
- II. The instrumentation to be supplied, installed and maintained shall include convergence bolts together with measuring deformation monitoring device, extensometers, pressure cells, disk load cells and levelling points.
- III. Deformation monitoring consists of an initial measurement and subsequent series of measurements to determine the degree and progress of deformation over time. All measurements shall be recorded and evaluated in the forms of tables and graphic presentations as approved by the Employer. The forms shall show, but not limited to, date, time of measurement, deformation and distance from the excavated face.
- IV. The purpose of the instrumentation program is to monitor deformations of the underground excavations and surrounding ground in order to evaluate ground stability. The typical support elements may require adjustment or construction sequences may have to be modified based on the observed behaviour.
- V. Damaged or missing instrument components or entire instruments shall be repaired or replaced immediately.

2. Approval of Instrumentation and Construction Procedures

- a) The Contractor shall, not later than Sixty (60) days after the Commencement Date, submit to the Employer details of the instruments proposed including:
 - ◆ A detailed description of the instrumentation including the ancillary measuring equipment it proposes to install.
 - ◆ If the Contractor proposes to install brands of instruments other than those specified, it shall submit to the Employer evidence that such brands have been installed and operated satisfactorily.
 - ◆ Procedures prepared by the manufacturers and/or suppliers of the instrumentation for the installation, testing, and operation of the instruments.
 - ◆ The layout of all equipment and accessories to be installed.
 - ◆ The experience of the Supervisor and technicians who will install the instruments.
- b) In accordance with the requirements for Contractor's Documents to allow for the initial review period before the anticipated date of installing any instrumentation, the Contractor shall submit to the Employer details of a complete instrumentation program including type,

number, the sequence of placing and installing the instrumentation and the procedure for taking measurements.

- A detailed description of the instrumentation including the ancillary measuring equipment it proposes to install.
- If the Contractor proposes to install brands of instruments other than those specified, it shall submit to the Employer evidence that such brands have been installed and operated satisfactorily.
- Procedures prepared by the manufacturers and/or suppliers of the instrumentation for the installation, testing, and operation of the instruments.
- The layout of all equipment and accessories to be installed.
- The experience of the Supervisor and technicians who will install the instruments.

3. Convergence Measurement

- a) Convergence bolts are bolts which are securely attached to exposed rock or shotcrete surfaces within the underground excavation and located such that at least two bolts are at directly opposite sides of the opening and a third is in the crown in the tunnels. The actual number of bolts in each set and their locations around the perimeter shall be sufficient to provide meaningful data on convergence and will depend on the size and shape of the tunnel or underground structure and the minimum number shall be subject to approval. A total station shall be used to monitor the deformations, if any, occurring during the period between excavation and construction of the final lining.
- b) The Contractor shall supply and install convergence bolts in the pattern indicated above or approved. The convergence bolts shall be installed as soon as practicable after the tunnel, shaft or underground structure has been excavated and supported, prior to the application of the first layer of shotcrete.
- c) The convergence bolts shall be protected against damage. Damaged bolts shall be replaced immediately by the Contractor.
- d) The convergence measuring bolts shall be installed in underground excavations where shown on the Drawings and where required to monitor the behaviour of the excavation.
- e) Convergence bolts will be monitored by the Contractor. Measurements will be made by the Contractor at maximum frequencies of daily until the deformations have decreased to less than 1 mm per day and weekly thereafter until the deformations have decreased to less than 1 mm per month. Thereafter the convergency rings can be measured monthly until underground excavation is complete and permanent lining is installed to cover the convergency ring. Additional excavation within 30 m of bolt locations will require twice-weekly monitoring until deformations have reduced to less than 1 mm per month. Other measurements will be taken as necessary.
- f) The Contractor shall prepare all results in graphical format agreed with the Employer and submit the results to the Employer the same working day after taking measurements.

4. Extensometers

- a) Borehole extensometers are to be installed as multipoint borehole extensometers which are securely anchored at locations within the rock strata. The relative movement, if any, of the individual rock strata and the rock surface in the underground excavations will be measured during the excavation and lining operations.
- b) The Contractor shall supply, install and test extensometers in the rock surrounding the underground excavations in the locations shown on the Drawings or approved. The extensometers shall be installed in accordance with the manufacturer's recommendations and within one tunnel diameter or 5 m of the working face.
- c) Borehole extensometers shall be designed, manufactured and installed to yield an accuracy of readings to within 0.1 mm.
- d) Each borehole extensometer shall consist of a downhole assembly of two, three or five individual anchors, each attached to a non-corrosive stainless-steel rod with protective casing, all assembled into a single bundle, and a mechanical readout head. Borehole extensometers will be grouted to the excavation surface and set in a steel pipe fitted with a steel waterproof protective cover.
- e) Cement grout and use of an expansion agent, shall be according to the borehole extensometer manufacturer's recommendations to produce a permanent non-shrink grout.
- f) The diameter of the boreholes shall be as recommended by the manufacturer of the extensometers. The use of drilling mud, oil, rod dope or any other material in the hole that will adversely affect the bond between the rock, grout and extensometer anchors will not be permitted.
- g) Once grouting of an extensometer has begun it shall not be interrupted until completed. Should grouting be interrupted the work will be deemed unsatisfactory and the Contractor shall replace the hole and anchor assembly.
- h) If any extensometer fails to work correctly, then it will be replaced by the Contractor.
- i) Extensometer readings will be taken by the Contractor. The Contractor shall provide access to enable these measurements to be witnessed. Readings will be made at maximum frequencies of daily until the heading has advanced 25 m past the extensometer and bi-weekly thereafter until the final lining is installed. In caverns readings are to be taken daily throughout the time of excavation.
- j) The Contractor shall install extensometers also for permanent monitoring of the completed underground structures after final lining is complete.

5. Pressure Cells

- a) The Contractor shall supply, install and test complete hydraulic pressure cell assemblies in all underground excavations. The cell assemblies shall be installed and tested, in accordance with the manufacturer's recommendations, inside the shotcrete in order for radial pressures and tangential pressures respectively to be measured.
- b) The hydraulic pressure cells shall be 100 mm x 200 mm overall cell size, 6 mm pad

thickness, pressure range 0-200 bar, supplied with a re-pressurising tube and shall be equal to the approved standard equivalent. Each measuring section will consist of at least three cells recording radial and tangential stresses in the shotcrete. More cells may be required in larger structures.

- c) A portable manual hydraulic readout unit shall be supplied complete with a hand operated hydraulic pump, with all necessary valves, flow controller and interchangeable pressure gauge, all mounted within a carrying frame.
- d) The pressure cells shall be read and reported by the Contractor. The Contractor shall provide access to enable these measurements to be witnessed.

6. Ground Water Monitoring

- a) Throughout the entire and final Contract period, the Contractor shall perform ground water monitoring. Ground water levels and discharges shall be measured and reported at intervals. The monitoring and reporting shall include:
 - Monitoring of precipitation data, daily.
 - Monitoring of ground water level and piezometric data in all observation wells.
 - Monitoring of seepage discharge from the tunnels at pumping stations or V-notch wherever applicable.
 - Monitoring and regulation of water pressure and water consumption in underground water infiltration systems, if applicable.
- b) Required monitoring, supervision and disconnection/connection of ground water infiltration holes that may be affected every time that grouting is performed in caverns, shafts or tunnels, if applicable.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 8
DRLLING AND GROUTING**

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CHAPTER 8 - DRILLING AND GROUTING

8.1. GENERAL

8.1.1. Requirement for Drilling

- (a) Drilling shall include:
- ♦ additional exploratory drilling with and without core recovery;
 - ♦ drilling for curtain, contact and consolidation grouting;
 - ♦ drilling for drainage holes;
 - ♦ drilling for installation of instrumentation including piezometers and extensometers;
 - ♦ drilling for anchors and rockbolts.
- (b) While the work, the Contractor shall be required to core drill vertical or inclined holes. Such cored holes shall be water tested in stages as the drilling progresses.

8.1.2. Location and Method

- (a) The location, direction and length of holes and their reference numbers will be determined by the Contractor and approved by the Employer.
- (b) If foundation conditions and rock conditions as revealed by the excavation, drilling, testing and grouting operations, indicate that grouting at greater depths or closer spacing or in other locations than those initially determined is necessary to achieve the required permeability, the Contractor shall drill holes to such depths and spacing.
- (c) Grout, test, exploratory and instrumentation holes may be drilled with either rotary type diamond drills or percussion type drills, provided that where holes satisfactory for subsequent grouting cannot be drilled by percussion type drills, rotary type diamond drills shall be used.
- (d) The diameters specified shall be obtained at the maximum depth required. The drilling equipment shall be capable of drilling at any angle and be capable of being set to an accuracy of one degree.
- (e) Holes shall be drilled to an accuracy of 3° of angle of that specified. Holes shall be drilled from positions shown on the Drawings with a tolerance of 150 mm. Holes for testing and grouting shall have diameters not less than 35 mm. For percussion drill holes the bit diameter shall be at least 8 mm greater than that of the coupling used for drill rods.
- (f) All holes shall be drilled without mud support and without the use of grease, rod dope or other non-water-soluble material or the lubrication of the drill rods. The Employer may permit the use of an additive in the drilling water. A sample of any proposed additive shall be submitted to the Employer at least Seven (7) days prior to its being used. The concentration of the permitted additive shall not exceed the manufacturer's recommendation.
- (g) All holes shall, immediately after drilling, be thoroughly washed out with water under pressure from the bottom. Water flushing shall continue until the wastewater runs clear.

8.1.3. Drilling Sequence

- (a) In local regions the upstream and downstream rows shall be drilled and grouted prior to drilling and grouting the central row of grout holes in that region.
- (b) When drilling curtain grout holes, the first holes drilled into the foundations shall be widely spaced and shall be drilled and grouted before intermediate holes are drilled and grouted, and in this manner the drilling and grouting of holes shall be completed to such final spacing as to produce the required grout curtain.
- (c) After holes in a region have been drilled and grouted, it may be found necessary to drill additional grout holes.

8.1.4. Casing

- (a) It may be necessary to install casing in portions of holes drilled for grouting. Any casing that is installed for the purpose of keeping the grout hole open for grouting shall be removed immediately prior to or simultaneously with the grouting process. Over lengths of the hole where grouting is required the casing left in place shall be perforated.

8.1.5. Capping Holes

- (a) Each grout hole in foundations shall be protected from becoming clogged or obstructed by installing a grout connection grouted into the grout hole and suitably capped, or by other means, until the hole is grouted, and any hole which becomes obstructed before being grouted shall be cleared.

8.1.6. Standpipes

- (a) Where holes are required below or behind concrete they shall be drilled through the concrete or through pipes embedded in the concrete. When grouting is carried out it shall be carried out through pipes set into the concrete or rock. The pipes shall project 300 mm above the rock surface or concrete and shall be bonded firmly into the top of the hole for a length of not less than 750 mm. The grout hole shall be suitably capped until the hole is grouted, and any hole which becomes obstructed before being grouted shall be cleared.
- (b) The standpipes shall be supplied and installed in accordance with this Technical Specification.

8.2. CORE DRILLING

8.2.1. General

- (a) The Contractor shall core drill such holes as may be required to determine the condition of the rock, the effectiveness of the grouting operations, the quality of the construction of the diaphragm cut-off beneath the plinth across the valley floor and for in-situ rock testing.
- (b) A minimum of one cored hole to the maximum depth of grouting in that region under consideration will be drilled for each 30 m length of curtain grouted.
- (c) All core drilling shall be performed with rotary type hydraulic feed core drilling

equipment, using NMLC or NQTT sized bottom discharge diamond bits and triple tube, swivel inner tube type core barrels. The Contractor shall ensure that cores obtained are in as good a condition as possible from all holes.

- (d) Drilling lifts shall be terminated and the cores removed from the barrel as often as considered necessary to secure the maximum possible amount of core. Drilling lifts shall not be longer than the length of core barrel.

8.2.2.Records

- (a) Within 24 hours of completing drilling of a cored hole, the Contractor shall submit in triplicate a complete log of the hole in a form approved by the Employer. The log shall include the following data:
- ◆ location
 - ◆ borehole number
 - ◆ type and diameter of boring
 - ◆ ground level
 - ◆ immediate, intermediate and equilibrium water levels with times and dates. Note on colour and losses, etc.
 - ◆ description and state of weathering of rock and the levels of its boundaries
 - ◆ percentage core recovery
 - ◆ fracture log
 - ◆ the results and levels of all in situ testing
 - ◆ a record of the driller's observations on progress of boring, rate of penetration, type of bit and speed of rotation of bit
 - ◆ water pressure test results.
- (b) The logging of rock cores shall be based upon the Geological Society Engineering Group Working Party Report "The Logging of Rock Cores for Engineering Purposes", Quarterly Journal Eng. Geol. Vol. 3 1970 London or BS 5930:2015 or ISRM or EM ISO-14689.
- (c) Preferably, cores should be logged by the same person to avoid discrepancies in description of rock.
- (d) Colour photographs of each box are to be taken for all cored drill holes showing the core from 90° to the plane of the box. The core is to be dampened prior to being photographed. Each photograph shall include project name, drill hole number, depth range of core, core box number, core size and a prominent scale graduated in 100 mm intervals. No core is to be removed from the core box prior to being photographed.
- (e) The Contractor shall provide strong 1.05 m long core boxes fabricated from zinc galvanised steel sheet. Each box shall hold cores from 5 m of hole, and they shall be provided with fastenable lids fabricated from galvanised steel sheet.
- (f) The Contractor shall place the core in the box in the correct sequence after extraction from the core barrel. The core at the bottom of each lift shall be marked immediately it has been placed in the box and a corresponding mark shall be printed on the side of the core box and on the rock core. When core is not recovered, timber blocks of

square cross section shall be cut to the same length as the core losses and placed in the positions in the box for which the core was lost. If these positions cannot be determined, the blocks shall be placed at the top of the lift. A box shall not contain cores from more than one hole. Designating marks, hole numbers and elevations shall be placed on the boxes and along the line of cores. The covers shall be fastened securely to the core boxes, and the boxes shall be delivered to the Employer at a point designated in the vicinity of the Works.

- (g) The cored holes shall be grouted as requested.

8.3. EXPLORATORY DRILLING

- (a) For the purpose of exploratory drilling, the Contractor shall use drilling procedures and equipment which, in the opinion of the Employer, are capable of obtaining samples listed below, in accordance with the requirements of ASTM D2113.
- (b) In cohesive soil and completely weathered in-situ rock the Contractor shall continuously take undisturbed samples using a thin-walled sampler having a minimum diameter of 62 mm. unless otherwise approved thin-walled samples shall be pushed into the soil with a smooth continuous action. Sample tubes shall be sealed using microcrystalline wax or an approved sealing device.
- (c) Material which is too hard to be penetrated by a thin-walled sampler N-size core samples shall be taken by drilling in accordance with the provisions of the relevant Chapter of Standard Technical Requirements. The Contractor shall, if necessary, vary the drilling technique until the maximum possible percentage core recovery is obtained and cores are intact and in good condition. Drill core shall be stored in zinc galvanised steel sheet core boxes as specified in the relevant Chapter of Standard Technical Requirements.
- (d) All samples and drill cores shall be placed in their tubes or core boxes, as appropriate, as soon as they have been extracted and shall be stored at each drill site completely protected from the weather. All drill cores shall be correctly identified by marking and the Contractor shall survey all drilled holes to determine their co-ordinates and elevations. The Contractor shall keep an accurate log of all drill holes in accordance with the provision of the relevant Chapter of Standard Technical Requirements.
- (e) The Contractor shall furnish all equipment required for the work. All core boxes and tubes containing samples shall become the property of the Employer and shall be delivered to the Employer at a point designated in the vicinity of the Works.

8.4. DRILLING GROUT HOLES IN TUNNELS, SHAFTS AND UNDERGROUND STRUCTURES

- (a) Prior to drilling grout holes in the rock surrounding tunnel and shaft linings and other lined underground structures, the Contractor shall complete all backfill grouting in the vicinity of such linings or plugs and such backfill grout shall have been completed for not less than Twenty-eight (28) days.

8.5. WATER PRESSURE TESTS

- (a) A water pressure test shall be carried out in all grout holes prior to grouting, and in cored and test holes.
- (b) Water pressure tests shall be carried out in stages of depth not exceeding 10 m, with clean water and the rate of flow shall be determined to an accuracy of ten (10) per cent for flows exceeding 1 litre/min, using an air vessel to smooth out fluctuations of pressure. The results shall be expressed in Lugeon units. One Lugeon unit is determined by a water pressure test where a leakage occurs of 1 litre of water per minute per metre length of hole under pressure of 1 MPa.
- (c) The water pressure test shall be carried out between a packer and the bottom of the hole or between packers in depth stages to suit the variation of jointing of rock.
- (d) Pressure shall be maintained for 5 minutes at each of five pressures, which shall be 0.1 MPa, 0.3 MPa, 0.5 MPa, 0.3 MPa, 0.1 MPa per metre of depth to the top of the stage, or as approved by the Employer. The pressure shall be determined to an accuracy of ten (10) per cent. The results of the tests shall be processed in order to yield by extrapolation the actual Lugeon Units values.
- (e) Should the flow be too great to hold the specified pressure, the flow shall be held constant at the maximum discharge of the pump and the pressure shall be observed at one-minute intervals over a period of 10 minutes. If the results do not give an adequate indication of the required grouting, the tests shall be repeated using two or shorter stage lengths.

8.6. PRESSURE GROUTING - GENERAL

8.6.1. Requirement for Grouting

- (a) Drilling and grouting operations shall be performed in accordance with the requirements of this Technical Requirements and with procedures developed by the Contractor with regard to experience as the work proceeds and submitted to and approved by the Employer from time to time.
- (b) These procedures shall embody the Contractor's recommendations on both the type and composition of the grout and the injection pressures to be used after determination by the Contractor of the basic parameters of the rock including permeability and jointing pattern.
- (c) It is anticipated that the majority of the grout will be of the cement type. In appropriate circumstances, sodium silicate grout will be required.
- (d) The addition of fine aggregate or bentonite to cement grout may be necessary where foundation rock is disturbed or contains large voids.
- (e) The Contractor shall use grout proportions and injection pressures as nominated in the approved procedures and it shall be responsible for control of those grout proportions and injection pressures.

8.6.2. Mixing and Pumping Equipment

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before commencing any grouting operations including the drilling associated therewith, the Contractor shall submit to the Employer for approval full details of the proposed mixing and grouting plant and related apparatus.
- (b) Grouting shall generally be carried out from one or more central stations which shall contain stores for grouting materials, batching plant, grout mixers, holding tanks, and grout pumps.
- (c) The arrangements shall be such as to ensure the continuous and uninterrupted flow of grout to the hole being injected and shall include standby equipment capable of being brought into use immediately in the event of a breakdown. The grouting shall be carried out by a return flow system to ensure continuous circulation of grout to the hole being injected and return surplus grout which is not accepted by the hole to the holding tank.
- (d) Each grouting unit, including the mixer, pump, hoses and pipelines used for surface grouting operations shall be capable of delivering not less than 60 litres of liquid grout per minute to each hole being injected up to a maximum pressure of 2.5 MPa and shall include a water storage tank of adequate capacity to be used for pressure testing and for flushing out the pumps.
- (e) Each grouting unit, including the mixer, pump, hoses and pipelines used for underground grouting shall be capable of delivering not less than 30 litres of liquid grout per minute to each hole being injected up to a maximum pressure of the hydrostatic pressure at the point of application plus 1 MPa. Sufficient water capacity shall be available for pressure testing and for flushing out the pumps.
- (f) Two compartment, high speed, colloidal mixers shall be used. The grout shall be mixed in one compartment and be discharged into a holding tank. A screen shall be inserted between the holding tank and the suction of the grout pump. The grout in the holding tank shall be continuously agitated. A water meter shall be provided for the accurate measurement of the water to be used for mixing. The holding tank shall be provided with a volume measure indicator to enable a record of grout take to be made.
- (g) All grouts shall be pumped with a screw feed or other approved type of pumping equipment, arranged with interconnecting pipes and valves in such a way as to permit a standby pump to be brought into immediate service. The pumping equipment shall be capable of forcing grout into the holes or grout connections in a continuous, uninterrupted flow at any specified pressure up to maximum pressures as noted above, only minimum fluctuations in pressure during the pump cycle being permissible. The grouting equipment shall be arranged to provide a supply line and a return line from the grout pump to the grout hole. Provision shall be made to permit accurate control of grouting pressures and of grout flow into the grout holes, and continuous circulations of grout within the grouting system.

- (h) Pressure gauges shall have an accuracy of +/- three (3) per cent.
- (i) A standardised gauge shall be provided for calibrating working gauges. Working gauges shall be used for no longer than two shifts after which time they shall be cleaned and calibrated. All working gauges, water meters and automatic recorders shall have permanently inscribed reference numbers for identification. Tests on gauges, meters and automatic recorders used in connection with drilling and grouting shall be carried out frequently and regularly by the Contractor.
- (j) The Contractor shall arrange to have available on Site an adequate number of water meters and pressure gauges correctly calibrated so that water pressure testing and grouting operations are not held up at any time due to the lack of accurate, calibrated equipment.
- (k) Packers shall be such that they seal drill holes at the specified level and shall then be capable of withstanding water pressure exceeding the maximum grout or water pressure to be used at the level without leakage. The Contractor shall have available on site an adequate supply of packers of a size to suit different holes being used.
- (l) The total length of pipe and hose between the hole being grouted and the pump shall be kept to a minimum.
- (m) A valve, bypass valve, and pressure gauge shall be fitted at the collar of a hole being grouted.
- (n) Communication facilities between the grout plant and the grout holes or grout connections being grouted shall be furnished by the Contractor.

8.6.3. Materials for Pressure Grouting

- (a) Cement used in pressure grouting shall comply with the requirements of this Technical Specification except that where considered necessary, bentonite shall be added to the cement at the rate of two (2) to seven (7) per cent by mass.
- (b) Clay for pressure grouting, which is to be used as an inert filler, shall be prepared as approved.
- (c) Bentonite for pressure grouting shall be as specified by the American Petroleum Institute as follows

Type	Sodium montmorillonite
Wet Screen Analysis Residue on U.S. standard sieve No. 200	2.5%, maximum
Moisture	10%, maximum
Fan Reading	30, minimum at 600 r.p.m.
Yield Point	3 x Plastic viscosity, maximum
Filtrate	13.5 cc, maximum

(d) Sodium silicate for pressure grouting shall be as follows:

Specific gravity at 15°C	more than 40 Be (Baume gravity meter)
SiO ₂	28 to 30%
Na ₂ O	9 to 10%
Fe	less than 0.02%
Matter insoluble in water	less than 0.2%

- (e) Fine aggregate for pressure grouting shall be clean and of such fineness that one hundred (100) per cent will pass a 2.36 mm sieve and not less than thirty (30) per cent a 0.300 mm sieve.
- (f) Cement grout mixtures within the range of two (2) parts of water to one (1) part of cement to a half (0.5) part of water to one part of cement by mass are envisaged although thinner or thicker grouts may also be required.
- (g) The basic mixture of clay cement grout shall be as below and this shall be the assumed average mixture.

GROUT MIXTURE PER m³

Material or Property	Quantity or Value
Water	880 litres
Clay	120 kg (dry weight)
Bentonite	12 kg
Cement	220 kg
Sodium silicate	10 litres
Marsh viscosity	30 sec. (500 cc Marsh Cone)
Decantation	less than 3%

- (h) Water having a temperature above 30°C shall not be used in grouting operations. The use of water at a temperature not exceeding 30°C is designed to limit the temperature rise in the grout during the grouting operation. The Contractor's attention is drawn to the need to provide shelter from effects of hot weather and wind, for the stored cement, water and grout lines and the other equipment handling the grout. Recommendations for hot weather concreting are contained in ACI 305 Title No. 74 33, and the Contractor shall adopt any of these recommendations applicable to grouting.
- (i) The Contractor shall submit recommendations to the Employer on the grouts and injection pressures to be used for:
- ◆ Trials in cored trial holes after determining the nature of the jointing, etc, and the permeabilities of the rock.
 - ◆ Production holes in the light of the grout trials in cored holes and subsequently in the light of experience.
- (j) The Contractor shall use approved grouts and injection pressures, and the Contractor shall be responsible for control of grout proportions and injection pressures.

- (k) Cement grout without chemicals which is not injected within two hours and chemical grout which is not injected within the setting time of the grout after mixing shall not be used for grouting.
- (l) Not less than Thirty (30) days before the commencement of grouting, the Contractor shall submit to the Employer the proposed source of the materials, test certificates or the results of the Contractor's tests and notes on any limitations in respect of the use of the material for grouting in the Works, with proposals to overcome those limitations where necessary.

8.6.4. Grouting Methods

- (a) Drilling and grouting of foundations and rock surrounding tunnels (of both type of contact grouting and consolidation grouting) and other underground works may be performed by using both the upstage method and the downstage method.
- (b) For the upstage method, the drilling and grouting of foundations and rock surrounding tunnels and other underground works shall be performed in successive operations, consisting in each case of:
 - ◆ Drilling the hole to its required final depth.
 - ◆ Installing a packer into the hole at the top of the lowest stage and grouting that stage.
 - ◆ Allowing the packer to remain in place until there is no back pressure and then installing the packer at the top of the next stage; and thus, successively grouting the hole in stages until the hole is completely grouted.
- (c) Whenever the downstage method is necessary, the drilling and grouting of foundations and rock surrounding tunnels or other underground works shall be performed in successive operations, consisting in each case of:
 - ◆ Drilling holes to a limited depth and grouting at that depth.
 - ◆ Allowing the grout in the grout holes to set for at least 24 hours, unless washing out of the hole is approved.
 - ◆ Drilling the hole to an additional depth and then grouting at the additional depth thus successively drilling and grouting the hole in stages until the required depth of hole is completely drilled and grouted.
- (d) Pressure grouting of any part of the foundations shall not be carried out until all excavation, drilling and water pressure testing has been completed within 30 m of the holes to be grouted, and any concrete or shotcrete through which the grout holes extend is at least Fourteen (14) days old.
- (e) The composition of the grout, the time of grouting and all other details of the grouting operations shall be as approved by the Employer.
- (f) Pressures as high as practicable, but which, as determined by trial, are safe against concrete or rock displacement or foundations heave, shall be used in the grouting.
- (g) The Contractor shall provide access for the Employer and shall give at least 24 hours advance notice to the Employer to enable him to be present during all pressure grouting operations.

8.6.5. Grouting Operation - General

- (a) If, during the grouting of any hole, grout is found to flow from adjacent grout connections in sufficient quantity to interfere seriously with the grouting operation or to cause appreciable loss of grout, such connections may be capped temporarily, provided that when grouting is being done with packers, the pressure of the grout returning from any adjacent hole shall be measured by seating a packer in the adjacent hole and the pressure in such adjacent hole shall be kept below the allowable pressure for that stage of that hole. Where such capping is not essential, ungrouted holes shall be left open to facilitate the escape of air and water from pockets in the surrounding rock as the grout is forced into other holes. Before grout has set, the grout pump shall be connected to adjacent capped holes and to other holes from which grout flow has been observed and grouting of all holes shall be completed at the approved pressure.
- (b) If, during the grouting of any hole, grout is found to flow from points in the rock surfaces, such leaks shall be immediately and effectively plugged or caulked by the Contractor. As a safeguard against rock or concrete displacement, or while grout leaks are being caulked, a reduction of the pumping pressure, or the discontinuation of pumping may be required.
- (c) After grouting of the holes is completed, the pressure shall be maintained by means of stopcocks or other suitable valve devices until the grout has set sufficiently so that it will be retained in the holes or connections being grouted.

8.6.6. Grouting Foundations

- (a) The depth of the grout curtain shall be such as to achieve a permeability of less than 5 Lugeons and to reach a rock class with non-erodible seams present, expected to be Class II or better. The depth of hole shall be measured from the final foundation level.
- (b) The grouting of any hole shall be a continuous operation until the hole or grout connection takes grout at the rate of less than 30 litres of grout mixture in 20 minutes if pressures of 0.7 MPa or less are being used; in 15 minutes if pressures between 0.7 and 1.4 MPa are being used; in 10 minutes if pressures between 1.4 and 2.5 MPa are being used, and in 5 minutes if pressures in excess of 2.5 MPa are being used.
- (c) Curtain grouting of any portion of the foundations shall be carried out using the following criteria unless otherwise approved.
- (d) Curtain grouting shall generally be started by the drilling of primary holes at 6 m centres. Secondary holes shall be midway between the primary holes. Zones of third and subsequent series holes (closure holes) may be necessary. No holes of subsequent series shall be drilled until grouting has been completed to full depth in adjacent holes of the previous series. Locations of grout holes shall be as approved.
- (e) If the excavated surface is not satisfactory for grouting, foundation concrete shall be placed prior to grouting.
- (f) Grouting shall be carried out in stages suited to the jointing and nature of the rock

and the grout to be used but not exceeding 10 m (except as allowed below) and shall be performed by using the upstage method except where the downstage method is necessary for satisfactory grouting.

- (g) In downstage grouting sufficient time shall be allowed for the grout to set before the next stage is commenced.
- (h) The water pressure test shall be carried out in stages before grouting. Permeabilities shall be measured in Lugeon units at the point in the hole being tested. A stage need not be grouted on its own but may be included in the next stage (the combined stages having a height of up to 20 m) where the permeability of the stage is less than 5 Lugeon.
- (i) The grouting of each stage shall commence with a lean grout of the type most likely to penetrate the rock, according to the jointing, etc, of the rock and of the results of the water pressure test, with the grout pressure being increased towards the maximum grout pressure described below.
- (j) Fissure splitting will be avoided. The maximum grout pressure shall be 20 kPa per metre of depth to the top of the hole. The viscosity of the grout shall then be increased if the pressure fails to increase to the required pressure per metre of depth whilst there is a high rate of take, or decreased if there is a quick increase of pressure with a low rate of take at high pressure. The grout shall be changed to a more viscous type or to a less viscous type as appropriate if the change of viscosity of the initial grout does not result in a satisfactory rate of take at the required pressure per metre of depth.
- (k) During grouting, grout leaks shall be caulked but if this cannot be achieved and the leaks are excessive, grouting shall be stopped and resumed later when the grout already injected into the leaking fissures has hardened. Precautions shall be taken to ensure that the grout does not enter other parts of the Works such as drains. Level reference points, upheaval gauges, etc shall be established and be observed as a check against uplift. Any possible movement shall be taken as an indication that the grouting pressure being used is excessive and it shall be immediately relieved.
- (l) Adequate communication by telephone or by any other approved means shall be maintained between the grout pump and the collar of the hole being grouted.
- (m) When a stage has been satisfactorily grouted, the Contractor shall flush out the hole with water before the grout has set sufficiently to require re drilling, except when it is considered desirable that the grout shall be left to set and the hole be re drilled. To confirm that the stage has been satisfactorily grouted it may be required that a grouted hole is water pressure tested after flushing out or re drilling.
- (n) When the last stage of the hole has been grouted, the hole shall be water pressure tested at the maximum specified pressure for grouting the topmost stage. If the test shows a permeability greater than that specified, then the zone of higher permeability shall be established by pressure testing suspect stages.
- (o) Any faulty stage or zone shall be re grouted with grout which may differ from that originally used until a satisfactory result is obtained, or, if this is unattainable the

depth concerned shall be grouted using immediately adjacent holes until a satisfactory result is obtained in the original hole. Grouting of a hole shall not be considered as complete until approved by the Employer. The completed hole shall then be filled with thick grout.

- (p) After grouting grout holes, grout pipes or casing set for foundation grouting shall be removed or cut off flush with the surface and the holes backfilled with dry packed mortar.

8.6.7. Pressure Grouting in Other Underground Structures

- (a) Pressure grouting of rock surrounding the tunnel in locations other than the plug may be required and in such cases the drilling and pressure grouting procedure shall be as approved.

8.7. GROUTING AND WATER TEST RECORDS

8.7.1. Details to be recorded

- (a) Within twenty (24) hours of doing the work concerned, the Contractor shall submit in triplicate and in an approved form a record of the grouting and water pressure tests. The record shall include the following data:
 - (b) The location and reference number of holes grouted and the lengths of stages. Level of grout pump and collar of hole.
 - (c) Water pressure test results including details of pressures, volumes of water used, timing of each operation, permeability values and graphical records of the tests.
 - (d) Details of grout injections, pressures, consistencies, quantities and timing for each stage of the grouting including the printout from the automatic recorders clearly identify each grout hole and its stage.
 - (e) Proportions of the grout materials, viscosities and, where appropriate, gelling times.
 - (f) General remarks on the procedure of the grouting, surface leaks and connections to other holes, if any.
 - (g) When directed by the Employer, the Contractor shall supply grout samples 0.5 kg in mass taken from any point in the grouting system.
 - (h) Within Sixty (60) days of completing grouting of a section of the Works, the Contractor shall submit to the Employer a report in triplicate, complete with record drawings in approved form showing details of the grouting in that section and any conclusions which it may have reached regarding methods used and the effectiveness of the grouting. Such records and drawings when approved by the Employer shall be submitted as built documents and drawings.

8.8. PIPES, FITTINGS AND OUTLETS FOR GROUTING

8.8.1. General

- (a) The Contractor shall furnish and install standard black pipes for all standpipes and grout connections set in the concrete or rock.

- (b) Pipes for grouting shall also be set over springs, crevices in the rock, faults or other foundation defects as approved.
- (c) Grout pipes set in concrete, except those for the grout cap shall end not less than 30 mm inside the finished surface of the concrete. When grouting is performed after the completion of concreting operations, a standard coupling and wrapped nipple, to facilitate removal after grouting, shall be attached to the grout pipe and shall extend outside the finished surface. The holes left upon removal of the wrapped nipples shall be filled immediately and completely with dry pack.
- (d) The size of the grout pipe for each hole and the depth of holes for setting pipe for foundation grouting shall be as approved. Each pipe shall be anchored into the rock or concrete into which it is set and the space around the pipe shall be carefully sealed with grout or other suitable material. All pipes and fittings to be embedded in concrete shall be cleaned thoroughly of all dirt, grease, grout and mortar immediately before being embedded in the concrete or rock.

8.8.2. Materials

- (a) All standard black pipe and fittings for grouting, special grout outlets, all nails, tie wire, wooden plugs, mastic material for sealing purposes, temporary supports and other accessories required for installation of the grouting systems, as described in this Clause, shall be furnished by the Contractor. The pipe shall be cut to length, threaded and fabricated where required, and placed by the Contractor.
- (b) The pipe shall be medium thickness, in accordance with ASTM A53.
- (c) The pipe fittings shall be malleable iron in accordance with ASTM A181, suitable for the pressure to be applied during grouting.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 9
PROTECTION AND SUPPORT OF EXCAVATION**

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CHAPTER 9 - PROTECTION AND SUPPORT OF EXCAVATION

9.1. GENERAL

9.1.1. Requirements

- (a) Protection of excavation shall mean measures taken to prevent the deterioration of excavated surfaces through the action of stress release, deformation, water, wind, temperature and other surface and near surface effects. The methods of protection include:
- ◆ Shotcrete
 - ◆ Grouting Shall be in accordance with Chapter 8
 - ◆ channel lining
 - ◆ riprap
 - ◆ stone pitching
 - ◆ wiremesh, gabions and mattresses; and
 - ◆ soil conservation measures.
- (b) Support of excavations shall mean both the primary and secondary protection and support measures taken to prevent the structural failure of excavations. The methods of support include:
- ◆ rockbolts
 - ◆ grouted bars
 - ◆ grouting (shall be in accordance with Chapter 8)
 - ◆ forepoling
 - ◆ wiremesh
 - ◆ shotcrete
 - ◆ prestressed rock anchors
 - ◆ steel arches
 - ◆ concrete
 - ◆ reinforced concrete
 - ◆ lattice girders; and reinforced earth walls.

9.1.2. Surface Excavations

- (a) The Contractor shall protect and support surface excavations, by the methods approved.
- (b) Unless otherwise approved, the Contractor shall not proceed with excavation more than 2 m below a point where support for the batters is necessary until the required support has been installed.

9.1.3. Underground Excavations

- (a) The Contractor shall protect and support underground excavations, by the use of rockbolts, grouted bars and/or shotcrete, steel ribs/lattice girders, prestressed rock anchors, as considered necessary, and approved.
- (b) Accessories for lattice girders in underground excavations shall be left in place, provided that such supports are entirely outside the minimum excavation line.

9.1.4. Responsibility for Safety

- (a) Nothing contained in this Technical Requirements shall relieve the Contractor from sole responsibility for the safety of excavations nor for liability for injuries to or deaths of persons or damage to property, nor of any obligations under the Contract.

9.2. ROCKBOLTS

9.2.1. General

- (a) For the purposes of this Technical Requirements a rockbolt is an element of steel reinforcing bar which has been installed in a drilled hole, anchored to the rock at the far end and tensioned by the application of an axial, tensile load through a nut and steel plate bearing against the surface of the rock or shotcrete. Such a rockbolt may be grouted or ungrouted. Unless otherwise specified, the rockbolt means the grouted rockbolts.
- (b) The Contractor shall furnish and install grouted or ungrouted rockbolts in surface and/or underground excavations where necessary to support the excavation.
 - i. Grouted rockbolts shall be used in locations requiring permanent rock support.
 - ii. Ungrouted rockbolts shall be used in locations requiring temporary rock support.
- (c) For the purposes of this Technical Requirements the term "grouted" means full encapsulation of the rockbolt in the hole with cement or other approved type of grout.
- (d) Rockbolts required for permanent support shall be protected against corrosion in accordance with this Technical Requirements.

9.2.2. Materials

- (a) Rockbolts shall be of the type shown on the Drawings or an equivalent approved by the Employer.
- (b) The Contractor shall furnish with each rockbolt all accessories including a chemical or mechanical anchor, a steel bearing plate, a ball-washer, a machine washer, a hexagonal nut and where cement grouting is required a rubber plug and accessories for grouting. The bearing plate shall have a bearing area of not less than 225 square centimetres per bolt and minimum thickness of 10 mm. Where cement or other approved grouting is required the bearing plate shall have two holes suitable to permit grouting and venting operations and shall be suitably located to ensure the whole length of the rockbolt can be fully encapsulated in grout.
- (c) Where rockbolts are required for permanent support, the bearing plate, the nut, and the ball and machine washers shall be coated by hot-dip galvanising and the mass of the coating shall be not less than 0.6 kg/m². Following installation and grouting, the exposed surfaces of the bearing plates and other external parts of the rockbolts shall be embedded in shotcrete to provide a minimum cover of 50 mm in all directions.

- (d) The Contractor shall supply test certificates for each batch of each size and type of rockbolts manufactured and delivered to site. In addition, one bolt in every 100 of each size and type shall be tested by the Contractor in the presence of the Employer to the ultimate strength of the bolt. When tests show satisfactory results the number of tests may be reduced, and if failures occur then additional tests, which may include testing each bolt, will be required. All failed bolts shall be replaced.

9.2.3. Patterns of Installation

- (a) The patterns in which the rockbolts are installed for permanent and temporary support shall be as required to ensure stability of the excavation, the Employer's Requirements and the Approved Contractor's Documents.
- (b) The types of rockbolts in surface excavations, together with specified loads are shown in the following table. The Contractor shall furnish bars with threaded ends not less than 180 mm in length for use as rockbolts.

Rockbolt Type	Minimum Yield Strength	Min. Thread Diameter (mm)	Axial Load (kN)
Grouted	400 MPa	24	60

- (c) The types of rockbolts in underground excavations, together with specified loads are shown on the following table. The Contractor shall furnish bars with threaded ends not less than 180 mm in length for use as rockbolts.

Rockbolt Type	Minimum Yield Strength	Class of Support	Min. Thread Diameter (mm)	Axial Load (kN)
Type A	400 MPa	Temporary (ungrouted)	24	120
Type B	400 MPa	Permanent (grouted)	24	120

- (d) The Contractor shall use only rockbolts that meet the requirements of this Technical Requirements. The method of installation shall be in accordance with the requirements of this Technical Requirements the manufacturer's recommendation.
- (e) The rock bolts shall be of expansion type and rock dowels of grouted type. The diameter and length of steelbars are presented in the table below and as shown on the Drawings.

Type	I	II	III	IV	V
Length (m)	2.0	3.0	4.0	4.0	4.0
Diameter(mm)	25	25	25	25	25

- (f) The Contractor shall have in stock at any time the various lengths of rock bolts.

Any delay in the progress of the work due to the lack of such stock shall be the responsibility of the Contractor.

- (g) The Contractor may nominate the use of:
- ◆ Rockbolts which are longer than 10 m, in which case the Contractor may fabricate the lengths on site provided the steel type and diameter meet the specific requirements and the couplers comply with the manufacturer's specification. The couplings shall have a centre stop so that each section of the rockbolt is connected by an equal length of thread. The diameter of the drilled hole shall be increased to ensure the coupler is embedded in the same thickness of grout as is the approved rockbolt without couplers.
 - ◆ Flat steel plates and rolled steel sections fastened by rockbolts.

9.2.4. Methods of Installation

- (a) The rockbolts and methods of installation, including the details of the equipment necessary to drill the hole, to clean out the drilled hole, to anchor the rockbolt in the hole and test the anchorage, to tension the rockbolt to the specified axial load and to grout the rockbolt, if required, shall be in accordance with the manufacturer's instructions.
- (b) In surface excavations the Contractor shall plan its operations so that routine installation of rockbolts, including grouting and the erection of steel mesh reinforcement and steel reinforcing fabric, unless otherwise approved, can be performed as the excavation proceeds. Excavation shall not proceed more than 2 m below the level of any designed or directed rockbolts until the rockbolts are installed, and grouted.
- (c) In underground excavations the Contractor shall plan its operations so that routine installation of rockbolts, including grouting, can be carried out up to the face.
- (d) Holes for rockbolts shall be drilled accurately to the depths and at locations and orientations shown on the Drawings. Hole diameters shall be compatible with the rockbolt diameter and in accordance with the manufacturer's recommendations. Hole orientations shall be within 3 degrees of those specified. Where resin anchorages are used, the hole length shall not exceed the placed length of the bolt by more than 100 mm.
- (e) When rockbolt support is required, the hole shall be drilled and cleaned out immediately and the rockbolt shall then be installed and tensioned without any further delay.
- (f) Each rockbolt shall be tensioned to the specified axial load using a calibrated hydraulic jacking system. The nut shall be done up until the gauge on the jack registers that the nut has begun to take the load of the jack. The jack shall then be released smoothly. The Contractor shall provide calibration curves and test certificates for the jack. The calibration check must have been performed within the last twelve months by an independent testing authority acceptable to the Employer. Recalibration shall be performed at least once every twelve (12) months or sooner if considered by the Employer to be necessary for any reason.

If a calibrated torque wrench is used, the wrench shall be tested daily by approved means. If a torque wrench is used, all threads and washers shall be clean and greased to ensure that friction is the same for each rockbolt. If any discrepancy is found in the daily calibration, then the rockbolts tested on the previous day shall be retested.

- (g) Where rockbolts have been installed and tensioned within 12 m of any blasting work, the tension of each bolt will be checked and each bolt retensioned, if necessary, to achieve the specified load.
- (h) Immediately prior to grouting each rockbolt in place the Contractor shall check that the required tension in each bolt has not been relaxed. Grouting shall not commence until all loosened bolts have been retensioned to the required axial load.

9.2.5. Grouting

- (a) If the rockbolt is to be grouted it shall be sealed in the hole to prevent leakage of grout past the bearing plate, and the space around the bolt shall be completely filled with grout.
- (b) Grout shall be cement grout, cement mortar or other approved material. All cement used in grout for grouting rockbolts shall comply the relevant provisions of this Technical Requirements. Grout mixtures, admixtures to ensure the necessary expansion of the grout, methods of mixing, grouting pressures and the equipment used for grouting shall be adequate to achieve the specified requirements. For this purpose, the Contractor shall use two compartment high speed colloidal mixers with agitator tanks. The Contractor shall have at the site where the work is being carried out at all times at least two (2) operable grout mixing units and grout pumps capable of doing the required work.
- (c) For cement grouted rockbolts, unless otherwise approved, a superplasticizer of approved standard or equivalent such as Sikament 320, or equivalent, shall be added to the dry cement for grout. Preparation shall be in accordance with the manufacturer's instructions.
- (d) The ratio of water to cement by mass in cement grout shall be between 0.38 and 0.44.
- (e) The grout shall be used within one (1) hour after starting to mix the components.
- (f) Where resin mortar encapsulation or resin grout is used the encapsulation and grouting shall be carried out in accordance with the manufacturer's recommendations.
- (g) Grouted rockbolts shall be grouted as soon as practicable after tensioning but within Twenty-one (21) days of installation. Each rockbolt shall be injected with grout in one continuous operation and the grout must flow from the vent until the consistency is equivalent to that being injected. The ventilation tube and subsequently injection tube shall be sealed under pressure until the grout has set. The facility must be provided to check that there is no drop in grout pressure after the grout pump is disconnected. In the event that loss of pressure occurs, the grouting process must be repeated. If the grouting process is interrupted for any

reason, the hole shall be immediately flushed out with water under pressure until all grout has been removed. The Contractor shall maintain full records of the grouting and submit copies to the Employer within one (1) day of grouting.

- (h) The grouting shall be arranged to fill the holes from the bottom to the top for rockbolts installed below the horizontal and from top to the bottom of the hole for rockbolts installed above the horizontal. The arrangement of grouting and ventilation tubes shall be arranged to suit the inclination of the installed rockbolt. The grouted rockbolts should not be disturbed or loosened in any way until at least Seven (7) days after the completion of grouting.
- (i) If, during the grouting of any rockbolt, grout is found to flow from points in the rock surfaces adjacent to the rockbolt, such leaks shall be plugged or caulked, and this leakage must be stopped prior to completion of the grouting.

9.3. GROUTED BARS

9.3.1. General

- (a) For the purposes of this Technical Requirements a grouted bar is an untensioned length of steel reinforcing bar which has been grouted into a drilled hole. The bars can be self-drilling or inserted in a pre-drilled hole.
- (b) Grouted bars are separate and distinct from grouted anchor bars used for anchoring concrete structures to foundations.
- (c) Grouted bars are in the form of steel reinforcing bars and are similar to rockbolts requiring accessories such as bearing plates, all washers and hexagonal nuts but the bearing plates do not require grouting holes, and grouted bars are not tensioned.
- (d) The Contractor shall furnish and install grouted bars in surface and/or underground excavations where approved, including overhead locations. For the purposes of this Technical Requirements grouted bars are untensioned, structural grade, deformed bars embedded in grout, used for stabilising slopes and excavations and in the roof and walls of underground excavations. Grouted bars may be used with or without steel mesh reinforcement.

9.3.2. Materials

- (a) Grouted bars shall be deformed bars complying with ASTM A615M, ASTM A616 or ASTM A617 Grade 60 embedded in cement grout or other approved material for the full length of the bar. Only cement grout shall be used where the grouted bars form permanent support.
- (b) Where grouted bars form part of the permanent support, the bearing plate, the nut, and the ball and machine washers shall be coated by hot-dip galvanising and the mass of the coating shall be not less than 0.6 kg/m². Following installation and grouting, the exposed surfaces of the bearing plates and other external parts of the bar shall be embedded in shotcrete to provide a minimum cover of 50 mm in all directions.
- (c) Cement for grouting shall comply with the relevant provisions of this Technical

Requirements.

9.3.3. Pattern of Installation

- (a) The location, length and direction of the bars for surface and underground excavations shall be as required to ensure the stability of the excavation.

9.3.4. Installation

- (a) The bored holes for the grouted bars should be not less than 1.75 times the nominal diameter of the bar. The holes shall be drilled wet, cleaned thoroughly with water and air under pressure and shall be completely filled with grout. This shall be done by filling the bored hole from the end by placing the grout hose to the end of the hole and withdrawing it slowly, always maintaining the hose embedded in the grout.
- (b) The grouted bar shall be forced into the hole before the grout takes its initial set and vibrated sufficiently to ensure the bar has intimate contact with the grout over its full length. The Contractor shall provide a means of ensuring the grouted bars do not move in any way until after the grout has gained strength.
- (c) The nut will be made snug-tight, and the bearing plate shall be placed to maintain uniform pressure on the rock or shotcrete surfaces.
- (d) The Contractor will submit a report on all anchor bar testing to the Employer within Two (2) days of testing.
- (e) In underground excavations the Contractor shall plan its operations so that routine installation of grouted bars, including grouting, can be carried out up to the face.
- (f) When grouted bar support is required, the hole shall be drilled and cleaned out immediately and the grouted bar shall then be installed and tightened without any further delay.

9.4. PRESTRESSED ROCK ANCHORS

9.4.1. General

- (a) The Contractor shall furnish and install prestressed rock anchors where necessary to ensure the stability of the excavation and approved. The anchors and their installation shall be in accordance with the provisions of this Clause.
- (b) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before commencing installation of the anchors, the Contractor shall submit to the Employer full details of the proposed prestressing system. Details shall be given of anchorages, anchorage reinforcement and sheathing, together with drawings of the installation and calculations to confirm the adequacy of the proposed anchorages. The cables shall be fixed in the rock only by a bond anchorage formed by injected grout. After the grout has gained sufficient strength, the cables shall be tensioned. The anchorage part of the rock anchors shall be of corrugated polyethylene sheathed designed for improved anchorage and corrosion protection. For the remaining free tendon length, the strands will be individually greased and sheathed in plastic tubes and these strands will be sheathed in an outer smooth polyethylene sheath.

After tensioning the free tendon length shall be fully grouted inside the outer sheath to prevent corrosion. The bearing plate shall be hot dip galvanised in accordance with the relevant provisions of this Specification. The strands shall be cut at a length which permits re-tensioning as required and the strand extensions and anchor heads shall be fully enclosed in a detachable hot dip galvanised sealed cover. The enclosure shall be filled with a corrosion inhibiting compound, recommended by the manufacturer of the anchor system, so as to fully encapsulate the anchor head and protruding strands.

- (c) The proposed system shall provide for:
- ◆ The required prestressing force.
 - ◆ Satisfactory corrosion protection of the stressed tendons, with at least 40 mm of grout cover to the tendon sheath.
 - ◆ Restressing of the tendons up to the time of secondary grouting.
 - ◆ Measurement of the load on the tendons.

9.4.2. Drilling Holes for Prestressed Rock Anchors

- (a) The Contractor shall drill holes for prestressed rock anchors at the locations and to the depths required and approved. The nominal diameter of the holes shall be at least 80 mm greater than the nominal outer diameter of the tendon sheath for the particular anchor.
- (b) Holes may be drilled with either percussion type drills or by rotary type diamond drills. The holes shall be straight to within 10 mm in 3 m and shall have a maximum deviation of 1 in 30 over the drilled length of the hole from the directed alignment.
- (c) The drill hole entry point shall be positioned within a tolerance of 75 mm. In ground likely to collapse, the sides of the drill hole shall be supported by suitable lining tubes until supported by the anchor itself. Drill holes shall be flushed clean on completion of drilling and the opening protected or sealed to prevent the entry of foreign matter.
- (d) During drilling continuous records of penetration rates shall be kept by the Contractor. Any sudden advance in the drill or sudden increase in penetration rate shall be particularly noted, together with the depth at which these variations occur. The location of clay seams, open cracks, soft or broken ground, water loss, water inflows and other relevant information shall be recorded. Drilling records that contain a full description of all materials encountered during drilling shall be submitted to the Employer at the completion of each day's work.
- (e) If it is necessary to investigate the nature of the rock to the full depth of the anchorages, the Contractor shall carry out core drilling to determine the conditions of the rock in the vicinity of the anchorages.

9.4.3. Water Pressure Testing

- (a) After each hole has been drilled to its full depth or redrilled, it shall be washed clean and shall be tested with clean water under continuous pressure to determine the extent of leakage, and the likelihood of grout loss around the fixed anchorage length.

- (b) If surface leaks occur the leaks shall be sealed and the hole retested.
- (c) Pressure shall be maintained at the directed pressure at the top of the hole for a minimum period of 10 minutes and the volume of water which has entered the hole during the 10-minute period shall be recorded. If the water loss in any hole during the 10-minute period is in excess of 1 litre/metre/min, the hole shall be pressure grouted.
- (d) After any hole has been pressure grouted and redrilled to its full depth it shall be water pressure tested and if the water loss is still in excess of 1 litre/metre/min, in a 10-minute period, the hole shall be regouted.

9.4.4. Pressure Grouting

- (a) Any hole required to be pressure grouted after water pressure testing has been completed shall be pressure grouted with cement grout. Cement used for pressure grouting shall comply with the relevant provisions of this Technical Requirements.
- (b) The grouting shall be carried out by means of nipple grouting for the full length of the hole, at approved pressures.
- (c) After each hole has been satisfactorily grouted and the grout has set, the hole shall be redrilled for its full depth and water pressure tested.

9.4.5. Required Properties of Prestressing Tendons

- (a) High tensile steel strand shall be from wire complying with ASTM A416.
- (b) The Contractor shall provide Production Test Certificates supplied by the manufacturer of the high tensile steel tendons.
- (c) Delivery of any batch of tendon material to the Site shall not be made until the Test Certificates have been submitted to the Employer.

9.4.6. Testing of Prestressing Tendons by the Employer

- (a) Three test pieces of the tendon to be used in the Works shall be supplied to the Employer. The test pieces of the tendon, which shall each be at least 3 m long, will be selected by the Employer from the body of the coils and shall be supplied to him at least Thirty (30) days before commencement of fabrication of the anchors.
- (b) Notwithstanding submission of Test Certificates, manufacture of the anchors made up of the high tensile steel tendon shall not commence until the use of the tendon has been approved.
- (c) Should any test piece taken by the Employer fail to satisfy the appropriate properties specified, the Employer will select two additional specimens for retesting from the same portion of the coil. If either of the additional test pieces fails to satisfy the appropriate properties specified, the quantity of material represented by that specimen shall not be used.

9.4.7. Care of Prestressing Tendons

- (a) At the time of installation in the drill holes, all prestressing steel shall be clean and free from loose millscale, loose rust, mud, oil, grease and any other deleterious

coating. A slight film of rust will not be regarded as harmful, but the steel shall not be visibly pitted by rust.

- (b) Care shall be taken that tendons are not damaged, kinked or bent. The prestressing strand, however manufactured, shall be in coils of sufficiently large diameter to ensure that the strand pays off in a reasonably straight manner.
- (c) Damaged or contaminated tendons will be rejected.

9.4.8. Anchorages

- (a) All top anchorages shall be provided with a positive centering device so that the anchorage heads do not move during the tensioning operation.
- (b) Top anchorages shall be capable of withstanding a force of not less than ninety-five (95) per cent of the specified minimum ultimate tensile strength of the tendons without damage or excessive deformation or draw in.
- (c) No damaged top anchorage shall be used. All steel in the anchorages shall be protected from corrosion at all times. All threaded parts shall be protected by greased wrapping and all tapped holes shall be protected by suitable plugs until used. The devices shall be kept free from mortar, loose rust, grease, tar, paint, oil, mud or any other coating.

9.4.9. Storage of Materials

- (a) All materials for prestressed rock anchors, whether made up or not, and all top anchorages shall be stored in an acceptable manner under a weatherproof shelter and supported at close intervals above the ground.
- (b) All prestressed rock anchors and accessories shall be protected from damage or corrosion until the completion of the Works.

9.4.10. Sheathing and Accessories

- (a) Sheathing for prestressed rock anchors shall be made of approved material and shall be so constructed that mechanical bond is provided between the sheath and primary and secondary grout.
- (b) The sheathing shall be strong enough to withstand the installation and grouting of the prestressed rock anchors without suffering any damage or deformation. The internal diameter of the ducting shall be as approved or directed, and the sheathing and any joints shall be watertight.
- (c) The corrugated and smooth sheaths shall be of a diameter to ensure the free flow of grout of the specified consistency around each tendon. The Contractor shall verify that the diameters proposed have been successfully used with anchors of the same size and length.
- (d) Grouting tubes shall be 12 mm internal diameter rigid PVC tube complying with ASTM D2241.
- (e) Any accessory to be permanently embedded in the anchorage shall be made of carbon steel or other approved material. Galvanised material will not be permitted.

9.4.11. Fabrication and Installation

- (a) Not less than Twenty-eight (28) days before commencement of installation of the anchors, the Contractor shall submit to the Employer full details of the methods it proposes to use to install the anchors.
- (b) Not less than 24 hours before commencement of installation of each anchor, the Contractor shall advise the Employer of the proposed programme for fabrication, installation in the hole, primary grouting, initial stressing, restressing and secondary grouting. During the progress of stressing and restressing operations the Contractor will take measurements of concrete deflections and concrete strain and submit the results to the Employer.
- (c) Holes shall be tested before the installation of the cables by lowering a weighted rigid tube 2 m long and with a diameter 10 mm less than the nominal diameter of the hole to the full depth of the hole. The tube shall slide freely in the hole over its full length. Holes which cannot be used for any reason shall be solidly backfilled with grout.
- (d) The anchors shall be fabricated, with all materials supplied by the manufacturer specifically for the particular anchors, strictly in accordance with the manufacturer's instructions. In the anchorage length the uncoated clean strands shall be bound between spreader rings at the specified spacing, and the free length of the tendons shall be encapsulated with a rust inhibitive grease and coated in a close-fitting plastic tube for each strand. Plastic spacers shall be used to maintain a minimum clear cover of 10 mm between the strands and the smallest inside diameter of the corrugated sheath and the same space the strands and inside diameter of the smooth sheath. The anchorage ends of the strands shall be enclosed in a steel nose cone so as to avoid damaging the sheathing during installation. The whole assembly together with grout pipes and spacers at 1 m intervals shall be placed in the sheath only after inspection by the Employer.
- (e) Before installation of the anchors in the drill holes, the holes shall be washed clean using water or air and water jets inserted to the full depth of the hole. The holes shall be effectively capped to prevent entry of foreign material after washing until the prestressing anchors are installed.
- (f) The fabricated anchors shall be picked up and installed into the drill holes in such a manner as to prevent damage to duct or strand. In planning the method of installation, the Contractor should take due regard for the stiffness of the fully fabricated anchor and the radius of curvature that it will accommodate without damage.

9.4.12. Primary Grouting

- (a) Immediately following installation of the anchors into the drill holes primary grouting shall be carried out. The primary grouting stage includes the grouting of the anchorage length and grouting outside the tendon sheath for the full length of the hole.
- (b) A primary grout vent pipe shall be sealed into the collar of the hole.
- (c) All cement used in the grouting of anchors shall be in accordance with the relevant

provisions of this Technical Requirements.

- (d) The maximum water/cement ratio in the cement grout shall be 0.50 to 1.0 by mass and the minimum compressive strength of test cubes of cement grout cured for Fourteen (14) days at 27+/- 1°C and ninety-seven (97) to one hundred (100) per cent relative humidity shall be 25 MPa. A superplasticizer such as Sikament 320 or equivalent shall be added to the grout mix. Preparation of the mix shall be in accordance with the manufacturer's recommendations.
- (e) Not less than Thirty (30) days before primary grouting of any anchor, the Contractor shall prepare in the presence of the Employer a trial mix of its proposed grout mixture including admixtures which will then be sampled and tested by the Contractor to verify its compliance with this Clause.
- (f) As the work progresses, the Contractor shall take further samples for testing and shall vary the grout mixtures as necessary to achieve the specified properties.
- (g) The grout shall be used within one hour of commencing to mix the ingredients.
- (h) The grouting equipment shall be arranged to provide a supply line and a return line from the grout pump to the point of grouting. Provisions shall be made for accurate control of grouting pressures and of grout flow, and continuous circulation of grout within the grouting system.
- (i) Before primary grouting commences clean water shall be introduced through the secondary grout tube into the sheathing until the sheathing is full. The water level shall then be observed for not less than five minutes to check the water tightness of the sheathing. If any water loss occurs the Contractor shall withdraw the anchor from the hole and shall replace or repair the sheathing and retest. During primary grouting the sheath shall be kept full of water and a uniform flow maintained through the secondary grout tube.
- (j) Prior to primary grouting clean water shall be circulated down the central primary grout tube and out of the primary grout vent. Grout shall then be injected and a uniform, slow, continuous flow of grout shall be maintained until the hole is completely filled and pure grout of the consistency being injected issues from the vent and until all entrapped air has been expelled. The consistency of the grout shall be verified by measuring the specific gravity. After verifying the consistency, samples of the grout issuing from the vent shall be made for compression testing to check that the strength complies with the requirements in Sub-clause 9.5.10. The results of each test shall be submitted to the Employer within 24 hours of its completion.
- (k) Pressure grouting of the primary stage will not be required. All care shall be taken to prevent loss of grout immediately after grouting. The grouting tubes shall be topped up with grout if a wastage or subsidence of grout occurs when disconnecting the pump.
- (l) The quantity of grout available for immediate use shall be such as to enable the primary grouting of a complete anchor to be carried out without interruption, refilling of the grout tank or the necessity for mixing further quantities.
- (m) Immediately after primary grouting the anchors shall be protected from corrosion

by filling the duct with a solution composed of 2 gm of calcium hydroxide per one litre of water or other approved chemical solution until secondary grouting takes place.

9.4.13. Stressing Operations

- (a) The anchors shall not be stressed until the primary grout has achieved a strength of at least 25 MPa and the concrete in the anchor block has achieved a strength of at least 30 MPa. The minimum lapsed time between primary grouting or placing of the anchor block concrete and stressing shall be Fourteen (14) days.
- (b) The stressing procedure for all prestressed rock anchors shall be in accordance with the requirements of ACI 318M. The stressing operation shall be performed only by technicians trained for and experienced in this type of work. Special care shall be taken to apply the stressing force smoothly and at an even rate and to release the jack smoothly. The stressing load of the jack shall be applied to the bearing plates using a stressing chair.
- (c) The process of stressing shall be continuous, the anchors being stressed in the sequence and to the design loads and the operation completed without interruption in as short a time as possible.
- (d) Care shall be taken during stressing to ensure the safety of all personnel engaged on the work and of other persons in the vicinity.
- (e) Jacks shall be restrained in case they lose their grip on the tendons. No person shall be allowed to stand above the jacks while stressing is in progress. The operation of the jacks, the measurement of the elongation and associated operations shall be carried out in such a manner and from such positions that the safety of all concerned is ensured.
- (f) During actual stressing operations warning signs in adequately large letters shall be displayed nearby.
- (g) All stressing equipment shall be power driven. The power unit shall be so adjusted that the rate of stressing is within the limits recommended.
- (h) Dynamometers and each set of equipment comprising pump, jack and pressure gauges shall be calibrated immediately prior to delivery to the site and every six months thereafter unless otherwise directed. Jacks shall be calibrated with an absolute accuracy not exceeding zero point five (0.5) per cent. The calibration shall extend from zero over the full working range and should be established for opening and closing operations of the jack. The calibration curve for each set of equipment shall be submitted to the Employer before the commencement of any stressing operations.
- (i) Pressure gauges shall be recalibrated after every 100 stressing against properly maintained master gauges complying with AS 1349.
- (j) Dynamometers shall be recalibrated after every 200 stressing unless complementary pressure gauges used simultaneously indicate no variation in which case recalibration shall be carried out every six months to an absolute accuracy not exceeding zero point five (0.5) per cent.

- (k) At the commencement of first stage stressing each anchor shall be loaded to seventy-five (75) per cent of its ultimate tensile strength to proof load the grouted anchorage. It shall then be locked off at the initial lock off load required by the design. After initial lock off, the jacking pressure shall be fully released to allow draw in, and the jacking pressure shall then be re applied so that the load can be measured when the end block has just lifted off the bearing plate sufficient to allow a 0.1 mm feeler gauge to be inserted. The load in each anchor shall be adjusted so that at the completion of first stage stressing the loads in all anchors are sensibly equal and accurately known.
- (l) Every two weeks during a period of at least two months after the first stage stressing operations have been completed the load in the anchors shall be checked by restressing with the jack until the end block lifts off as specified. If, after two months the load in the prestressed anchor is less than the lock off load required by the design restressing will be required.
- (m) The stressing force shall be measured both directly by measurement of the force and indirectly by measurement of the elongation of the tendons.
- (n) Where there is a discrepancy of more than five (5) per cent between the load measured by the jack and the load calculated from the measured extension, additional measurements shall be carried out.
- (o) If on completion of tensioning of an anchor the requirements of this Clause and ACI 318M are not completely satisfied, the anchor shall be released from the jack and restressed.
- (p) Before stressing commences the protruding end of the anchor shall be cleaned of any contamination which may have accumulated since placing. Each anchor shall be checked before tensioning to ensure that it is free to move inside the duct. Special care shall be taken to set the jack accurately in the line of the anchor. A nominal force shall be applied initially to take up the slack of the anchor so as to seat the jack firmly, but the force normally associated with the particular method of prestressing shall not be exceeded.
- (q) After taking up the slack, the elongation of the anchor shall be accurately measured from the extension of the jack. Reading of force and elongation shall be taken at stages during the tensioning of an anchor and plotted to determine the zero error in measuring elongation.
- (r) If the extension of the jack is not sufficient to fully stress the anchor in one operation, locking off and resetting of jacks shall be done carefully to minimise damage to the strands.
- (s) Should an anchor fail for any reason to meet the requirements of this Technical Requirements under the required prestressing load the anchor shall be replaced.
- (t) After restressing has been completed, the excess length of tendons shall be cut off in such a manner as to avoid injury to the concrete or the anchorages.
- (u) Flame cutting will not be permitted.
- (v) The following data shall be recorded during stressing operations and forwarded

to the Employer:

- ◆ Identification numbers of all equipment, including dynamometers, gauges, pumps and jacks.
- ◆ Identification particulars of anchors.
- ◆ Initial force or gauge pressure when anchors are marked for measurement of elongation.

9.4.14. Secondary Grouting

- (a) As soon as possible after stressing and restressing operations have been completed the Contractor shall carry out secondary grouting. The secondary grouting stage shall consist of pressure grouting within the tendon sheath to completely encase the tendons for the full length of the hole.
- (b) Grout mixtures and grouting methods shall be in accordance with those specified for primary grouting, except that when the duct is completely filled, the grout shall be held at a pressure of 200 kPa for a period of 15 minutes after sealing the secondary grouting vent. The grouting inlet shall be plugged after satisfactory completion of secondary grouting.

9.4.15. Monitoring

- (a) For the purpose of monitoring, load cells shall be supplied and installed by the Contractor.
- (b) The Contractor shall supply a read-out unit, compatible with the load cells, to indicate the level of load in the anchors.

9.5. SHOTCRETE

9.5.1. General

- (a) The Contractor shall apply reinforced or unreinforced shotcrete to the excavated surfaces of surface and/or underground excavations where required to ensure stability of the excavation and where approved.
- (b) For the purposes of this Technical Requirements shotcrete is concrete, with set accelerator, pneumatically applied at high velocity onto a prepared surface. The dry mix process or wet mix process shall be used.
- (c) Shotcrete shall be applied in accordance with the requirements of the American Concrete Institute Standard ACI-506, Guide to Shotcrete or Concrete Institute of Australia Recommended Practice Sprayed Concrete or of equivalent standard. Steel fibre reinforced shotcrete shall be applied in accordance with the guidelines of ACI 506-1 State-of-the-art Report on Fibre Reinforced Shotcrete.
- (d) Where shotcrete support is required, the Contractor shall apply shotcrete to give the minimum thicknesses required for support and approved.
- (e) The Contractor shall have on site at all times at least three (3) operable shotcreting units capable of performing the required work.

9.5.2. Materials

- (a) Cement for shotcrete shall comply with the requirements for Type I cement in

ASTM C150.

- (b) Water used in shotcrete and for curing shall comply with the relevant provisions of this Technical Requirements.
- (c) Coarse and fine aggregate for shotcrete shall comply with ASTM C33 and the provisions of this Technical Requirements.
- (d) The Contractor shall periodically test the aggregate held in the batch bins for moisture content.
- (e) An accelerating admixture shall be used and as approved by the Employer to develop quickset and high early strength, in line with the American Concrete Institute Standard ACI-506, Guide to Shotcrete. Admixtures shall be cementitious, not corrosive to steel and shall not encourage other detrimental effects such as cracking and spalling. Admixtures containing calcium chloride will not be permitted. The minimum quantity of set accelerator shall be used. The properties of accelerating admixtures for normal use shall not exceed six (6) per cent of cement content by mass for powder and eight (8) per cent for liquid accelerators but in no case shall the amount used to be in excess of the manufacturer's recommendations or the amount verified as acceptable by testing, whichever is less.
- (f) Subject to the approval of the Employer, admixtures to control rebound, increase plasticity or reduce water may be used. Details of admixtures proposed shall be submitted to the Employer and shall include:
 - ◆ brand names
 - ◆ place of manufacture
 - ◆ base chemical composition
 - ◆ any manufacturers promotion literature.
- (g) The method of adding the admixture shall be in accordance with the manufacturer's instructions.
- (h) Other additives may include:
 - Fly ash (pulverised fuel ash)
 - Fly ash is a finely divided inorganic Pozzolan material which can be added to concrete to improve or achieve certain properties in the plastic and/or hardened state. Fly ash for use in all shotcrete shall conform to ASTM C618.
 - Ground granulated blast furnace slag (GGBFS)
 - GGBFS is a fine granule latent hydraulic binding material which can be added to concrete in order to improve or achieve certain properties in the plastic and/or hardened state.
 - GGBFS used in sprayed concrete shall comply with national standards and regulations valid in the place in use of the sprayed concrete.
 - Silica fume
 - Silica fume is a finely divided, highly active inorganic pozzolan material which can be added to concrete to improve or achieve certain properties.

- Silica fume used in sprayed concrete shall comply with the national standards or regulations valid in the place of use of the sprayed concrete. Where such standards and/or regulations do not exist the use of silica fume shall comply with the recommendations of the suppliers.
- Maximum levels for these additives will be as follows:

Cementitious Material	Maximum Addition
Silica Fume	15 percent of the mass of Portland cement
Fly Ash	30 per cent of Portland cement
	15 per cent of Portland/Fly Ash cement
	20 per cent of Portland blast furnace slag cement
GGBFS	30 per cent of Portland cement

9.5.3. Proportioning

- (a) Materials and preparation of the shotcrete mix shall be such that the mix, when discharged from the nozzle, contains a minimum cement content of 350 kg/m³ of mix with a maximum water/cement ratio of 0.4 by mass and that three cast cylinders 150 mm diameter by 300 mm high made from the shotcrete mix, including admixture additives, achieve an average minimum early strength in line with the American Concrete Institute Standard ACI-506, Guide to Shotcrete and for age beyond 24 hours as follows:
 - ◆ compressive strength at One (1) day - 8 MPa minimum
 - ◆ compressive strength at Three (3) days - 16 MPa minimum
 - ◆ compressive strength at Twenty-eight (28) days - 30 MPa minimum.
- (b) Steel fibre reinforced shotcrete shall contain not less than 30 kg of steel fibres per cubic metre of shotcrete at the mixer.
- (c) Mixed wet shotcrete shall be discarded if not placed within a time determined by the Employer on the basis of the moisture content of the mix and the amount of admixture.

9.5.4. Equipment

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than sixty (60) days before applying any shotcrete, the Contractor shall submit to the Employer drawings showing the proposed plant arrangement together with a general description of the equipment it proposes to use, the methods of operation, the mix proportions and admixtures. Mixing of ingredients by hand will not be permitted.

- (b) The type and amount of admixture used shall be as determined from test results. The dosing equipment shall be of such type as to ensure accurate control of the dosage rate and calibration certificates shall be submitted to the Employer. Calibration checks shall be carried out by the Contractor monthly, and the results shall be submitted to the Employer.
- (c) Accelerating admixture shall be introduced in a dry or liquid form. The means of introduction of the admixture shall be capable of continuous control and metering.
- (d) The accelerating admixture shall not be added until immediately prior to depositing the materials in the placing equipment. Preference shall be given to the liquid form, and the accelerating and mixture shall be accurately proportioned into the shotcrete mix at the application nozzle.
- (e) The air supply system shall be capable of supplying the delivery machine and hose at the pressures and volumes recommended by the manufacturer of the machine. Air supply systems that deliver air contaminated by oil or are incapable of maintaining constant pressure shall not be used.
- (f) The delivery machine shall have a manufacturer's rated capacity of not less than 7.5 m³/hr. The machine shall be capable of introducing mixed materials to the delivery hose at a uniform rate with ejection from the nozzle at velocities which ensure adherence of materials to the treated surface with minimum rebound and maximum density.

9.5.5. Workmanship

- (a) Not less than Thirty (30) days before applying shotcrete or steel fibre reinforced shotcrete, the Contractor shall prepare at least three test panels of each type of shotcrete in the presence of the Employer for each admixture to be used. The test panels shall be made by applying at least 150 mm thickness of shotcrete or steel fibre reinforced shotcrete to a hardboard panel approximately 750 mm square with sides splayed outwards at 45 degrees. The shotcrete shall be applied to the panels in the same manner (vertically down, horizontally and overhead), equipment and pressures that will be used in the Works and shall be cured in the same manner as proposed for the actual work.
- (b) Early strength tests in accordance with the American Concrete Institute Standard ACI-506, Guide to Shotcrete have to be conducted.
- (c) The Contractor shall take six 75 mm diameter core samples from each panel. Cores shall have a length/diameter ratio of 2.0 and shall not be taken from within 125 mm of the edge of the panel. The cores shall be tested either uncapped, with parallel machined planar ends within 2° of normal to the core axis, with bonded caps in accordance with ASTM C617 or with unbonded caps in accordance with ASTM C1231.
- (d) No shotcrete shall be applied to the Works until the quality of workmanship and the compressive strength of the shotcrete, as determined from cores taken from the test panels, is shown to conform to the strength requirements specified in Sub-clause 9.5.10 of this Chapter.
- (e) The Contractor shall employ only skilled nozzlemen and a full-time foreman who

has at least five years' experience in shotcreting.

- (f) The thickness of the shotcrete shall be determined during the application.
- (g) The distance of the nozzle from the work shall be between 600 mm and 1500 mm and the nozzle shall be held perpendicular to the application surface except that, when spraying around reinforcing bars, the nozzle may be held closer and at a slight angle in order to facilitate encasement. The shotcrete shall emerge from the nozzle in a steady uninterrupted flow. Should the flow become intermittent from any cause, the nozzle operator shall direct it away from the work until it again becomes uniform.
- (h) Layer thickness shall mainly be governed by the requirement that the material shall not slump or sag and is dependent on factors such as position of reinforcement, plane of application, mix design, constituents and use of admixtures. Where thick layers are applied it is important that the leading edge be maintained at a slope. Where necessary to achieve great overall thickness, a layer of shotcrete may be covered by a succeeding layer, but it shall first be allowed to stiffen. This surface will be inspected and approved by the Employer prior to application of further layers.

During the application of shotcrete, the Contractor shall provide adequate lighting and ventilation facilities and take such other measures as are necessary for the safety of the Contractor's workmen. Nozzlemen and other shotcreting assistants shall be provided with protective clothing and appropriate headgear incorporating respirators.

9.5.6. Admixtures

- (a) The type and amount of admixture used shall be as determined from test results. The dosing equipment shall be of such type as to ensure accurate control of the dosage rate and calibration certificates shall be submitted to the Employer. Calibration checks shall be carried out by the Contractor monthly and the results submitted to the Employer.
- (b) Accelerating admixtures shall not contain chlorides or materials corrosive to steel nor shall they cause other detrimental effects such as cracking or spalling.

9.5.7. Preparations

- (a) Depending on the condition of the rock being supported by shotcrete and the temporary or permanent nature of the support any one or more of the following methods of treatment may be required.
 - ◆ shotcrete without steel reinforcement
 - ◆ shotcrete with steel reinforcing fabric (= wire mesh)
 - ◆ shotcrete with steel reinforcing bars
 - ◆ steel fibre reinforced shotcrete.
- (b) Steel reinforcement shall be securely fastened with surface anchors and supported with spacers to provide 50 mm clearance between the reinforcement and the rock surface.
- (c) Surface anchors are defined as devices used for fastening the reinforcement, but which do not penetrate to rock to a depth greater than 600 mm and include nails,

staples, and embedded wire ties and masonry anchors.

- (d) Wherever shotcrete is required, the Contractor shall clean and prepare the surfaces to receive the coating. Loose or shattered rock, rock debris, soil or other loose material and any oil film or otherwise objectionable substances shall be removed from the surfaces. Where necessary a degreasing liquid or high-pressure steam shall be used to remove the oil film.

9.5.8. Application

- (a) Care shall be taken to ensure that cavities resulting from cutting back of seams or geological defects, are completely backfilled with shotcrete. Wherever practicable, rock surfaces shall be rendered free of water flowing over or seeping through the surfaces to be shotcreted immediately before the shotcrete is applied. Where steel reinforcement is used, shotcrete shall cover the reinforcement to a depth of at least 30 mm or other specified thickness, if greater.
- (b) Where very poor rock conditions are anticipated, shotcreting equipment shall be available before blasting so that shotcrete can be applied with the minimum of delay.
- (c) All rebound and other loose material shall be removed from the surface of each layer as work proceeds. Such rebound shotcrete shall not be used/reused but shall be removed from the Works and disposed of by the Contractor as part of the work under this Clause.
- (d) During the application of shotcrete, any remaining water flowing over or seeping through the surfaces to which the shotcrete is to be applied shall be diverted by the use of panning, pipes, felt strips or other acceptable means. Where necessary, formed holes or pipe outlets shall be provided in the shotcrete, to relieve water pressure on the shotcrete.
- (e) No more than one layer of reinforcement shall be shotcreted at a time.
- (f) Pressure relief holes of 42 mm diameter shall be drilled through the shotcrete to a depth of 200 mm into the rock in any areas of high-water pressure build-up. Holes shall be drilled at a density of at least one hole per 4 m², or as required to relieve pressure. Holes shall be drilled at the minimum density in all areas of shotcrete applied to the excavated surfaces.

9.5.9. Safety of Works

- (a) The application of shotcrete as temporary or permanent support shall not be considered as relieving the Contractor of its responsibility to maintain all portions of the Works in a safe condition.

9.5.10. Testing and Repairs

- (a) For early strength of shotcrete up to 24 hours of age, tests according to the American Concrete Institute Standard ACI-506, Guide to Shotcrete shall apply.
- (b) The Contractor shall perform production control tests comprising 75 mm diameter test cores from in-place shotcrete at the locations and times directed. Cores shall be drilled through the full thickness of shotcrete at the rate of six (6) suitable cores per month or for every 2000 m² of completed shotcrete, whatever comes first. The

cores shall have a length/diameter ratio of two and shall be tested by the Contractor in accordance with the requirements set out below. In places where the specified thickness of shotcrete will not provide cores with a length/diameter ratio of two, the Contractor shall provide test panels in accordance with Sub-clause (g) of this section and secure them immediately adjacent to the area proposed to be shotcreted and tested. The shotcrete shall be applied for the full thickness of 150 mm at the same time as the shotcrete is being applied to the excavated surface and in the same application direction. The same number of cores shall be taken from the test panels

- (c) Two cores shall be tested for compressive strength requirements at One (1) day, Three (3) days and Twenty-eight (28) days.
- (d) The compressive strength requirements for each set of cores shall be satisfied if:
 - ◆ each core has a compressive strength equal to or greater than that specified in (j) of this Section, or
 - ◆ the average compressive strength is equal to or greater than that specified in Sub-clause (j) and the difference between the strengths is less than twenty (20) per cent of the average.
- (e) Where plain shotcrete is applied, the Contractor shall carry out an average of three sets of compressive strength tests (6 cores) for every 2000 m² of shotcrete applied.
- (f) For the application of fibre reinforced shotcrete at least two sets of test panels on average shall be constructed by the Contractor for every 2000 m² of shotcrete applied. Three sets of compressive strength tests (6 cores) shall be conducted from each panel.
- (g) For flexural strength, toughness index and compressive strength testing, test panels shall be constructed by spraying into moulds 750 x 750 x 150 mm deep with sides sprayed outwards at 45 degrees to prevent the entrapment of rebound. Panels shall be made for each mix and position sprayed by fixing the moulds to downward, vertical and overhead positions. Panels shall be clearly marked to identify the time and date of spraying and the location and position where they were sprayed.
- (h) The thickness of the shotcrete support shall be tested when directed by drilling five randomly located holes in a rectangular area 1 000 mm by 1 500 mm. The locations of the holes shall be as directed. The holes shall be approximately 40 mm in diameter.
- (i) Areas of shotcrete which are drummy, below strength or otherwise defective, shall be removed and repaired.
- (j) Testing for shotcrete shall be performed in accordance with the Standards included in the following table:

Performance Parameter		Testing Specification	Fibre Reinforced Shotcrete	Plain Shotcrete
Compressive strength	at 24 hours	As approved	8 MPa	8 MPa
Compressive strength	at 3 days	ASTM C39	16 MPa	16 MPa
Compressive strength	at 28 days	ASTM C39	30 MPa	30 MPa
First crack and ultimate flexural strength	at 7 days	ASTM C1018	8 MPa	N/A
Bond strength		As approved	0.5 MPa	0.5 MPa
Setting time	Initial set	ASTM C403	3 min	3 min
Setting time	Final set	ASTM C403	9 min	9 min

- (k) The Contractor shall test the setting time of the accelerating admixture in accordance with ASTM C266 as modified herein. The accelerator shall be added to 50 grams of cement in the preparation of the paste, together with water to produce a water cement ratio of 0.40, in the varying percentages expected to be used in actual shotcrete application. The minimum possible time interval shall be used to attain the proper mixing without disturbing the initial set of the paste. The test report shall be submitted to the Employer.
- (l) The compressive strength test of cement with set accelerating admixtures shall be carried out in accordance with ASTM C109. In these tests the accelerator in the varying percentages expected to be used in the shotcrete mix design shall be added to the mortar prepared with a water cement ratio of 0.40. The Contractor shall submit the test report to the Employer.

9.6. DEFECTIVE SHOTCRETE

- (a) For the purposes of routine testing, the quality of the shotcrete shall be considered satisfactory if every result is at least ninety (90) per cent of the specified strength and if at least ninety (90) per cent of all results exceed the specified strength.
- (b) Should test samples of shotcrete not achieve the specified minimum strength, additional tests shall be carried out by the Contractor to determine new mix proportions to avoid further such failure.
- (c) Contractor shall be responsible for any corrective measures in shotcrete surface

if the shotcrete surface is encountered by any crack due to shotcrete defective and any other reasons.

- (d) If the Employer considers that the low strengths of the applied shotcrete may reduce the long-term stability of the Works and be detrimental to the effectiveness of the support, the Contractor shall:
- ◆ Remove the defective shotcrete in strips or panels in such a way that the safety of the works and persons is not endangered and replace with shotcrete that is complies with this Technical Requirements, which may also require the replacement of reinforcing fabric.
 - ◆ Apply an additional layer of shotcrete not exceeding the thickness originally required provided that sufficient space clearance exists.

9.7. STEEL MESH AND REINFORCING FABRIC

- (a) The Contractor shall furnish and install, where approved, steel reinforcing fabric and/or steel mesh reinforcement in conjunction with:
- ◆ rockbolts
 - ◆ shotcrete
 - ◆ lattice girders

9.8. LATTICE GIRDERS

9.8.1. General

- (a) The Contractor shall furnish and install lattice girders in underground excavations where required.

9.8.2. Supply

- (a) At all times during underground excavation, the Contractor shall have available on the Site, ready for immediate use, at least 20 lattice girders suitable for installation in the particular section of the underground excavation.

9.8.3. Installation

- (a) Placement of lattice girders should be completed as soon as possible after each advance. The maximum unsupported advance in each heading shall be as approved.

9.8.4. Steel Mesh Lagging

- (a) Steel mesh lagging shall consist of steel mesh reinforcement and/or steel reinforcing fabric complying with the relevant provisions of this Technical Requirements and, where required, shall be placed between supports for the purpose of supporting the rock. The steel mesh lagging shall be attached firmly to the supports by welding. Dimensions of the steel mesh lagging shall be as approved.

9.8.5. Removal of Timber before Concreting

- (a) Before placing the concrete lining, all loose timber shall be removed as completely

as practicable, and all timber spreaders shall be removed. The Contractor shall securely brace the supports with the minimum practicable amount of blocking and wedging.

9.9. STEEL RIB SUPPORT

9.9.1. General

- (a) The design and fabrication of steel rib supports, including size, mass, accessories and methods of installing the ribs in all parts of the underground excavation shall be subject to the review of the Employer's Representative and the steel ribs shall comply with ASTM A36 or approved equivalent.

9.9.2. Material and Equipment

- (a) The Contractor shall furnish all steel supports consisting of structural steel ribs, foot beams, lagging and other approved structural steel members, complete with bolts, nuts, wedges, tie rods and other accessories required for assembling the permanent structural steel supports and supporting them in place in accordance with following requirements:
- Structural steel: ASTM A6 or equivalent
 - Steel rib/ lattice girders: ASTM A36 or equivalent
 - Welding: AWS A5.1, A5.17 or equivalent
- (b) Suitable steel liner plates shall be provided with continuous internal flanges for bolting adjacent plates together and providing the necessary shoring strength. For filling voids behind this lining with grout, injection holes in the plates shall be provided. In sections where ingress of water is expected, plates with sealing flanges shall be used.
- (c) Occasionally, it may be appropriate to use lagging made out of corrugated steel plates. These plates shall be provided with orifices to place gravel fill. Welding or clamps may be used to connect supports and plates.

9.9.3. Execution of Work

- (a) Structural steel supports shall be placed in an approved manner to the lines, grades, and dimensions shown on the Drawings. Actual spacing of the structural steel supports shall be determined by local conditions revealed during excavation. For the uniform distribution of pressure, collar braces between the structural steel support sets shall be held in place by tie rods to complete the support system.
- (b) Steel supports shall be placed as soon as possible after excavation of each face is finished and in such a way that the natural strength of the rock is optimally used.
- (c) The maximum unsupported advance in each front shall be determined by the Contractor at the work site, according to the soil or rock conditions, so that cave-ins in ceiling, walls or front do not occur. Wherever rock is excessively soft, loose or disturbed, it may be necessary to install supports at the face of the excavation. The Contractor shall provide such provisional support for the face and excavate in slopes, placing the required final support as soon as practicable.
- (d) Installation of supports shall be done in such a way as to keep grades and

alignments in accordance with the Drawings. All ribs shall have a steel base plate set on steel sections, wooden blocks or prefabricated concrete blocks, using also steel wedges in order to avoid sinking of the supports.

- (e) In general, the permanent steel supports shall be firmly and securely placed and kept securely in position so that they are not disturbed by the lining or by any of the Contractor's operations. Improper supports and/or steel supports damaged by the Contractor's operations shall be repaired or replaced immediately at the Contractor's own expense.

9.9.4. Steel Rib Support Installation

- (a) Where steel rib supports are required, the rock shall be excavated to enable the steel ribs to be installed true to lines and grades shown on the Drawings and shall be maintained by the Contractor in proper condition and alignment.
- (b) Suitable temporary timbering may be used only if accepted by the Employer's Representative where such temporary timbering is necessary to support the roof and sides of the excavation during construction and to facilitate installation of permanent supports. Such temporary timbering shall be removed by the Contractor shortly before placing the concrete and/or shotcrete lining and it shall be the Contractor's responsibility during excavation to conduct his operations so that no temporary timber is installed which cannot be removed when required and as requested by the Employer's Representative.
- (c) Suitable steel liner plates shall be used where such permanent or temporary lagging is necessary to support the roof and sides of the tunnel. These plates shall be provided with continuous internal flanges for bolting together providing the necessary shoring strength. For filling voids behind this lining with grout, injection holes in plates shall be provided.

9.9.5. Tests and Properties

- (a) The Contractor shall furnish certified copies of reports to the Employer's Representative of all tests and inspections required to show compliance with the applicable Standards and assembly instructions.

9.10. FOREPOLING

- (a) The Contractor shall use forepoling either of grouted or ungrouted as required where ground conditions warrant and stand-up time is insufficient for shotcrete support.
- (b) Forepoling is a system of driving rods into the face keeping the leading edge always buried. Excavation is performed inside this protective canopy of steel. The use of grouted bars angled ahead of excavation is the preferred forepoling method.

9.11. GRAVEL BEDDING

9.11.1. General

- (a) The Contractor shall place and compact gravel bedding in conjunction with protection works for surface excavation and elsewhere as required and approved.

The material used for gravel bedding shall be obtained from sources of coarse aggregate for concrete, shall be reasonably well graded, free draining, and shall have a maximum size of 40 mm.

9.11.2. Compaction

- (a) Compaction of gravel bedding may be performed by the treads of crawler type tractors, surface vibrators, smooth rollers, power tampers or other appropriate equipment.
- (b) Where compaction of gravel bedding is performed by hand or mechanical tamping, the material shall be deposited in horizontal layers not more than 150 mm thick after being compacted; or if the compaction is carried out by use of crawler type tractor treads, surface vibrators, or similar equipment, the material may be deposited in layers not more than 300 mm thick after being compacted.
- (c) During the compaction of gravel, the material shall be wetted thoroughly throughout the entire layer being compacted.
- (d) The relative density of the compacted material shall be not less than seventy (70) per cent as determined in accordance with ASTM D4253.

9.12. CHANNEL LINING

9.12.1. General

- (a) The Contractor shall furnish and install channel lining where required and approved.

9.12.2. Materials

- (a) Material for channel lining and bedding shall be obtained from required excavation or other approved sources.
- (b) The rock used for channel lining and bedding shall be hard, dense and durable. The inclusion of earth and organic material will not be permitted. The rock need not be hand placed but shall be dumped and spread where required in such a manner that the completed lining is stable, with no unreasonably large unfilled spaces and with the larger rock fragments uniformly distributed. Hand working of the outer surface may be necessary to meet this requirement.

9.12.3. Grading

- (a) The Contractor shall select, separate and blend the materials from required excavation and from stockpiles where necessary so that when placed the material will be well graded with an even distribution of rock fragments of various sizes within the following limits, unless verified by design that larger size material will be required:
 - ◆ No material shall have any dimension greater than 600 mm.
 - ◆ At least ten (10) per cent of material shall consist of rock having an average dimension of not less than 450 mm.
 - ◆ At least twenty-five (25) per cent of material shall consist of rock having an average dimension of not less than 300 mm.

- ◆ Not more than twenty-five (25) per cent of material shall consist of rock having an average dimension of less than 200 mm.

9.12.4. Bedding

- (a) Before placing the channel lining, a layer of gravel bedding shall be placed on the sides and base of the channel to a thickness of 300 mm, measured normal to the surface on which the bedding is placed.

9.12.5. Placing

- (a) During and after placing, the channel lining material shall be raked and blended such that the finer material is positioned against the surface of the channel banks and the coarser material is positioned on the water face of the lining.
- (b) The thickness of the channel lining after dumping and spreading shall not be less than 600 mm, measured normal to the surface on which the lining is placed, exclusive of the thickness of the bedding.

9.13. RIPRAP

9.13.1. General

- (a) The Contractor shall furnish and install riprap for protection of excavation where required and as approved.

9.13.2. Materials

- (a) Material for riprap shall consist of hard, dense and durable rock and shall be obtained and selected from required excavations or other approved sources.

9.13.3. Grading

- (a) Material for riprap shall be well graded within the following limits:
 - ◆ The maximum rock size shall be not greater than that which can be encompassed in the specified layer thickness.
 - ◆ Not less than twenty-five (25) per cent of the material shall consist of rock having an average dimension greater than 600 mm or other approved dimensions.
 - ◆ Not more than forty (40) per cent of the material shall consist of rock having an average dimension of less than 100 mm.

9.13.4. Bedding

- (a) Where riprap is to be placed against an earth, gravel or weathered rock foundation which is not suitable for bedding for riprap, the riprap shall be bedded on a 300 mm thick continuous layer of gravel bedding or sand and gravel or rock fragments conforming to the requirements for gravel bedding.

9.13.5. Placing

- (a) The rock used for riprap shall be dumped and spread to the designed layer thickness so that:
 - ◆ The finer material is generally near the surface of the excavation.
 - ◆ The larger rocks are generally near the outer surface.

- ◆ The completed riprap is stable without any tendency to slide.
 - ◆ There are no large unfilled spaces. The riprap may need to be specially worked to meet this requirement.
- (b) The Contractor may place materials by raking and blending in situ in order to achieve the specified grading and layer thickness.

9.14. STONE PITCHING

9.14.1. General

- (a) The Contractor shall furnish and install stone pitching in drains and channels and on surfaces of slopes and batters as approved.

9.14.2. Materials

- (a) Rock used for stone pitching shall be sound durable rock selected from the harder rock from the required excavations or other approved sources. Stone for pitching shall have a minimum volume of 0.0075 m^3 . The minimum thickness of any stone measured normal to the pitched surface shall be the nominal thickness of the pitching and shall not be less than 150 mm. The exposed surface of each stone shall be approximately flat and of an area not less than 0.03 m^2 .
- (b) Mortar for bedding and jointing shall consist of 3 parts of clean fine aggregate to 1 part of cement by volume complying with the requirements of AS 2701.

9.14.3. Bedding and Placement

- (a) The rock shall not be less than 150 mm thick and shall be properly bedded in mortar to a uniform surface. The exposed surface of each stone shall be approximately flat and of an area not less than 0.03 m^2 .
- (b) The surfaces to be stone pitching shall be trimmed and shaped where necessary.
- (c) Joints
- ◆ All interior voids between stones and bedding shall be filled with mortar as specified above.
 - ◆ Stone shall be random coursed.
 - ◆ Joint widths normally shall be 12 mm and the distance across a joint from one stone to an adjacent stone should not be more than 50 mm at any point.
 - ◆ All joints shall be raked to a depth of 12 mm.
- (d) Drainage
- Weep holes shall be provided as necessary but at a frequency of not less than 2000 mm^2 per 4 m^2 .
 - Unless otherwise detailed, material within 300 mm of the upstream end of weepholes shall be granular.
- (e) Finish

The finished pitching surface shall be neat, clean and free from mortar droppings. The top of the pitching shall be finished to an even grade or vertical

curve, variations along the back edge being filled in with mortar, so as to produce a smooth, neat appearance.

9.15. GABIONS AND MATTRESSES

9.15.1. General

- (a) The Contractor shall furnish and install gabions and mattresses in required locations as approved.
- (b) The foundation for each gabion and mattress shall be prepared by the Contractor and irregularities in the foundation shall be excavated or tightly filled with gravel to produce a surface which has no protrusions or cavities in excess of 100 mm.
- (c) The gabions and mattresses shall be flexible galvanised gabions and shall be fabricated from wire mesh and selvedge. Each gabion and mattress shall be divided by diaphragms into cells, whose length shall not be greater than the width of the gabions or mattresses plus 100 mm. The gabion and mattress boxes shall be fabricated Maccaferri type or approved equivalent.
- (d) The prefabricated gabions and mattresses shall be obtained complete with sufficient suitable galvanised wire for completing the wiring of the gabions and mattresses on Site.
- (e) The wire in the gabions and mattresses and its galvanising shall be equal to or better than that used in Maccaferri galvanised gabions. The wires in the gabions and mattresses shall be arranged so that the spacing between the wires is similar to or smaller than in Maccaferri gabions and mattresses.

9.15.2. Assembling and Filling Gabions and Mattresses

- (a) The gabions and mattresses shall be assembled, placed, filled and finished in accordance with the manufacturer's instructions.

9.16. SOIL CONSERVATION MEASURES

9.16.1. General

- (a) The Contractor shall carry out soil conservation measures using the approved methods in all required locations including:
 - On the batters of all embankments including for roads, parking areas, turning bays, switchyard, etc.
 - In and around all features and structures of the Facility exposed to public view, not covered by other specified or designed requirements, to comply with overall landscaping requirements of the Employer's Requirements which are considered by the Employer to be necessary before the Facility can be deemed to be complete for Taking Over.
 - In and around all areas within the boundary of the Services Buildings and areas around the boundary disturbed by the construction.
 - On erodible batters of excavations.
 - On drainage channels and ditches
 - On disposal areas, except such areas approved within the reservoir, unless otherwise approved.

- In borrow areas unless otherwise approved.
 - On all other areas of the Works to be reinstated in accordance with the Contract.
 - Elsewhere as required.
- (b) For compliance with Paragraph a. of this Subclause, the Contractor shall as a minimum requirement provide a generally smooth, neat finish to such areas to the lines, grades and dimensions shown on the Drawings and cover all such areas with the thickness of topsoil specified in this Clause followed by the establishment of a complete, healthy cover of grass by any one of the methods specified in this Clause or other approved methods.
- (c) The Contractor shall carry out soil conservation measures in successive stages at the first opportunity during the execution of the Works when weather conditions are suitable for the establishment of grasses and other approved vegetation.

9.16.2. Methods

- (a) Soil conservation measures shall be carried out in accordance with any of the following methods or combinations of methods:
- By topsoil placement, which consists of distributing topsoil to depths of between 75 mm and 100 mm. Areas to be covered with topsoil shall first be scarified to a depth of not less than 100 mm just prior to the application of topsoil. The finished surface should be uniform, and level and any large stones are to be removed.
 - The topsoil shall be spread evenly to the required thickness harrowed to break up lumps and clods and finished to a uniform surface free from humps and depressions such that the whole surface drains freely in accordance with the finished design surface contours and levels.
- (b) By seeding and fertilising areas where topsoil has been placed or in other areas as directed. These areas shall be sown with an approved grass seed mixture appropriate to the area at a rate of not less than 25 kg/ha and fertilised with an approved fertiliser at a rate of not less than 60 kg/ha. The seed mixture and fertiliser shall each be applied in two approximately equal applications at times of sowing. The areas covered with topsoil shall be scarified at the time of initial sowing, followed by initial watering.
- (c) Mechanical application of seed and fertiliser by the method termed hydroseeding.
- (d) By planting rooted sprigs of an approved grass at a maximum spacing of 300 mm in lines spaced no more than 300 mm apart.
- (e) By placing turf sprigs.
- (f) By fertilising areas where topsoil has rooted sprigs and/or turf sprigs have been placed or in other areas as required. These areas shall be fertilised with an approved fertiliser at a rate of not less than 60 kg/ha.
- (g) By establishing a protective cover of grass over erodible surfaces by blanket sodding or strip sodding using sods of dense, well-rooted grass cut to a depth of not less than 40 mm.
- (h) Where blanket sodding is required, the Contractor shall cover the complete

surface with sods.

- (i) Where strip sodding is appropriate the sods shall be bedded in horizontal strips not more than 250 mm apart so as to cover not less than twenty (20) per cent of the required surface with sods.
- (j) The sods shall be well bedded in topsoil, pegged to the ground where necessary and kept watered daily until the sods have rooted. The Contractor shall replace any sods which die or fail to take root.
- (k) By straw mulching, which consists of the application of a surface protection of 500 bales of meadow hay or straw per hectare, held in place by black wire netting or sprayed down with cold asphalt at the rate of 0.25 L/m².
- (l) By constructing contour banks and associated small pondages to contain drainage water, at the spacings, sizes and locations directed, followed by the placing of grass turf as previously specified.
- (m) By constructing willow wattle or other appropriate fences.
- (n) By placing willow or other appropriate bundles.
- (o) By placing brush matting.
- (p) By constructing grass chutes.
- (q) By constructing chutes with bitumen protection.
- (r) By stone pitching set in mortar.
- (s) By placing asphalt emulsion on surfaces within the Works that are susceptible to erosion and that are not protected by rockfill protection.
- (t) By appropriate biological and mechanical methods of soil stabilisation installed in accordance with the manufacturer's instructions.

9.16.3. Maintenance and Watering

- (a) On completion of the seeding specified in Sub-clause 9.16.2, the Contractor shall maintain and water the seeded areas as necessary to ensure germination occurs and a healthy, dense, continuous sward is achieved. Areas that fail to germinate shall be reseeded and re-fertilised until a uniform grass cover develops. Maintenance including regular cutting, removal of all weeds and other undesirable growth and regular watering shall continue until the completion of the Works. Any areas subsequently killed or damaged or found to be unhealthy before completion of the Works shall be immediately restored, re-grassed, fertilised, watered and maintained by the Contractor.
- (b) On completion of the grassing, the Contractor shall maintain including regular cutting, removal of all weeds and other undesirable growth and regular watering of the grassed areas as necessary to create and maintain a good healthy cover of grass and good growth from full face or strip sodding or any other approved form of grassing. Any areas subsequently killed or damaged or found to be unhealthy before completion of the Works shall be immediately restored, re-grassed, watered and maintained by the Contractor.

- (c) After initial watering, the Contractor shall water the grassed area when necessary to the equivalent of 25 mm of rain per week. The watering system shall include provision for measurement of the quantity of water applied.
- (d) Irrespective of the method of grassing proposed by the Contractor and the Employer's approval thereof, the Contractor shall be responsible for ensuring that all areas to be covered with grass have been completely covered before the time for Taking Over of the whole of the Works.

9.16.4. Application of Asphalt Emulsion

- (a) The asphalt emulsion shall be applied by spraying.
- (b) The specific composition of the (diluted) emulsion shall comply with the following:
 - asphalt percentage (by mass) between twenty (20) and thirty (30) per cent of the emulsion;
 - a minimum penetration into the existing materials of 25 mm;
 - an adequate durability to provide a lifetime of at least four years; and
 - the asphalt used for preparing the emulsion must have a penetration of 180/210.
- (c) When the emulsion is diluted in situ, clean and fresh water shall be used.
- (d) In situ tests using the existing materials and the correct slope shall be made to prove the adequacy of the proposed emulsion.
- (e) The execution of the test shall be finalised before the commencement of the actual spraying of the selected areas.
- (f) All the areas protected by spraying of asphalt emulsion shall be maintained by the Contractor.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 10
CONCRETE PRODUCTION AND CONSTRUCTION**

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CHAPTER 10 - CONCRETE PRODUCTION AND CONSTRUCTION

10.1. GENERAL

10.1.1. Scope

- a) This Chapter covers the construction of cast-in-place concrete both for open and underground work as shown on the Drawings approved by the Employer or as specified herein.

10.1.2. Definitions

1. Fine Aggregate

- a) The term "fine aggregate" is used to designate aggregate in which the maximum size of particles is 4.75 mm.
- b) Fine aggregate for concrete, mortar and grout shall be natural sand, manufactured sand, a blend of natural sands or a blend of natural and manufactured sands.

2. Coarse Aggregate

- a) The term "coarse aggregate" is used to designate aggregate in which the minimum nominal size is 4.75 mm, and which is reasonably well graded from 4.75 mm to the largest size required in the work.
- b) Coarse aggregate for concrete shall consist of natural gravel, a mixture of natural and crushed gravel or manufactured aggregate.

3. Construction Joint

- a) Concrete surfaces, upon or against which concrete is to be placed and to which new concrete is to adhere, that have become so rigid that the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints.
- b) Whenever work is suspended on any section for more than one-hour, concrete surfaces shall be treated as a construction joint.

4. Expansion or Contraction Joint

- a) All joints allowing relative movement of concrete structures with respect to an adjacent one, due to expansion, shrinkage, settlement of foundations, etc. are to be considered expansion or contraction joints.

10.1.3. Submissions

1. General

- a) For manufacture of concrete at the Site, the Contractor shall, not less than Sixty (60) days before installing his plant and equipment, submit flow charts, drawings and written descriptions of his proposals for the production of aggregates and the production and placing of concrete and mortar in the Works to the Employer.

2. Cement

- a) The Contractor shall indicate in writing to the Employer the source of the cement not less than Sixty (60) days in advance of his purchase order, indicating the shipping schedule and the estimated quantity to be obtained from each source.
- b) The Contractor shall submit, not less than Thirty (30) days before the use of cement, a report of mill tests performed at the factory including the physical and chemical properties of the cement proposed for the works.

3. Aggregates

- a) Not less than Ninety (90) days prior to placing any concrete, the Contractor shall submit to the Employer for approval the confirmation of sources, processing procedures, gradation curve and quality assurance.

4. Batching Plant Facilities

- a) Complete description and drawing showing the general plant arrangement and equipment for processing, handling, storing and proportioning concrete ingredients shall be subject to the Employer's approval.
- b) Approval of plant and equipment or their operation, or of any construction procedure, will not waive or modify any provisions or requirements contained in this Specification governing the quality of the materials or of the finished work.

5. Mix Proportion

- a) Not less than Sixty (60) days prior to placing any concrete the Contractor shall submit details of his proposed mix proportion for the various classes of concrete specified, for the approval of the Employer.

6. Conveyance Facilities

- a) Description of equipment and methods proposed for the transport of concrete from the batching plant to the works including placement equipment such as cranes, conveyors, concrete pumps and similar shall be subject to the Employer's approval.

7. Reinforcing Steel

- a) Not less than Sixty (60) days prior to fabrication, the Contractor shall submit data showing bar bending details, bar lists, placement drawings, placement schedule and delivery schedule, all prepared in accordance with applicable standards.
- b) Not less than Sixty (60) days prior to installation, the Contractor shall provide the Employer with representative splice samples for each bar size if mechanical splicing is proposed.
- c) Upon receipt of reinforcing steel on site, the Contractor shall submit certified copies of mill test reports, including chemical analysis and physical properties of each heat. In case a load contains more than one heat, a list of bar mark numbers by heat shall be included.

8. Drawings and Schedules

- a) The Contractor shall submit in advance the drawings showing the order, magnitude and construction joints proposed for the cast-in-place concrete.
- b) The Contractor shall submit in advance, a weekly placing schedule, giving the detailed locations of the placement, the approximate placement volume and the date on which the concrete will be placed.

10.1.4. Contractor's Plant, Equipment and Construction Facilities

1. General

- a) The Contractor may manufacture concrete at the Site in accordance with the requirements of technical requirements and the relevant applicable standards or obtain ready-mixed concrete.

2. Concrete Manufactured at Site

- a) For manufacture of concrete at the Site the Contractor shall, in accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before installing its plant and equipment, submit flow charts, drawings, and written descriptions of its proposals for the source, transportation and storage of cement, the source and production of aggregates and the production and placing of concrete, mortar and shotcrete in the Works to the Employer.
- b) All aggregate shall be produced using plant capable of supplying aggregate at a rate which is adequate to meet the requirements for the progress of the Works.
- c) The Contractor shall install, maintain and operate a communications system linking the points of placing concrete with the concrete batching and mixing plant, and such shall be available to the Employer at all times. All aggregate shall be produced using plant capable of supplying aggregate at a rate, which is adequate to meet the requirements for the progress of the Works. The Contractor shall install, maintain and operate a communications system linking the points of placing concrete with batching and mixing plant.

3. Transporting and Handling Equipment

- a) The use of transporting and handling equipment including buckets, chutes, hoppers, agitator trucks or pumps which cannot readily handle, and place concrete of the slumps specified will not be permitted.

4. Alternative Type of Equipment

- a) Where this technical requirement requires specific types of equipment to be used or specific procedures to be followed, such requirements are not to be construed as prohibiting use by the Contractor of alternative types of equipment or procedures if it can be demonstrated that equal results will be obtained by the

use of such alternatives.

10.1.5. Composition

1. General

- a) Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified, all well mixed and brought to the proper consistency.
- b) All concrete and its constituent materials and all methods and procedures shall conform to applicable Standards.

2. Maximum Size Aggregate

- a) Unless otherwise approved, the nominal maximum size aggregate used in concrete shall be as follows:
 - 80 mm - for concrete in walls, slabs and sections more than 400 mm in thickness but not within 1 m from exposed surfaces.
 - 40 mm - for concrete in walls, slabs and sections less than 400 mm in thickness.
 - 20 mm - for heavily reinforced sections, precast concrete units and walls less than 250 mm thickness.

3. Responsibility for Mix Design

- a) The Contractor shall be responsible for the design of concrete mixes and for ensuring that all concrete placed in the Works meets the requirements of the Technical Requirements.
- b) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before placing any concrete in the Works the Contractor shall submit to the Employer details of proposed mixes for the various classes of concrete specified or other classes as approved.
- c) The Contractor shall prepare, in the Employer's presence, trial mixes of the proposed mixes and carry out tests in accordance with the provisions of this Technical Requirements to verify their compliance with the Technical Requirements. Following the laboratory tests, preliminary field tests shall be prepared under full-scale site conditions using the Contractor's batching plant. The required average compressive strength shall be in accordance with the requirements of ACI 318M.
- d) The class of concrete, its minimum characteristic strength, minimum cement content and maximum water cement ratio applicable to the concrete for various structures shall be as specified in Table 10-1.
- e) The various classes of concrete shall be designed so that the amount of cement, aggregates, water and admixtures are the minimum necessary to obtain concrete having approved workability, density, impermeability, resistance to abrasion,

durability and shrinkage in accordance with this Technical Requirements.

- f) The various classes of concrete shall be placed in the locations shown in the Table 10-2 or approved.

Table 10.1: Standard Classes of Concrete

Class of Concrete	Maximum Water-Cement Ratio	Minimum Cement Content per Unit Volume of Concrete (kg/m ³)	Characteristic Strength (MPa)
A	0.6	340	25.0
B	0.50	320	25.0
C	0.45	320	25.0
D	0.40	360	40.0
E	0.50	340	30.0
F	0.70	200 maximum	15.0 at 90 days
G	0.60	320	20.0
H	0.55	275	20.0
I	0.35	425*	50.0

Note: * denotes cement content includes silica fume. Silica fume shall be 10% by mass of total cement content.

- g) The various classes of concrete shall be placed in the location specified in the following Table 10-2 and elsewhere as approved.

Table 10.2: Class of Concrete to be used in Structures

Class of Concrete	Location
A	Miscellaneous concrete
B	Structural concrete general (weir, intake, desanders, powerhouse, tailrace and HRT tunnels, surge shaft, valve chamber and permanent adits)
C	Concrete placed by Tremie under water
D	Prestressed beams; precast concrete
E	Bridge decks embedment concrete for gate guides and seats embedment concrete for gate guides and seats
F	Backfill concrete
G	Administration Complex and Housing
H	Weir mass concrete (not exposed)
I	Abrasion resistant concrete to diversion weir spillway and under sluices invert

4. Required Properties of Concrete

- a) Plastic concrete shall be liable to rejection if:
- The air content is not within the following ranges:

Coarse Aggregate (nominal maximum size, mm)	Total Air Content (percentage of volume of concrete)
20	6+/-1
40	5+/-1
80	4+/-1

- After the concrete has been discharged at the placing point and before it has been consolidated, the slump exceeds:
 - 100 mm for concrete in tunnel lining and behind steel tunnel liners
 - 80 mm for all other concrete except mass concrete
 - 50 mm for mass concrete.

Concrete with a lesser slump shall be used whenever concrete of such lesser slump can be consolidated into place by means of the vibration specified.

b) Hardened concrete shall be liable to rejection if:

- ◆ The compressive strength of any cylinder tested at Twenty-eight (28) days is less than the characteristic strength specified for the class of concrete being tested.
- ◆ The characteristic strength of the concrete for the particular class does not comply with ACI 318M.
- ◆ The drying shrinkage is more than zero point zero six (0.06) per cent plus or minus 0.005 per cent at Fifty-six (56) days. To achieve this, drying shrinkage measured in accordance with this Technical Requirements should be less than zero point zero four (0.04) per cent at Twenty-eight (28) days.
- ◆ The density of the concrete is less than 2 400 kg/m³.
- ◆ The chloride ion content of the concrete is not in compliance with ACI 318M.

5. Regulation of Water Content

- a) During batching, the Contractor shall periodically measure the moisture content of the fine aggregate held in the batch bins.
- b) The amount of water used in the concrete shall be regulated to adjust for any variation of the moisture content or grading of the aggregates as they enter the mixer.
- c) Addition of water to overcome stiffening of the concrete before placing will not be permitted. Concrete shall have uniform consistency from batch to batch.

- d) Aggregate shall not be batched for concrete or mortar when free water is dripping from the aggregate.

10.1.6. Standards and Codes

In this Specification, all or part of the standards and recommendations as listed in ACI 301 are applicable. These references include, but not limited to, the following:

- ◆ ASTM A416: Steel Strand, Uncoated Seven wire for Prestressed Concrete
 - ◆ ASTM A421: Uncoated stress Relieved steel wire for Prestressed Concrete
- a) American Society for Testing and Materials
- ◆ ASTM C29: Bulk Density (Unit weight) and voids in Aggregate
 - ◆ ASTM C42: Obtaining and testing drilled core and Sawed Beam of Concrete
 - ◆ ASTM C31: Standard Method for Making and Curing Concrete Test Specimens in the Field
 - ◆ ASTM C33: Specifications for Concrete Aggregates
 - ◆ ASTM C39: Compressive Strength of Cylindrical Concrete Specimens
 - ◆ ASTM C40: Organic Impurities in Sand
 - ◆ ASTM C70: Test for Surface Moisture in Fine Aggregate
 - ◆ ASTM C88: Soundness of Aggregate
 - ◆ ASTM C94: Ready Mix Concrete
 - ◆ ASTM C109: Test for Compressive Strength of Hydraulic Cement Mortars
 - ◆ ASTM C114: Chemical analysis of Hydraulic Cement
 - ◆ ASTM C117: Test Method for Material finer than 75 μm (No. 200)
 - ◆ ASTM C118: Concrete pipe for Irrigation or Drainage
 - ◆ ASTM C123: Light weight particle in Aggregate
 - ◆ ASTM C127: Test for Specific Gravity and Absorption of Coarse Aggregate
 - ◆ ASTM C128: Test for Specific Gravity and Absorption of Fine Aggregates
 - ◆ ASTM C131: Abrasion of Coarse Aggregate
 - ◆ ASTM C136: Test for Sieve or Screen Analysis of Fine and Coarse Aggregates
 - ◆ ASTM C138: Unit Weight, Yield and Unit Air Content (Gravimetric) of Concrete
 - ◆ ASTM C142: Clay Lumps and Friable Particles in Aggregate
 - ◆ ASTM C143: Slump of Portland Cement Concrete
 - ◆ ASTM C150: Standard Specification for Portland Cement
 - ◆ ASTM C151: Test for Autoclave Expansion of Portland Cement
 - ◆ ASTM C157: Length change of Hardened Hydraulic Cement of Concrete
 - ◆ ASTM C171: Sheet Materials for Curing Concrete
 - ◆ ASTM C172: Sampling Freshly Mixed Concrete
 - ◆ ASTM C191: Test for Time of Setting of Hydraulic Cement by Vicat Needle
 - ◆ ASTM C192: Making and Curing Concrete in the laboratory
 - ◆ ASTM C227: Test for Potential Alkali Reactivity of Cement Aggregate Combination (Mortar Bar Method)
 - ◆ ASTM C231: Test for Air Content of Freshly Mixed Concrete by the Pressure Method
 - ◆ ASTM C233: Testing Air Entraining Admixture for Concrete
 - ◆ ASTM C260: Air Entraining Admixtures for Concrete
 - ◆ ASTM C289: Test Method for Potential Reactivity of Aggregate (Chemical Method)
 - ◆ ASTM C309: Specification for Liquid Membrane Forming Compound for Curing

Concrete

- ◆ ASTM C451: Test for Early Stiffening of Portland Cement (paste method)
- ◆ ASTM C494: Chemical Admixtures for Concrete
- ◆ ASTM C535: Test for Resistance to Abrasion of Large Size Coarse Aggregate by use of the Los Angeles Machine.
- ◆ ASTM C618: Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete
- ◆ ASTM C881: Epoxy Resin Base Bonding Systems for Concrete
- ◆ ASTM C979: Pigments for Integrally Coloured Concrete
- ◆ ASTM C1017: Chemical Admixtures for Use in Producing Flowing Concrete
- ◆ ASTM D75: Sampling Aggregates
- ◆ ASTM D147:
- ◆ ASTM D412: Test Methods for Rubber Properties in Tension
- ◆ ASTM D422: Standard Method for Particle Size Analysis of Soils
- ◆ ASTM D792: Test Method for Specific Gravity of Density of Plastics by Displacement
- ◆ ASTM D1667: Flexible Cellular Materials Vinyl Chloride Polymers and Copolymers
- ◆ ASTM D1752: Performed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- ◆ ASTM E11: Wire Cloths and Sieve for Testing Purposes
- ◆ ASTM E323: Perforated Plate-Sieve for Testing Purposes
- ◆ BS 812: Testing of Aggregate
- ◆ BS 4251: Specification for Truck Type Mixture
- ◆ BS 12: Specification for Portland Cement
- ◆ BS 3963: Method for testing the mixing performance of concrete mixtures
- ◆ AS 3972: General Purpose and blended cement
- ◆ AS 1379: Specification and supply of concrete

b) American Concrete Institute

- ◆ ACI 211.1: Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- ◆ ACI 214: Recommended Practice for Evaluation of Compression Test Results of Field Concrete
- ◆ ACI 221: Recommended Practice for Selecting Proportions of Concrete
- ◆ ACI 301: Structural Concrete for Buildings
- ◆ ACI 304: Recommended Practice for Measuring, Mixing and Placing Concrete
- ◆ ACI 304.2R Placing Concrete by Pumping Methods
- ◆ ACI 305: Recommended Practice for Hot Weather Concreting
- ◆ ACI 308: Recommended Practice for Curing Concrete
- ◆ ACI 311.1R: Manual of Concrete Inspection
- ◆ ACI 311.4R: Guide for Concrete Inspection SP2
- ◆ ACI 318: Building Code Requirements for Reinforced Concrete
- ◆ ACI 343R: Analysis and Design of Reinforced Concrete Bridge Structures
- ◆ ACI 347: Recommended Practice for Concrete Formwork
- ◆ ACI 350: Concrete Sanitary Engineering Structures
- ◆ ACI 423.3R: Recommendations for Concrete Members Prestressed with Unbonded Tendons

c) United States Bureau of Reclamation

- ◆ USBR: Concrete Manual
- ◆ USBR Designation 13: Determination of Clay Lumps Content
- ◆ USBR Designation 22: Method of Slump Test
- ◆ USBR Designation 26: Mixer Performance Test

d) Indian Standard Codes

- ◆ IS 456 (2000): Plain and Reinforced Concrete
- ◆ IS 13920 (1993): Ductile detailing of reinforced concrete structures subjected to seismic forces
- ◆ SP 16 (1980): Design Aids for Reinforced Concrete to IS 456:1978
- ◆ IS 1893-1 (2002): Criteria for Earthquake Resistant Design of Structures
- ◆ IS 457 (1957): Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and Other Massive Structures
- ◆ IS 516 (1959): Method of Tests for Strength of Concrete
- ◆ IS 800 (2007): General Construction In Steel - Code of Practice

10.2. MATERIALS

10.2.1. Cement

1. Type of Cement

- a) All the cement to be used for the Works shall conform to ASTM C150, "Standard Specification for Portland Cement", or as otherwise approved by the Employer. In general cement of Type, I shall be used.
- b) The Contractor shall deliver with each shipment of cement a certificate, by which the cement is guaranteed to comply with the requirements of the Specifications. The certificate shall indicate the date of arrival of each shipment at the concrete plant, the quantity shipped and the identification of the silo, lot or bin at the factory, where the cement originate.
- c) The Employer reserves the right to take samples soon after delivery or at a later stage and to require the performance of tests of the cement that the Contractor uses or intends to use. If the tests demonstrate, that the delivered cement is not satisfactory, it shall be replaced.

2. Testing of Cement

- a) Cement shall be tested in accordance with the provisions of this Specification.
- b) Any cement, which has been stored on Site for more than Sixty (60) days, has to be representatively sampled and if the test results are not satisfactory, the cement shall be removed from the Site.

3. Maximum Storage Period

- a) Cement that has not been used within three (3) months from the date of initial sampling shall not be used in the Works unless it has been retested and is shown

to conform to the specified requirements.

4. Form of Delivery

- a) Cement to be used in the Works shall be delivered in bags or in bulk. The cement type has to be clearly indicated on each delivery.
- b) Cement in bags shall be delivered to the Site in strong paper bags, factory-sealed, unbroken or undamaged and uncontaminated by moisture, oil or other substance.
- c) Cement may be delivered in bulk provided that the Contractor furnishes adequate transportation, weighing devices and all the necessary facilities to warrant the good condition of the material when the shipments arrive at the Contractor's storage bins.
- d) The temperature of the cement as delivered to Site shall not exceed 60°C.
- e) If the cement has deteriorated during transportation, handling or storage, it shall be removed immediately from the Site.

5. Delivery of Bulk Cement

- a) Where cement is supplied in bulk containers, the following requirements shall apply:
 - All containers shall be completely weatherproof and maintained in good order and condition.
 - All apertures in the containers shall be fitted with completely watertight closures and shall be sealed after filling. Depending on the transportation methods adopted, the Employer may require being present when these seals are broken at any subsequent transfer or delivery point.
 - All containers shall be filled as completely as possible.
 - All containers shall be completely cleaned out at each transfer or delivery point after each and every use and before being returned for refilling.
 - Each and every container dispatched from the manufacturer's works or any intermediate transfer point shall be accompanied by a delivery docket signed by a responsible person which shall clearly show the brand and type of cement, identification number or numbers relating to the testing and certification of the cement, the date of filling the container and the net mass of the cement in the container. This docket shall be carried in a suitable fashion inside the sealed container and shall be handed over to the Employer at any subsequent transfer or delivery point.
 - Cement supplied in bulk shall not be re-bagged for use in the Works.

6. Delivery of Bagged Cement

- a) Where cement is supplied in bags the following requirements shall apply:
- Cement shall be delivered in sound undamaged bags uncontaminated by moisture, oil or any other substance.
 - Individual bags, which vary by more than 5 percent from the nominal mass, shall be rejected.

Where the average mass of 50 bags taken at random from any one consignment is less than the nominal mass, the whole consignment shall be rejected.

- Every bag shall be marked with the manufacturer's brand, the type of cement, identification number or numbers relating to the testing and certification of the cement, and the date the bag was filled.
- The contents of broken or damaged bags shall not be rebagged.

7. Storage and Handling of Cement

- a) The following requirements shall apply to the storage and handling of cement at site or at any intermediate transfer or storage point:
- All methods for transporting, handling and storing bulk and bagged cement shall be designed, constructed and arranged so as to ensure the use or transfer of cement in the approximate chronological order of manufacture.
 - Cement of both types has to be stored in sufficient quantity not to hamper the construction progress at any time.
 - All storage bins and cement handling equipment shall be completely weatherproof and substantially dust-proof and shall be designed and constructed so as to ensure that there will be no dead storage of cement.
 - The Contractor shall not set up cement handling facilities where cement dust may come in contact with electrical and mechanical equipment stored in the vicinity and to which cement dust will be deleterious.
 - All loading and unloading facilities for cement shall be under cover and weatherproof.
 - All storage bins and silos shall be drawn down so as to be substantially emptied for cleaning at regular intervals not exceeding three (3) months.
 - When cement is handled by pneumatic means, which involve contact of compressed air with the cement, the temperature of air in contact with the cement shall not at any time exceed 38 ° C. Where necessary, after-coolers or other means shall be provided to cool the compressed air. All compressed air supplies where the air may come in contact with the cement shall be fitted with filters for the removal of moisture, oil or any other contaminating substances. Such filters shall be regularly inspected and maintained by the Contractor.
 - All bagged cement shall be stored at all times, up to its use in the Works, in completely weatherproof structures, which shall include a raised floor and be adequately ventilated to prevent the accumulation of moisture.

- The floor of the stores shall have a wooden deck at least 30 cm above ground and shall be provided with waterproof membranes. Storage of cement in bags on the ground will not be permitted under any circumstances.
- All storage of bagged cement shall be arranged so as to permit easy access for inspection and definite identification of all cement in the storage.
- Cement in bags shall be stored in stacks not higher than 8 layers.
- Cement of different quality shall be stored in separate sections of the store or in separate silos.
- For each silo the following items shall be recorded and submitted on a weekly basis to the Employer:
 - ◆ Cement quantity in store at the end of the week;
 - ◆ Quantities, origins and storage locations of the batches delivered to Site during the week;
 - ◆ Daily quantities used from each silo.

8. Cement Used in Ready-mixed Concrete

- a) If ready-mixed concrete is used, the Contractor shall ensure that the supplier continuously maintains a record of the use of cement so related to the test certificates as to permit the immediate identification of cement in use at any time.

9. Temperature of Cement

- a) The temperature of the cement as delivered to the Site shall not exceed 60° C

10. Rejection of Cement

- a) Cement not conforming to the requirements of this Specification shall not be used in the Works.

10.2.2. Fly Ash

- a) Fly ash shall be used for replacing the cement content to an appropriate proportion in order to reduce the risk against the effect of alkali aggregate reaction which may be caused by using the aggregate produced from the sources available at the Site.
- b) Fly ash for use in all concrete and mortar shall conform to ASTM C618.

10.2.3. Admixtures

1. General

- a) Concrete admixtures shall comply with ASTM C260, C494 and C1017.
- b) Admixture containing calcium chloride will not be permitted.
- c) Only approved admixtures shall be used in the concrete, shotcrete or mortar for the Works. When more than one admixture is to be used, each admixture shall be batched in its own batcher and added to the mixing water separately before discharge into the mixer. Admixtures shall be delivered in suitably labeled

containers to enable identification. All admixtures shall be prevented from segregating before batching.

- d) Liquid or powdered admixtures shall be stored in such a way that the materials are used in the same chronological order as their delivery to the Site.
- e) Admixture which has been in storage at the Site for longer than six months, shall not be used until retest proves to be satisfactory.

2. Air-entraining Agent

- a) The Contractor will be permitted to use a neutralised, vinsol-resin, air-entraining agent. Where an alternative air-entraining agent is proposed, the Contractor shall demonstrate its compliance with ASTM C260, when tested with the cement, aggregates and admixtures used in the Works.
- b) The amount of air-entraining agent used in each concrete mix shall be such as will effect the entrainment of the percentage of air specified in the concrete at the point of delivery.
- c) The air-entraining agent shall be supplied and batched as a solution with a solids content not exceeding fifteen (15) per cent by mass, if using vinsol-resin with an approved, stable and consistent ph.

3. Expanding Agent

- a) The Contractor may use an expanding agent in a small amount of the concrete and mortar used in the Works. The expanding agent shall consist of an approved aluminium powder or other approved material.

4. Water-reducing, Set-retarding Agent

- a) The Contractor may use a water-reducing, set-retarding admixture and shall confirm to ASTM C494. The use of such an admixture will not be permitted to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be used as an aid to overcoming unusual circumstances and placing conditions.
- b) The specified limits in respect of maximum slump, slump loss during transit and the time allowed for concrete to remain in the mixer may be changed when a water-reducing, set-retarding agent is used.

5. Calcium Chloride

- a) Calcium chloride shall not be used as an admixture in any concrete or grout.

10.2.4. Mixing Water

- a) The water used for mixing, rinsing and curing concrete and/or processing concrete aggregates, shall be clean and free from oil, salt, alkali, silt, organic matters or other substances deleterious to concrete such as clay and mud, etc., The total dissolved solid in the water shall not exceed 2,000 parts per million.

- b) The water shall conform to the requirement of ASTM C94.
- c) The aggregate moisture content shall also be considered as mixing water. The content shall be determined in compliance with ASTM C70.
- d) If, water from local natural sources should contain, at certain times, quantities of impurities in excess of these limits, the Contractor will be required to take all necessary measurements for ensuring its purity before use.

10.2.5. Aggregates

1. General

- a) The Contractor shall produce or purchase fine and coarse aggregate for concrete from suitable rock material from required excavation in the Works, from deposits of river sand and gravel.
- b) Fine and coarse aggregates shall conform to ASTM C33 and to the requirements of this Specification.

2. Tests

- a) Aggregate shall be tested in accordance with the provisions of this technical requirements.

3. Deleterious Substances

- a) Aggregates shall consist of hard, dense, durable, uncoated rock particles and shall be free from organic matter and the amounts of dust, clay lumps, soft or flaky particles, shale, alkali, loam and other substances considered deleterious by the Employer shall not exceed the values in the following table:

Maximum Amounts of Deleterious Substances

Item	Maximum Percentage by Mass	
	Fine Aggregate	Coarse Aggregate
Material passing 0.075 mm sieve	2.0	0.5
Lightweight material	1.0	1.0
Organic impurities	Zero	Zero
Clay lumps	1.0	0.5
Other deleterious substances (such as alkali, mica, coated grains, soft and flaky particles and silt)	2.0	1.0

- b) The sum of the percentages of all deleterious substances in aggregate as delivered to the mixer, shall not exceed three (3) percent for fine aggregate and two (2) percent for coarse aggregate.
- c) Fine aggregate which produces expansion in, or deterioration of concrete

through reactivity with alkalis in cement or other causes shall not be used in the works. The test for alkali reactivity shall be in accordance with ASTM C227.

- d) Aggregate which, when tested in accordance with ASTM C289, Figure 2, is considered deleterious, will be rejected.

4. Particle Shape

- a) The aggregates shall consist substantially of particles of satisfactory shape. A particle of satisfactory shape is defined as a particle having a maximum dimension not greater than three (3) times the minimum dimension. The shape of the particles in the fine and coarse aggregate shall be generally spherical or cubical.
- b) The sum of elongation and flakiness indexes of manufactured coarse aggregates as calculated with BS812 shall not exceed 60%.

5. Grading of Fine Aggregate

- a) The fine aggregate as batched shall be well graded and when tested shall conform to the limits specified.
- b) The grading of the fine aggregate shall be so controlled that at any time the fineness module of at least nine (9) out of ten (10) consecutive test samples of finished fine aggregate will not vary more than 0.20 from the average fineness modulus of the ten (10) test samples.
- c) Where fine aggregates from different sources are being used at the one batching plant at the same time, they shall be so blended to ensure uniform grading and color in successive batches.

Grading of Fine Aggregate

Sieve size (mm)	Percentage of total mass passing sieve
9.50	100
4.75	95-100
2.36	80-100
1.18	50-85
0.60	25-60
0.30	10-30
0.15	2-10
Pan	2-5

6. Nominal Size Range and Grading of Coarse Aggregate

- a) The coarse aggregate as batched shall be separated into nominal sizes and shall be well graded such that when tested by the sieves designated in the following table the minimum amounts of intermediate sizes are:

NOMINAL SIZE RANGES OF COARSE AGGREGATE

Designation of Aggregate size (mm)	Nominal size range (mm)	Minimum percentage of total mass retained on sieve indicated
10	5 to 10	Not applicable
20	10 to 20	25 on 16.0 mm
40	20 to 40	25 on 32.0 mm
80	40 to 80	25 on 63.0 mm

- b) Separation of the coarse aggregate into the specified sizes shall be such that when the aggregate, as batched, is tested by the sieve designated in the following tabulation, the materials passing the undersize test sieve shall not exceed two (2) per cent by mass, and all materials shall pass the oversize test sieve.

Designation of Aggregate Size (mm)	Size of Square Opening in Sieve	
	For undersize test	For oversize test
10	4.0	11.2
20	8.0	22.4
40	16.0	45.0
80	32.0	90.0

- c) The grading of the coarse aggregate within the separated size groups according to ASTM E11 and ASTM C136 shall conform to the following requirements as delivered to the mixer.

Sieve Size	Percentage Passing Individual Sieves by Weight	
U.S. Standard Square Mesh	4.8 to 19.1 mm (No. 4 to 3/4")	19.1 to 38.1 mm (3/4" to 1 1/2")
50.8 mm (2 inch)	-	100
38.1 mm (1 1/2 inch)	-	90 - 100
25.4 mm (1 inch)	100	20 - 45
19.1 mm (3/4 inch)	90 - 100	0 - 10
9.5 mm (3/8 inch)	30 - 55	0 - 5
4.8 mm (No. 4)	0 - 5	-

7. Other Properties

a) Aggregate which does not comply with the following may be rejected.

	Fine Aggregate	Coarse Aggregate
Minimum specific gravity	2.56	2.56
Aggregate strength (on fraction greater than 9.5 mm)		
· Minimum wet strength	N/A	80 kN
· Maximum wet/dry strength variation	N/A	35%
Maximum weighted loss of a portion retained on an 0.300 mm sieve when subject to 5 cycles of sodium sulphate test	8% by mass	10% by mass
Maximum loss in Los Angeles abrasion test	N/A	35%
Maximum sum of flakiness and elongation indices	N/A	60%
Minimum fineness modulus	2.10	N/A
Maximum fineness modulus*		
natural sand	3.10	N/A
manufactured sand	2.80	N/A
*For a mixture of natural sand and manufactured fine aggregate the maximum fineness modulus shall have a value between 3.10 and 2.80 in proportion to the constituent materials.		

8. Storage of Aggregates

- Fine and coarse aggregates shall be stored separately in such a manner as to prevent inclusion or intrusion of foreign matters, or the intermixing of various sizes in the bins.
- Aggregates shall be stored only in covered steel silos or bins or under approved sheds.
- Fine aggregate must reach the mixing plant with uniform and constant moisture, which shall not exceed 6% of its dry weight. Variations in moisture content shall not exceed 0.5 % from hour to hour or 2 % over a ten (10) hours concreting shift.
- The method of testing for surface moisture shall be in accordance with ASTM C70.
- Sufficient aggregate shall be maintained on the Site at all times, to permit continuous placement and completion of any lift of concrete started.
- Methods of stockpiling, which permit the aggregate to roll down the slope as it is added to the pile, or which permit hauling equipment to operate over one area at the same level repeatedly, or which permit the free fall of material from a stacker, allowing fine material to be separated from coarse material by wind, will not be allowed. Stackers, if used, shall have an adjustable discharge height so that excessive dropping heights can be prevented.

10.3. EXECUTION

10.3.1. Production of Coarse and Fine Aggregate

1. Source

- a) Only aggregates from approved sources shall be used in the Works.
- b) Should the Contractor elect to process aggregates from alluvial deposits, the material shall be removed in an approved manner, and the areas cleaned up or restored all in accordance with the provisions of this Specification.
- c) Approval of the Contractor's use of any deposits shall not be construed as constituting approval of all materials taken from the deposit, and the Contractor will be held responsible for the specified quality of all such materials used in the Works.

2. Clearing

- a) Before excavating materials for the production of concrete aggregate, the Contractor shall clear trees, roots, brush, sods, clay, unsuitable sand and gravel, weathered and unsound rock and other objectionable matter from all of those portions of the surface deposits from which aggregates are to be produced.
- b) The areas from which aggregates are to be obtained shall be located and operated so as not to detract from the usefulness of the deposits or any other property and so as to preserve, insofar as is practicable, the future usefulness or value of the deposits. Materials, including stripping, removed from the deposits and not used in carrying out the Works shall be disposed of as specified.

3. Processing

- a) Processing of the raw materials may include crushing, screening and washing, milling and blending, to produce fine and coarse aggregates meeting the requirements of this Specification.
- b) Water used for washing aggregate shall comply with the provisions of this Specification.
- c) After washing, fine aggregate shall be stored in stockpiles with a free draining base for at least 72 hours and shall be subsequently handled to ensure that sand delivered to the batching plant has a uniform and stable moisture content.
- d) Where the surface of stockpiles from which fine aggregate is being delivered directly to the batching plant is substantially drier or wetter than the bulk of fine aggregate in the pile, handling shall be such as to exclude this surface material from the batching plant.

10.3.2. Batching and Mixing

1. Plant

- a) If the Contractor installs at the Site a plant for batching concrete ingredients, it shall be constructed and operated in accordance with Section 4 of AS 1379 / BS

3963 / ASTM C94 and this Specification.

- b) The plant shall be an efficient and dependable, automatically or semi-automatically controlled batching plant capable of supplying concrete at a rate adequate to meet the requirements of the Contract.

2. Measuring and Tolerances

- a) Cement shall be weighed separately on an individual scale. Water shall be weighed separately on an individual scale or may be measured by volume. All other ingredients shall be measured by mass except that liquid admixtures may be measured by mass or volume. If water is measured by volume, two (2) flow meters shall be installed in parallel so that no delay shall result from faulty operation of the meters.
- b) The equipment shall be capable of controlling the delivery of each size of aggregate to the mixer within the tolerances specified in ASTM C94.

3. Calibration

- a) The construction and accuracy of the weighing and measuring equipment will be such that the equipment will maintain accuracy within 0.4% of the scale capacity. The equipment will be capable of ready adjustment for compensating for the varying weight of any moisture contained in the aggregates and for effecting changes in concrete mix proportions.
- b) Batching equipment shall be maintained and operated so that the combined inaccuracies in feeding and measuring the materials will not exceed 1.0% for water, air-entraining agent or other ingredients and 3.0% for cement and each size of aggregate.
- c) The Contractor shall provide standard certified test weights and any other auxiliary equipment required for checking the accuracy of each measuring device.
- d) The Contractor shall calibrate each measuring device. Such tests shall be made at least once every month in the case of equipment for measuring aggregates and at least once every two weeks in the case of equipment for measuring cement, water and admixtures.
- e) The Contractor shall furnish copies of the complete results of all calibrations to the Employer and shall adjust, repair or replace any measuring device, which does not meet the requirements for accuracy.

4. Batching and Weighing Equipment

- a) The batching equipment shall be capable of handling a minimum of two (2) different sets of mix proportions without the necessity of resetting the scales manually and shall be capable of recording the batches of each mix separately.
- b) Materials shall be weighed individually and each weighing device shall be equipped with a visible springless dial, which shall register the scale load at any stage of the weighing operation.

- c) The Contractor shall provide all necessary facilities for obtaining representative samples of aggregates and cement from the discharge streams between the bins and weigh-hoppers or between weigh-hoppers and the mixers.
- d) All gates and closing devices shall be positive in action and shall prevent leakage of materials when in the closed position.
- e) Batching equipment shall be interlocked so that:
 - ◆ A new weighing cycle cannot be started until all weigh-hoppers are completely emptied and the discharge gates closed.
 - ◆ The discharge-gates of the weigh-hoppers cannot be opened until the correct masses of materials are in and the scales in balance.
 - ◆ The discharge-gates cannot be closed until all materials are entirely discharged and the scales are back in balance.
 - ◆ The discharge-valve of the water-measuring device cannot be opened until the filling-valve is closed.
 - ◆ Accidental over batching of admixtures is prevented.
- f) The batch bins will be constructed so as to be self-cleaning during drawdown and the bins shall be drawn down until they are practically empty at least three times per week. Materials shall be deposited in the batch bins directly over the discharge gates. The coarse aggregate shall be deposited in the batch bins through effective rock ladders when the distance through which the aggregate would fall is greater than 1.0m. Equipment for conveying batched materials from the batchers or hoppers to and into the mixer shall be so constructed, maintained and operated that there will be no spillage or contamination of the batched materials or overlap of batches. Equipment that fails to conform to this requirement shall be effectively repaired, modified or replaced.
- g) When cement and aggregates are hauled from a central batching plant to the mixer, the cement for each batch shall be placed in an individual covered watertight compartment, which, during transit, will prevent the cement from intermingling with the aggregates and will prevent loss or contamination of cement. Aggregates shall be covered to prevent changes in moisture content during transit. Each batch compartment shall be of sufficient capacity to prevent loss in transit and to prevent spilling and intermingling of batches as compartments are being emptied. Surface haulage of batched aggregates from a central batching plant to mixers will not be permitted, if when so hauled the changes in moisture content of the fine aggregate between batching plant and mixer exceeds 1%.

5. Records

- a) The batching equipment shall include an accurate recorder for making a continuous, visible record, combined on a single chart, of the measurement of each separate concrete ingredient, including all mixing water and admixtures. The recording equipment shall include facilities for automatically registering on the chart the time of day at intervals of not more than 15 minutes. The recorder shall be so constructed that the Employer can view the recorder chart and make notes on the chart without interfering with the plant operators. All graphic records shall be

furnished to the Employer at the completion of each day's production. The records shall become the property of the Employer.

6. Mixer

- a) The concrete ingredients shall be mixed thoroughly in batch-mixers, which are so designed as to ensure uniform distribution of all of the component materials throughout the mass at the end of the mixing period.
- b) The Contractor shall not use any mixer that does not conform to the requirement of "Uniformity Test of Mixer" designated in ASTM C94.

7. Testing

- a) The approved laboratory shall test mixers to ensure compliance and the Contractor shall submit the results to the Employer. Every mixer shall be tested not more than Thirty (30) days before being used to manufacture of concrete required under this Specification.

8. Truck-mounted Mixer and Agitation Units

- a) Truck-mounted mixer and agitator units and the mixing and transporting of concrete in such units shall be in accordance with the requirements of AS 1379 Sections 5 and 6 / BS 4251 / ASTM C94. Each unit shall be fitted with a mixer drum revolution-recording counter, which can be manually reset, to zero, but shall not be capable of being advanced.

9. Mixing Time

- a) The mixing of each batch shall continue for not less than the time recommended by the batch plant manufacturer.
- b) The minimum mixing periods recommended by the batch plant manufacturer are conditional on the materials being fed into the mixer in a manner which will facilitate efficient mixing and on operation of the mixer at its designed speed.

10. Charging Sequence

- a) The concrete of a given composition, as discharged from the mixer, shall be uniform in composition and consistency within batches and from batch to batch.
- b) Water shall be added before, during and following the mixer-charging operations. Excessive over-mixing, requiring addition of water to preserve the required concrete consistency, will not be permitted.

11. Discharging Period

- a) Concrete shall be completely discharged from the mixers or agitator drums within 40 minutes after the mixing water has been added to the dry ingredients. During weather not conducive to quick stiffening of concrete, this period may be extended.
- b) Any concrete which requires additional water to be added to permit satisfactory discharge or placing will not be accepted regardless of the time which has elapsed since the mixing water has been added. Such rejected concrete shall be removed

from the Works with the least possible delay.

12. Mix Proportion

a) Mix proportions shall be designed by the Contractor to obtain a workable mix, suitable for the specific conditions of placement and a product which, after proper curing and adequate setting time, will have acceptable durability, impermeability and the required strength.

- ◆ To obtain the best results, the type of the structure concerned and the pouring procedure involved shall be taken into consideration for proportioning.
- ◆ The Contractor shall be fully responsible for producing and maintaining the quality of concrete with especially compressive strength not inferior to the specified one.
- ◆ After successful completion of tests, the Contractor shall inform the Employer of the proportioning of mixtures to be adopted for the various classes of concrete.
- ◆ During the progress of the concrete work, additional trials shall be made with the purpose of improving the proportions of the various classes of concrete. Mix proportions of concrete shall be determined by the Contractor in accordance with the requirements of the Specification.

b) Required Compressive Strength for Mix Proportion

- ◆ During proportioning tests the average value of the compressive strength of three cylinders made from that concrete mix shall be as follows:
- ◆ If a record of at least 30 compressive strength tests of the same concrete mix is available, the serial compressive strength shall exceed the required compressive strength by at least:
 - 10% if the standard deviation is less than 0.07;
 - 15% if the standard deviation is between 0.07 and 0.10;
 - 20% if the standard deviation is between 0.10 and 0.14;
 - 25% if the standard deviation exceeds 0.14.
- ◆ If above mentioned record is not available, the required average compressive strength shall be 25% higher than the required compressive strength.
- ◆ Each test shall represent the average of at least three cylinders.

c) Water/cement Ratio

- ◆ The net water content of all concrete mixtures shall be the minimum necessary to properly place the concrete.
- ◆ Mixing water shall include all water present, that is the surface moisture in the aggregate and the water added in the mix. It shall not include the moisture absorbed by the aggregate reaching a saturated surface dry state.
- ◆ Surface moisture content in the aggregates shall be determined in accordance with ASTM C 70.

- ◆ The water/cement ratio shall be determined by the requirements for specified strength, durability and impermeability.
- ◆ Addition of water to overcome stiffening of the concrete before placing will not be permitted.
- ◆ Once the proportion of a mix including its W/C ratio has been determined and specified for use in a structure, it shall be maintained constant during the pouring.

d) Consistency and Slump

- ◆ Concrete shall have a consistency and workability suitable for the conditions on the work. For most of concrete, a "plastic" mix is required so that the concrete will not crumble but will flow sluggishly when vibrated, without segregation.
- ◆ Slump tests shall be performed in accordance with the "Standard Method of Slump Test for Consistency of Portland Cement Concrete", ASTM C 143.
- ◆ Wherever the limits for consistency and/or slump are exceeded, the concrete shall be rejected and removed at the Contractor's expense.

13. Concrete Not Accepted

a) The concrete shall be rejected in any of the following events:

- ◆ When mixing operations have not been started within thirty (30) minutes after the cement is added to the aggregates;
- ◆ When more than fifteen (15) minutes have elapsed between the discharging of the mixer and the actual placing of the concrete, without agitating the concrete mix;
- ◆ When more than one (1) hour has elapsed between adding of the cement to the aggregates, and the actual placing of the concrete; even when agitator trucks are used for transport of concrete unless the mix is not designed with retarders and approved by the Employer for higher time duration.
- ◆ When the mixture does not comply with the Specification.

b) Lesser time shall be adopted, if hot weather or other conditions cause quick stiffening of the concrete.

c) None of the concrete rejected shall be utilized in any of the permanent works.

10.3.3. Transportation

1. General

- a) Concrete shall be conveyed from the mixer to the place of final deposition, and finally poured as rapidly as practicable by approved methods, which will prevent segregation, loss of ingredients or damage by exposure to the atmospheric agents, and shall be deposited to its final position as practicable as possible. Concrete can be conveyed by truck mixers and agitators, buckets, truck or rail cars chutes and pipes, belt conveyors, concrete pumps. Conveying equipment shall be of such size, design and condition to ensure a practically continuous supply of concrete at the point of placement, and a concrete placing in approximate

horizontal layers while the previous layer is still soft.

- b) All conveying equipment shall be supported independently of the forms. The conveying equipment shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.
- c) Should the concrete show signs of segregation when it reaches the placing point, and provided that the maximum permissible time has not elapsed, it shall be remixed by mechanical means in the vicinity of the placing point. Otherwise, it shall be rejected at Contractor's expense.
- d) In particular, the Contractor shall take appropriate measures to avoid excessive loss of moisture by evaporation, during the transportation and placing of the concrete. Addition of water in the mixture to make up for the evaporation losses shall not be permitted.

2. Conveying Equipment

- a) Truck mixers and agitators
 - Truck mixers and agitators may be used for agitating and transporting mixed concrete to the point of delivery.
 - Truck mixers may be employed for mixing concrete to be used for minor works. Measuring tanks on truck mixers shall be equipped with water meter for readily and accurately determining the amount of water in the tank.
 - Truck mixers and agitators shall be capable of discharging the concrete with a satisfactory degree of uniformity.
 - The concrete mixed in truck mixers shall not be discharged until at least twenty revolutions performed at the optimum speed are completed.
 - When concrete is mixed completely in a stationary mixer and a truck mixer or agitator is used for transporting the concrete to the delivery point, the concrete shall be mixed in accordance with the Specification, and agitating during transport shall be at the minimum speed.
 - The mixers and agitators shall be operated within the limits of capacity designated by the manufacturers of the equipment.
- b) Bottom dump buckets
 - Bottom dump buckets moved by cranes and other similar equipment will be adopted as normal means for placing concrete except where their use is not technically possible. The buckets shall be capable of prompt discharge of low slump, lean mix concrete. The dumping mechanism shall be capable of controlling the discharge at a slow rate, and of discharging a relatively small portion of concrete in one place. Dumping of buckets on the swing or in any manner which results in separation of ingredients or disturbances of previously placed concrete will not be permitted.

c) Truck or rail cars

- The conveying of concrete by trucks or rail cars, without agitating equipment will be permitted provided the concrete has a slump of 50 mm or lower and that the equipment has a proper cover when used outdoor.
- Trucks and rail cars used for transporting non agitated concrete shall be of a type specially designed for transporting and discharging concrete unless the trucks or rail cars are used for conveying concrete in approved concrete buckets.
- Bodies of non-agitating trucks shall be smooth preferably stream lined, water tight metal containers equipped with gates that will permit control and ready discharge of the concrete.

d) Chutes and pipes

- Chutes and pipes shall be of a design such that segregation of the concrete constituents will not occur. The chutes shall have a smooth, mortar tight lining (preferably metal) and sides sufficiently high to prevent the concrete from falling over. A vertical drop at the end of chutes and pipes shall be provided, preferably in the form of two sections of metal drop chutes, to prevent segregation. Pipes shall be protected from sun, wind and rain, and shall be less than 10 m in total length.

e) Belt conveyors

- Belt conveyors used for the transportation of concrete, or for pouring shall have such a shape, size and speed as to prevent the loss of concrete on the way, and their slope shall be such as to avoid the displacement or sliding of the coarse aggregates, which would cause the segregation of the concrete. At the ends, such belts shall be furnished with scraper blades to avoid that the finer part of the concrete may remain on the belt conveyor.
- Segregation at transfer points and ends shall be avoided by the use of suitable hopper and drop chutes. The conveyors shall be protected from sun, wind and rain.
- If necessary, to prevent exposure of the concrete during transportation, the belt conveyors shall be furnished with a continuous protective cover.

f) Concrete pumps

- Concrete pumps may be used for the transportation of the concrete on condition that the concrete to be poured is designed with a slump of 100 mm or more. Furthermore, the increased cement content generally acquired for pumped concrete will not be paid for.
- Pneumatic pumps i.e. pumps which need compressed air to move the concrete are not permitted unless otherwise approved by the Employer.
- Addition of water to the mixture after it has been discharged from the mixer shall not be permitted, neither during the loading of the pump nor at the outlet of the

piping which conveys the concrete.

- The joints between the various elements which form the piping shall be perfectly tight, to avoid water leakage and loss of the finer part during pumping operations.
- Delivery piping shall be arranged to provide sufficient delivery points, so that segregation caused by flowing of concrete in the forms will not occur.

10.3.4. Temperature of Concrete

Placing Temperature

- a) The temperature of all concrete when it is being placed shall not exceed:
 - ◆ 30°C for structural concrete
 - ◆ 25°C for mass concrete
 - ◆ 30°C for all other concrete
- b) The temperature of all concrete when it is being placed shall not fall below:
 - ◆ 7°C when the mean daily temperature drops below 5°C for two or more successive days and the special measures for protection of the concrete are adopted as specified
 - ◆ 10°C at other times

Cooling Plastic Concrete

- a) The Contractor shall, where necessary, employ effective means such as precooling the aggregates, refrigerating the mixing water, adding chipped or flaked ice to the mixing water, placing at night or a combination of these or other methods to ensure that the concrete does not exceed the temperatures specified.

Heating Plastic Concrete

- a) Whenever it is necessary to maintain the temperature of the concrete above the temperatures specified as it is placed, the Contractor shall heat concrete ingredients to a temperature not higher than that necessary to keep the temperature of the mixed concrete, from falling below the specified temperature. In no case shall any ingredient be heated to a temperature higher than 60 ° C. Methods of heating concrete ingredients shall be subject to approval.

Cooling Hardened Concrete

- a) In addition to the requirements of this Clause, the Contractor will be required to control the temperature of mass concrete after placing.
- b) To control the concrete temperature, the Contractor, if necessary shall use cooling pipes. All costs to install the cooling pipes as well as supplying and draining water to the cooling pipes shall be included in the unit price of the concrete.

10.3.5. Sampling and Testing

1. Testing Facilities

- a) The Contractor shall provide a laboratory and all equipment required for concrete and materials for concrete. The Contractor shall also provide an approved

laboratory supervisor and all other personnel required for performing sampling and testing.

- b) At all batch and mixing plants the Contractor shall provide and maintain a lock-up, weatherproof, dustproof, soundproof room for use by the Employer. The room shall have a minimum area of 15 m² with a 3.5 m high ceiling and shall be located immediately adjacent to and on the same level as the operations console of the plant. Each room shall be furnished with a bench 3 m long by 60 cm wide, fitted with a sink connected to drainage with a water supply over and electricity power points and fluorescent lights. The design layout and location of each room shall be submitted, for approval, and all costs associated with the provision of these rooms shall be included in the rates for concrete.

2. Standards

- a) Sampling and testing of concrete materials, plastic concrete and hardened concrete shall be in accordance with the testing methods and recommended practices of the approved Standards, which shall be equivalent to the following, specified Standards.
- b) Tests on materials for concrete, plastic concrete and hardened concrete shall include, but not necessarily be limited to, those listed in the following tables.
- c) All sieve sizes referred to in this Section refer to the aperture dimensions in millimetres of sieves conforming to ASTM E11 and ASTM E323.
- d) In checking the grading of aggregate and other materials imperial size ASTM sieves shall be related to specified metric sizes.

Standards for Testing Concrete

Test	Designation No.
Sampling	ASTM C172
Compressive strength	ASTM C39
Slump	ASTM C143
Air Content	ASTM C231
Unit weight	ASTM C138
Chloride ion content	ACI 318M
Drying shrinkage	ASTM C157

Standards for Testing Aggregate

Test	Designation no.	Sampling/testing Frequency (m ³)
Sampling	ASTM D75	500
Flakiness and Elongation	BS812	2500
Material finer than 0.075 mm	ASTM C117	500
Light particles	ASTM C123	500
Friable particles	ASTM C142	500
Organic impurities	ASTM C40	500

Soundness	ASTM C88	2500
Grading	ASTM C136	500
Los Angeles Abrasion	ASTM C131, C535	500
Unit weight	ASTM C29	2500
Specific gravity and absorption	ASTM C127, C128	500
Alkali Reactivity	ASTM C227, C289	2500

Standards for Testing Fly Ash

Test	Designation No	Sampling/testing Frequency
Moisture content	ASTM C311	1 per 400 t
Loss on ignition	ASTM C311, C114	1 per 400 t
Fineness	ASTM C311, C430	1 per 400 t
Autoclave expansion	ASTM C311, C151	1 per 400 t
Specific gravity	ASTM C311, C118	1 per 400 t
Pozzolanic activity	ASTM C311, C109	1 per 400 t
Remaining physical and chemical tests	ASTM C311, C114 and C411	1 per 2000 t

3. Testing Cement at Source

- Cement shall be sampled at the source and tested by the manufacturer and certified as conforming to the requirements of this Specification before being dispatched from the factory of the cement manufacturer. All costs associated with the sampling and testing shall be included in the rates for concrete.
- Bulk or bagged cement used for concrete, mortar or shotcrete shall be tested by taking one grab sample representing not more than 300 tons of cement manufactured in an uninterrupted process and stored in one silo. The sample shall be tested for all the requirements given in ASTM C150 by the methods given in that Standard. Cement shall have an alkali content, or Na_2O equivalent, of less than 0.6 percent. Test results shall be forwarded to the Employer within a period following testing as determined by the Employer.
- The Employer may allow a reduction in the tests made for the determination of the chemical oxide and hypothetical compound composition, and for the heat of hydration, provided that at least one of these tests shall be made from one randomly selected grab sample representing an uninterrupted manufacture of not more than 1000 tones of cement stored in one silo.
- Cement used for pressure grouting shall be additionally sampled by taking one grab sample (usually one integral bag), representing not more than 480 bags filled with cement manufactured in an uninterrupted process and delivered to the Site in one consignment. This additional sample shall be tested in accordance with AS 3972 / BS 12 / ASTM C150 for specific surface and for the percentage of material retained on the 0.150 mm and 0.075 mm sieves.

- e) The Employer may require the Contractor to take random samples of cement from any bulk or bagged storage, transfer point or usage point and arrange for testing. Cement found not to comply with the requirements of this Technical Requirements shall be removed from the Site. The Employer may require the removal of any concrete, mortar or shotcrete produced with cement not complying with the requirements of this Technical Requirements.
- f) Cement found not to comply with the requirements of this Specification should be removed from the Site.

4. Testing Aggregate

- a) Not less than Sixty (60) days before placing any concrete, the Contractor shall submit to the Employer results of tests on representative samples of the proposed aggregates that have been tested by the approved laboratory for compliance with this Specification.

5. Sampling and Testing Fly Ash

- a) The Contractor shall take samples of fly ash from any storage, transfer point or usage point and arrange for testing. Fly ash found not to comply with the requirements of this Specification should be removed from the Site.
- b) Fly ash shall be sampled by taking one grab sample representing not more than 400 tons of fly ash proposed for use in concrete.

6. Sampling and Testing Plastic Concrete

- a) The Contractor shall sample concrete, for testing, from the batching and mixing plant, delivery trucks, at the forms or elsewhere where concrete is being handled or placed. Samples shall be obtained at uniform intervals, as directed, throughout the production or delivery of concrete for a given placement. A placement shall be considered as an operation involving the continuous placing of concrete between adjacent construction joints. In general, the frequency of sampling of a class/type of concrete in any one placement shall be in accordance with the following table for at least slump, air content and concrete temperature of fresh concrete and 28-day compressive strength.

Frequency of Sampling Concrete

Up to 10 m ³	1 sample
10 to 40 m ³	2 samples
40 to 80 m ³	3 samples

For each additional 50 m³, one (1) additional sample shall be taken.

- b) Where the concrete is deposited in to the forms directly from the agitator truck chute, sampling shall be from the discharge and the sampling procedure will be as ASTM C172.
- c) The Contractor shall test the plastic concrete to determine its compliance with

the provisions of this Specification.

- d) The number and frequency of the tests on plastic concrete shall be not less than four (4) tests for each eight (8) hours of concrete production.
- e) Tests for chloride ion content will be required whenever the source of cement, coarse aggregate or fine aggregate is varied from the sources approved by the Employer for use in the various classes of concrete.

7. Testing Cylinders or Cubes

- a) The compressive strength of the concrete will be determined by tests on 150 mm diameter by 300 mm cylinders / 150 mm cubes. Concrete containing aggregate coarser than 40 mm shall be sieved to remove all larger particles before the cylinders / concrete cubes are made.

8. Test result of Compressive Strength

- a) The compressive strength of an individual class of concrete placed in the works shall be considered satisfactory if test result is met with the requirement of ASTM C94 and ACI 318.

9. Testing Hardened Concrete in Structures

- a) Hardened concrete liable to rejection may be tested for compressive strength in accordance with ASTM C42 Core specimens shall be 150 mm in diameter. At least three (3) specimens shall be tested.
- b) If the average compressive strength of the core specimens so obtained is more than 85% of the specified and more than 75% of minimum strength for that section of the Works, then the concrete represented by the core specimens shall be considered to be structurally satisfactory.
- c) If the concrete is considered to be structurally satisfactory, then the holes left by the removal of the test cores shall be repaired as specified.
- d) Unless otherwise directed concrete which fails to meet the requirements of this Clause shall be removed and replaced in a manner approved by the Employer.
- e) Impact hammer test shall not be acceptable as a means of verifying that hardened concrete liable for rejection is structurally satisfactory.

10.3.6. Concrete Construction

1. General

- a) All concrete construction shall conform to the requirements of this sub-clause of the Specification. All structures shall be built in a workmanlike manner to the lines, grades and dimensions shown on the Drawings approved by the Employer.

2. Accessories

- a) The Contractor shall place and attach to each structure all timber, metal or other accessories necessary for its completion, as shown on the Drawings approved by

the Employer.

3. Changes to Dimensions

- a) The dimensions of each structure shown on the Drawings approved by the Employer will be subject to such changes to adapt the structures to the conditions disclosed. Such variations shall not modify the terms and the unit prices and shall give the Contractor no rights for other claims.

4. Changes in Color

- a) Abrupt changes in color of external concrete surfaces exposed to public view will not be permitted. The Contractor shall ensure that as far as possible these surfaces shall be of uniform or well-graded color.

5. Application of Loads

- a) Loads shall not be applied to concrete placed in the Permanent Works without prior approval.

6. Joint Fillers and Sealants

- a) Not less than Fifty-six (56) days before use, the Contractor shall submit to the Employer samples of the proposed joint fillers and sealants together with the manufacturer's technical data and the details of the recommended method of application.

10.3.7. Construction, Contraction and Expansion Joints

1. Construction Joints

- a) The shape and position of all construction joints shall be proposed by the Contractor and are subject to the approval of the Employer, if not shown on the Drawings.
- b) Construction joints shall be sealed by waterstops or other means if so shown on the Drawings approved by the Employer.
- c) Construction joints needed between invert and side wall and arch due to separate construction of the portions if so approved shall fully guarantee water tightness. Construction joints shall not cause any irregularity on the surface.
- d) After the initial set, but before final hardening of the concrete, the unshuttered surface of the joint shall be washed with water and compressed air jets to thoroughly remove the top layer of mortar and all semi-detached parts from the surface, and to expose the upper half of the big-size aggregates without loosening or undercutting them.
- e) If the surface of a lift with reinforcing steel is congested and is relatively inaccessible, or if for any other reason disturbing an unhardened surface is considered undesirable, green cutting by air-water jets will not be permitted and the use of wet sand blasting will be required after hardening of the concrete.
- f) When employed in the preparation of construction joints, wet sand blasting shall

be performed immediately before final cleaning for the following lift. The operation shall be continued until all unsatisfactory concrete and all laitance, coatings, stains, debris and other foreign materials are removed.

- g) Immediately before pouring is resumed, air and water jet cleaning will be repeated, until the washing water remains quite clear; the Contractor shall deal in a controlled way with the water employed in washing, carefully diverting it from the pouring zone, leaving the surface wet, but without water puddles.
- h) The air pressure used in the jet shall be not less than 0.6 MPa, and the water pressure shall be sufficient for thorough cleaning.
- i) When construction joints are not covered with concrete within Twenty (20) days after their formation, the Contractor shall apply wet sand blasting or roughen all surfaces by light jack hammering, when preparing for the next lift. The extent of concrete to be removed will be indicated by the Employer. The treatment described above shall also be carried out when construction joints have been covered by stagnant water for a period of more than Ten (10) days or by foreign materials difficult to remove by normal cleaning operations.
- j) Formed surfaces of construction joints shall be roughened prior to continuing concreting and shall be clean and free from oil, objectionable coatings and loose, semi-detached or unsound fragments. The period of moistening of concreted surface shall not be less than Two (2) days. Wherever possible, forms for construction joints shall be made of expanded metal.
- k) Formed surfaces of construction joints to be grouted shall be cleaned of all accretions of concrete or other foreign material by scraping, chiselling or other effective means.

2. Expansion or Contraction Joints

- a) Joints shall be provided at the locations indicated on the Drawings. In no case shall any fixed metal embedded in the concrete, continue across an expansion or contraction joint.
- b) The expansion or contraction joints can be of the smooth and even or dented type to guarantee the contact of the structures. The opposite faces, which form the joint, shall be completely separated.
- c) Expansion or contraction joints shall be sealed by waterstops and/or joint sealants.
- d) The Contractor shall undertake the pouring of the second surface only after the first one has thoroughly hardened.
- e) When shown on the Drawings, a sheet of plain joint filler or other approved material may be placed in contact with the first pouring before starting the second pouring.

10.3.8. Tolerances for Concrete Construction

1. General

- a) Allowable deviations from plumb or level and from the alignment, profile, grades and dimensions shown on the Drawings approved by the Employer are defined as "tolerances". Tolerances shall be inclusive of surface irregularities. Deviations from the established lines, grades and dimensions will be permitted to the extent set forth in this sub-clause.
- b) Where tolerances are not stated in the Specification nor shown on the Drawings for any individual structure or feature thereof, permissible deviations will be interpreted in conformity with the provisions of this sub-clause. Notations on the Drawings or in this Specification of specific tolerances in connection with any dimensions shall be considered as supplementary to the tolerances specified in this sub-clause.
- c) Concrete work that exceeds the tolerance specified shall be remedied or removed and replaced by the Contractor.

2. Concrete

- a) Tolerances for reinforced concrete structures shall be in accordance with the requirements of ACI 117 or such tolerances otherwise specified by this Specification or the Drawings.
- b) Construction tolerances for concrete structures shall be as follows unless otherwise specified elsewhere.

- i. Variation from vertical:

- In the lines and surfaces of columns, piers, walls and towers

- In 3 m +/-5 mm

- In 6 m +/-8 mm

- In 12 m or more +/-16 mm

- For exposed columns control joint grooves and other conspicuous lines

- In 6 m max +/-5 mm

- In 12 m or more +/-10 mm

- ii. Variation from the level or from the grades indicated on the approved Drawing:

- In 3 m +/-5 mm

- In any bay or 6 m max +/-8 mm

- iii. Variation of the linear structure lines from established position in plan and related position of walls

- In any bay or 6 m max +/-12 mm

- In 12 m or more +/-25 mm

- iv. Variation in location of sleeves and sizes and locations of floor openings and wall openings ± 5 mm
- v. Variation in cross-sectional dimensions of

columns, beams ± 5 mm

thickness of slabs and walls ± 10 mm

- vi. Variation in steps:

- In a flight of stairs

Rise ± 3 mm

Tread ± 5 mm

- In consecutive steps

Rise ± 2 mm

Tread ± 3 mm

- vii. Variation in lining concrete:

- In design center line ± 30 mm

- In inner diameter ± 30 mm

- Tolerance in lining thickness ± 30 mm

3. Reinforcement

- a) Tolerances for reinforcing steel:

- Length of splice: ± 25 mm

- Variation of protective cover: ± 5 mm

- Variation in indicated position of reinforcement: ± 25 mm

- Dimensions of bent bars:

stirrups and ties: ± 5 mm

other bars: ± 10 mm

- b) Provided that the number of bars required by the specified spacing is not varied.

4. Embedded Metalwork

- Tolerances for placing embedded metalwork: ± 5 mm.

5. Soleplates

- Tolerances for placing soleplates:

variation in level: ± 3 mm

maximum tilt along a diagonal: ± 3 mm

10.3.9. False work

- a) False work covers temporary works necessary for the temporary support and erection of the permanent works.
- b) The Contractor shall be responsible for the adequacy of all false work required for concrete construction.

10.3.10. Formwork

1. General

- a) Formworks shall be used to confine the concrete and shape it to the required lines.
- b) Formworks shall be designed and constructed by the Contractor in accordance with ACI 347 and shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position.
- c) Formworks shall be sufficiently tight to prevent loss of mortar from the concrete.
- d) Moulding strips shall be placed in the corners of formworks so as to produce beveled edges on permanently exposed concrete surfaces. Interior angles on such surfaces and edges at formed joints will not require beveling unless the requirement for beveling is shown on the Drawings.
- e) The Employer shall be informed before the contractor strips any form work.
- f) The Contractor shall remain fully responsible for the safety of structures from which he removes formwork.

2. Formwork Requirements for Various Finishes

- a) The type of formwork sheathing or lining shall be in accordance with the following minimum requirements for the formed surface finishes.
- b) When Finish F1 is specified, forms may be any grade of steel and wood sheathing, free from great surface roughness or irregularities.
- c) When Finish F2 is specified, forms shall be of pressed fiberboard, ordinary lumber, and plywood or steel sheathing, free from surface roughness or irregularities.
- d) Where Finish F3 or F4 are specified, forms shall be of at least 20 mm thick plywood, 30 mm thick first class timber or steel sheathing with plate not less than 3 mm thick, with very smooth and uniform surfaces. Steel lining shall not be permitted.
- e) Forms for the tunnel shall be only steel forms except for transitions and discontinuous cross sections, where timber is admitted.
- f) The first class timber used in the forms shall be free from warp, and wooden forms shall be made of dressed lumber of uniform thickness and width, which is free from loose knots, decay, or other defects. Steel sheathing shall be defined as a steel

plate supported by structural shaped steel.

- g) Steel lining shall be defined as thin steel sheaths, supported by a backing of wood boards.

3. Forms of Curved Surfaces

- a) Forms for curved surfaces and transition sections shall be constructed to conform accurately to the required curvatures. Dimensions from horizontal and vertical base lines will be given at several sections throughout the length of the curved or transition sections. The Contractor shall interpolate intermediate sections as necessary for the type of form construction being used, and shall construct and erect the forms so that the curvature will be continuous between sections. Erection templates shall be used on all curved frameworks where necessary to meet the requirements for curvature. The form sheathing shall be built up of laminated splines cut to make tight, smooth form surface. After the forms have been constructed, all surface imperfections shall be corrected, and any roughness and all angles on the surfaces of the forms caused by matching the form material shall be dressed to the required curvatures.

4. Tunnel Forms

Portable Telescopic formwork should be used for the execution of tunnel formworks.

- a) The concreting of the tunnel shall be carried out with high-rigidity steel forms to obtain perfect smooth surfaces.
- b) Windows shall be provided in the forms to allow vibration, inspection and final checking. The openings shall be located alternatively at distances not exceeding 3 m from one to another.
- c) Provisions shall be made to allow the easy and safe installation of pipes for weep and grout holes, of formwork for recesses, of anchor plates, of aeration and de-aeration pipes, etc.
- d) The stop ends of the tunnel forms for construction joints shall be preferably made of expanded metal to obtain a rough surface.

5. Form Ties and Bolts

- a) The design of form ties shall be such that no metal shall be within 20 mm of any exposed surface, except where Finish F1 is specified.
- b) Where Finish F1 is specified, ties shall be terminated within the formed surfaces, or cut off flat with the formed surfaces. Wire ties will be permitted only where Finish F1 and F2 are specified. Sufficient form ties and bolts shall be used on both sides, and within a few centimeters of construction joints, to ensure the forms fit snugly against the concrete previously placed, and shall remain in tight contact during placing operations.
- c) After completion of the concreting, the Contractor shall withdraw the bolts and securely fill up the holes with cement mortar patch.

- d) The terminal part of the wire ties, if their use is allowed, shall be shaped in such a manner that cutting and removal will not damage the concrete surfaces exposed to the sight.

6. Treatment of Forms

- a) At the time of concrete placing, the inner surface of the forms, the contacts and connections shall be free from any encrustation, mortar, grout or other foreign matter that may contaminate the concrete. Prior to pouring, the surface of the forms, with the sole exception of those made of rough wood, shall be smeared with a bond-breaking compound such as emulsified oil, or with refined mineral paraffin oil, designed to prevent sticking of concrete on the form except the surface where the concrete is finished with plastering material such as mortar. The treatment of the forms shall not cause harmful effects, or stains, on the concrete surface, or on the reinforcement system. Bond-breaking compounds shall be applied before reinforcement is placed if this procedure is feasible.
- b) Formworks made of timber, which have been left in place for such a period, that they have dried out, shall be wetted.
- c) Furthermore, special care must be taken to prevent concrete adhering to the surface of the formworks.
- d) Oil treatment shall be made in such a manner as to avoid spillage on previously placed concrete. All excess oil on the formwork surfaces, and any oil on the concrete, metal or other parts to be embedded in the concrete, shall be carefully removed.

7. Removal of Formworks

- a) The removal of the formworks shall be carried out when the concrete has reached sufficient strength, so that removing will cause no damage.
- b) As a rule, the formworks shall be kept in place at least for the time hereunder indicated after concrete has been placed:
- | | |
|-----------------------------|--------------|
| ◆ Tunnel lining: | 12 hours |
| ◆ Pier and retaining walls: | 36 hours |
| ◆ Columns and walls: | 96 hours |
| ◆ Beams and slabs: | 7 to 14 days |
- c) The minimum time which shall elapse between the completion of concreting and removal of the formworks for beams and slabs shall be established according to the design calculations approved by the Employer. After removal, the formworks shall be removed as soon as practicable, to avoid delay in specified curing of concrete, and also to enable earliest practicable repair of surface imperfections. Methods of formwork removal likely to cause overstressing of the concrete, or injury to the concrete surface, shall not be used. Formworks and their supports shall be removed in such a manner as to allow the concrete to take the stresses due to its own weight uniformly and gradually. Provisions shall be made by means of suitable wedges, sand boxes or other devices, for the gradual relaxation

of the support given by false work and centering.

10.3.11. Preparation for Placing Concrete

1. General

- a) Concrete shall not be placed until all construction of formwork, falsework, installation of reinforcement and parts to be embedded, preparation of surfaces, methods and equipment for transporting, handling, placing and finishing concrete, the number of vibrations and method of consolidating concrete, and method of curing the concrete have been approved for concreting in a nominated section of work.
- b) Concrete shall not be placed in water unless the method of depositing the concrete has been approved.
- c) Concrete shall not be placed in running water and shall not be subject to the action of running water until after the concrete has hardened.
- d) All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed, shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.
- e) Where excavated surfaces which are to form the foundations for structural concrete are absorptive or likely to become otherwise unsuitable, the Contractor shall place a 'blinding course', as directed by the Employer, uniformly over the foundation such that the upper surface is at grade elevation. This blinding concrete shall be placed before installing reinforcement or formwork.

2. Preparation of Foundations

- a) Immediately before placing concrete, all surfaces of foundations upon or against which the concrete is to be placed shall be free from standing water, mud, debris, oil, objectionable coatings and loose, semi-detached or unsound fragments, and, all rock surfaces shall be cleaned thoroughly by the use of high pressure air water jets, wet sand blasting, wire brush, stiff brooms or other approved methods.
- b) The surfaces of absorptive foundation against which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete.
- c) Any water flowing over the surface of the excavation shall be diverted through proper drains to a sump, or shall be removed by other approved methods in order to prevent washing away of the freshly deposited concrete or any of its constituents.
- d) Where foundation with loose material is accepted, its surfaces shall be thoroughly evened out and compacted by mechanical or manual means, until a solid and homogeneous abutment surface is obtained. All the areas and surfaces containing water, mud, slime and organic substances shall be drained and cleaned by removing such substances, and consequently filling up the cavities with approved material until the prescribed profile is reached.

3. Preparation for Tunnel Lining

- a) For tunnel lining, temporary drain shall be provided to relieve any build-up of seepage water behind the lining, if any, and such drain shall be remained until when the permanent drain holes have been drilled. Drain pipes shall be set in the forms prior to concreting and shall be securely fixed to prevent displacement during the concrete operations.

4. Cleaning of Previously Placed Concrete Surfaces

- a) The surfaces of construction joints shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coatings, sand, curing compound if used, and other foreign material.
- b) The surfaces of blockouts against which concrete is to be placed shall be roughened by scabbling.
- c) The surfaces of all construction joints, including surfaces of blockouts, shall be washed thoroughly with air-water jets immediately before placing adjoining concrete. All pools of water shall be removed from the surfaces of construction joints before the new concrete is placed.
- d) The surfaces of all contraction joints shall be cleaned thoroughly of accretions of concrete or other foreign material.

10.3.12. Placing Concrete

1. General

- a) The Contractor shall place all concrete in structures as shown on the Drawings or approved in accordance with this Technical Requirements or as approved by the Employer. The Contractor shall give the Employer not less than 24 hours notice of when concrete will be placed and concrete shall only be placed with the approval of the Employer.
- b) The concrete shall be deposited generally in horizontal layers in such a manner as to maintain, until completion of the pour, a plastic surface approximate horizontal. The thickness of each layer shall not exceed 50 cm. The placement shall be carried out at such a rate that no concrete surface can reach an initial set before additional concrete is placed thereon.
- c) The maximum lift of pouring shall not exceed 2.00 m.
- d) The Employer may authorize higher lifts or layers where concrete can be placed or consolidated in thick layers. Concrete shall be deposited as closely as possible, directly into its final position and in such as to avoid segregation or modification of other properties. Bouncing concrete off forms, reinforcing steel or any other obstruction is prohibited. Distributing of concrete with vibrators or by other means will not be permitted. For locations where direct placement is not possible, and

in narrow forms, hopper and trunks of a size to allow a proper placing must be provided.

- e) Any tendency to segregation shall be corrected by shoveling stones into mortar, rather than mortar into stones.
- f) Concrete that is of excessive slump, segregated, partially hardened, or unworkable shall not be placed in forms, or if placed, shall be removed and dumped at the Contractor's expense.
- g) Each layer of concrete, which shall be placed and compacted with suitable types of equipment until the concrete is consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces and embedded materials.
- h) Construction equipment used for spreading, vibrating or other operation must absolutely not spatter loose oil, fuel and grease on the concrete.
- i) Any unconsolidated concrete shall be removed before completing the placement. During placement, and until curing has been completed, the concrete shall be protected against the harmful effects of exposure to sunlight, wind and rain.
- j) Where two different classes of concrete are shown on the Drawings adjacent to one another without an intervening movement joint, the two classes shall be placed at the same time. Where the surface of division between the two classes is vertical or inclined, the two classes of concrete shall be placed together using a separator which shall be withdrawn as the concrete is placed. Alternatively, the concrete may be placed in alternate batches of one class and then the other without a separator, provided measures are taken to prevent excessive intermixing of the two classes.

2. Concreting During Hot Weather

- a) The Contractor's attention is drawn to the recommendations contained in "ACI 305R Guide to Hot Weather Concreting. The Contractor shall adopt any or all of these recommendations as necessary, to manufacture and place concrete in accordance with this Technical Requirements.
- b) All reasonable precautions shall be taken by the Contractor to place concrete at the temperatures specified having regard to the ambient temperature conditions at the Site. Under no circumstances will concrete be accepted if the temperature of the concrete as deposited into the formwork exceeds that specified.
- c) The Contractor shall provide for the cooling of mixing water to and for the efficient insulation of any storage tanks and pipe lines for mixing water.
- d) Aggregate bins, batching and mixing equipment shall be painted white and coarse aggregate stock piles shall be sprinkled with water.
- e) Appropriate measures shall be taken with respect to transporting and placing the

concrete to control the temperature of concrete. Pipe lines for conveying concrete shall be shaded and insulated or painted white; the elapsed time from mixing to placing shall be minimised. Concrete shall be placed promptly when delivered and finishing operations shall not be delayed; concrete surfaces shall be protected from wind and sun during placing, finishing or curing operations.

3. Placing Restriction

a) Reinforced Structures and Embedded Parts

- Where concrete has to be dropped through reinforcement, care shall be taken so that no segregation or displacement of bars occurs. Closed chutes, elephant trunks, or tremies receiving hoppers, shall be used to place concrete in deep forms, around reinforcement, or other places not readily accessible for direct placing.
- Extreme care shall be devoted to placing the concrete around the various embedded parts to ensure that unbalanced loading and impact from placing concrete will not cause distortion or dislocation of parts. Both during and after placing of a lift, careful checks shall be made by the Contractor to see that the parts requiring accurate setting have not been displaced.
- A minimum of seventy two (72) hours shall elapse between the placing of each successive lift. Lifts may be terminated at any time to allow implementation of any action necessary to maintain the accuracy requirements.
- Mechanical vibrators shall not be used for placing concrete around movable embedded parts: In this case, concrete shall be consolidated thoroughly by hand spading and tamping.

b) Rain

- Outdoor concreting shall not be started during rains unless the Contractor has taken all protective measures including proper shelters so that during transport and placing. Should concreting be already in process, the Contractor will provide proper shelters in order to complete the pouring operation. In any case, placing operations shall be suspended, if the rain affects the quality of concrete, i.e. when the slump of vibrated concrete is 25 mm (1") or more than the slump tested at the batching plant for the class of concrete being poured.

c) Water

- No concreting shall be carried out under water, unless it is foreseen on the Drawings. The "drop-bottom bucket" or "tremie" method shall be used to pour concrete under water.
- Concreting shall neither be conducted in running water, nor be exposed to the action of the same, before it is sufficiently set.

d) Blockouts, Recesses, etc.

- The Contractor shall place concrete in blockouts, recesses, etc., as shown on the Drawings, after e.g. the installation and adjustment of metal work has been completed.
- Before concrete is placed in the blockouts, recesses, etc. the surfaces of the concrete previously placed shall be roughened and cleaned. The Contractor shall place the concrete in a way to ensure satisfactory bond with the existing concrete, to secure complete contact with e.g. metalwork to be embedded and to avoid any displacement. Concrete placed in recesses, etc., shall contain an approved expanding agent or non-shrink grout. No force or load shall be applied before the concrete reaches its Twenty-eight (28) days strength.

4. Consolidation

- a) Concrete shall be compacted with mechanical vibrating equipment, supplemented by hand spading and tamping, to a maximum practicable density so that it is in complete contact with the formworks, reinforcement and other embedded parts.
- b) The vibration shall be carried out by means of immersion type high-frequency vibrators, of the electrically driven or compressed air types, or by means of engine driven vibrators. For the consolidation of concrete where immersion vibrations shall prove impracticable, vibrators rigidly attached to the formworks shall be adopted.
- c) The size and number of vibrators, at each pour, shall be sufficient to thoroughly compact concrete, at the rate and conditions of placement.
- d) For water depths exceeding 1 m, the concrete shall be placed so that it does not fall freely through the water, that the cement is not washed out and that no separating layers of laitance are formed.
- e) For components of secondary importance the concrete may be deposited layer-by-layer with bottom- opening skips or traveling tremies on the foundation bed or on the surface of the individual layers of concrete.
- f) The tremies must be constantly and sufficiently far immersed in the concrete already placed for the concrete flowing out of the tremies to displace the earlier concrete.
- g) For every four (4) vibrators in use on the Works, an additional standby vibrator of similar consolidating capacity and in good working order shall be provided.
- h) When vibrating a layer of fresh concrete, the vibrator shall be held in a near-vertical position. The immersion of the vibrator shall be sufficiently deep to vibrate the entire depth of a new layer: the vibration should penetrate several centimeters into the layer below, to ensure thorough union of the layers.
- i) No new layer of concrete shall be placed before the underlying one has been thoroughly vibrated. Immersion points for the vibrators shall be adequately spaced,

so as to make sure that every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement steel, especially that starting initial set. Vibrators shall not be allowed to come into contact with form or finish surfaces.

- j) Displacing and spreading concrete horizontally with vibrators is prohibited. Vibrators shall not be applied to reinforcing steel, embedded parts or formwork. Where F2 and F3 finishes are specified, the vibrating head shall be kept 50 mm clear of the formwork.
- k) Provisions shall be made to ensure that any entrapped air, formed during the placing of concrete, be allowed to escape, by leaving effective air vents in the formwork. Care shall be taken to provide a dense envelope of concrete surrounding the waterstops with no voids or honeycombing.
- l) Excessive vibration, causing segregation and laitance, and tending to bring water to the surface shall be avoided.
- m) Vibration or disturbance of concrete which is partially hardened will not be allowed. Necessary traffic over new concrete shall be constructed on independently supported timber walkways so that the fresh concrete is not disturbed.

5. Green Cutting

- a) The Contractor shall remove laitance on concrete surfaces, on which another lift of concrete will be placed, by green cutting with a high velocity water jet or air-water jet.
- b) Green cutting shall be performed before concrete has taken its final set so that all laitance will be removed, but that large pieces of aggregate will remain embedded in the matrix.
- c) Materials, which are loosened or dislodged as a result of green cutting, shall be completely removed from the surface of the lift.

10.3.13. Finishes and Finishing

1. General

- a) Irregularities to finish as described herein are to be distinguished from tolerances as specified.
- b) In the event that finishes are not definitely specified herein or on the Drawings, the finishes to be used shall be those specified for similar adjacent surfaces.
- c) Skilled workmen shall perform finishing of concrete surfaces.
- d) The Contractor shall notify the Employer when concrete will be finished.
- e) The Employer will test concrete surfaces where necessary to determine whether surface irregularities are within the specified limits.

- f) Surface irregularities are classified as "abrupt" or "gradual".
- g) Offsets caused by displaced or misplaced form sheathing or lining or form sections, or by loose knots or otherwise defective form timber will be considered as "abrupt" irregularities, and will be tested by direct measurements.
- h) All other irregularities will be considered as "gradual" irregularities, and will be tested by use of a template, consisting of a straight edge or the equivalent thereof for curved surfaces.

2. Class of Finish for Formed Concrete

- a) The classes of finish for formed concrete surfaces are designated by use of symbols F1, F2, F3 and F4.
- b) Sandblasting will not be required on formed surfaces.
- c) Grinding will not be required on formed surfaces, but grinding will be required for the repair of surface imperfections or for the removal of concrete, which is outside specified tolerances.
- d) Unless otherwise specified or indicated on the Drawings, the classes of finish shall apply as follows:

- i. Class F1 (Sawn)

This finish is generally intended for surfaces against which backfill, concrete or grout will be placed being permanently invisible.

These surfaces shall not be subject to any special treatment, except for the repair of defective concrete, tie rod holes, etc. Correction of surface irregularities will be required only for depression, which exceeds 25mm.

- ii. Class F2 (Wrought)

This finish is required for structural surfaces permanently exposed to view or the surface covered by plastering material. Gradual irregularities may be up to 8 mm and abrupt irregularities up to 5 mm.

- iii. Class F3 (Precast Quality)

This finish is required for the surface of exposed concrete in prominent or important architectural features and for precast concrete units. The surfaces shall be also capable to be subjected to the passage of fast flowing water.

No abrupt irregularities are permitted and the gradual irregularities shall not exceed 6 mm.

- iv. Class F4 (Frigid Accurate)

This finish is required for formed concrete surface when accurate alignment and evenness of surface are essential for prevention of the destructive effects of water action. This surface will be exposed to water flow of high velocity.

No abrupt irregularities are permitted and the gradual irregularities have to be limited to less than 4 mm.

3. Class of Finish for Unformed Concrete

- a) The classes of finish for unformed concrete surfaces are designated by the symbols U1, U2 and U3. Interior surfaces shall be sloped for drainage where shown on the Drawings approved by the Employer. Surfaces which will be exposed to the weather and which are nominally level shall be sloped for drainage approximately two percent unless the use of other slopes or level surfaces are shown on the Drawings approved by the Employer. Unless otherwise specified or shown on the Drawings, these classes of finish shall apply as follows:
- i. U1 - Finish U1 (screeded finish) applies to unformed surfaces that will be covered by fill material or by concrete. Finish U1 is also used as the first stage of finishes U2 and U3. The surfaces shall be leveled and screeded sufficiently to produce even, uniform surfaces. Surface irregularities shall not exceed 10 mm.
 - ii. U2 - Finish U2 (floated finish) applies to unformed surfaces not permanently concealed by fill material or concrete, or not required to receive finishes U1 and U3. Finish U2 is also used as the second stage of Finish U3. Floating may be performed by use of hand or power-driven equipment. Floating shall be delayed until the screeded surface has stiffened sufficiently to prevent the formation of laitance, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. If Finish U3 is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling. Surface irregularities shall not exceed 5 mm. Joints and edges shall be tooled down where shown on the Drawings approved by the Employer or directed.
 - iii. U3 - Finish U3 (trowelled finish) applies to the tops of parapet walls and elsewhere as shown on the Drawings approved by the employer or as directed. When the floated surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel-trowel trowelling shall be started. Trowelling shall be performed with firm pressure, such as will flatten the sandy texture of the floated surface and produce a dense uniform surface, free from blemishes and trowel marks. Surface irregularities shall not exceed 5mm. Immediately following steel trowelling, the surfaces of floor slabs shall be floated with a foam-rubber face float to achieve a uniformly textured slightly roughened non-skid surface as directed.

4. Specific Application of Finish

- a) The specific application of the classes of finish to architectural concrete shall be as follows.
- i. Foundation of the buildings: F1
 - ii. Exposed concrete in the buildings: F2
 - iii. Concrete plastered with mortar: F2, U2

- iv. Concrete applied with asphalt waterproofing: F3
- v. Concrete applied with trowelled concrete: U1
- vi. Troweled concrete: U3

5. Sprinkling with Cement

- a) Sprinkling of the surfaces with dry cement or any other material during finishing operations for drying off the concrete, to facilitate trowelling or for any other purpose will not be permitted.

6. Floor Hardeners

- a) Where shown on the Drawings approved by the Employer, the surfaces of concrete floors shall be chemically case-hardened by application of an approved surface hardening liquid. The method, rate of application and timing shall be in accordance with the manufacturer's instructions.

10.3.14. Curing of Concrete

1. General

- a) Curing of concrete shall be made in general for the following:
 - i. Hydration of cement is developed gradually and completely;
 - ii. Concrete does not quickly pass from plastic state to elastic state;
 - iii. Concrete is not cracked or damaged by high differential temperatures or rapid changes in temperature; and
 - iv. Surfaces of concrete are neither damaged by traffic, nor discolored by chemical agents.
- b) All concrete shall be cured using water in accordance with this Clause except that, for certain surfaces, membrane curing may be approved. Membrane curing will not be approved for surfaces exposed to public view or surfaces, which are to be subsequently coated.
- c) The unformed top surfaces of walls and slabs shall be moistened by covering with water-saturated material or by other effective means as soon as the concrete has hardened sufficiently to prevent damage by water. The surfaces shall be kept completely and continuously moist, before and during form removal, by water applied on the unformed top surfaces and allowed to pass down between the formworks and the formed concrete faces. This procedure shall be followed by the specified water curing or membrane curing.

2. Method and Equipment for Water Curing

- a) Not less than Fourteen (14) days before placing concrete in any structure to be water cured, the Contractor shall transmit to the Employer details of the methods and equipment which he proposes to use for water curing.
- b) After the initial placement of concrete in any structure, subsequent placements will not be permitted until equipment for curing has been satisfactorily installed and is operating on all previous placements in the structure.

- c) The equipment and method proposed shall provide for adequate control of the application of curing water to avoid interrupting other work.

3. Water Curing Period

- a) Concrete cured with water shall be kept continuously wet for at least Seven (7) days immediately following placement of the concrete, or until covered with fresh concrete. Water used for curing shall meet the requirements of this Specification for water used in concrete, but with the additional requirement that the water shall not contain any chemicals or other substances that will cause staining of concrete surfaces.

4. Membrane Curing

- a) At least Thirty (30) days before using curing compound, the Contractor shall submit to the Employer details of the proposed compound. Such details shall be accompanied by test certificates to show that the compound will give satisfactory results for the proposed application. Curing compounds shall comply with ASTM C309.
- b) Membrane curing, if approved, shall be by application of a type of curing compound, which forms a water retaining membrane on the surface of the concrete. Curing compound shall be applied to the concrete surfaces in accordance with the manufacturer's instructions.
- c) When curing compound is to be used on unformed concrete surfaces, application of the compound shall commence immediately after the finishing operations are completed.
- d) When curing compound is to be used on formed concrete surfaces, the surface shall be moistened with a light spray of water immediately after the forms are removed, and shall be kept wet until the surface will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the curing compound shall be applied. There shall be ample coverage with the compound at edges, corners and blow-holes of formed surfaces. After application of the curing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with curing compound in accordance with the foregoing requirements.
- e) Equipment for applying curing compound and the method of application shall comply with Chapter VI of the Eighth Edition of the United States Bureau of Reclamation Concrete Manual.
- f) Traffic and other operations by the Contractor shall be such as to avoid damage to coatings of curing compound for a period of not less than Twenty-eight (28) days after application of the curing compound. Where it is impossible because of construction operations to avoid traffic over surfaces coated with curing compound, the membrane shall be protected by a covering of sand not less than 25 mm in thickness or by other effective means. The protective covering shall not be placed until the sealing membrane is completely dry. The Contractor shall remove all

sand covering after completion of the curing period. Any sealing membrane that is damaged or that peels from concrete surfaces within Twenty-eight (28) days after application shall be repaired without delay.

- g) Curing compound shall be delivered to the Site in suitably labeled containers to enable identification of the batch number and date of manufacture.

10.3.15. Protection of Concrete

1. General

- a) The Contractor shall protect all concrete against damage or disfigurement in accordance with AS 3600 / BS 8110 Part 1 / ACI 318M.

2. High Temperatures

- a) When the ambient temperature in the vicinity of the Works is likely to reach or exceed 32°C, the Contractor shall protect all concrete from drying winds or surface temperature rise for not less than 48 hours after it is placed. Such protection shall include methods as recommended in Manual of Concrete Practice Part 2, "Hot Weather Concreting - American Concrete Institute 305R - 77".

3. Freezing

- a) The Contractor shall protect the surface of concrete against freezing by adopting the measures recommended in Manual of Concrete Practices Part 2, "Cold Weather Concreting - ACI 306 R-78" or amended by this Specification.
- b) When the mean daily temperature in the vicinity of the Works falls below 5°C for two or more successive days the concrete shall be protected against freezing for at least 72 hours after it is placed.
- c) At any time when the ambient temperature i.e. expected to fall below 5° C within 24 hours of the commencement of concrete placement, the concrete surface shall be protected against freezing for the first 48 hours after placing.
- d) The minimum temperature of the concrete during the protection period shall be 7°C.
- e) At the end of the protection period the surface concrete temperature shall be allowed to cool gradually to the ambient temperature at a rate not exceeding 5°C in 24 hours.
- f) Concrete shall be prevented from drying during the required curing period including the protection period. Concrete cured by water curing shall be protected against freezing for Four (4) days following the protection period and shall be discontinued 24 hours before exposure of the concrete to freezing temperatures.
- g) When artificial heat is employed special care shall be taken to prevent the concrete from drying.

10.3.16. Repair of Concrete

1. General

- a) Skilled workmen shall perform repair of concrete. The Contractor shall inform the Employer when concrete will be repaired
- b) The Contractor shall correct all imperfections on the concrete surfaces as necessary to produce surfaces that conform to those specified. For formed concrete, where the formworks are removed within Three (3) days of concrete placement and repair of imperfections completed within 24 hours after removal of formworks, or for unformed concrete where repairs are completed within 24 hours after the placing of the concrete, repairs shall be dry-pack, mortar or concrete repairs. Otherwise repairs shall be epoxy resin repairs.
- c) Fins and encrustations shall be neatly removed from surfaces for which F2 and F3 finish are specified and encrustations shall be removed from surfaces for which U2 and U3 finishes are specified.
- d) Concrete that is damaged from any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which is rejected because of excessive surface depressions, shall be removed and built up with dry-pack, mortar, or concrete, as hereinafter specified, to bring the surface to the prescribed lines. Where bulges and abrupt irregularities protrude outside the limits specified on formed surfaces for which F2 and F3 finish are required, the protrusions shall be reduced by bush-hammering and grinding so that the surfaces are within the specified limits. After the dressing, the irregularities shall not exceed the limits specified.
- e) Concrete surfaces that are to be repaired by dry-pack, mortar or concrete shall be in a saturated-surface-dry condition immediately before doing the repair.
- f) All areas to be repaired with mortar, dry-pack or concrete shall be trimmed square to the surface for a minimum depth of 20 mm.
- g) All repairs shall be cured in accordance with the provisions for concrete curing in this Technical Requirements.
- h) The repairs of cracks shall be carried out in accordance with the approved method of epoxy resin grouting.

2. Dry-pack

- a) Dry-pack shall be used for filling holes having a depth greater than the least surface dimension; for narrow slots cut for repair of cracks; and for tie-rod fastener recesses as specified. Dry-pack shall not be used for filling behind reinforcement or for filling holes that extend completely through a concrete section.
- b) Dry-pack shall be composed of a mix of 1 part of cement, by volume, to 2.5 parts, by volume, of fine aggregate passing 1.18 mm sieve, together with enough water to produce mortar which will just stick together when molded into a ball by a light pressure of the hands and will not exude water, but will leave the hands damp.
- c) Dry-pack shall be placed and packed into under-cut holes in layers each having a

thickness of approximately 10 mm. Packing shall be carried out with a hardwood stick struck with a hammer to compress the dry-pack thoroughly into contact with the surfaces of the hole.

3. Mortar

- a) Mortar-filling, placed under impact by use of a mortar gun, shall be used for repairing defects, which are too wide for dry-pack fillings and too shallow for concrete filling and no deeper than the far side of the reinforcement that is nearest the surface.

4. Concrete

- a) Concrete-filling shall be used for holes extending entirely through concrete sections; for holes which are greater than 0.10 m² in area and deeper than 80 mm; and for holes in reinforced concrete which are greater than 0.05 m² in area and which extend beyond the reinforcement that is nearest the surface.

5. Epoxy Resin

- a) Epoxy resin repairs shall be used where approved. Epoxy resin repairs shall not be made until Twenty-eight (28) days after the concrete has been placed, unless earlier repairs are approved, and shall be completed within Sixty (60) days after the concrete has been placed. All materials used for epoxy resin repairs shall be subject to approval and the repairs shall be the following types:
 - i. Epoxy Bonded Repairs - an unfilled epoxy resin is used as the bonding medium between old concrete and the repair material, which can be dry-pack, shotcrete or concrete.
 - ii. Epoxy Filled Repairs - A previously filled epoxy resin or an unfilled resin to which is added approved filler forms the repair material. This method will normally be approved only for filling of small holes to produce a required surface finish, but will not be permitted on surfaces for which F1 and F2 finish is specified.
- b) Epoxy resin repairs shall be carried out as follows:
 - i. All imperfections to be repaired with epoxy resin shall be chipped back to sound concrete and the edges of the holes trimmed square for a minimum depth of 3 mm.
 - ii. Immediately before performing a repair, the surface of the concrete to be repaired shall be freed of all contaminants by grit blasting, scabbling, and shall present a clean, sound, dry, roughened and dust free surface with the surface temperature not less than 13°C.
- c) After preparation, the following procedures shall be performed:
 - i. Epoxy Bonded Repairs - The surface of the area to be repaired shall be covered with a thick coat of an approved unfilled, solventless epoxy resin, prepared, batched and mixed in accordance with the manufacturer's instructions and thoroughly brushed into the surface. Immediately and

before the resin becomes "tacky", the repair material shall be placed and finished to the required standard. Curing of the repair shall be performed in accordance with the provisions of this Specification with the additional requirement that the repair is to be maintained at a temperature not less than 21°C for a period of 24 hours without allowing heat to be directed onto the repair and cause excessive drying of the repair material. Epoxy resin which has become "tacky" before the repair material has been placed against it, shall be removed and the surface again prepared.

- ii. Epoxy Filled Repairs - The repair material, consisting of an approved filled resin or an unfilled resin with sand or other approved fillers added on Site, prepared, batched and mixed in accordance with the manufacturer's instructions, shall be placed and given a smooth finish. The repair shall be cured by maintaining it at a temperature not less than 21°C for a period of 24 hours.
- iii. Unused epoxy resin, either filled or unfilled shall be wasted when it loses its plastic condition. Excess or spilled resin on surfaces for which F1 and F2 finish is specified shall be cleaned immediately and while the resin is in a plastic state.
- iv. Should it be necessary to form an epoxy filled repair, either the forms shall be incompatible with the resin or the form coated with a special release agent.

6. Staining of Concrete

- a) For concrete surfaces for which F1, F2 and F3 finish is specified, care shall be taken that accumulation of foreign materials or staining due to any cause does not occur on the finished surface. The Contractor shall clean off any accumulation or staining.

7. Plugging Form-tie Holes

- a) In formed concrete, surface holes remaining after dismantling form-ties shall be cleaned out and neatly plugged with dry-pack as specified, except that for tie bolt holes with color control. The dry-pack shall be color matched with surrounding concrete.

8. Materials Used in Repairs

- a) All materials used in the repair of concrete shall conform to the requirements of this Specification and the repairs shall be made in accordance with the procedures of Chapter VII of the Eighth Edition of the United States Bureau of Reclamation Concrete Manual. All fillings shall be bonded tightly to the surface of the holes and shall be sound and free from shrinkage cracks and drumly areas after the fillings have been cured and have dried.

10.3.17. Cooling of Concrete

1. Requirement

- a) In order to prevent cracking of the concrete the Contractor shall design the mix,

formwork and curing systems and time and sequence of placement of concrete such that:

- For mass concrete the difference between the concrete at the surface and at any internal point shall not exceed 20°C subsequent to placement.
 - For all other concrete the difference between the concrete at the surface and at any internal point shall not exceed 25°C subsequent to placement.
 - The maximum temperatures of mass concrete shall not exceed 50°C at any time subsequent to placement.
 - The maximum temperature of all other concrete shall not exceed 65°C at any time subsequent to placement.
- b) For the purposes of this Clause mass concrete placements shall mean any concrete placement whose least dimensions are 1.0 m or greater.
- c) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before placing concrete in the structure, the Contractor shall submit to the Employer its proposal for placing concrete conforming to the above requirements. These proposals may include:
- Alteration to mix design, to keep the cement content to a minimum, consistent with other requirements of the Technical Requirements.
 - The use of cement or pozzolanic materials having low heat of hydration.
 - Reduction in the temperature at placement of the concrete by pre cooling the aggregates and/or mixing water, or the concrete mix itself.
 - Casting the unit in sections, the size, relative positions and time interval between which will ensure adequate surface area for cooling.
 - The incorporation of special cooling arrangements, such as using a system of black steel pipes embedded in the concrete through which cooling water is circulated.
 - Avoiding concreting in hot weather.
 - Place concrete at night or early morning.

2. Thermocouples and Thermometers

- a) The Contractor shall furnish approved types of thermometers, thermocouples and a suitable device for determining temperatures, in accordance with Sub-clause 19.2.7 of Standard Technical Requirements, and shall monitor the internal temperature differential by an approved method from the time of placement in accordance with the requirement of this Sub-clause.
- b) The Contractor shall record all data pertaining to the temperature of the concrete and the operation of any cooling system. The following data shall be recorded, where applicable:

- Maximum and minimum daily air temperature.
 - Location and date of concrete lifts placed and cooling procedures carried out.
 - Concrete placing temperature which shall be taken as the temperature of the concrete when delivered to the point of placement.
 - Locations of thermometers or thermocouples in the concrete placement.
 - Where artificial cooling by water circulation is used:
 - daily cooling water temperature at entry to and exit from the concrete;
 - the date of disconnecting cooling coils from any lift, and any subsequent re connection; and
 - daily concrete temperature for Eight (8) days after placing any lift, then at Two (2) day intervals up to Fourteen (14) days and thereafter at weekly intervals for a period of Three (3) months. Concrete temperatures shall be measured by an approved method on the axial centerline at mid height, 250 mm from the base and 250 mm from the top of the placement.
- c) All data pertaining to the temperature of the concrete and the operation of any cooling system shall be submitted to the Employer within 24 hours of temperature readings being taken.

3. Repairs

- a) After fulfilling their purpose, any thermometer pipes and cooling water pipes incorporated in the mass concrete left by the Contractor shall be filled with grout and the surface of the concrete at the ends of each pipe shall be repaired and made good to achieve the required concrete surface finish.

4. Temperature Control Measures

- a) The Contractor shall make the necessary provisions in the storage of concrete materials, handling and batching facilities, as required for complying with the hot weather concreting requirements.
- b) During hot weather conditions, the temperature of the fresh concrete shall not exceed 25°C for mass concrete and 30°C for structural concrete, when placed in its final discharge point. To meet these requirements, the Contractor shall be prepared to undertake any, or all, of the following corrective measures:
- i. Aggregate stockpiles shall be shaded and sprayed as required to reduce the temperature of ingredients prior to mixing.
 - ii. Formwork shall be continuously sprayed with cold water in advance of concreting, and excess water shall be removed from inside the forms immediately prior to placement of concrete.
 - iii. Reinforcement and metal formwork shall be protected from the effects of hot winds and direct sunlight.

- iv. Suitable barriers shall be provided to protect the freshly placed concrete from wind until the concrete is sufficiently hard to allow it to be covered.
 - v. The concrete shall be mixed, transported, placed and consolidated, as rapidly as possible and shall then be covered with an impervious membrane or wet hessian until moist curing begins.
 - vi. Supply cool mixing water, or adding ice to the concrete during mixing.
 - vii. Cool the fine and coarse aggregates before mixing operations.
 - viii. Prevent exposures of batching, mixing and conveying equipment to direct sunlight.
- c) Use of ice for mixing water shall be carefully controlled to ensure complete melting before mixing is terminated.
 - d) The application of ice water to the fine aggregate will not be permitted. Refrigerating units, and the cooling plants, shall be planned in such a way as to secure the maximum continuity of service.
 - e) For mass concreting, the Contractor shall also determine the layer and lift thicknesses during various weather conditions based on ambient temperature at site during different periods by making temperature studies.

10.3.18. Filling of Tunnel Crown

- a) After concreting the tunnel lining or parts thereof, or placing the plug concrete, the Contractor shall fill all cavities between rock/shotcrete and concrete lining or between shotcrete/concrete lining and plug concrete with cement mortar as stipulations set forth in Chapter 8 "Drilling and Grouting" of the Specifications.
- b) This contact grouting of tunnel cavities shall commence only, when the concrete has reached sufficient strength to withstand the loads from the grouting.
- c) To prevent any damage to the surface of the lining due to drilling operation, grout pipes shall be placed prior to concreting the lining. These pipes of not smaller than 50 mm diameter shall be located on the vertical tunnel axis at an interval of 3.00 m and shall be firmly fixed to the tunnel formwork. After concreting the lining the holes shall be re-drilled and the drill holes shall extend at least 0.30 m into the rock.
- d) Additionally, and wherever required, vent pipes will have to be installed to ensure a complete filling of all crown cavities.

10.3.19. Dental Concrete

- e) Dental cavities shall be filled with concrete or shotcrete wherever possible prior to concrete placement. Where dental concrete is used, it shall have the same mix proportion as the concrete covering it.
- f) Dental cavity side surfaces shall be cleaned of all loose and friable materials

prior to concrete placement.

10.3.20. Second-Stage Concrete

- a) The work shall be scheduled in conformity with the work of the Sub-Contractors as shown on the Drawings approved by the Employer and;
 - i. For encasement or mounting of vertical guides for gates and trash rack, limit second-stage concrete placement rate so as not to exceed 30 cm per hour.
 - ii. For encasement or mounting the air conditioner or other, the Contractor shall cooperate and coordinate the procedures with the relevant manufacturer.

10.3.21. Waterstop

1. General

- a) Waterstops shall be placed in joints of concrete structures as shown on the approved Drawings.
- b) Waterstops to be used in the Works shall have sufficient stiffness so that they remain in their correct position during concreting.
- c) The type of waterstop shall suit the particular location in the structure in which the waterstop is to be placed and the pattern shall be such that concrete can be placed all around it with complete consolidation and no voids or crevices.

2. Material

- a) Waterstops shall be of extruded polyvinyl chloride complying with ASTM D4551. The plastic waterstop shall meet the following requirements:

Requirement	Method of Test
Tensile strength using die "C": not less than 150 kgf/cm ²	ASTM D-412
Ultimate elongation using die "C": not less than 330%	ASTM D-412
Stiffness in flexure, 6 mm span: not less than 28 kgf/cm ²	ASTM D-747
Tear resistance: not less than 30 kgf/cm ²	ASTM D-624
Specific gravity: not less than 1.20	ASTM D-792

- b) The width of the waterstop shall be within a tolerance of 10 mm of the nominal width shown on the approved Drawings exclusive of nailing strips.

3. Joints and Bends

- a) The number of joints in the waterstops shall be the minimum practicable and all joints and bends shall be made in an acceptable manner. The number of butt joints shall be kept to a minimum and all "Tee" and "Flat X" joints shall be factory produced.
- b) All joints shall be made with a temperature-controlled apparatus and in such a manner as to ensure the following:
 - i. The material is not damaged by heat, searing or by the application of cementing materials.

- II. The splices have a tensile strength not less than 80 per cent of that required of the specified material.
- III. The splice is watertight and free of air bubbles.
- IV. Splices in the continuity or at the intersection of runs of waterstops shall be performed by heat sealing on the adjacent surfaces, in accordance with the supplier's recommendations.
- V. The ribs and central bulb, where applicable, match up exactly and are continuous.

4. Joints and Bends

- a) To eliminate faulty installation that may result in joint leakage, particular care shall be taken to see that the waterstops are correctly positioned during installation. Adequate provision shall be made to support the waterstops during the progress of work and to ensure the proper embedment in concrete. The method of securing the waterstops will be to the approval of the Employer. The symmetrical halves of the waterstop shall be embedded in the concrete on each side of the joint. Waterstop shall be thoroughly cleaned of foreign material before concrete is placed.
- b) Waterstops shall be secured in the concrete placement in accordance with the manufacturer's instructions by using clips on the edge rib and tying back to the reinforcement or steel bars specifically placed for the purpose, where reinforcement does not exist, in two opposing directions, the waterstop shall be properly secured by appropriate clips as per manufacturer's recommendation.
- c) Care shall be exercised in placing and vibrating the concrete about the waterstop to ensure complete filling of the concrete under and about the waterstop and to obtain a continuous bond between the concrete and the waterstop at all points around the perimeter of the waterstop.
- d) Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstop from mechanical damage at all times. The PVC waterstop which will remain exposed for more than Ten (10) days shall be covered or shaded to protect it from the action of temperature and ultraviolet rays.
- e) The Contractor shall replace or repair any punctured or damaged waterstop or waterstop which has been dislodged during concrete placements.

10.3.22. Metal Seals

1. General

- a) The Contractor shall furnish and install sealing strips of corrosion resisting metal in joints in the structures where approved. The shape and method of the placing of metal seals shall be as shown on the Drawings. Metal seals shall be joined carefully by welding or brazing so as to form continuous watertight diaphragms in the joints. Adequate provision shall be made to support and protect metal seals during the progress of the work. The Contractor shall replace or repair any metal seal punctured or damaged before final acceptance of the work.

2. Materials

- b) Metal seals shall be 0.8 mm thick, soft tempered copper complying with ASTM B370 and nails shall comply with AS 2334 or the relevant ACI code.

10.3.23. Bituminous Seals for Contraction Joints

1. General

- a) The Contractor shall construct bituminous seals in contraction joints as shown on the Drawings approved by the Employer.

2. Materials

- a) Bitumen shall comprise a resilient, adhesive compound, which is capable of being brought to a uniform pouring consistency suitable for completely filling the formed holes without inclusion of large air holes or discontinuities and without damage to the material. The bitumen shall form a tight bond with the concrete and shall have the following properties:
- b) Softening point as determined in accordance with ASTM Designation D36: 80°C maximum - 60°C minimum.
- c) Penetration at 25°C as determined in accordance with ASTM Designation D 5: 40 maximum - 20 minimum.
- d) Pour point as determined in accordance with the applicable provisions of ASTM Designation D 1191: 107°C maximum - 82°C minimum.
- e) Generally comply with the requirements of ASTM D994.

3. Heating

- a) When the ambient temperature is likely to fall below 0°C, the Contractor shall furnish and install heating wires.
- b) The heating wires shall be installed to the bottom of the hole before the first bitumen is placed. The wires above the top of the hole shall be protected against damage during construction.
- c) The bitumen shall be heated and placed in the hole to the top of each lift of concrete. After each bituminous seal has been completed to the top of the structure in which it is located, the bituminous seal shall be capped as shown on the Drawings.

4. Construction

- a) The 125 mm diameter holes for the bituminous seals shall be formed at each contraction joint between blocks to provide a continuous uniform hole free from obstructions.
- b) After each lift of concrete has been completed, the recesses for the bituminous

seals shall be cleared of all aggregate and other foreign matter and the surfaces of the holes shall be thoroughly dried by air blasts or other acceptable means.

10.3.24. Joint Strips for Expansion Joints

1. Requirement

- a) Joint strips for expansion joints shall be furnished and installed by the Contractor, where joint strip is used, all joints in the joint strips shall be close fitting butt joints and the location of all joints shall be subject to approval.
- b) Joint strips shall be a commercial grade of rubber or PVC pre-formed strip or a resilient waterproofing compound.

10.3.25. Polystyrene Filler for Expansion Joints

1. Requirement

- a) The Contractor shall furnish and install expanded polystyrene filler in expansion joints where shown on the Drawings.
- b) Expanded polystyrene shall be 25 mm thick and shall be installed in as large a size sheet as possible.

2. Installation

- a) The Contractor shall cut the polystyrene filler to cover the required surface of the concrete at expansion joints and to fit around all openings.
- b) Where placed against vertical surfaces, polystyrene filler shall be held in place against the completed side of an expansion joint by waterproof cement applied to the face of each piece of polystyrene filler as a marginal strip coating approximately 50 mm wide.
- c) Joints in the polystyrene filler shall be scarfed, made tight and filled so that mortar from the concrete will not seep through to the opposite concrete surface. The number of field joints shall be kept to a minimum.
- d) Where shown on the Drawings the polystyrene filler shall be raked out after the concrete has set.

10.3.26. Bituminous Fiber Sheet for Expansion Joints

3. General

- a) The Contractor shall furnish and install bituminous fiber sheet in expansion joints where shown on the Drawing.

4. Materials

- a) The bituminous fiber sheet shall be 12 mm thick and complying with ASTM D1751.

5. Installation

- a) Exposed edges of the bituminous fiber sheet shall be installed flush with either the

back of the recess formed by chamfers on the corners of the concrete or the finished concrete surface as shown on the Drawings.

- b) Joints in the bituminous fiber strips shall be scarfed. The number of field joints shall be kept to a minimum and where possible joints shall be factory produced.

10.3.27. Mastic Filler

6. General

- a) The Contractor shall furnish and install mastic filler where shown on the Drawings.

7. Materials

- a) Mastic filler shall be a two-part polysulphide liquid polymer sealant complying with ASTM D1850.
- b) At least Sixty (60) days before its intended use, the Contractor shall submit a sample of the proposed mastic filler together with the manufacturer's technical data and the details of the recommended method of application.

10.3.28. Pipe Wrapping Material

8. Requirement

- a) The Contractor shall furnish and install a pipe wrapping material where required and approved.

9. Material

- a) The wrapping material shall be a closed-cell polyethylene foam 20 mm thick.
- b) The pipe wrapping material shall not absorb water to any appreciable extent, shall be chemically inert and shall be compatible with concrete, the material of the item being wrapped and its external coating.
- c) In accordance with the requirements for Contractor's Documents to allow for the initial review period, at least Sixty (60) days before its proposed use the Contractor shall submit:
 - A sample of the proposed pipe wrapping material.
 - Details of its composition.
 - Details of its proposed use, including the method of attachment to the item being wrapped.
 - A certificate from an approved independent laboratory that the proposed pipe wrapping material satisfies the requirements of this Subclause.

10. Pipe Wrapping for Embedded Pipework

- a) The pipe wrapping material for use with embedded pipework shall be capable of being deformed, without rupture, by the following longitudinal and radial movements of any point on the pipe-shell relative to the surrounding concrete:
 - 4 to 10 mm radially after being subjected to a pressure of 35 ka.
 - 10 to 25 mm longitudinally.

11. Pipe Wrapping for Spiral Casings

- a) The wrapping material for use with spiral casings shall permit the following minimum longitudinal and radial deformations of the above embedded items relative to the adjacent concrete after allowance is made for pre-compression due to wet concrete pressure.

Longitudinal Deformation Cycle Movement				Radial Deformation Cycle Movement			
Max. Possible	No. of Cycles	Mean	Amplitude	Max. Possible	No. of Cycles	Mean	Amplitude
2 mm	1.46×10^5	1.5 mm	1 mm	3 mm	1.46×10^5	1.5 mm	1 mm

- b) Such material shall be capable of larger longitudinal and radial deformations to suit the requirements of the design of the spiral casing and surrounding concrete structure.

12. Application

- a) The material to be used shall be applied in at least two equal layers with joints between sheets offset at least 200 mm from the joints of the adjoining layer. The joints between adjacent sheets shall be tightly sealed with a contact adhesive tape to prevent the ingress of concrete or mortar. An adhesive shall be used to fix the material to the pressure pipelines and spiral casings.

10.3.29. Annular Seal for Pipes

1. General

- a) The Contractor shall furnish and install an annular seal in a formed groove between the pipe shell and surrounding concrete where the pressure pipelines emerge from the concrete.

10.3.30. Material

- a) The annular seal material shall:
- Consist of a silicone elastomer, similar to Rhodorsil Mastic 3b.
 - Permit a relative movement of 25 mm between the pipe shell and the concrete without breaking its bond to the concrete or to the pipe shell.
 - Be compatible with the pipe wrapping material.
- b) In accordance with the requirements for Contractor's Documents to allow for the initial review period, at least Sixty (60) days before its intended use, the Contractor shall submit a sample of the proposed elastomer together with the manufacturer's technical data and details of the recommended method of application.

10.3.31. Cork Board

2. General

- a) The Contractor shall furnish and install cork board where required and approved.

3. Material

- a) Cork board shall be at least 12 mm thick, coated in the factory on both faces with bitumen, thick enough to cover all surface voids, but not thicker than 1.5 mm at high points.

4. Installation

- a) The Contractor shall cut the cork board to cover the required surface of the concrete.
- b) The exposed edges of the cork board shall be given two (2) coats of a bituminous damp proofing compound.

10.3.32. Cork Mastic

1. General

- a) The Contractor shall furnish and apply cork mastic where required and approved.

2. Materials

- a) The cork mastic shall be a mixture of bituminous emulsion, granulated cork and Portland cement. The mixture shall contain at least sixty (60) per cent by volume, of granulated cork and not more than ten (10) per cent of cement.
- b) The granulated cork shall be clean, dry cork in granules not larger than 3 mm and not smaller than 1.5 mm.

3. Application

- a) The surfaces to be coated shall be clean and dry immediately before application of the cork mastic. All grease and dirt shall be cleaned from the surface by wiping with a clean rag soaked in mineral spirits. The surface shall then be primed with one or more coats of a bituminous primer.
- b) The ingredients of the cork mastic shall be thoroughly mixed to ensure an even distribution of the cork granules and cement. Cork mastic shall be applied immediately after mixing, using a trowel, to a thickness of 12 mm on the steel surfaces to be coated, except the steel pipe liners where the thickness shall be 6 mm. The coverage shall be complete and uniform and shall terminate neatly. Cork mastic applied in excess of that required shall be completely removed.
- c) Following application the cork mastic shall be allowed to set for a period of at least 24 hours. The cork mastic shall then be covered or wrapped with a single thickness of bituminous fibreglass fabric having 8 meshes/cm. The fabric shall be lapped at the edges and bonded to the cork mastic with a coat of a bituminous adhesive. The coating shall be allowed to set for a further period of at least 24 hours, before being covered with concrete.
- d) The Contractor shall protect the cork mastic from damage at all times and make good any damage.

10.3.33. Epoxy Mortar

1. General

- a) The Contractor shall construct blackouts and place non-shrink epoxy mortar in the blackouts as approved to permit installation of items of structural steelwork, metalwork, plant and equipment.

- b) The Contractor shall place epoxy mortar under baseplates, bearings, etc as approved after such baseplates, bearings, etc have been levelled and aligned correctly and the baseplates rigidly secured in place by the anchor bolts and nuts. All spaces under the base plates, bearings, etc shall be completely filled with non-shrink epoxy mortar.

2. Composition

- a) Epoxy mortar shall consist of an approved filled resin or an unfilled resin with sand or other approved fillers added on site. The compressive strength of the non-shrink epoxy mortar shall be not less than 60 Mpa at Twenty-eight (28) days.
- b) All sand shall comply with the manufacturer's specification and must be thoroughly dry before being mixed with resin.

3. Preparation and placing

- a) Epoxy mortar shall be prepared and placed in accordance with the applicable manufacturer's instructions.
- b) All surfaces on which epoxy mortar shall be placed shall be roughened in accordance with the requirements for construction joints in this Technical Requirements.

10.3.34. Non-shrink Mortar

1. General

- a) The Contractor shall place non-shrink epoxy mortar in blockouts as shown on the Drawings.
- b) The Contractor shall also construct blockouts and place epoxy mortar in the blockouts as shown on the Drawings to permit installation of items of structural steelwork, metalwork and equipment.
- c) The Contractor shall place epoxy mortar under base plates as shown on the Drawings after base plates have been leveled and aligned correctly and the base plates rigidly secured in place by the anchor bolts and nuts. All spaces under the base plates shall be completely filled with epoxy mortar.

2. Composition

- a) Epoxy mortar shall consist of a filled resin or an unfilled resin with sand or other fillers added on site.
- b) All sand must be thoroughly dry before being mixed with resin.

3. Preparation and Placing

- a) Epoxy mortar shall be prepared and placed in accordance with the applicable manufacturer's instructions.

10.3.35. Reinforcement

1. General

- a) The Contractor shall furnish and install all reinforcement required for execution of the Works.

2. Material

- a) Reinforcement shall be deformed and plain steel bars Grade 40, 50 and 60 complying with ASTM A615M or ASTM A616 or ASTM A617, and steel deformed bars Grade 60 complying with ASTM A706. Similarly, deformed steel reinforcement of minimum yield stress of 500 N/mm² can also be used as per Indian Standard or approved equivalent.
- b) Reinforcing fabric shall comply with ASTM A185.
- c) Test certificates shall be submitted to the Employer for all reinforcement and reinforcing fabric furnished by the Contractor to be used in the Works and such submission will be prior to using the material in the Works.

3. Drawings

- d) Detailed reinforcement drawings shall be prepared by the Contractor showing the arrangement of the steel reinforcing bars. Such drawings shall be submitted to the Employer for prior approved.

4. Bar Lists

- a) The Contractor shall prepare complete reinforcing bar lists, including bar bending details, for each reinforcement detail drawing in an approved form. All reinforcing bars shown on the reinforcement detail drawings shall be identified on the bar lists in accordance with the standard reinforcing bar shapes as shown on the Drawings. All bar lists shall be identified with the relevant reinforcement detail drawing and all bars scheduled on the bar lists shall be defined and dimensioned in an approved manner.
- b) The Contractor shall furnish to the Employer for approval the following. The reinforcing bar list for that drawing, together with the reinforcement detail drawing marked up with each bar identified in accordance with the bar list.

5. Placing Reinforcement

- a) The Contractor shall be responsible for the accuracy of the cutting, bending and placing of the reinforcement.
- b) Before the reinforcement is placed, the surfaces of the bars or fabric and the surfaces of any metal bar supports shall be cleaned of heavy rust, loose mill scale, dirt, grease and other objectionable foreign substances. Heavy flaky rust which can be removed by firm rubbing with hessian or equivalent treatment is considered objectionable. After being placed, the reinforcing bars or fabric shall be maintained in a clean condition until they are completely embedded in the concrete.

- c) Reinforcing bars or fabric shall be accurately placed and secured in position so that there will be a clear distance of at least 25 mm between the bars or fabric and any adjacent embedded metalwork and so that the bars and fabric will not be displaced during the placing of concrete, and the Contractor shall ensure that there is no disturbance of the reinforcing bars or fabric in concrete that has already been placed.
- d) Chairs, hangers, spacers and other metal, plastic or concrete supports may be furnished and used by the Contractor for supporting reinforcing bars or fabric. Concrete supports where used shall conform to the concrete requirements of this Technical Requirements. Steel spacers which are liable to cause rust staining of finished surfaces shall not be used.

6. Joining and Splicing Reinforcement

- a) Where it is necessary to splice reinforcement, the splices shall be made by lapping, by welding or by mechanical means in accordance with AS 3600 or the relevant ACI code and the detailed provisions of this Clause.
- b) Reinforcing bars which are spliced by welding or by mechanical means shall be tested by the Contractor to verify that the splice has sufficient strength to develop a tensile stress appropriate to the type and grade of steel in the smaller bar at the splice of
 - 1.25 times the specified rigid stress, or
 - 0.95 times the specified ultimate strength, whichever is less.
- c) Joints or splices in reinforcing bars or fabric shall generally be made at the positions shown on the Drawings, or as approved by the Employer provided that the joints and splices in adjacent bars are staggered. Approval of such additional splices will generally be restricted to splices not closer than 8 m in horizontal bars or 4 m in vertical bars measured between the midpoints of laps. The number of splices shall be kept to a minimum.
- d) Welding of cold worked deformed reinforcing bars will be permitted only for a particular case or application for which no alternative splicing is practicable and subject to satisfactory testing in accordance with this Clause.
- e) If the Contractor proposes to use mechanical couplings for reinforcing bars, it shall submit samples of the proposed coupling, in accordance with the requirements for Contractor's Documents to allow for the initial review period, not less than Sixty (60) days before their proposed use.
- f) Before being permitted to use mechanical couplings on the Works, the Contractor shall prepare four test specimens for each size of coupling using the same materials and processes as will be used for the actual reinforcement. The length of each test bar shall be not less than 450 mm before connection. The connected bars shall be tested by the Contractor in accordance with Subclause a. of this Clause. If all test specimens meet the strength requirements, the coupling will be approved for the

Work.

- g) The Contractor shall test two specimens, representing every 100 splices made using welding or mechanical coupling. Each size of splice shall be considered separately. Welds shall not be made and couplings shall not be installed until the representative production control samples have been approved. Test specimens may be made from short lengths but shall be taken from the same bundle of bar stock as it represents and shall be made during the production run using the same processes so as to represent the installed welds or couplings as nearly as possible.

7. Welding Splices

- a) If the Contractor proposes to use welded splices in reinforcing bars, the equipment, materials and all welding and testing procedures shall be in accordance with AS 1554.3 or the relevant AWS code or equivalent. However, steel reinforcement of minimum yield stress of 500 N/mm² or equivalent should be exempted to any kinds of welding processes and mechanical coupler shall be preferred in accordance with Sub-clause 10.3.35.6 of this Specification.
- b) In accordance with the requirements for Contractor's Documents to allow for the initial review period before placing reinforcement, the Contractor shall submit, for approval, details of proposed welding procedures, electrodes and equipment. Welding may be performed by metal arc welding or flash butt welding at the Contractor's option.
- c) The Contractor shall employ operators skilled in the type of welding procedures used for the welding of the reinforcement bars. Before being permitted to weld bars on the job, each operator shall make four satisfactory test welds of the bars, using the same bar material, preparation, pressures, heating and upsetting as will be used for the actual reinforcement. The length of each test bar shall be not less than 450 mm before welding. The welded bars shall be tested by the Contractor in accordance with Paragraph (a) of this Subclause.
- d) If all test welds meet the strength requirement the welding process and operator will be approved for the work; provided, that if the weld does not meet the requirements, the operator may be permitted to weld an additional set of bars, and if such additional test welds meet the requirements the process and the operator will be approved.

8. Screwed Couplings

- a) If the Contractor uses screwed couplings, the couplings shall be installed in accordance with this Subclause.
- b) The ends of the bars shall be cut square and a short length threaded, one bar being cut with a left-hand thread and the other with a right-hand thread. The inside of the coupling shall be threaded to suit the threads on the ends of the bars to be joined to permit screwing of the coupling on to each bar by hand.
- c) The thread on the bars shall be clean cut from the full bar diameter and, in the case of the screwed coupling, from the correct bore diameter for the size of the thread to

be cut. The threads shall be coated with grease immediately after cutting and shall be maintained free from rust until assembly of the coupling. Grease shall be cleaned from all exposed portions of bars and couplings before placing concrete. Couplings or reinforcing bars with damaged threads may be rejected at any time before assembling the coupling and corrective re-threading will be permitted only where approved.

- d) The lengths of the thread on the bars to be joined and in the coupling shall be such that the coupling is not prestressed by butting of the bars together within the coupling and shall be such that the bars are not weakened by lengths of fully cut thread extending beyond the limits of the coupling.
- e) The screwed coupling shall be assembled carefully so that the coupling engages the threaded ends of the two bars to be joined at approximately the same time to ensure that, when the coupling is completely tightened, both bars are fully and equally engaged in the coupling. All screwed couplings shall be tightened equally to approve torque.
- f) Such couplings shall have the sleeve cast in flush with the surface of the first stage concrete and be temporarily plugged by approved methods.

9. Mechanical Couplings other than Screwed Couplings

- a) If the Contractor uses mechanical couplings other than screwed couplings, such as swaged splices the couplings shall be installed in accordance with the procedure proposed by the Contractor and approved by the Employer.

10.3.36. Grouted Anchor Bars

10. General

- a) The Contractor shall drill holes and furnish, install and grout anchor bars for anchoring concrete structures or parts of structures to the foundations where required and approved.

11. Materials

- a) Anchor bars shall comply with the relevant requirements for reinforcing bars.
- b) Anchor bars shall be provided with centering devices at 1.5 m centres along the bar to ensure that they are fully encompassed in grout.
- c) Anchor bars shall be coated by hot-dip galvanising with the mass of the coating not less than 0.6 kg/m².
- d) Grout materials, mixing and method of injection shall comply with that specified for rockbolts in this Technical Requirements.

12. Installation

- a) The dimensions of the anchor bars and the locations, diameters and depths of the drilled holes shall be as required and approved.

- b) The diameter of each drilled hole shall not be less than 1.75 times the diameter or greater cross-sectional dimensions of the anchor specified for that hole.
- c) The hole shall be cleaned thoroughly and shall be completely filled with grout. If the hole cannot be kept dry during the filling operation, the grout shall be introduced into the bottom of the hole by means of a pipe which shall subsequently be withdrawn.
- d) The anchor shall be forced into place before the grout takes its initial set and, where practicable, shall be vibrated or rapped. Thereafter, the Contractor shall ensure that movement of the placed anchor does not occur, and concrete shall not be placed around anchors until 24 hours after the anchors have been grouted.

13. Testing

- a) The Contractor shall carry out load tests, in the presence of the Employer, on anchor bars selected by the Employer. The required frequency of testing will not exceed one test for every two hundred (200) anchor bars installed. The testing method and equipment shall be capable of stressing the largest diameter anchor bar to the yield stress of the bar. All test results shall be submitted to the Employer.

10.3.37. Dowel Bars

14. General

- a) The Contractor shall furnish and install galvanised steel dowel bars and accessories required for the execution of the Works.

15. Materials

- a) All dowel bars shall be of plain round steel bar 250R, produced in accordance with the requirements of ASTM A615M or preferably square steel bar of equivalent properties. The bars shall be hot dipped galvanised to ASTM A385 after fabrication.

16. Fabrication and Placing

- a) The dowel bars shall be placed in the locations shown on the Drawings or approved.
- b) The fixed end of the dowel bar shall be always placed in the first concrete placement and the bars shall be accurately placed and fixed in position so that they will not be displaced during the placing of the concrete.
- c) The dowel bar shall be placed so that it is perpendicular to the plane of the joint. Any bar which is not perpendicular to the plane of the joint shall be replaced or rectified by the Contractor.
- d) Prior to forming the second concrete placement the exposed length and end of the dowel bar shall be coated with two coats of a thick bituminous compound, not less than 1 mm thick on the circumference and 2 mm thick on the end. In the case of square dowel bars 2 strips of 10 mm thick polystyrene, one on each of two opposing sides shall be tapped to the bar.

10.3.38. Silica Fume

17. General

- a) Silica fume for use in concrete shall comply with IS 15388 -2003 and / or ASTM C 1240 05a.
- b) Silica fume shall be supplied in 25 kg bags to the site.
- c) Silica fume supplied to the site shall not have been produced more than four months prior to the delivery of the material to the site.

18. Requirement for supply

- a) The Contractor shall demonstrate, via submission of testing records for the six months prior to placing any order for supply of silica fume that the silica fume produced by the supplier or source complies with the standards specified.
- b) All silica fume delivered to the site shall be accompanied by a delivery docket that confirms the authenticity of origin and that the material has been tested for compliance with the standards specified.

Silica fume found not to comply with the requirements of this Specification shall be removed from the Site.

19. Properties

- a) The chemical and physical properties of the silica fume shall be in accordance with IS 15388 -2003.
- b) Silica fume shall be tested for compliance in accordance with the requirements of IS 15388 -2003.

20. Preparation and Placing

- a) Epoxy mortar shall be prepared and placed in accordance with the applicable manufacturer's instructions.
- b) All surfaces on which epoxy mortar shall be placed shall be roughened in accordance with the requirements for construction joints in this Technical Requirements.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 11
CONCRETE IN STRUCTURES**

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CHAPTER 11 - CONCRETE IN STRUCTURES

11.1. CONCRETE IN SURFACE STRUCTURES

11.1.1. General

- (a) The Contractor shall place all required concrete in the surface works including:
- ♦ Diversion weir, Undersluice, Intake structure, guide walls, stilling basin, downstream apron
 - ♦ Approach Canal, Gravel Trap, Side spillway
 - ♦ Desanding Basin and Headpond
 - ♦ Tunnel Inlet Structure
 - ♦ Headrace Tunnel
 - ♦ Rocktrap
 - ♦ Top of surge shaft
 - ♦ access/maintenance tunnel portals
 - ♦ Powerhouse and Tailrace
 - ♦ footings, trenches, ducts and drainage
 - ♦ Works Routes culverts, headwalls and associated drainage
 - ♦ kerb and guttering on Works Routes and other roads and parking areas
 - ♦ miscellaneous structures
- (b) The concrete shall be placed to the approved dimensions, lines and elevations shown on the Drawings or otherwise approved.
- (c) Unless otherwise specified or approved, the Contractor shall construct all surface structures that will be permanently submerged using formwork Class F3 and surface finish U2, as specified in the relevant Chapter of Standard Technical Requirements.
- (d) Unless otherwise specified or approved, the Contractor shall construct all surface structures that will be permanently exposed to public view using formwork Class F2 and surface finish U3, as specified in in the relevant Chapter of Standard Technical Requirements.

11.1.2. Abrasion Resistant Concrete

The Contractor shall place abrasion resistant concrete to areas subject to high velocity or turbulent flow conditions.

11.2. CONCRETE IN TUNNELS, SURGE SHAFT AND ADITS

11.2.1. General

- (a) The Contractor shall place all required concrete for tunnels, shafts and adits.
- (b) The concrete shall be placed to the approved dimensions, lines and elevations as shown on the Drawings or otherwise approved.

11.2.2. Construction Procedures

In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days prior to construction of any

equipment including fabrication of any tunnel form, shaft form, other temporary works or Permanent Works associated with the concrete lining of any tunnel or shaft, the Contractor shall submit details of all equipment and procedures for construction of the concrete lining including the subsequent grouting to the Employer.

11.2.3. Placing Concrete in Tunnels

- (a) Concrete in tunnel linings shall be placed by a displacement type pump or by pneumatic placing equipment or by any other acceptable method. The equipment used in placing the concrete, and the method of its operation, shall be such as will permit introduction of the concrete into the forms without high velocity discharge and resultant segregation. After the concrete has been built up over the arch of tunnel lining at the start of a placement, the end of the discharge line shall be kept adequately buried in the concrete during placement of the arch to ensure complete filling. The discharge line shall be marked so as to indicate the depth of burial at any time. Concrete shall be forced into all irregularities in the rock surface to fill the arch completely. Placing equipment shall be operated by experienced operators only. Cold joints in tunnel linings shall be avoided.
- (b) Where an appreciable quantity of water flows from the rock against which the concrete is to be placed, the water shall be excluded from the space to be filled with concrete by caulking, diverting by pipes, pans and other means, and the pumping from sumps, until the concrete has set sufficiently to be unaffected by action of the water through percolation, hydrostatic pressure or abrasion.

11.2.4. Concreting Behind Tunnel Liners

- (a) Before concreting behind steel liners all objectionable material shall be removed from the outside surface of the steel liners which shall be maintained clean until concrete is placed. Field welding of any joint including inspection and testing shall be completed before concreting. All temporary timber struts, loose material and debris shall be removed from outside the liner before concreting.
- (b) The Contractor shall adequately support and anchor the steel liners with effective steel or concrete cradles. Site welding of supports to the outside of the pipeshell will not be allowed. The temporary internal stiffeners of the tunnel liners shall not be removed for at least 24 hours after placing concrete backfill behind the liners.

11.2.5. Backfill Grouting

1. General

The Contractor shall backfill grout all spaces between the concrete lining and rock and between the concrete and steel liners remaining unfilled after placement of the concrete has otherwise been completed provided that such grouting shall be performed after the concrete has cooled and obtained sufficient strength to resist the grouting pressures. All concrete in a section to be backfill grouted shall be not less than Twenty-eight (28) days old. The injection of the grout shall be done at a pressure not exceeding 200 kPa or such higher pressure as may be approved providing such higher pressures are in accordance with the design capacity of the structure.

2. Unreinforced Concrete Lining

In unreinforced concrete lined sections, the backfill grout shall be injected through holes drilled through the concrete or through pipes set in the concrete. The location of such holes shall include the high points in the excavated surface.

3. Reinforced Concrete Lining

In reinforced concrete lined sections, the grout shall be injected through pipes set in the concrete lining. The location of such pipes shall include the high points in the excavated surface.

4. Steel Lining

In steel lined sections, the grout shall be injected through holes drilled to rock at the location of the predrilled grout holes provided in the steel liners. At any point where inspection indicates that a cavity exists between the steel liner and the concrete, the Contractor shall drill and tap the liners to provide additional grouting points unless an external system of grouting has been approved.

5. Grouting Holes and Pipes

- (a) The size and location of the holes or pipes shall be as approved.
- (b) Grout holes or pipes shall be located at points of over-excavation in the crown of the tunnel.

6. Composition of Backfill Grout

- (a) The backfill grout shall be composed of:
 - ◆ cement and water
 - ◆ cement, fine aggregate and water, or
 - ◆ cement, filler and water, as appropriate and as approved.
- (b) The proportions of water to cement by mass shall be within the range 0.7 to 0.8. The proportion of fine aggregate to cement by mass shall be within the range 1.5 to 2.0. The fine aggregate for grout shall be clean, one hundred (100) per cent shall pass a 2.36 mm sieve and at least thirty (30) per cent shall pass at 0.30 mm sieve.
- (c) Grout plugs in steel liners

After completion of the backfill grouting, the grout holes shall be sealed off with threaded steel plugs and a sealing compound.
- (d) At any point where inspection indicates that a cavity exists between the steel liner and the concrete, the Contractor shall drill and tap the liners to provide additional grouting points. After completion of the backfill grouting, the grout holes shall be sealed off with threaded steel plugs and a sealing compound.
- (e) To minimise the amount of drilling of the steel liners, the Contractor may propose an extended system of grout pipes for the purpose of grouting cavities that exist between the steel liner and the concrete.

11.3. CONCRETE IN TUNNEL PLUGS

11.3.1. General

- (a) The Contractor shall place all required concrete for the tunnel plugs in the Diversion Tunnel and access/maintenance adits as approved.
- (b) In access/maintenance adit, the bulkhead doorframes shall be cast in first stage concrete of the plug.
- (c) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days prior to the commencement of construction of each plug, the Contractor shall submit details of all equipment and procedures for construction of the plug, including the proposal for cooling the concrete and the subsequent grouting, to the Employer.

11.3.2. Placing Concrete in Tunnel Plugs

- (a) The cooling system and thermometer pipes shall consist of black steel pipes embedded in the concrete. Cooling shall commence at the time of placing the concrete in the plug and shall continue until the concrete temperature has been reduced to that of the surrounding rock, but in any case, not more than 25°C.
- (b) The Contractor shall supply, install and test thermometers.
- (c) Grouting between concrete and rock and/or concrete and shotcrete and between the plug placements shall be carried out after the concrete has cooled to the surrounding rock temperature, but in any case, not less than 25° C. The cooling rates shall not be greater than 2°C/day for a maximum of Five (5) days and subsequently reduced progressively and uniformly to a cooling rate of not greater than 1°C/day over a period of Ten (10) days thereafter and then cooled at a rate of not greater than 0.8 degree□Celsius/day until the specified temperature has been achieved.
- (d) After the cooling and thermometer pipes have served their purpose, the embedded pipes shall be filled with grout. The grout shall be forced into the pipes with only sufficient pressure to ensure that the pipes are completely and solidly filled. All holes left at the grout connections shall be filled immediately and completely with dry pack.
- (e) The Contractor shall furnish and install closure stoplogs in accordance with the requirements for diversion. The concrete in the diversion tunnel plug shall be placed immediately after the stoplogs have been installed and all the work required by this Clause shall be completed as soon as is practicable thereafter.
- (f) Grouting of the joints between the first and second stage concrete in the tunnel plug or between the concrete and the shotcrete or between the concrete and rock shall not commence until the concrete has cooled to 25°C or the temperature of the surrounding rock, whichever is lower.

11.4. CONCRETE IN UNDERGROUND CAVERNS

11.4.1. General

The Contractor shall place all required concrete in the Headrace Tunnels, Valve Chamber, and associated underground structures as shown on the Drawings or approved.

11.4.2. Openings

Openings in floors and walls shall be formed before the concrete is placed.

11.4.3. Allowance for Floor Tiles

Concrete slabs to be covered with a floor finish or tiles shall be left at a sufficient depth below the finished floor elevations to permit placing of the required thickness of floor finish or tiles, and proper allowance shall be made for the finish when anchor bolts, pipes and other metalwork are placed. Concrete slabs forming floors shall be carefully screeded to the required design levels. Scabbling or grinding to bring the floor to the correct levels or other works producing dust will not be permitted after installation of mechanical or electrical plant and equipment has commenced.

11.5. PLANT EMBEDMENT CONCRETE IN THE POWERHOUSE

11.5.1. Preparation of Site

- (a) The Contractor shall prepare the Site for installation of the components of the powerhouse and equipment.
- (b) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days prior to the commencement of construction of second stage concrete in the Powerhouse, the Contractor shall submit details of all equipment and procedures for construction of each part of the second stage concrete, including the proposal for cooling the concrete and the subsequent grouting, to the Employer.

11.5.2. Concrete Embedment

- (a) The joint between the first and second stage concrete shall be deemed to be a construction joint and shall be prepared as such in accordance with the provisions of this Technical Requirements.
- (b) Concrete embedment shall not proceed without the prior approval of the Employer.

11.5.3. Cooling and Thermometer Pipes

- (a) Prior to the placement of the spiral casing embedment concrete, the Contractor shall provide a system of 25 mm diameter black steel pipes for cooling water. At the commencement of placing concrete, the Contractor shall commence the cooling of the concrete by circulating cooling water with an inlet temperature not exceeding 5°C through these cooling pipes at a rate of 20 litres/min for Ten (10) days. In a second stage of cooling to be nominated, the Contractor shall circulate water at a temperature not exceeding 10°C at a rate of 10 litres/min until such

time as the average temperature of the concrete has reached no more than 25°C. The direction of water flow in these pipes shall be reversed every 24 hours. The Contractor shall design the distribution and collection systems for these pipes to permit the direction of water flow to be reversed. The system shall be tested for a pressure equal to 1.5 times the working pressure prior to placing concrete.

- (b) The Contractor shall provide suitable thermometers, thermocouples and cables for monitoring the concrete temperatures at locations within and at the surface of the concrete.
- (c) At the completion of the cooling operation, the cooling and temperature pipes shall be completely filled with grout and the surface of the concrete at the ends of each pipe made good.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 12
PRECAST AND PRESTRESSED CONCRETE
CONSTRUCTION**

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CHAPTER 12 - PRECAST AND PRESTRESSED CONCRETE CONSTRUCTION

12.1. PRECAST CONCRETE

12.1.1. General

- (a) The Contractor shall construct and erect precast reinforced concrete units in accordance with this Clause where and as shown on the Drawings approved by the Employer
- (b) Except as otherwise provided in these Clauses, all units shall be constructed and erected in accordance with the applicable requirements of the Specification and AS 3600 / BS 8110: Part 1 / ACI 318M.
- (c) All units shall be cast in individual forms and may be cured by steam curing.
- (d) Where the use of immersion type vibrations is not practicable, the Contractor shall consolidate thin precast concrete slabs and units on a vibrating table or by another effective method.
- (e) Units shall not be branded or marked in any position which can be seen in the finished work or against which any corrected is to be placed.
- (f) The unit may be supplied by a manufacturer or may be manufactured by the Contractor at an approved location. For units other than concrete blocks and precast units which are detailed on the Drawings, the Contractor shall also submit to the Employer all details of the individual units, including proposed reinforcement, proposed concrete strength and location of lifting points as hereinafter specified.
- (g) Repairing of damaged units will not be permitted except where such damage and repair will not impair the installation or the appearance of the units after installation.

12.1.2. Submission of Proposed Methods

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days before commencing manufacture of each type of precast reinforced concrete unit and each type of prestressed concrete units, the Contractor shall submit to the Employer all details of the methods to be used in manufacture, handling, transport, storage and erection of the units.

12.1.3. Handling

- (a) During transportation and storage, all precast reinforced concrete units shall be supported until their final position. All units shall be adequately braced and supported during erection to ensure proper alignment and safety. Such bracing or supports shall be maintained until adequate permanent connection have been made.

12.1.4. Tolerances

- (a) The dimensions of all finished precast reinforced concrete units shall be within

the following limits at the time of placement of the units in the structure, unless otherwise shown on the Drawings approved by the Employer:

- ◆ Overall dimensions of units: $\pm 5\text{mm}$

Cross-section dimensions:

- ◆ Section less than 75mm: $\pm 1.5\text{mm}$
- ◆ Section over 75mm: $\pm 5\text{mm}$
- ◆ Deviation from straight line in long sections: not more than 5mm per 6m
- ◆ Deviation from specified camber: $\pm 1.5\text{mm}$ per 3m of span

Max differential in camber between adjacent units in erected position: 10mm

12.2. PRESTRESSED CONCRETE

12.2.1. General

- (a) If prestressed concrete units (or members) are approved, with the provision of this sub-clause shall apply.
- (b) The work shall be supervised either by specialist staff experienced in prestressing or shall be carried out by a specialist subcontractor, and shall comply with ACI 318M except as otherwise specified in this Clause.
- (c) The Contractor shall construct and erect the prestressed concrete members to the approved lines, grades and dimensions.

12.2.2. Methods of Prestressing

- (a) The Contractor shall propose a prestressing system to the Employer for his approval.
- (b) The proposed system shall provide means of:
 - ◆ prestressing in stages, and destressing at any stage before grouting; and
 - ◆ measuring the load in the tendons.
- (c) The prestressing system shall be designed for the required prestress forces and eccentricities. Reinforcement behind prestressing anchor plates shall be designed for the anchor plate sizes and prestressing forces.
- (d) The Contractor shall submit to the Employer to allow for the initial review period of not less than Sixty (60) days before commencing manufacture of each type of prestressed concrete member, full details of anchorages, anchorage reinforcement, sheathing and relevant particulars of the proposed tendons, method of forming, placing and curing of the members and of its handling, transporting, erection, stressing and grouting methods.
- (e) Any prestressing systems proposed by the Contractor shall be such that the general arrangement, depth and outward shape of the members remain unaltered.
- (f) The Contractor shall submit to the Employer, at least Sixty (60) days before constructing any members, full details of anchorages, anchorage reinforcement,

sheathing and relevant particulars of the proposed tendons, together with complete drawings of those parts of the structure affected by the change and all appropriate design calculations.

- (g) The Contractor shall precast the prestressed members at an approved location.

12.2.3. Submission of Proposed Methods

- (a) The Contractor shall at least Thirty (30) days before commencement of manufacture of the prestressed members:
- I. Submit, to the Employer, full details of his method of forming, placing and curing of the members and of his handling, transporting, and erection, stressing and grouting methods. The Contractor shall not vary his methods without resubmitting full details of the proposed changes.
 - II. Submit shop drawings and details of all metalwork, prestressing tendon anchorages to be embedded in the members, schedules of locations of material and marks by which individual items can be identified.

12.2.4. Concrete Materials

- (a) Cement, admixtures, water and aggregates for prestressed concrete members shall comply with the applicable requirements of this technical requirements.

12.2.5. Materials for Tendons

- (a) High tensile steel wire and strand shall conform to ASTM A416 - A421.
- (b) High tensile alloy bars shall have the following physical properties:
- ◆ Minimum tensile strength of 1080 MPa.
 - ◆ Proof stress at a non-proportional strain of five (5) percent, not less than eighty-five (85) percent of the minimum tensile strength.
- (c) High tensile steel bars will be individually inspected for superficial tears, nicks, roller marks or any other form of surface imperfection.
- (d) A high tensile steel bar not less than 30 mm diameter with surface imperfections that range from 0.15 mm to 0.40 mm deep may be accepted for use at the sole discretion of the Employer, provided the imperfections whose depths range from 0.15 mm to 0.40 mm are filed smooth with a finecut half round file.
- (e) A high tensile steel bar not less than 30 mm in diameter with surface imperfections that exceed 0.40 mm in depth will not be acceptable for use. A high tensile steel bar with a diameter less than 30 mm in diameter with any imperfections, as determined by the Employer, shall not be used.
- (f) Notwithstanding the above conditions of acceptance, any bar which has an imperfection that the Employer considers detrimental to the strength of the bar shall not be used.
- (g) Three (3) test pieces selected by the Employer shall be tested by the Contractor and manufacture of cables or placing of tendons shall not commence until satisfactory results have been received from these tests. Further test pieces,

approximately one for each tonne of tendons used in the construction, will be taken during the progress of the work and shall be tested by the Contractor for conformity with the requirements of this Technical Requirements.

- (h) The ratio of length to diameter of test pieces will exceed 100:1. Test pieces will not be taken from the end 1.5 m of a coil of wire or strand.
- (i) All testing shall be carried out in an approved, authorised and registered laboratory.

12.2.6. Anchorage Devices and Couplings

- (a) All anchorages for high tensile steel strand tendons shall generally be in accordance with ACI 318M. All anchorages shall be provided with a positive centering device so that the anchorage heads shall not move during tensioning.
- (b) All high tensile steel bar tendons shall be anchored by means of rolled threads and nuts except that, for wholly embedded anchorages, tapped plates shall be used in conjunction with the rolled threads.
- (c) Anchorages and coupling devices shall be capable of withstanding a force of not less than 95 percent of the specified minimum ultimate tensile strength of the tendon without damage or excessive deformation or draw-in.
- (d) Swaging of strand and button-heading of wire shall be carried out only by approved methods and the swages/button-heads shall develop not less than 95 percent of the specified minimum ultimate tensile strength of the strand or wire.
- (e) At least Thirty (30) days before the start of concreting operations, the Contractor shall supply to the Employer, details and results of tests carried out on the following;
 - ◆ Two (2) complete anchorages and couplings for each type of tendon to be used in the Works.
 - ◆ Two (2) sample lengths of tendon with ends treated for anchorages and couplings.
- (f) Further anchorages and couplings shall be tested by the Contractor during the progress of the work at the rate of one anchorage of each size and one coupling for the strand prestressed tendons and one complete high tensile steel bar tendon for each consignment delivered to the Works.
- (g) Sufficient length of the appropriate made-up tendon shall be tested with each anchorage or coupling for the strand prestressed tendons to suit testing arrangements.
- (h) Anchorages and tendons shall not be installed until test results for the anchorages have shown that they meet the specified requirements.
- (i) Should any anchorage or coupling fail to withstand a specified force in this sub clause, the quantity of anchorages or couplings represented by that specimen shall be replaced.
- (j) No damaged anchorage or coupling devices shall be used. All steel in the anchorages shall be protected from corrosion at all times. All threaded parts

shall be protected by greased wrapping and all tapped holes shall be protected by suitable plus until used. The devices shall be kept free from mortar, loose rust, grease, tar, paint, oil, mud or any other coating. A suitable coating may be used to protect the exposed faces of anchorages and anchorage plates after embedment in the precast girder segments, but all such coating shall be removed immediately before the tendons are installed.

12.2.7. Ducts

- (a) Ducts for the insertion of prestressing tendons shall be formed in the concrete members by means of light-gauge steel conduits, flexible steel sheathing or by other acceptable means except that bars may be cast in place after wrapping with a tape coating to prevent bonding with the concrete.
- (b) The ducts shall be strong enough to withstand the placing and the vibration of the concrete without suffering any damage or deformation. Internal and external diameters of the ducts shall be within the limits shown on the Drawings approved by the Employer.
- (c) The ducts and any joints shall be mortar tight and the ducts shall be in one piece between the ends of each segment or placement. Curved pieces of duct shall be pre bent and shall be checked with lengths of tendon for flattening and other distortions which might obstruct the free movement of the tendons.
- (d) Before the ducts are embedded in the concrete, they shall be accurately aligned and securely fixed in position by means of rigid supports spaced at intervals of not more than 1 m. Bar tendons to be cast in place shall be similarly aligned and fixed but shall not be welded to the supports.
- (e) Grout holes shall be provided at both ends of ducts and shall be at least 10 mm in diameter. The grout holes shall be equipped with a plug, valve or similar device capable of withstanding a grout pressure of 700 kPa without loss of water or air. For ducts with high points along their length, additional vents with plug valves of similar diameter shall be provided at the high points to bleed air and water and to ensure that the duct is completely filled with grout after grouting.

12.2.8. Handling and Storage of Tendons and Accessories

- (a) The Contractor shall receive all materials at the Site and store the materials under cover on suitable supports above the ground. High-tensile steel wire and strand shall be supplied in coils, which shall be supported so that they are free to rotate before lengths of tendons are drawn from them. Materials shall be kept free from loose or thick rust, oil, grease, tar, paint, mud, or any other deleterious substance but shall not be brought to a smooth polished condition. A slight film of rust will not be regarded as harmful, but the steel shall not be visibly pitted by rust.
- (b) The Contractor shall be responsible for checking that all dimensions and quantities shown on the manufacturers' schedules are correct and shall obtain copies of these schedules from the manufacturers for this purpose.
- (c) Before being assembled or worked in any way, the prestressing materials shall

be clean and free from kinds or damage. All damaged materials shall be removed from the Site and replaced.

12.2.9. Marking of Precast prestressed Members

- (a) The date of casting, length of member and the identification number shall be marked on every precast prestressed member in an approved position which cannot be seen in the finished work. The word "TOP" and/or lifting positions shall also be marked on the member.
- (b) Temporary identification and date of casting marking shall be scratched into the top surface of the member near an end immediately after screeding off.
- (c) The final marking shall be made by indelible marking material using letters approximately 75 mm high.

12.2.10. Lifting, Handling and Stacking of Precast Prestressed Members

- (a) Post-tensioned members shall be fully stressed or stressed to the extent shown on the Drawings and all stressed tendons shall have been grouted for Seven (7) days before lifting or handling of the member unless the moving of post-tensioned members off their casting beds before grouting stressed tendons is approved. If such approval is given each ungrouted tendon shall be adequately marked for possible slip and should any slip or damage occur, the tendon shall be replaced and/or restressed as directed.
- (b) At all times, during handling, members shall be secured in an upright position by means of suitable packing pieces and braces. Members shall not be braced against each other but shall be provided with independent bracing. Special care shall be exercised not to damage the flanges of members.
- (c) Members shall not be stacked on top of each other and no superimposed load shall be placed on a member.
- (d) Members shall be handled, lifted and supported carefully at the positions and in the manner shown on the Drawings approved by the Employer. Where no method of lifting is shown on the Drawings, the Contractor shall submit details of his proposal for lifting the members.

12.2.11. Dimensions and Tolerances

- (a) The dimensions and shape of prestressed concrete members stated on the Drawings shall be taken to apply to the members and structure at the time of their completion when under self-weight alone.
- (b) The dimensions and profile of the forms shall compensate for deformations caused by prestressing so that the dimensions and profile of the completed members shall conform to the designed dimensions and profile.
- (c) Variation in the overall length and length centre to centre of bearings shall be accurate to within 5 mm or ± 0.06 percent of the length, whichever is the greater.
- (d) Sagging profiles will generally not be accepted but upward deviation (hog) from the required profile of up to 0.1 percent of the span length will be permitted.
- (e) The deviation of a member from the required profile in a horizontal plane shall

not exceed 5 mm or ± 0.06 percent of the length of the member, whichever is greater.

- (f) Variation in location ducts and sheathing shall be within ± 4 mm.
- (g) Cover to ducts and sheathing shall be not less than 50 mm.

12.3. MANUFACTURE OF PRESTRESSED CONCRETE MEMBERS

12.3.1. General

- (a) The Contractor shall manufacture precast prestressed concrete members to the dimensions shown on the Drawings approved by the Employer.
- (b) Care shall be taken during tensioning to ensure the safety of all personnel engaged on the work and of other persons in the vicinity.
- (c) Jacks shall be secured in such a manner that they will be restrained should they lose their grip on the tendons. No person shall be allowed to stand behind the jacks or close to the line of action in front while tensioning is in progress. The operation of the jacks, the measurement of the elongation and associated operations shall be carried out in such a manner and from such positions that the safety of all concerned is ensured.
- (d) Heavy stoppers made either of hardwood or sheet metal shall be provided and placed in such a manner as to prevent any tendon, which might become loose, recoiling unchecked. During actual stressing operations, warning signs in adequately large letters shall be displayed at both ends of the post-tensioned member.
- (e) Sheathing for all ducts shall be placed accurately in the formwork in the position shown on the Drawings and shall be adequately tied and held against movement during concreting. The sheathing shall be fixed so as to ensure the alignment as well as the position of ducts at joints is accurate. The joint between the sheathing and anchorage plates shall be mortar tight. Ducts shall be stiffened during concreting by means of an internal strand of diameter equal to or greater than the final strand tendons.
- (f) High tensile steel bar tendons shall be located as shown on the Drawings and suitable devices shall be provided to ensure that the tendons are maintained in their correct position, both laterally and vertically, during casting. When bar tendons are being placed, particular care shall be taken that the tendons shall not come into contact with the oiled surface of the forms or be otherwise contaminated. Any oil or other contamination, which might collect on the tendons, shall be removed by cleaning the affected tendons with clean rags soaked in mineral spirit or by other approved methods. Welding of high tensile steel bar or plate will not be permitted. High tensile steel bars or plates splashed by weld splatter shall be removed and replaced at the expense of the Contractor. After installation of the bar tendons in the forms, the exposed parts of the rolled threads on the bars shall be protected and such protection shall be kept over the threads until just before tensioning the tendon.
- (g) All anchorage plates for prestressing tendons shall be accurately positioned

square to the line of action of the tendons and held firmly during concreting. Any mortar adhering to the exposed faces of the anchorages shall be removed.

12.3.2. Tensioning Equipment

- (a) All tensioning equipment shall be preferably power driven. The power unit shall be adjusted so that the rate of extension of the tendon is within recommended limits or as directed.
- (b) Dynamometers and each set of equipment comprising pump, jack and pressure gauges shall be calibrated immediately prior to delivery to the site and every six months thereafter unless otherwise directed and the true force determined from the calibration curve. Calibration certificates shall be submitted to the Employer prior to the equipment being delivered to the Site. Dynamometers and scales shall permit force and elongation respectively, to be determined within an accuracy of 2 percent.
- (c) Pressure gauges shall be concentric scale gauges accurate to within 1 percent of their full capacity. They shall be selected so as to be used between 50 and 90 percent of their full capacity. Where pressure gauges are used, a snubber, or similar device, shall be fitted so as to protect the gauge against sudden release of pressure. Provision shall also be made, by such means as a Tee connection, for the attachment of a second gauge to be used as a check when directed.

12.3.3. Required Strength and Age of Concrete for Prestressing

- (a) The prestressing force shall not be applied to a member until all the concrete in the member has attained the compressive strength, nor shall it be applied at an earlier age than 60 hours after casting (or repair) or 36 hours after casting (or repair) when steam cured, provided that when steam cured the temperature of the concrete has returned to the ambient temperature. The use of excess cement to obtain high early strength will not be permitted.
- (b) The age at which the prestressing force is to be applied shall take into consideration the modulus of elasticity of the concrete. Variations in atmospheric temperature and humidity may make it desirable to vary the age at which members are prestressed so that the modulus of elasticity, and hence the resulting deformations, are as alike as possible.
- (c) No stressing shall be carried out when the temperature of the surrounding air is lower than 0°C.

12.3.4. Tensioning Force Required

- (a) The tensioning force applied to any tendon shall be measured both directly by measurement of the force or jacking pressure and indirectly by measurement of the elongation of the tendon.
- (b) The Contractor shall measure tensioning force required for the elongation and for the force in the tendon at the jack. Allowance shall be made for the anticipated draw-in at the anchorage devices on release of the jacks. Any difference in the force determination from each measurement greater than 5 percent shall be ascertained and corrected.

- (c) Determination of the tensioning force by means of elongation will only be accepted when the limits of variation of the secant modulus, at the tensioning stress guaranteed by the Contractor, are approved. Should the secant modulus of batches of tendons differ by more than 3 percent, the required elongation shall be adjusted accordingly.
- (d) Every endeavour shall be made to obtain the force shown on the Drawings. A tolerance of 5 percent will be permitted for individual tendons provided that the total prestressed load being applied at that time is within 2 percent of the required value.
- (e) If, on completion of tensioning of a tendon, the requirements of this sub-clause and ACI 318M are not satisfied, the Contractor shall adopt special methods overcoming friction loss, such as lubricating the tendon with a water soluble oil, and may direct the tendon to be stressed simultaneously from both ends in the restressing operation if this is physically possible.

12.3.5. Placing and Tensioning of Tendons

- (a) Strand prestressing tendons shall be placed in the sheathing in accordance with the recommendations of the prestressing system supplier and this sub clause.
- (b) The method of placement shall be such as to ensure that neither the tendon nor the sheathing shall be damaged during the operation.
- (c) Immediately before placing each tendon, the Contractor shall ensure that all water is driven out of the duct and that the strand tendon, once placed, shall be completely protected against weather, in the period between placing in the duct and grouting, by covering and sealing openings in the duct. In the period between placing in the duct and grouting of the tendon, ends exposed to weather shall be provided with weatherproof coverings.
- (d) The tensioning procedure for all tendons shall be in accordance with ACI 318M. Tensioning shall be performed only in the presence of the Employer and only by technicians trained for and experienced in this type of work. Special care shall be taken to apply the tensioning force smoothly and at an even rate and to release the jack smoothly. Members shall be prestressed in accordance with the best practice applicable to the particular prestressing method.
- (e) The process of prestressing shall be continuous, the tendons being stressed in the sequence and to the loads and the operation completed without interruption in as short a time as possible, unless otherwise specified.
- (f) The protruding ends of tendons shall be cleaned of any contamination, which may have accumulated since placing. Tendons shall be checked before tensioning to ensure that they are free to move inside the duct, and anchorages shall be thoroughly cleaned before commencement of tensioning. Special care shall be taken to set the jack or jacks accurately in the line of the tendon. The force, which is applied initially to take up the slack of the tendon, shall be chosen so as to seat the jack firmly but shall not exceed the force normally associated with the particular method of prestressing.

- (g) During the tensioning of each tendon, after taking up the slack, the jack force (or pressure) shall be read and an elongation reading made. Subsequent similar readings of force and elongation shall be made at intervals and plotted to determine the total tendon elongation. The draw-in on anchoring shall also be measured.
- (h) In the case of slipping of one or more components or tendons of a group tensioned together, a compensating increase in the elongation of the remaining tendons of the group shall be made provided that the jacking force does not exceed eighty five (85) percent of the minimum ultimate strength of each of the tendons.
- (i) If a tendon breaks or slips during or after tensioning, so that the allowable tolerances are exceeded, the tendon shall be released, replaced if necessary and restressed.
- (j) Unless otherwise shown on the Drawings, strand tendons shall be stressed from one end only.
- (k) When stressing a tendon from both ends is directed, the jacking forces shall not differ by more than 10 percent throughout the tensioning operation. The tensioning operation shall continue until the required force in the tendon at each jack is reached.
- (l) Where tendons are to be stressed simultaneously, the force shall be increased in each tendon so that the maximum jacking force for each tendon is reached and tendons are anchored at approximately the same time.

12.3.6. Data to be Recorded

- (a) The following data, where applicable, shall be recorded by the Contractor:
 - I. Identification number of dynamometers, gauges, pumps and jacks.
 - II. Identification particulars of tendons.
 - III. Initial force (or pressure) when tendons are marked for measurement of elongation.
 - IV. Final force (or pressure) and elongation obtained on completion of tensioning.
 - V. Elongations remaining after release of jacks.
 - VI. Ramming pressures.
 - VII. Elongation obtained at suitable intervals during tensioning together with corresponding force (or pressure).
- (b) All records shall be forwarded to the Employer on completion of each stressing operation and prior to grouting of the tendon ducts. All forms shall be forwarded to the Employer on completion.

12.3.7. Grouting of Prestressed Tendons

- (a) The Contractor shall completely fill with grout each prestressed tendon duct in accordance with "Post Tensioning Institute (PTI) Manual" or other approved equivalent.

- (b) Tendons shall be grouted within 24 hours of tensioning unless otherwise approved.
- (c) The ratio of water to cement by mass in the cement grout shall not be more than 0.45 and the compressive strength on 150 mm by 75 mm diameter cylinders of cement grout, cured for Twenty-eight (28) days at 20°C +/- 2°C and ninety seven (97) to one hundred (100) percent relative humidity, shall be at least 27.5 MPa. Grout mixing shall be carried out in accordance with the provisions of Chapter 8 of Standard Technical Requirements and sieved through a 1.4 mm sieve and the flow time through a standard flow cone shall be not greater than 30 seconds.
- (d) Before injection, the grout mixture shall be mixed for a minimum of three minutes by means of a high-speed mechanical stirrer and sieved through a 1.4 mm sieve and the flow time through a standard flow cone shall be not greater than 30 seconds.
- (e) The grout shall be prepared using a mixture and additives, which prevent shrinkage and bleeding. Neither aluminium powder nor chloride compounds shall be used as an additive. A methylcellulose additive may be used to improve fluidity and control bleeding. Water used in the grout mixture shall be substantially free of either chloride or sulphate compounds.
- (f) At least Sixty (60) days before grouting any prestressing tendons, the Contractor shall prepare a trial mix of his proposed grout mixture including admixtures, which shall then be sampled and tested by the Contractor to verify its compliance with this sub clause.
- (g) As the work progresses, the Contractor shall take further samples for testing when directed.
- (h) The grout shall be used within one hour of commencing to mix the ingredients.
- (i) The grouting equipment shall be arranged to provide a supply line and a return line from the grout pump to the grout connection. Provision shall be made to permit accurate control of grouting pressures and of grout flow at the grout connection, and continuous circulation of grout within the grouting system.
- (j) The duct to be grouted shall first be filled with water under pressure of 700 kPa for at least one hour before grouting. All ducts shall be flushed with clean water followed by compressed air immediately before grouting until all loose particles are removed. Grout shall then be injected by means of a grout pump of either the piston displacement type or screw or impeller type. An even, slow, continuous flow of grout shall be maintained until the duct is completely filled and pure grout of the consistency being injected issues from all vents and until all entrapped air has been expelled. The vents shall be progressively closed until the duct is completely filled. The grout shall then be held at 700 kPa pressures for at least one minute after which the grouting end shall be plugged. All care shall be taken to prevent loss of grout immediately after grouting. The grouting tubes shall be topped up with grout if a wastage or subsidence of grout occurs when disconnecting the pump. Unless otherwise approved, all vents and other openings shall be kept closed until regrouting commences.

- (k) Sufficient grout shall be available for immediate use to enable the grouting of a whole duct without interruption, refilling of the grout tank or the necessity of mixing further quantities.
- (l) Regrouting of prestress tendons, in accordance with this Subclause, shall be carried out by the Contractor during the second hour after the first grouting of the tendon has been completed but in any case before the grout begins to set. Grout shall be injected in such a way as to prevent air being introduced into the duct with the grout. A mineral pigment in the grout to help determine when grout from the second grouting operation is beginning to flow through vent openings shall be used.

12.3.8. Cutting and Protection of Anchorages

- (a) After the grout in any tendon duct has set, the wire or strand ends shall be cut to the prestressing system supplier's requirements with a cutting disc.
- (b) All anchor heads for strand tendons shall be protected by grout or concrete with a minimum clear cover of 25 mm.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 13
STRUCTURAL STEEL WORKS**

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CHAPTER 13 - STRUCTURAL STEEL WORKS

13.1. GENERAL

13.1.1. Scope of Work

- (a) The work described in this Chapter includes the supply of all labour, Plant and materials to complete the design and detailing, supply, fabrication, painting or galvanizing, and installation of the structural steel and miscellaneous embedded and non-embedded metalwork as shown on the Drawings approved by the Employer.
- (b) For this Chapter of Standard Technical Requirements, structural steelwork includes all rolled, cold formed and fabricated sections and miscellaneous structural steelwork required for completion of the Works.

13.1.2. Submissions

The following documents shall be submitted to the Employer.

1. Fabricator

- (a) The Contractor shall submit the name of fabricator, official address, list of past practice and brochures showing manufacturing facilities and location of factories, at least two months before beginning the manufacturing.

2. Schedule

- (a) The Contractor shall submit a work schedule indicating time schedule of all works including shop fabrication, transportation, field fabrication, erection at the site and other necessary items related to the work.

3. Detail Design, Calculation and Shop Drawing

- (a) The Contractor shall submit complete shop drawings supported by structural computations, of all structural steel work showing sizes, type and grade of metal, method of assembly, hardware and anchorage or connection with the main structures at least Sixty (60) days before beginning the manufacture of the various items.
- (b) Full account shall be made in the design for all temporary loads and stresses, which may occur during fabrication, assembly, transportation or erection.

4. Erection Procedure

- (a) The Contractor shall submit drawings or documents explaining erection procedure including the temporary bracing method and installation equipment or machinery, at least one month before beginning the erection.

5. List of Materials

- (a) Prior to the procurement of materials, the Contractor shall submit list of materials to be used. The name, official address and brochures showing manufacturing facilities of the manufacturer of materials shall be attached with the list.

6. Mill Sheet and Certificates of Materials

- (a) Mill sheets or certificates of materials, which are based on the tests, performed in the steel maker or an approved independent laboratory shall be submitted to the Employer.

7. Welding Procedure

- (a) The Contractor shall submit welding procedures and certificates of qualifications of welders which shall be in accordance with the AWS D1.1

13.1.3. Standards and Codes

- (a) All design, material, execution of work shall comply with the applicable standards and codes listed below, in particular, with the AISC codes, the AISC Handbook of Steel Construction, and all local building codes or regulations.
- I. American Institute of Steel Construction (AISC)
 - Specification for the Design, Fabrication and Erection of Structural Steel for Building
 - Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design
 - Specification for the Design of Cold-formed Steel Structural Members
 - II. Association of Iron and Steel Employers (AISE)
 - III. American Iron and Steel Institute (AISI)
 - IV. American National Standard Institute (ANSI)
 - V. American Society of Civil Engineers (ASCE)
 - VI. American Society for Testing and Materials (ASTM)
 - VII. British Standards Institute (BS)
 - VIII. Deutsche Institute for Normung (DIN)
 - IX. International Organization for Standardization (ISO)
 - X. Japan Architectural Standard Specification (JASS)
 - XI. Japanese Industrial Standards (JIS)
 - XII. American Welding Society (AWS)
 - XIII. Steel Structures Painting Council (SSPC)
 - XIV. Indian Standard (IS)

13.2. MATERIALS

- (a) All material furnished by the Contractor under this Chapter shall be new, free from defects and imperfections and conform to the following standards or

equivalent.

Material	Standards
Structural steel shapes, bars, plates	ASTM A6, A36/A36M
Floor plates	ASTM A6, A36/A36M
Cast iron	ASTM A 48 Class 25
Angle steel, Channel steel, H-steel	ASTM A6, A36
Steel pipe	ASTM A53, A500, A501
Bolts, nuts and washers	
- high strength	ASTM A 325M or ASTM A 490M
- stainless steel	ASTM A 193
- standard strength	ASTM A 307 Grade A or B
- threads	Coarse thread series
- washers, hardened	ASTM F436M
- washers, standard strength	Standard commercial quality
- bevel washers	Malleable iron or steel
- shear connectors (studs)	ASTM A108 Grades 1010 through 1020
Welding materials	AWS A5.1, A5.17 or A5.5

- (b) Unless otherwise specified herein or shown on the Drawings, all exposed fastenings shall be of the same material, colour and finish as the metal to which they are attached.
- (c) Grout for baseplates and bearing plates shall be dry-pack mortar.
- (d) Non-shrink cementitious grout Sika Grout 212 HP or approved equivalent to be used as structural grouting under column base plates.
- (e) The Drawings and the Specifications indicate as a rule the size of steel pipes and shaped steel in the metric system. The Contractor will be permitted to use those of inch size, which are approximately the same, or more in size as those indicated on the Drawings or the Specifications.
- (f) The Contractor shall give a five (5) year guarantee on all materials under this chapter for quality and properties as to withstand the climatic weather conditions of the region.

13.3. EXECUTION

13.3.1. WELDING OF STRUCTURAL STEELWORK

1. Standards

- (a) All welding shall be carried out by an electric arc method and, wherever possible, automatic or manually guided machine welding shall be used for both shop fabrication and field erection.
- (b) All welding shall comply with AWS D1.1.

- (c) A full description of each welding procedure and the equipment to be used shall be submitted for approval at the same time as the personnel, together with their qualifications, to perform the work are proposed. The welding procedures and equipment to be used shall be submitted in accordance with the requirements for Contractor's Documents to allow for the initial review period before the commencement of any fabrication.
- (d) Operators of manually guided machine welding equipment or manual welders using covered electrodes shall be qualified in accordance with AWS D1.1.
- (e) Submerged arc consumables for fabrication of structural steel work shall comply with AWS A5.17.
- (f) Gas shielded or self shielded consumables for automatic or semi-automatic welding shall comply with AWS A5.20 or AWS 5.18.
- (g) Covered electrodes for manual welding shall be controlled hydrogen electrodes complying with AWS A5.1. All electrodes shall be baked at a temperature as recommended by the electrode manufacturer but not expected to be less than 2 hours at 300°C minimum. After baking, electrodes shall be stored at 100°C minimum and used from continuously heated containers.
- (h) Wherever possible welding of high yield stress steel and of mild steel plates of combined thickness greater than 50 mm shall be carried out by a procedure which uses a high arc energy to ensure freedom from heat affected zone cracking.
- (i) Where a high arc energy procedure is not used the amount of preheat and the arc energy shall comply with AWS D1.1. Preheat temperatures shall be continuously maintained as a minimum interpass temperature from the time welding of a joint commences until 1 hour after welding of the entire joint is complete. Preheat shall be maintained continuously throughout back gouging or any other interruption to the welding.

13.3.2. FABRICATION OF STRUCTURAL STEELWORK

1. Certificates

- (a) Materials shall not be transported to the Site until all tests, analyses and final inspections have been made or certified copies of reports of tests and analyses or manufacturer's warranties have been submitted to the Employer. The tests specified in the Standard Technical Requirements shall be carried out by the manufacturers of the materials or by an approved testing laboratory and three certified copies of test reports shall be supplied.

2. Storage

- (a) All materials stored at the fabricating plant prior to fabrication and all fabricated materials shall be supported above the ground so as not to cause over stressing, shall be protected properly from rust, and shall be kept free from dirt, grease, oil and other foreign matter. Material which shows signs of pitting due to rust may be rejected.

3. Quality

- (a) Before being laid out or worked on in any way, rolled material shall be straight

and shall be cleaned of all loose rust and dirt. Sharp kinks or bends will be cause for rejection of the material. If straightening is necessary, it shall be done by methods not likely to produce fracture or other injury. Heating shall not be to a higher temperature than 650°C. After heating, the metal shall be cooled slowly.

- (b) All cut edges shall be finished neatly.
- (c) Welded splices that develop the full strength of the material being joined shall be kept to a minimum.

4. Changes to Proposals

- (a) Changes shall not be made in any of the Contractor's Documents including drawings after they have been submitted unless such Documents or Drawings are resubmitted in accordance with the Contract.

5. Protective Coating

- (a) After the structural steelwork has been fabricated and inspected, the Contractor shall clean and coat all such steelwork in accordance with Chapter 14 of Standard Technical Requirements.

6. Shop Fabrication

- (a) Measuring Tape
 - Measuring tapes for shop fabrication and for erection at site shall be of steel, and deviation of each other shall be measured and informed to the Employer.
- (b) Marking Off on Material
 - The positions of bolthole and shape, dimensions of plate shall be accurately marked on base metal using full size templates.
- (c) Cutting and Forming
 - In cutting base metal, automatic flame-cut methods shall be employed.
 - Base metal shall be accurately cut at right angle to the axis and true to marked line and well-formed to size and shape as marked on.
 - Roughness, bursts or any other irregularity of all edges shall be removed using a grinder or a planer.
- (d) Bending
 - Except where inevitable, bending of structural steel shall be done cold. In case it is necessary to employ a heating process, bending of steel shall be done while the steel is red hot.
- (e) Bolt Hole
 - Holes shall be drilled with a bit at right angles to the surfaces and shall not be made or enlarged by burning holes. All the boltholes shall be clean-cut without any burrs or ragged edges resulting from drilling.
 - When loose boltholes are employed, the shape of loose boltholes shall be shown on the drawings.

(f) Welding

i. Welder

- Welding shall be executed only by welders who are skillful with welding with all positions and experienced in welding of structural steel for more than 6 months.

ii. Edge Preparation and Assembling

- Edge to be welded shall be made into shape in accordance with the approved edge preparation plan, and shall be free from loose scale, slag, grease, paint or other objectionable materials.
- Materials to be welded shall be held firmly by an adequate method so as not to move during the welding works. Tack welding shall be performed in such a manner as to minimize residual internal stress. The Contractor shall take other proper means to prevent strain or residual internal stress from welding.

iii. Handling of Welding Rod

- The welding rod shall be stored in their original packing in a dry place, with appropriate protection against the weather. If the welding rod seem to have suffered from the effects of moisture but does not have any other damage, it can only be used when they have been dried in satisfactory manner.
- Welding rods, which have areas where the flux covering is broken or damaged, shall be rejected.

iv. Common Procedure

- Positioning
 - Materials to be welded shall be positioned so as to be welded under flat position as far as possible.
- Procedure
 - Welding procedure shall be put in order to minimize residual internal stress.
- Preheating
 - If the temperature at place where welding is performed is between zero (0) degree Celsius and minus fifteen (-15) degrees Celsius, the area within 100 mm from the parts to be welded shall be preheated to more than thirty six (36) degrees Celsius.
- End tab
 - End tab shall be employed at the end of weld line.
 - End tabs employed at invisible part after the beams are installed

shall be cut off except the parts 3 mm to 5 mm from root. End tabs employed at visible part after beams are installed shall be cut off all.

- Removing of slag
 - Welding of the second layer or thereafter shall be performed after thoroughly removing the slag of the preceding layer.
- v. Full Penetration Butt Welding
 - Back Chipping
 - When the welding is executed on both sides, the bottom of the weld, which is executed, first shall be grooved by gas gauging or other adequate means before the back run welding is commenced.
 - If it is evident that complete penetration can be obtained without back chipping, back chipping may be omitted.
 - Backing Strip
 - When the welding is executed on one side only, the backing strip shall be employed. In this case, care shall be taken so that full penetration into the base metal to be welded is obtained by first pass.
 - Reinforcement of Weld
 - The reinforcement overlayer of weld shall be less than 4 mm in height, and excessive overlayer of more than 4 mm shall be removed carefully with a grinder.
 - In the case of tee (T) joint or corner joint, the weld shall be reinforced by fillet weld with more than one-fourth thickness of butting plate.
- vi. Fillet Welding
 - The portion, which shall be fillet-welded, shall be placed in contact with each other as close as possible.
 - The height of reinforcing overlayer of weld shall be less than $0.1 \times S + 1$ mm, where S is the designed size of fillet weld.
- vii. Stud Welding
 - Stud welding shall be executed by electric arc stud welding method. Especially in the case of field welding, when the stud bolts are welded penetrating deck plate, the method shall be proved by adequate field test.

- The length of welded stud bolts shall be designed length plus minus ($\pm$) 2 mm.

viii. Correction of Welding Defects

- Welding defects listed below shall be carefully removed and re-welded, corrected or treated.
 - Blowhole, slag inclusion, and inadequate penetration, pit, overlap, under cut, crack.
 - Insufficient throat and leg length of fillet welding.

ix. Permissible Variation

- Permissible variation in dimensions of the steel members fabricated at the manufacturer shall be approved by the Employer.
- Base Preparation and Treatment
 - After the completion of fabrication at shop, all of the surface to be painted shall be cleaned of all rust, dirt, oil, slag, scale and any other foreign substance. Cleaning of the surface shall be executed with sandblasting or shotblasting and immediately thereafter wash-primer shall be applied to the surface.
- Rust-resistant Painting
 - Rust-resistant paint shall be applied in two coats in accordance with the provisions of the Chapter 15 "Painting" of the Specifications prior to the shipment.
- Contacting Faces for Friction Grip Joint
 - Contacting faces for friction grip joint of high strength bolt shall be cleaned with sand blasting or shot blasting. Wash-primer, or rust-resistant paint shall not be applied on those faces.

x. Shipment

- Prior to shipment, each member shall be marked with erection marks for identification and ease of erection and the Contractor shall furnish erection diagrams with its Contractor's Documents for such work, showing the erection marks thereon. The Contractor shall also furnish a copy of each shipping statement showing the weight of individual members in each shipment. Members weighing more than 3 t shall have their weights marked thereon. Structural members shall be loaded in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

7. Transportation

- (a) The Contractor shall be responsible for all necessary notifications to the concerned office or authority concerning to the transportation of the member

and parts of structural steel. They shall be transported carefully to the site in such a manner as to prevent deformation, corrosion, or other damage to beams.

- (b) If necessary, adequate reinforcements, bracing, stiffeners or other means shall be provided.

13.3.3. TOLERANCES FOR STRUCTURAL STEELWORK

1. Requirement

- (a) All structural members shall satisfy the tolerances for rolled steel sections and built up members specified in AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings and the tolerances mentioned in this Clause whichever are less.
- (b) Where tolerances are not stated in this Technical Requirements for any individual structure or part thereof, permissible deviations will be interpreted in conformity with the provisions of this Clause. Specific maximum or minimum tolerances in connection with any dimensions, shall be considered as supplementary to the tolerances specified in this Clause.
- (c) The Contractor shall be responsible for completing the work within the tolerances specified in this Clause. Steelwork which exceeds the tolerance limits specified in this Clause shall be remedied or removed and replaced by the Contractor.

2. Tolerances - General

- (a) Tolerances shall be:

Straightness Struts, beams and columns	$\leq$ length of member /1000 mm
Camber	5 mm
Length	+ zero - 5 mm
End of beams, out of squareness	$\leq$ depth /400 mm

- (b) Tolerances for Built Up Members

For built up members the following additional tolerances shall apply:

Lateral deviation between centreline of web and centreline of each flange at the contact surface	5 mm
Deviation from specified depth, measured at web centreline	4 mm
Deviation from flatness in web plates between stiffeners or between flanges	$\leq$ Depth of Web /200 mm
Warpage or tilt of flanges	$\leq$ width of flange/100 mm

13.3.4. ERECTION OF STRUCTURAL STEELWORK

1. General

- (a) The Contractor shall furnish all necessary equipment and shall erect the

structural steel in a workmanlike manner and in accordance with this Technical Requirements and the Drawings.

- (b) Structural steel members to be stored shall be placed on blocks so that no part of the members will touch the ground or be over-stressed and shall be kept clean and properly drained.
- (c) Steelwork which has been galvanised shall not be welded. When the galvanising has been damaged, the area affected shall be cleaned and coated. Proper allowance shall be made to compensate for shrinkage of field welds so that the structure will not be unduly stressed or correct alignment affected.

2. Anchor Bolts

Anchor bolts shall be positioned with a template before the concrete is placed and the Contractor shall ensure that the anchor bolts are maintained in the correct position during the placing of concrete.

3. Friction Grip Joint

(a) Length of High Strength Bolt

- Standard length of stem shall be obtained by adding respective length tabulated below to the grip thickness.

Nominal diameter of bolt D (mm)	Length to be added to grip thickness L (mm)
16	30
20	35
22	40
24	45

- The bolt set shall be stored in their original packing, and care shall be taken so that materials would be free from dirt, damage and corrosion.
- (b) Treatment of Contacting Surfaces
- The surfaces to become in contact with surface of another steel plate in friction grip joint shall be free from paint, oil and other defects that would decrease friction force.
- (c) Tightening
- Drifting shall only be performed to bring corresponding parts into proper positions and shall not result in enlargement of holes or distortion of base metal. All out-of-tolerance holes shall be drilled or reamed.
 - Temporary tightening shall be performed using bolts not less than one third (1/3) of the total number of bolts in each completed joint but never less than two. Bolts for temporary tightening shall be distributed uniformly about the joint.
 - Excessive tightening of the bolts shall not be permitted.
- (d) Calibration of Impact Wrench

- If the bolts are tightened by impact wrench method, each impact wrench shall be calibrated prior to the commencement of the work each in the morning and the afternoon.
- The impact wrenches shall be equipped with torque indicating scale or calibrating means so that the torque can be measured clearly.

4. Erection

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Thirty (30) days before starting erection the Contractor shall submit drawings and method statements showing the method of erection proposed and the equipment to be used.
- (b) Hammering that will injure or distort the members will not be permitted. The members shall not be over-stressed during the process of erection. Any error in the work which prevents proper assembling and fitting of parts shall be corrected by approved methods.
- (c) Erection in the field will be by bolting, high-strength friction grip bolting, arc welding or a combination of these methods. In bolted connections where black bolts are used, the bolts shall be drawn tight, and where required the threads shall be burred or spot welded so that the nuts cannot become loosened. Where high tensile bolts are required the method of fabrication and assembly of the connections shall comply with the provisions of AISC Specification for Structural Joints using ASTM A325M or A490M Bolts, for friction type joints.
- (d) During the erection works, the steel structure shall be ensured sufficiently to withstand all loads such as its own weight, live loads, wind loads and erection loads. All temporary bracing, guys and bolts necessary to ensure safety of the structure shall be provided.

13.3.5. Permissible Variation

- (a) Permissible variation shall be in accordance with the standards stipulated in the Sub-clause 13.1.3.

13.3.6. Field Retouch Painting

- (a) After installation, all damaged shop coated areas and all bolting, welded and other surfaces left un- painted with rust-resistant paint shall be cleaned of all rust, dirt and any other foreign substances and shall be painted with rust-resistant paint.

13.3.7. Inspection

5. General

- (a) All materials supplied and all work performed shall be subject to inspection by the Employer at the place of manufacture, fabrication and/or erection.
- (b) Acceptance of material or waiving of inspection thereof shall in no way relieve the Contractor of the responsibility of furnishing the materials and workmanship conforming to the Specifications in all respects.
- (c) The Contractor shall submit the records of tests stating the name of test, time

and place, results and name of inspector.

- (d) The judgment of results of test and inspections shall be made according to the applicable provisions of standards stipulated in Sub-clause 13.1.3.
- (e) Tests or inspections may be waived with the approval of the Employer in case the Contractor submits mill sheets or certificates or other appropriate evidences.

6. Material Test

- (a) Quality of the principal materials to be used, such as rolled steels, bolt and nuts, electrodes shall be tested.

7. Qualification Test for Welding Operators, Welders and Welding Procedures:

- (a) Qualification tests for welders and welding procedures shall be performed in accordance with the applicable provisions of AWS Code.

8. Inspection of Edge Preparation;

- (a) Inspection of edge preparation shall be performed in accordance with the approved plan.

9. Appearance and Measurement Inspection

- (a) The appearance inspection shall be made on welded joints, bolts holes to be bolted in the field, coated surfaces and on other items for defects.

10. Inspection of Welded Joint

- (a) Welded joint shall be inspected by means of radiographic (X-ray) method and/or ultrasonic method. The rate of spot inspection shall be not less than 10% of the total welded length.

13.3.8. Quality Control

- (a) The Employer reserves the right to require independent analysis and tests. For this purpose, the Employer may take drillings for analysis and have pieces cut out side by side with pieces subjected to test in the workshops. Should the comparison of the result of any independent analysis or test be unsatisfactory, the materials represented will be rejected. All incidental cost for the above shall be borne by the Contractor.

13.3.9. Auxiliary Work

- (a) Mortar grouting at the baseplates, installation of embedded steel parts in concrete structure shall be included in the work. Shuttering needed for these works shall also include in the work.

13.4. REQUIREMENTS FOR PARTICULAR WORKS

13.4.1. Steel Roof Truss of Powerhouse

1. Standard for design

- (a) Design of the structure and members for a possible steel roof truss in the powerhouse shall satisfy the strength requirements of ANSI/AISC 360 or

approved equivalent standard.

- (b) The Contractor may design the steel roof truss according to the provisions for Load and Resistance Factor Design (LRFD) by which the design satisfies the requirements of ANSI/AISC 360 when the design strength of each structural component equals or exceeds the required strength determined on the basis of the LRFD load combinations or based on other approved equivalent standard for design.

2. Load to be considered

- (a) Steel Roof Truss shall be designed taking account of the following loads:
- I. Dead loads on the roof truss including, but not limited to, self weight, lighting facilities, ventilation facilities, inspection pass
 - II. Live load including weight of inspection staff (2.5 kPa)
 - III. Seismic load / Wind Load
 - IV. Temperature Load

3. Deflection Limits

Vertical deflection of steel beams or members subject to flexural load at serviceability limit states (SLS) shall satisfy following requirements:

Vertical Deflection Limits for Steel Beams

Deflection limit for span (l)	Deflection limit for roof span (l)	Deflection limit for cantilever
$\Delta V/l \leq 1/360$	$\Delta V/l \leq 1/240$	$\Delta/l \leq 1/180$

Note: ΔV : vertical deflection of beam, l: length of beam member.

13.4.2. Formed Steel Roof Sheetting

1. General

- (a) The work in this Sub-clause includes roofing, flashing items and accessories like galvanized purlin, ridge capping, eaves gutter, downspout screen, bottom flap, acroterion cover, corner pieces, opening surround, cover strips, plugging, water tightness material for joints, etc.
- (b) The steel roof sheet shall be of prefabricated type or from independent sheets and thermal insulation blanket assemble on the site by the Contractor.

2. Materials

- (a) Thermal Insulation
- I. Thermal insulation material shall be rock wool mineral-fiber blanket or panel, thermal conductivity shall be less than 0.04 W/mk, or equivalent material.
 - II. Non-load bearing insulating panels or blankets contributing to the heat resistance shall be installed.
 - III. Work shall comprise all laying and connection constraints, in

particular for ventilation between roof sheets and insulation.

- IV. If panels or blanket are used, they shall be cut and raised level with ridge ventilation openings, to ensure free ventilation of powerhouse.

- V. The insulation mineral-fiber blanket shall be fungi resistant

(b) Steel Roof Sheet

- I. The roof sheet shall be made up of pre-painted hot-dip aluminium-zinc alloy-coated steel sheet, which is corrugated shape interlocking type and coated with several anticorrosive layers on both. It shall have a maximum heat transmission coefficient of $0.5 \text{ W/m}^2/^{\circ}\text{C}$, for the roofs and for the walls.
- II. Metal sheet for the roof shall be in single length for each span, and fixed by galvanized or anticorrosive painted clip to purlin material. Each sheet connection shall be interlocking type without screwing or bolting to the sheet.

- Steel core sheet

Tensile strength shall be minimum 440 N/mm^2 , as specified by ATM A792, or equivalent.

- Hot dip aluminium-zinc layer

Hot-dip 55% aluminium-zinc alloy-coated, weight of minimum 120 g/m^2 or more, conforming to AsTM A792, or equivalent.

- Primer coat

For enhancing adhesiveness between galvanized layer and coloured antiweather coat

- Coloured antiweather coat.

Coloured polymeric resin antiweather coating as the final coat.

- III. All accessories shall be approved aluminium zinc coated steel sheet as for outside roofing, with the same colour. All types of additional profiles and joint needed (like compriband expandable joints or gun laid joints), particularly at connecting points with other structures (for instance masonry, window and door frames) shall ensure absolute air and watertightness and perfect finish.
- IV. Additional expansion joint cover shall be provided at connection with other structures, if design required. However, expansion joint cover also shall be interlocking type fixing, without screwing through roof sheet.
- V. Corner pieces shall be provided and especially shaped for re-entrant and projecting angles.

- VI. All the holes in the steel roof sheet shall be such as to avoid any deformation (oblong holes), in any direction due to the deformation of the steel framing, and any hole through roofing sheet shall be sealed by approved sealant.

(c) Galvanized Purlin Channel

The purlin channel will be made up of galvanized light gauge steel, shaped Z or C, minimum plate thickness shall be 2.3mm. The purlin channel will be supported by steel angle or plate clip to steel structure frame by adequate bolting. The purlin size and spacing shall be calculated as uniformed structure with roofing steel sheet.

3. Execution

The Contractor shall obtain manufacturer's detailed instructions for installation of the steel roof sheets. At the initial time, or after installation, the supplier shall investigate installation condition to advise the Contractor in order to avoid any defects. The roof steel main sheet shall not be allowed to cut on site. When required, special washers or fillers shall be introduced to avoid direct contact between different metal materials in order to avoid anti-electrolytic corrosion

13.4.3. Aluminum Spandrel Ceiling

- (a) Aluminum spandrel for ceiling to install in the powerhouse shall be of high grade product extruded and anodized sheathing flanged on both sides of the panel confirming to JIS H4100 and JIS A6063 or equivalent standard. Spandrels shall be securely fixed to the steel bed true to line with stainless screws at suitable intervals, recommended by the manufacturer. Surface of aluminum spandrel shall be colored confirming to JIS H8602 or equivalent standard.
- (b) At all openings on the ceiling and walls, the ceiling and wall beds shall be reinforced. Ceiling trim, corners and joiners shall be of extruded or formed aluminum sections. They shall be the same color as adjacent spandrels.
- (c) Aluminum spandrel shall be uniformed system including supporting system and materials recommended by the special manufacturer.

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**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 14
MINOR METAL WORK**

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CHAPTER 14 - MINOR METAL WORK ITEMS

14.1. GENERAL

- (a) The work to be performed under this Chapter consists of furnishing and installing the various metal works including the entire auxiliary works in all structures of the Work as shown on the Drawings approved by the Employer.
- (b) The work shall consist of detail design, supply of all materials, fabrication, transportation, storage, erection, painting, inspection, quality control including survey, loading and unloading, protection from damages and other auxiliary works as required.
- (c) Being the supply of civil and hydromechanical works in the plant the responsibility of a Contractor is the precise limit of supply between following items indicated as included in the Civil Works and Hydromechanical works shall be decided by the Contractor based on the qualification and design responsibility of his suppliers. Possible repetitions of the requirements made in these Contract Documents shall not be taken into account.
- (d) The work covered by this Chapter shall be, but not limited to, the followings:
 - General
 - Steel pipe
 - Steel grating
 - Steel ladder
 - Steel cover
 - Steel stair and platform
 - Frame for opening and cover
 - Headworks Area
 - Net Fence
 - Gate
 - Guard Rail
 - Handrail Type A (Outdoor fixed type)
 - Handrail Type B (Outdoor removable type)
 - Tailrace Outlet
 - Handrail Type A (Outdoor fixed type)
 - Handrail Type B (Outdoor removable type)
 - Powerhouse
 - Steel Hatch Cover
 - Cable Trench Covers
 - Steel Ladders
 - Steel Handrail Type-C (Indoor fixed type)
 - Steel Handrail Type-D (Indoor removable type)
 - Stair Handrail
 - Galvanized Steel Pipes

14.1.1. Submission

- (a) Not less than Sixty (60) days prior to commencing the work, the Contractor

shall submit to the Employer the following documents for his approval.

- Detailed shop and construction drawings, which shall include complete details, sections and plans of all parts, assemblies, components, connections and supports, and connections to the work of other items
- Detailed structural analysis of the proposed metal structures, if required
- Test certificates proving the physical properties stipulated in the Specifications

14.1.2. Standards and Codes

- (a) All design, material, execution of work shall comply with the applicable standards and codes listed below, in particular, with the AISC codes, the AISC Handbook of Steel Construction, and all local building codes or regulations approved by the Employer.
- American Institute of Steel Construction (AISC)
 - Specification for the Design, Fabrication and Erection of Structural Steel for Building
 - Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design
 - Specification for the Design of Cold-formed Steel Structural Members
 - Association of Iron and Steel Employers (AISE)
 - American Iron and Steel Institute (AISI)
 - American National Standard Institute (ANSI)
 - American Society of Civil Engineers (ASCE)
 - American Society for Testing and Materials (ASTM)
 - British Standards Institute (BS)
 - Deutsche Institute for Normung (DIN)
 - International Organization for Standardization (ISO)
 - Japan Architectural Standard Specification (JASS)
 - Japanese Industrial Standards (JIS)
 - American Welding Society (AWS)
 - Steel Structures Painting Council (SSPC)

14.1.3. Structural Metalwork

- (a) Minor metalwork having a structural function shall be fabricated and installed in accordance with Chapter 13 of Standard Technical Requirements.

14.1.4. Welding

- (a) All welding of minor metalwork shall be performed in accordance with Chapter 13 of Standard Technical Requirements.

14.1.5. Embedded Metalwork

- (a) Metalwork to be embedded in concrete shall be embedded when the concrete is being placed or, if shown on the Drawings, recesses or blockouts shall be made in the concrete and the metalwork shall be grouted in place or embedded in blockout concrete. The surfaces of all metalwork to be in contact with

concrete shall be thoroughly cleaned immediately before the grout or concrete is placed. Metalwork shall be accurately positioned and aligned in accordance with the specified tolerances and shall be held securely in the correct position during placing and setting of the concrete.

14.1.6. Cement Products

- (a) Grout, mortar, epoxy mortar and others required for the embedment of metalwork shall be supplied in accordance with Chapter 8, and 10 of Standard Technical Requirements.

14.1.7. Corrosion Protection

- (a) All minor ferrous metalwork items shall be hot dip galvanised, unless otherwise specified on this Technical Requirements.

14.1.8. Quality Procedures

- (a) The Contractor shall develop procedures to ensure the correct embedment in concrete of all relevant items of metalwork.

14.2. EXECUTION

14.2.1. General

1. Fabrication and Installation

- (a) All works shall be executed by skilled workers in a workmanlike manner.
- (b) All members shall be cut in such a manner as not to cause deformation or distortion. Irregularity of cut surface shall be properly finished by planer.
- (c) The work shall be shop fitted and shop assembled where possible and shall conform to the details on approved shop drawings to be provided by the Contractor.
 - ◆ Welding shall be made by arc welding.
 - ◆ Where necessary, metals shall be insulated to prevent electrolysis due to contact between dissimilar metals and to prevent corrosion due to contact between metals and masonry or concrete. Insulation shall be by means of bituminous paint or other approved means.
 - ◆ All fastenings, anchors and accessories required for fabrication and erection of the work under this chapter shall be provided by the Contractor. Exposed fastenings shall be kept to an absolute minimum, evenly spaced and neatly set out. Wood plugs shall not be permitted.
 - ◆ Metal work to be embedded in concrete shall be set and fixed in position as shown on the approved Drawings before placing concrete. If blockouts will be arranged at the locations where embedded parts are set in concrete as shown on the approved Drawings, the metal work shall be fixed in place by the second stage concrete.
 - ◆ The bond surfaces between the first and the second stage concrete shall be roughened. The cross- section dimensions of the second stage concrete and the locations of embedded anchor bolts shall be as shown on the approved.

- ◆ Where it is impracticable to place anchors or anchor bolts when the concrete is placed, holes will be drilled in the hardened concrete Twenty-eight 28 days after placing concrete. And expansion bolts, adhesive anchor bolts or other approved anchors will be installed and fixed in place and then grouted or backfilled with mortar.

2. Painting and Galvanizing

- (a) All components of the metal works shall either be painted or galvanized against corrosion prior to assembly and/or erection. Any preliminary treatment against corrosion shall ensure a basic protection remaining effective for at least six months.
- (b) All steel surfaces except galvanized surface and embedded parts in concrete shall be painted. Rust-resistant paint shall be applied in two coats and finishing paint shall be applied in two coats. The quality of paint and the painting works shall be performed in accordance with the provisions of Sub-clause 15.11.2 (k) and Sub-clause 15.12.9 (e).
- (c) Components to be installed to the exterior shall in any case be hot dip galvanized. Galvanizing of steel shall be in accordance with ASTM A123, A153 and A386 and the zinc coating shall be not less than 610 g/m².

3. Auxiliary Works

The following auxiliary works and services shall be deemed to be included in the metal works:

- ◆ transport, storing and protection of all structural components on site;
- ◆ protection of the executed works from detrimental influences, theft and damages until the time of handover;
- ◆ supply of consumable stores; and
- ◆ removal and making good of all contaminations (building rubbish, refuse and the like) arising from and in connection with the Contractor's works.

14.2.2. Steel Pipe

1. General

- (a) Steel pipes are used for conveying water or air for various uses, protection of cables or other purposes as required.
- (b) Where required, the Contractor shall design, furnish and install steel pipes for drainpipes or air vent pipes or for other uses as required as shown on the approved Drawings.
- (c) Unless otherwise specified, steel pipes shall conform to the requirements of ASTM A501 or equivalent.
- (d) Where welding is required, electric welding of an approved method shall be adopted. The electrodes to be used shall be of a quality corresponding to the quality of the pipe steel. They shall ensure a tight, pore less weld, according to the rules of a good workmanship. Slag shall be properly removed. In certain cases, a pressure test for the pipes may be required and any imperfect welding

shall be corrected.

- (e) All associated pieces such as anchors, fixtures, etc. required for appropriate installation shall be furnished and installed.

2. Galvanized Steel Pipe

- (a) For the galvanized steel pipes, application of galvanizing and testing shall conform to the requirements of ASTM A123. Also, the Zinc for galvanizing shall comply with ASTM A123.
- (b) The galvanizing of bolts, nuts and washers shall be in accordance with ASTM A394. Nuts shall be tapped after being galvanized and the threads of nuts left bare in accordance with ASTM A394.

3. Galvanized Steel Pipe in Powerhouse

The Contractor shall design the arrangement of various sizes of galvanized steel pipes in the powerhouse taking account of, but not limited to the following requirements:

- ◆ Embedded pipes for water supply
- ◆ Water supply system for station use
- ◆ Water supply system for the fire extinguishing system

14.2.3 Steel Grating

- (a) The steel gratings shall be provided to serve as covers for gutters, catch basins, etc. The steel gratings are normally of a rectangular shape. Some are to be provided with openings for the passage of pipes or ducts as shown on the approved Drawings.
- (b) Sizes of steel gratings shall be such as to afford easy handling.
- (c) The bearing frames of steel angles or channels shall be anchored to the concrete with steel bolts or straps as shown on the Drawings approved by the Employer.
- (d) Before installation the frame shall be adjusted to allow the steel grating to have a continuous support by the frame.
- (e) Before ordering the gratings, the Contractor shall check all relevant locations, dimensions and shapes of the openings. Steel gratings and frames shall be galvanized. Damaged finishing shall be repaired on site.

14.2.3. Steel Ladder

- (a) Where required, the Contractor shall design, supply and install stepladders and steel ladders to the numbers and dimensions as shown on the approved Drawings.
- (b) All steel members shall be galvanized. All bolts for fastening the ladder to the concrete wall shall be of stainless steel. Where splices are required, bolted connections have to be used.

14.2.4. Steel Cover

- (a) Steel covers such as steel hatch cover, steel manhole cover and steel trench cover shall be designed and installed at openings and trenches as designated on the approved Drawings
- (b) Steel covers shall be of steel plate or checkered steel plate, with sufficient thickness against the expected load and with lifting devices as shown on the Drawings. The thickness and type of the checker plates shall be determined and selected depending on the expected load and location.
- (c) Frames shall be composed of shaped steel sections, angles, etc. and shall be anchored to concrete. The frame shall be adjusted during installation to provide an accurate fit with the cover.
- (d) In order to ease removal and setting, all covers shall be tapered along the perimeter towards the bottom. The maximum clearance between hatch cover and outer frame shall be 5 mm around at finished floor level.
- (e) The corrosion protection shall be generally achieved by painting.

14.2.5. Steel Stair and Platform

- (a) Where required, the Contractor shall design, supply and install steel stairs and platform as shown on the approved Drawings.
- (b) All landings, stairs and platform shall be made of standard steel sections of angle, channel and I-beam shape.
- (c) Components or portions thereof shall be pre-assembled with field points designed such as to allow fast and easy erection on site.
- (d) Treads of stairs and landings shall be of galvanized steel grating, which have slip less nosing, also the floor of platform shall be made by galvanized steel grating.
- (e) All outdoors metal parts shall be hot-dip galvanized after manufacture but prior to assembly and no tooling on these parts will be permitted after galvanization.
- (f) Of indoor sections only the steel gratings and the chains of railings shall be galvanized and the entire supporting steel structure and railings shall be painted.

14.2.6. Frame for Opening and Cover

1. Frame for Opening

- (a) Steel angle, z-and/or channel profiles shall be provided for all openings in the size and shape indicated in the approved Drawings. These frames shall be embedded in the concrete and attached to the concrete by anchors securely welded to each side of the frame. Anchors may be replaced by anchor plates and stud bolts whenever possible and where shown in the approved Drawings.
- (b) All corners of the frames shall be metered. The surfaces of the frames shall be flush with the concrete surface and the supporting parts, if any, shall be aligned in a way to prevent riding of the covers.

2. Frame for Cover

- (a) Concrete covers shall be designed and provided with steel frames as shown on the approved Drawings. In general these frames shall be formed by channel profiles, however, the lateral and vertical surface shall be slightly inclined to ease lifting of the covers.
- (b) All corners of the frame shall be metered and continuously flush- welded. All welding seams shall be ground smooth. For the connection between the frame and the cover concrete anchors or steel bars shall be welded to the frames.
- (c) The frames shall be coated by hot dip zinc and provided with lifting rings or other arrangements to allow lifting of the covers.

14.2.7. Net Fence

- (a) Prior to commencement of the work, the Contractor shall submit to the Employer for his approval shop drawings and installation method of fences.
- (b) All steel material shall be SS400 steel or equivalent.
- (c) The fence shall be galvanized steel chain link fence type and shall conform to ASTM A392 11a "Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric".
- (d) Steel post and steel frame shall be of galvanized, and the steel post shall have buttress without extra cost.
- (e) The Contractor shall arrange small gates (doors) as parts of the net fence with necessary accessories such as hinges and locks.

14.2.8. Guard Rail

- (a) The Contractor shall design, supply and install guardrails at the location shown on the Drawing along the perimeter of platform area facing steel slopes.
- (b) The Contractor shall design the guardrail in accordance with the applicable standards in Nepal or other standards approved by the Employer.
- (c) The guardrails and posts shall consist of steel pipes and concrete foundation conforming to international standards or as specified in the relevant Chapters of the Specification and formed to the dimensions as shown on the approved Drawings.
- (d) Required bolts, nuts, and washers shall be galvanized. The post shall be set to the required depth and be held firmly in place by foundation concrete of Type C25-20.
- (e) Prior to commencement of the work, the Contractor shall submit to the Employer for his approval shop drawings and installation method of guardrails.
- (f) The guardrails shall be constructed in accordance with the approved Drawings and the provisions in this Chapter, and other relevant Chapters and Clauses of the Specification.

- (g) After the guardrails are installed in place, painting shall be executed in accordance with the provisions in other relevant Chapters and Clauses of the Specification.

14.2.9. Handrail

- (a) The Contractor shall design, supply and install the handrails of the following types along the perimeter lines of concrete floors or platform areas as required:
- Handrail Type A (outdoor fixed type)
 - Handrail Type B (outdoor removable type)
 - Handrail Type C (indoor fixed type)
 - Handrail Type D (indoor removable type)
 - Stair Handrail
- (b) Not less than Twenty-eight (28) days prior to commencement of the work, the Contractor shall submit shop drawings of handrails to the Employer for approval.
- (c) The handrail shall be designed in accordance with this Specification and/or the standard of National Fire Protection Association (NFPA, USA) or other equivalent standard approved by the Employer.
- (d) All steel material shall be SS400 steel or equivalent.
- (e) All exposed material of the outdoor type handrails shall be coated by hot dip zinc and of the indoor type handrails shall be coated by oil paint in accordance with the provisions of Sub-Clause 15.11.2 (k) "Painting".
- (f) Fabrication of handrails shall be executed true to the shapes and dimensions as shown on the approved Drawings.

14.2.10. Pre-embedded Metal Parts

The Contractor shall install the pre-embedded parts for setting, adjusting and erecting their own mechanical parts without transmission of operating loads.

14.2.11. Other Incidental Metal Works

- (a) Other incidental metal works which are required for execution of any works, such as grout pipes, anchor bars for gates and other equipment shall be furnished and installed as shown on the approved Drawings.

14.2.12. Threaded Fasteners for Metalwork and Timber

1. Fasteners for Metalwork

- (a) Threaded fasteners for metalwork comprise all bolts, nuts, studs, anchor bolts, ferrules and threaded inserts, screws and washers. Unless otherwise provided, all threaded fasteners shall be to the ISO metric system, normal series, coarse pitch, in accordance with ASTM A307.
- (b) Steel bolts shall be forged.

- (c) Steel fasteners greater than 8 mm diameter and with coarse threads shall be hot dip galvanised in accordance with ISO 1459-1461.
- (d) Steel fasteners with fine threads and those with coarse threads less than 8 mm in diameter shall be of stainless steel or electroplated with zinc to ISO 2081.
- (e) Fasteners in contact with water shall be of stainless-steel complying with ASTM F738M or F860M.
- (f) Fasteners for the installation of light aluminium door and window frames, and the like, shall be zinc plated self-tapping screws for interior use and stainless steel self-tapping screws for exterior use.

2. Special Requirements for High Strength Fasteners

- (a) High strength fasteners shall comply with ASTM A325M.
- (b) High strength steel fasteners shall be hot dip galvanised if the manufacturer certifies that this will not result in any loss of desirable properties and otherwise shall be electroplated with zinc to ISO 2081

3. Fastening Practices for Metalwork

- (a) All parts shall be spot-faced or machined for nuts or bolts excepting the case of clearance bolts in structural steelwork.
- (b) Tapped holes shall not be used in sheet metal less than 6 mm thick.
- (c) Fasteners of less than 6 mm diameter shall not be used except where specifically approved by the Employer.
- (d) Fasteners of more than 8 mm diameter shall have hexagon or socket hexagon heads.
- (e) All threaded fasteners shall be locked in an approved manner. Direct welding of bolts or nuts will not be accepted, except as provided in Paragraph (f) of this Subclause.
- (f) Ordinary carbon nuts and bolts for permanent assembly of structural steelwork shall be drawn tight and the exposed threads burred or spot-welded to prevent loosening.
- (g) Bolts and studs greater than 50 mm diameter shall be arranged for tightening by hydraulic tensioning devices.
- (h) High strength fasteners shall be tightened to the recommended preloads.

4. Fasteners for Timber

- (a) Woodscrews for interior use shall be dull nickel-plated brass unless otherwise specified.
- (b) Woodscrews for exterior use shall be stainless steel.
- (c) Coach bolts and coach screws shall be hot dip galvanised.

14.2.13. Anchorages to Concrete, Brickwork, and Blockwork

1. Bolts and Ferrules

- (a) Wherever practicable, cast-in anchor bolts shall be used for the fixing of structural steelwork, major steel fabrications, plant and equipment. Cast-in ferrules are an acceptable alternative.
- (b) Anchor bolts and ferrules shall be stainless steel, ordinary carbon steel or high strength steel. All ferrous products shall be hot dip galvanised unless the manufacturer certifies that this will result in any loss of desirable properties and otherwise shall be electroplated with zinc in accordance with ISO 2081. All anchor bolts and ferrules for exterior use shall be stainless steel.
- (c) Galvanised or electroplated anchor bolts shall be wrapped with 1 mm thickness of corrosion resistant tape extending 20 mm above and below the concrete surface.
- (d) Ferrules shall be of the crossbar type lapped to or extending below the concrete reinforcement.
- (e) Anchor bolts and ferrules shall be supplied with all nuts, bolts, screws, washers and turnbuckles.
- (f) Anchor bolts and ferrules shall be positioned using a template and maintained rigidly in place during concrete construction.

2. Chemical and Expansion Anchors

- (a) Chemical and expansion anchors may be used to fix metalwork, plant and equipment to concrete in accordance with ASTM C1242.
- (b) Studs for chemical anchors shall be stainless steel.
- (c) Exposed metal components for expansion anchors shall be as specified for anchor bolts. Hidden components shall be protected from corrosion.
- (d) Expansion anchors holding components of structural or safety importance shall be cast or forged into the cone-and-shell or wedge-and-shell configuration.
- (e) Where required by the Employer the Contractor shall supply certified test results of anchorage performance.

3. Light Duty Anchors

- (a) Light duty anchors will be permitted only for the installation of minor equipment, building furniture, saddle clips for small diameter pipes and other like applications where engineering stresses would not be computed and fastener failure would have no serious consequences.
- (b) Light duty anchors shall be installed in drilled holes. The use of explosive implanting is not permitted.
- (c) Light duty anchors shall be based on caulked lead plugs, proprietary metal or plastics inserts. Timber or fibre plugs shall not be used.
- (d) Metal parts of light duty anchors shall be adequately protected against

corrosion.

- (e) The Contractor shall demonstrate the performance of light duty anchors at the Employer's request.

14.2.14. Valves for Metal Pipe Work

The Contractor shall furnish and install valves and hydrants where required and approved.

14.2.15. Fences

- (a) The Contractor shall construct security fences and gates at required locations including:
- All gate shaft hoist building i.e. service building
 - Powerhouse building and switchyard
 - Tailrace outlet area
 - Access/maintenance adits portal areas, Surge shaft top areas
- (b) The fences shall be fabricated accurately set to the correct alignment and profile. The ground surface shall be levelled and cleared of rocks and shrubs for a distance of 2 m on either side of the centreline of the fence. Gate openings shall be located where required.
- (c) The chain wire link mesh and barbed wire shall be uniformly tensioned before securing to the fence posts and rails.
- (d) The barbed wire shall be of galvanised steel with two strands twisted and four pinned barbs. The strands of the barbed wire shall be of gauge three.
- (e) In case of flat tape, the tape shall be of stainless steel with a minimum thickness of 0.6 mm and with a bond length of not less than 20 mm.

14.2.16. Miscellaneous Embedded Metalwork

1. General

The Contractor shall furnish and install miscellaneous embedded metalwork as required. Miscellaneous embedded metalwork shall include:

- ♦ Socket and plugs for removeable handrails
- ♦ Monorail beam supports
- ♦ Embedded winching hooks
- ♦ Steel linings
- ♦ Frames for seepage measuring weirs
- ♦ Embedded sockets and anchors
- ♦ Hatch cover frames
- ♦ Float switch frames
- ♦ Embedded welding pads and plates

2. Protective Treatment

Except for brass and stainless-steel metalwork, miscellaneous embedded steel metalwork shall be hot dip galvanised, unless otherwise specified, before embedment in accordance with the relevant provisions of Sub-clause 15.11.2

(k) of Standard Technical Requirements.

14.2.17. Miscellaneous Non-Embedded Work

1. General

The Contractor shall furnish and install miscellaneous non-embedded metalwork as required. Miscellaneous non-embedded metalwork shall include:

- Covers for ducts and trenches
- Covers for hatches
- Stair guides
- Inspection covers and screens
- Perforated plate for transformer drainage cells.

2. Protective Treatment

Except for brass or stainless-steel metalwork, miscellaneous non-embedded ferrous metalwork shall be hot dip galvanised. Galvanizing of steel shall be in accordance with ASTM A123, A153 and A386 and the zinc coating shall be not less than 610 g/m².

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**CHAPTER 15
BUILDING CONSTRUCTION**

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CHAPTER-15: BUILDING CONSTRUCTION

15.1. GENERAL

- (a) The Contractor shall perform the whole of the building construction work which shall conform with the requirements of this Chapter 15 of Standard Technical Requirements. Building works include:
 - ◆ Powerhouse
 - ◆ Control room and Switchyard Building
 - ◆ Utility Building, Guard house & Gate operating Building
- (b) All building construction and finishing work shall be performed by experienced tradesmen or accredited specialists. The Employer may require the Contractor to supply proof of competency of any tradesman or specialist employed on the work.

15.1.1. Obvious Work

- (a) If the Employer's Requirements do not contain particulars of materials and works which are obviously necessary for the proper completion of the work and the intention to include which is nevertheless to be inferred, all such materials and works shall be supplied and executed by the Contractor.
- (b) Similarly, the Contractor shall supply, place and attach to the structure all timber, metal or other accessories necessary for the proper completion of the work as shown on the Drawings or as specified.
- (c) The Contractor shall provide and fix all incidental flashings, damp proofing, weather seals or other approved materials necessary to render the building completely watertight and weatherproof.

15.1.2. Samples

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period of not less than Sixty (60) days prior to the date the Contractor wishes to place or confirm orders, the Contractor shall submit, for approval, samples of all materials with specimens of workmanship, colour and finish for all items described in this Section 15 of this Technical Requirements.

15.1.3. Nominal Sizes

- (a) The Contractor shall allow for variations between nominal sizes and actual sizes where such variation is within the required tolerances or is normal trade practice.

15.1.4. Finishing Work

- (a) Finishing Work shall not commence until each or all of the following conditions have been met to the satisfaction of the Employer:
 - The area concerned and such adjacent areas which may affect the finishing work have been weatherproofed.
 - Unless otherwise specified, all construction including installation of permanent plant, fittings and equipment has been completed.

- The concrete or other materials have dried out sufficiently.

15.1.5. Cement, Water and Fine Aggregate

- a) Cement, water and fine aggregate for plaster, mortar and grout shall conform to the requirements of these Technical Requirements except that the grading of fine aggregate shall conform to the following limits:

Sieve Size	Percentage by Mass Passing Screen
2.36 mm	100
1.19 mm	70-100
0.6 mm	40-80
0.30 mm	4-40
0.15	0-10

15.1.6. Provision for Services

- a) In all wall and ceiling finishing, the Contractor shall make necessary provision for the installation of pipes, metal frames, electrical conduit, electrical wiring, lighting fittings, and other fixtures, and shall neatly finish the surfaces around them to conform to the surrounding wall or ceiling finishes. Permanent openings shall be finished neatly, and the Contractor shall furnish and cut as required such special shapes of materials as are required for neat finishing at edges. Where required in suspended ceilings, access openings neatly finished at edges shall be formed by the Contractor and panels with surfaces corresponding to the ceiling finish shall be fabricated by the Contractor and fitted into the openings in such a manner as to blend with the ceilings.

15.1.7. Trial Panels

- a) Where walls, floors or ceilings are to receive a plastered, tiled or painted finish, the Employer may direct that trial panels, approximately one metre square, be erected in the locations where the particular types of finish are required. The trial panels will be required to demonstrate the final appearance of the alternative types of finish which may be required at a particular location.

15.1.8. Tiles and Sheets

- a) All required floor and wall tiles and sheets of a particular colour or type shall be purchased by the Contractor from the one source and at the one time.

15.1.9. Chromium Plating

- a) Items required to be chromium plated (C.P.) shall be plated in the best manner in accordance with ASTM B117 (Chromium on steel), B320 (Chromium on cast iron) and B687 (Chromium on copper and brass). Steel shall be heavily coppered, heavily nickelled, and finally, chromium plated. Copper and brass shall be heavily nickelled and then chromium plated.

15.1.10. Dissimilar Metals

- a) The Contractor shall take all precautions to prevent contact between dissimilar metals in the finished structure and shall provide suitable permanent separating material as approved. The following precautions shall also apply:
- All abutting of aluminium, steel or copper shall be protected by black polythene of 0.20 mm thickness fixed with an approved adhesive. Alternatively, zinc chromate primer may be used, taking care not to mark exposed aluminium faces.
 - Where aluminium abuts onto concrete, the aluminium shall be protected by coating with bituminous paint, taking care not to mark exposed aluminium surfaces.

15.1.11. Protection

- a) It is anticipated that during installation of permanent plant, damage may be caused to concrete or blockwork in walls, floors, columns and ceilings, to fittings and fixtures, and to building finishes, including aluminium and other metalwork, glass and paintwork. The Contractor shall provide and maintain adequate protection from such damage to such work carried out under the Contract.

15.1.12. Painting

- a) Painting of the work described in this Chapter 15 shall be carried out as described in the relevant section of this Technical Specifications.

15.1.13. Keying System

- a) The Contractor shall provide a keying system for all doors at the Facility to the extent required by the Employer. The number or numbers of construction key, master key, grand master key and great grand master key shall be submitted to the Employer for approval.

15.2. WATER PROOFING

15.2.1. General

- (a) The work under this Chapter shall comprise the design of the asphalt waterproofing for the buildings, supply of all labor, materials and equipment and the performance of all required works necessary as shown in the Contractor's design drawings and as specified herein.
- (b) The Contractor may propose an alternative waterproofing. The alternative shall in no way be inferior to the one specified above.

15.2.2. Material

- (a) Asphalt Waterproof
- The asphalt waterproof roofing shall be 3-Ply built-up for roof and 2-ply built-up for lavatory respectively applied with the following layers:

3-Ply Built-up Roofing	2-Ply Built-up Roofing
- Asphalt primer	- Asphalt primer
- Asphalt compound	- Asphalt compound
- Asphalt felt (1 st layer)	- Asphalt felt (1 st layer)
- Asphalt compound	- Asphalt compound
- Special asphalt felt (2 nd layer)	- Asphalt felt (2 nd layer)
- Asphalt compound	- Asphalt compound
- Asphalt felt (3 rd layer)	
- Asphalt compound	

- Asphalt primer shall be factory mixed primer composed of blown asphalt, solvent naphtha and benzene in an approximate weight ratio of 4.5:3.0:2.5.
- Asphalt compound shall be of blown asphalt having the following characteristics:
 - Penetration index : 15 - 25
 - Melting point : 100°C or over
 - Malleability (Daw Smith 25°C) : 2 or over
- Asphalt felt shall be a bituminous sheeting with a coating of high penetration index asphalt with fabric reinforcement.

(b) Caulking /Sealing

- The Contractor shall submit the manufacture's catalogue of materials and work procedure on caulking/sealing.
- Following material shall be applied to the various combinations of surfaces. All material shall comply with JIS A 5758 or equivalent.

Surface Combination	Caulking Material	
Metal	Metal	Silicone
	Concrete	Metamorphic Silicone
	Glass	Silicone
	Ceramic Tile Stone	Polysulphide
Concrete	Concrete	Polysulphide or Polyurethane
	Ceramic Tile or Stone	Polysulphide
Cement Board	Metamorphic Silicone or Polyurethane	

- In the case caulking material is painted after, polyurethane is recommended to be used.
- All concrete and cement board surfaces shall be fully cured before application of caulking.

- ◆ All joint surfaces to be filled shall be sound, clean and dry. Joint surfaces to be filled shall be primed with the manufacturer's recommended primer, compatible with every sealing compound and appropriate for the surfaces to be sealed.
- ◆ Mixing and application of filling compound shall be in accordance with the manufacturer's instructions.
- ◆ All filler works shall be done by skilled workmen.

15.2.3. Execution

(a) Asphalt waterproof layer

- Substrata for the roofing shall be made by applying smooth mortar plastering on concrete surface. All external and internal angles shall be made round in a radius or not less than 50 mm.
- Asphalt primer shall be applied only on the smooth mortar when completely dry.
- Roofing work shall be performed by workmen skilled in this trade. The work shall not be performed on damp or rainy days.

(b) Protection Concrete on Built-up Roofing

- Materials such as cement, aggregate and sand, mixing, casting and curing of concrete shall comply with applicable provisions in Chapter 10 "Concrete Production and Construction for Structures".
- The concrete shall cover the entire face of the roofing in a thickness of 6 cm.
- The top of the joint shall be filled up with asphalt compound to a thickness of 25 mm on top of bituminous or foamed plastic board.

15.2.4. Test

- a) Prior to applying protection mortar on the completed asphalt waterproofing, waterproof test shall be carried out. During the testing, water shall be left on the whole area of waterproof layer except risers for 24 hours, and no water leakage from the concrete slab shall be checked.

15.3. PLASTERING

15.3.1. Scope

- a) The work under this Chapter shall comprise the supply of all labor, materials and equipment and performance of all works for the plastering of floors, walls, and ceilings in the buildings. The work shall be performed as shown in the Contractor's design drawings approved by the Employer and as specified herein.

15.3.2. Material and Execution

1. Mortar

(a) Material

- The sand to be used in the mortar shall be clean, hard, solid and durable and shall not contain harmful amounts of dust, mud, organic materials or other objectionable matters. The grading of the sand shall be within the following limits:

Classification	Screen Designation	Percentage by Weight Passing Screen
Rendering coat	4.75 mm 0.15 mm	100 % 10 % or below
Finishing coat	2.36 mm 0.15 mm	100 % 10 % or below

- The mix proportions of the cement mortar shall be as follows:

Applying Bed	Place of Application	Rendering Coat Cement: Sand	Finish Coat Cement: Sand or Cement: Sand: Lime
Concrete	Floor	-	1 : 2
	Interior wall Ceiling	1 : 2	1 : 4 : 0.3
	Exterior wall	1 : 2	1 : 4 : 0.3
		1 : 2	1 : 4
Brick & Concrete Block masonry	Interior wall	1 : 3	1 : 4 : 0.3
	Exterior wall	1 : 3	1 : 4

(b) Execution

- The surfaces which are to receive a rendering coat shall be roughened, brushed or washed clean, free from all laitance, scum, loose carbonate scale, loose aggregate, dirt and other foreign matters. In the case of concrete block or brick surfaces, they shall be sufficiently and uniformly dampened before the application of mortar.
- Concrete surfaces shall be roughened and kept thoroughly dampened for 24 hours prior to application of mortar.
- Mortar shall be used within 30 minutes after mixing. Re-tempering will not be permitted.
- The materials for the plastering shall be of 1:4 Ordinary Portland cement sand proportion by weight for the walls and superstructures, R.C. structures, base for floor punning and mosaic work and ceiling. The thickness of the plastering shall be 12mm.
- When the finishing coat is applied, the entire surface of wall or ceiling shall be finished in one operation in order to minimize joint marks. Where expansion and control joints exist in the base structure, provision shall be made to avoid cracking the mortar by inserting galvanized steel expansion beads within the coating thickness. The finished surface shall be perfectly plumb or level as the case may be without any bulging, runs, bruises of stains.
- After application of the finishing coat, the surfaces shall be kept

continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently to prevent displacement or damage.

- ◆ Where shown in the Contractor's drawings, metal wire lath shall be fixed to concrete block wall surfaces and into waterproof mortar on roofs before applying mortar plaster. The metal wire lath shall be galvanized expanded metal sheet with reinforcing ribs and shall be fixed with staples.

2. Waterproof Mortar

- (a) Waterproof mortar shall be applied to roofs, balconies, parapets, eaves, external walls and other required places as shown in the Contractor's drawings approved by the Employer.
- (b) Mortar shall conform to the Specification as provided for in this Chapter. Waterproof admixture shall be used in the mortar in accordance with the manufacturer's instructions to work on waterproofing.

3. Expanding Grout

- (a) An expanding grout shall be used around any pipe passing through a concrete or masonry wall where water may stand on one or both sides of the wall and where the pipe is not embedded in the structure constructed initially. Such grout shall expand upon setting to work on bonding between the concrete and the pipe. An expanding agent shall be used, and the grout composition shall conform to the manufacturer's instructions.

4. Colored Cement Spray

- (a) The sand to be used shall have the same quality and grading as specified in this Chapter. The mix proportion of the colored cement mortar shall be 1:2:6:9 in ratios by volume of white cement, ordinary Portland cement, slaked lime and sand. Waterproofing admixture and pigment shall be subject to the approval of the Employer. Colored cement mortar spray shall be applied with two coats. The first coat shall be executed in sufficient thickness to produce a uniform appearance in color and texture. The second coat shall be applied 24 hours after execution of the first coat.

5. Pebble Washout

- (a) Pebble washout finishing is composed of exposed gravel aggregates boned in the mortar.
- (b) The topping finish shall be trowled to a smooth even surface 30mm in thickness. When the finish surface starts to set, the surface shall be sprayed with water gently so that the gravel on surface shall be partially exposed. The cement paste left on the exposed surface of the gravel shall be removed and washed down with a soft brush and water.

6. Spray Tile Finish

- (a) Materials

- ◆ The material for spray tile shall be composed of ready-mixed acrylic resin as the main component, and aspects, dolomite, pigment, etc. as subcomponents. The spray-finished surface shall show a rippled, smooth and glossy surface resembling ceramic tile. The materials shall be brought to the Site in sealed containers.
- ◆ The material shall consist of 3 coats, i.e. primer, base coat and top coat. The base coat shall have "Dew" surface or "Moon Surface", with 2 to 3 mm in thickness. The top coat is glossy coloring layer, and the color shall be approved by the Employer.

(b) Execution

- ◆ Concrete, cement mortar or any other surface to receive the spray tile shall be cleaned of dust, laitance, loose particles or any other foreign matters and shall be ground and puttied to a smooth surface. The surfaces shall be completely dry, and the surrounding structures, fittings and fixtures shall be properly protected from being smeared. Joints shall be provided at adequate intervals to prevent cracks.
- ◆ The spray tile shall be applied in accordance with the manufacturer's instructions.
- ◆ The spray tile shall not be applied in rain, fog or mist.

7. Terrazzo Coping, Terrazzo Floor

(a) Materials

- The marble chips to be used for terrazzo work shall be of hard and durable and of colors approved by the Employer. The grading of the chips shall be as follows:
 - Percentage (by weight) passing through 12 mm mesh screen 100%
 - Percentage (by weight) passing through 2.5 mm mesh screen 0%
- Color pigments shall be added to produce the required color pattern. Samples of terrazzo shall be submitted to the Employer for his approval.

(b) Execution

- The marble chips shall be mixed with white cement paste to a ratio of 1:2.5 in volume. The total thickness of terrazzo in-situ including base mortar shall be 40 mm thick.
- The base for the terrazzo finish shall be of cement mortar rendering 18 mm thick as specified herein.
- After sufficient hardening of the finish coat, the surface shall be ground with emery powder ranging from coarse particles to fine ones by using appropriate grinding machine or hand tools and polished with wax to a luminous and satisfactory finish.

15.4. TILING

15.4.1. Scope

- (a) The work under this Chapter shall comprise the supply of all labor, materials and equipment and the performance of all work required for the various tile works in the buildings. The work shall be performed as shown in the Contractor's design drawings approved by the Employer and specified herein.

15.4.2. Materials

- (a) Only first-class quality tiles shall be used in the works. The Contractor shall submit samples of the tiles for the approval of the Employer.
- (b) Colors and size of tiles shall be approved by the Employer.

15.4.3. Ceramic Tile for Wall

- (a) The ceramic tiles shall have a glazed surface and round arris. The ceramic tile at battery room shall be acid resistant type. The size of tiles shall not be less than 200mm x 300mm.

15.4.4. Ceramic tile for Floor

- (a) Ceramic tile for floor shall have unglazed surfaces. Ceramic tile for floor shall be non-slip type/non- skid ceramic tile. The ceramic tile at battery room shall be acid resistant type. The sizes of tile shall be 300mm x 300mm.

15.4.5. Ceramic tile for Skirting

- (a) The ceramic tile at battery room shall be acid resistant type.

15.4.6. Porcelain exterior wall and floor Tile

- (a) Surface finishes including glaze of porcelain exterior wall and floor tile shall be approved by the Employer. Different types of tiles may be proposed by the Contractor for approval without extra cost.

15.4.7. Stair nosing Tile

- (a) Stair nosing tile shall be non-slip type. Surface patterns shall be approved by the Employer.

15.4.8. Execution

- (a) Concrete and/or hollow brick surfaces to receive the tiles shall be cleaned free from dirt, oil, grease and other deleterious substances and soaked with clean water prior to application of the rendering cement mortar base.
- (b) Ceramic tile and porcelain tile for the floors shall be set with 1:3 cement mortar to the level and slope specified. Ceramic tile and porcelain tile for the walls shall also be with 1:3 cement mortars.
- (c) After completion of setting, the tile surfaces shall be washed down until clean with plain water or a muriatic acid solution according to the manufacturer's instructions.
- (d) Plumbing fixtures and any others to be built in the tile surface shall be installed

as tiling work progresses.

- (e) Shop drawings showing pattern and tile arrangement shall be submitted for the approval of the Employer prior to the commencement of tiling work.
- (f) Tile arrangement shall be coordinated with the location of the sanitary fixtures of the plumbing system, in order that the sanitary fixtures such as faucets, drains, and other pipes can be installed at the joint of tiles.

15.5. FINISHING WORK

15.5.1. General

- (a) The works under this Chapter shall comprise the supply of all labor, materials and equipment, and the performance of all work necessary for the interior and exterior finishing works in the buildings. The works shall be performed as shown in the Contractor's design drawings approved by the Employer and as specified herein.

15.5.2. Material

All materials shall be of the best quality and shall comply with the applicable standards.

- (a) Acoustic Rockwool Board

Acoustic rockwool board shall be of a product of plaster and rockwool having a fissured surface simulating travertine stone with a white finish

- (b) Non-Asbestos Cement Board

Non-asbestos Cement board used for the finishing shall be 4 mm thickness.

- (c) Plaster Board

Plaster board used for the finishing wall shall be 12.5 mm thickness.

- (d) Ceramic Floor Tile

Materials of ceramic tiles shall be subject to Section 15.4 "Tiling".

- (e) Vinyl Base Board

Vinyl base board to skirting shall be 100 mm high.

- (f) Heat Insulation

The heat insulation shall be of glass wool 50 mm thickness. The density of the glass-wool shall be 10 kg/m³ or more.

- (g) Corrugated Galvanized Steel Sheet and Galvanized Steel Sheet

Corrugated galvanized steel sheet and galvanized steel sheet shall be of the galvanized steel sheet which is coated with several anticorrosive layers on both faces as the following

construction.

(h) Steel Core Sheet

Made of cold-rolled 0.63 and 1.2 mm thick steel sheet.

(i) Galvanized Layer

Zinc plating, with weight of 244 g/m^2 or more.

(j) Primer Coat

For enhancing adhesiveness between galvanized layer and colored anti-weather coat.

(k) Colored Anti-Weather Coat

- ◆ Colored polymeric resin anti-weather coating as the final coat.
- ◆ Colored Zn/Al roofing sheet shall be in accordance with AS 1397-1993 and hot dipped 55%- Aluminum, 43.5%-Zinc 1.5%-Silicon Alloy coated steel sheets, roll formed into corrugated roofing sheet.

(l) Polyester Resin Overlaid Plywood Partition

Partition shall be of wooden fabrication finished with polyester resin.

(m) Free-access floor

- ◆ Free access floor shall consist of assembly of modular panels supported by adjustable pedestals and stringers.
- ◆ The system shall provide an under floor cavity for wires, cables, conduits, ducts or other mechanical, electrical or communication services.
- ◆ Each corners of panel shall be supported by an adjustable pedestal, consisting of a steel head to interface with for adjoining panels, a base plate suitable for anchoring to slab and a threaded column with a self-locking nut for height adjustment.
- ◆ Each pedestal shall be attached to pedestal heads bolting to fix the floor panel.
- ◆ The entire system shall be capable of supporting loads with a safety factor of 3. The loads to be supported shall be subject to the design on the Electromechanical Works,
- ◆ Free access floor shall be an electrically continuous unit with maximum resistance between panel and understructure to be between $1.0 \times 10^6 \Omega\text{m}$ and $1.0 \times 10^7 \Omega\text{m}$ without surface finish.

15.5.3. Execution

(a) Acoustic Rockwool Board

- ◆ Ceiling suspension system shall be constructed of steel or aluminum

complete with anchors, hangers, clips, main runners furring strips and such other accessories as ceiling moulding.

- ◆ Adequate reinforcing and metal training shall be provided for mounting the lighting fixtures and ceiling access holes.
- ◆ Gypsum board shall be securely fixed to the furring strips with galvanized screws true to level and line.
- ◆ Acoustic rockwool board shall be fixed to the gypsum board by suitable adhesive and galvanized staples recommended by the manufacturer.
- ◆ Ceiling trims shall be of plastic moulding and fixed to the wall.
- ◆ The entire suspended ceiling trims shall be to the level with adequate camber and shall not have a deviation in levels and lines of more than 3 mm in 4m bay.
- ◆ The ceiling sheets shall be so arranged that the fractional tile cut to fit the room is a minimum. Ceiling access holes shall be provided in the rooms as directed by the Employer. The access hole covers shall match the surrounding ceiling and continuity of the ceiling pattern shall be maintained as much as possible.

(b) Non-Asbestos Cement Board

The non-asbestos cement board ceiling shall include the complete suspended ceiling shall include the complete suspended ceiling system same as specified of the rockwool acoustic tile in this Chapter. The sheets shall be fixed securely to the ceiling joints with stainless flat head screws. Joints shall be of open joints 5 mm wide, straight and uniform. Ceiling access holes shall be provided in the same manner as specified for the rockwool acoustic tile. The surface of the sheet shall be finished with vinyl emulsion paint as shown in the Contractor's design drawings approved by the Employer.

(c) Plaster Board

- ◆ Concrete or hollow brick surface under the plaster board shall be cleaned the dust, laitance, loose particles, or any other foreign matters, and shall be completely dry.
- ◆ Gypsum-type adhesive specified by the manufacturer of the plaster board shall be used for the glue.

(d) Ceramic Floor Tile

Execution of ceramic floor tile shall be subject to section 15.4.8.

(e) Vinyl Baseboard

Vinyl baseboard shall be applied on a smooth surface, dry and clean. Adhesive shall be applied and vinyl baseboard firmly placed with its toe in contact with the finished floor. The base shall then be rolled with a roller. External and internal corners shall be installed with performed pieces.

(f) Heat Insulation

The heat insulation material shall be laid on the ceiling of the top floor of the buildings after the installation of building equipment concealed in the ceiling.

(g) Stainless Steel Handrails and Ladders, Curtain Boxes

- ◆ Stainless steel handrails and ladders shall be fabricated and installed as designed by the Contractor. Stainless steel handrails and ladders surface shall be hair line finish.
- ◆ Curtain box shall be fabricated and installed with 1.5 mm thick aluminum (factory made).
- ◆ They shall be carefully fixed to the walls above windows and ceiling joists.

(h) Corrugated Galvanized Steel Sheet and Galvanized Steel Sheet

The installation method of the corrugated galvanized steel sheet and galvanized steel sheet shall be in accordance with the manufacturer's standard and instructions unless otherwise stipulated below.

- ◆ No lapped joint of the panels is allowed between the ridge and the eaves of the roof.
- ◆ Sealing strip shall be applied at the corrugated opening of the eaves.
- ◆ Ridge capping, verge cover strip and other joint strips shall be neatly connected with the panels and the slit shall be filled with caulking material.

15.6. DOOR AND WINDOW

15.6.1. General

- (a) The work under this Chapter shall comprise the supply of all labor, materials and equipment and the performance of all work necessary to supply and install steel doors and frames, steel rolling shutter, fire proof steel rolling shutter, aluminium doors, window, louvers and glazing in the buildings. The work shall be performed as shown in the Contractor's design drawings approved by the Employer and as specified herein.
- (b) The Contractor shall submit shop drawings showing details of various parts, method of anchoring and any other pertinent details to the Employer for his approval.
- (c) Before placing orders, the Contractor shall submit catalogues and samples of hardware to the Employer for his approval.
- (d) All steel surfaces exposed to view, except stainless steel, shall be applied with rust-resistance primer and finished with paint. Specification of the painting shall be in accordance with Sub-Clause 15.11.2 (k) of this specification.

15.6.2. Material and Execution

(a) Hollow Steel Door Leaves

- ◆ Hollow steel door leaves shall be fabricated of galvanized steel sheet.
- ◆ The door leaves shall be full flush seamless panel type, 40 mm thick unless otherwise specified. All four edges shall be sealed and ground smooth.
- ◆ Door leaves shall be adequately reinforced for stiffness and for fixing hardware.
- ◆ Where designed by the Contractor, pane and louver openings shall be provided with metal beads.

(b) Steel Door Frames

- ◆ Door frames shall be formed of galvanized steel sheet of 2.3 mm thickness unless otherwise specified. The frame shall be made solid by filling the void with cement grout.
- ◆ Door frames shall be profiled accurately to details and dimensions shown in the shop drawings approved by the Employer.
- ◆ Door frames shall be reinforced, drilled and tapped to receive hardware and shall be provided with rubber bumpers.
- ◆ Door frames shall be provided with adjustable anchors as required. Perimeters of door frames facing outdoor shall be securely caulked with approved caulking material.

(c) Steel Rolling Shutter

- ◆ The steel rolling shutter shall be of both electrical and manual operation type.
- ◆ The shutter shall be a roll-up type, composed of slats, guide rails, rolling drum and cover case complete with a motor control gear, safety switch, all wiring and all other necessary accessories.
 - Slat: Interlocking type, stainless steel plates 1.6 mm thick, designed against a wind velocity of not less than 25 m/sec.
 - Guide rail : 2.3 mm thick formed stainless steel plate, depth of 75 mm, with safety stop at a height of 2.2 m above the floor, anchored securely to the concrete jambs and flush with surrounding surfaces
 - Cover case: 1.6 mm thick galvanized steel plate with adequate reinforcement and inspection hole.
 - Motor: Electric power source: 400 volt, 3-phase, 50 Hz. Operation speed: 3 to 5 m/min. Motor shall be installed in the cover case.
 - Operation box: Installed on the side wall at an adequate height and provided with both electric and manual operation devices complete with all necessary accessories and provided with a stainless steel door.
- ◆ The manual operation device shall be suitably geared to allow operation by one

man.

- ◆ The Contractor shall submit detailed shop drawings prior to fabrication. Fabrication shall not be commenced until shop drawings have been approved by the Employer. The outside perimeter of the shutter guide rails shall be securely caulked with approved caulking materials.

(d) Fire Protection and Smoke Proof Steel Rolling Shutter

- ◆ The fire protection and smoke proof steel rolling shutter shall be of both electrical and manual operation type. The shutter shall be automatically closed with the fire alarm signal delivered from the fire alarm control panel when fire breaks out. In addition, the shutter shall be closed by pushing the emergency button in the manual closure system. A seat-plate switch to detect an obstacle shall be installed on the bottom of the shutter curtain and shall make the shutter curtain stop closing when the shutter curtain bottom touches a person or the switch detects an obstacle.
- ◆ The shutter shall be a roll-up type, composed of slats, guide rails, rolling drum and cover case complete with a motor control gear, safety switch, all wiring and all other necessary accessories.
- ◆ Specifications for the various components shall be as follows:
- ◆ Electric and manual operation devices complete with all necessary accessories and provided with a stainless steel door.
- ◆ The manual operation device shall be suitably geared to allow operation by one man.
- ◆ The Contractor shall submit detailed shop drawings prior to fabrication. Fabrication shall not be commenced until shop drawings have been approved by the Employer. The perimeter of the shutter guide rails shall be securely caulked with approved caulking materials.

(e) Aluminium Doors, Windows and Frames

- ◆ All aluminum sections including louvers shall be of extruded aluminum with satin anodized finish and shall be protected with strippable plastic before delivery. The plastic shall be removed after the major construction work has been completed.
- ◆ Aluminium alloy shall be of type "6063 – T5" or equivalent which has an ultimate tensile strength of at least 15 kg/mm² and hardness (BRINELL) not less than 60 kg/mm², according to British standard BS 1474 or equivalent Standard.
- ◆ Glass used for shutters shall be fibre reinforced glass. The glass shall be of high quality confirming to the Standard DIN 1249. The glass shall withstand a permissible impact loading as specified by the standard DIN EN 12600-

Pendulum Test (for flat glass and fibreglass). When the glass breaks, it shall not split into pieces. The broken pieces shall be messed by the glass fibres.

- ◆ Doors and windows including louvers shall be furnished and installed complete with door and window frames, fixing lugs and glazing beads. Fixing lugs shall be firmly secured in the openings and the frames attached to the lugs so that glazing surfaces are vertical.
- ◆ Prior to installation of doors and windows, the Contractor shall ensure that the surfaces of the concrete or steel to receive the frames are free from all loose and foreign materials. The frames shall be installed in vertical planes without warping and shall be adjusted before glazing is commenced. Spaces between the frames and the surroundings concrete shall be grouted with waterproof cement mortar. The surface of aluminum frames touching cement mortar shall be applied with anti alkali paint. Outdoor perimeters shall be sealed with approved caulking materials.
- ◆ Insect screens shall be fabricated of extruded aluminum frames with wire secured in frames to the inner side of windows by means of splines or galvanized screws. Screen units shall be removable and re-wirable. Screen wire shall be aluminum mesh, stainless mesh or other approved wire.

(f) Hardware

- ◆ The Contractor shall submit catalogues and samples of the hardware to the Employer for his approval. The hardware shall comply with the following requirement:

Floor hinge;	Cast iron body with stainless steel cover, oil and spring activated with 90 degree stop device
Push and pull handle;	For entrance door, stainless steel, 20 cm x 20 cm in size
Hinge;	Bronze or stainless steel, 13 cm in approximate size, 3 hinges to each door leaf (less than 2.1 m high)
Knob or lever handle;	Stainless steel or bronzed aluminum
Lock set;	Bronze, cylindrical lock, 3 keys per lock to be furnished
Door closer;	Die-cast aluminum body, oil and spring activated with 90 degree stop device
Door bolt;	Bronze, surface or flush type
Sash fastener;	Die-cast aluminum
Door Stopper;	Wall or floor mounted type with rubber bumper and holder

- ◆ The Contractor shall supply master key sets as directed by the Employer.

(g) Door Grilles

Steel door and aluminium door shall be provided with grilles and insect screen in the door panels for the ventilation. The doors needed grilles and the size of grilles shall be shown in the Contractor's drawings of the ventilation and air-conditioning system.

(h) Glazing

- ◆ The material of glass shall be subject to approval by the Employer:
- ◆ All panes shall be accurately cut to fit in the frames with 3 mm clearance all around. Panes in windows or door leaves shall be set in glazing mastic applied on all four sides for the full length using spacer shims and vinyl spliced glazing bead as recommended by the manufacturer.
- ◆ All door and window panes shall be cleaned and polished when the building work is completed.

15.7. ARCHITECTURAL MISCELLANEOUS WORKS

15.7.1. General

- (a) The work under this Chapter shall comprise the supply of all labor, materials and equipment and the performance of all works necessary to install architectural miscellaneous works in the buildings. The works shall be performed as shown in the Contractor's drawings approved by the Employer and specified herein. All materials to be incorporated in the works shall be of the best of its kind.
- (b) Catalogues or samples of each material shall be submitted to the Employer for his approval.
- (c) The Contractor shall prepare and submit shop drawings showing complete details of all parts, assemblies, components, supports and connections to the Employer for his approval.
- (d) The work shall be shop fitted and shop assembled where possible.
- (e) Wherever necessary, metallic material shall be insulated to prevent electrolysis due to contact with dissimilar metals. Insulation shall be by means of bituminous paint or other approved means.

15.7.2. Materials and Execution

(a) Roof and floor drains

- Roof and floor drains of the buildings shall be of cast iron body, heat coated with asphalt. Care shall be exercised in fitting the surrounding waterproofing works to prevent any damage to the water proofing membrane. Caulking shall be applied as required.
- Floor drains shall be fitted with flat removable cast iron grates. Roof drain grates shall be convex in profile, at least as high as the pipe diameter, and the total area of the openings of the grate shall be larger than 1.5 times the cross-sectional area of the drainpipe. Grates shall be fixed with non-corrosive screws.

- Roof drains shall have two flanges. The bottom flange shall be integral with the drain body and shall be set to coincide with the waterproofing or with the top surface of the surrounding concrete. The top flange shall be screwed to the bottom flange and shall be set lower than the surrounding roof finish. The two flanges shall be used to clamp the roof waterproof membrane. Different types of drain may be proposed by the Contractor for approval without extra cost.
- (b) Roof and floor drain pipe
- Roof and floor drains of the building shall be of polyvinyl chloride (PVC) pipe. Material and installation of the pipe shall conform to the relevant description in "Plumbing System".
 - The joint of the pipe and roof drain shall be flexible joint or off-set joint, which can absorb vertical movement of the pipe caused by the change of temperature, in order that the pipe will not push the roof drain and harm the waterproof layer.
- (c) Stair non-slip
- Stair non-slip shall be brass or stainless steel with serrated or plastic tire for non-slip. The stair non-slip shall be approximately 40 mm wide and installed on the full width of each stair tread. Anchorage shall be provided to the underside of the nosing.
- (d) Covers of expansion joints
- Covers for expansion joints shall be provided along the joints on the wall and floor. Steel angles and stainless steel cover plates shall be neatly fabricated so as to prevent water infiltration, to allow structural movement and also to provide a satisfactory finish appearance as designed by the Contractor and approved by the Employer. The surface of stainless steel cover plates shall be hairline finish and coated with clear lacquer. Caulking shall be applied between stainless steel cover and other materials as approved.
 - Different types of the expansion joints may be proposed by the Contractor for approval.
- (e) Doormat
- A stainless steel doormat shall be provided at the entrance floor of the entrance door at outgoing terminal. The doormat shall be a grate type, fabricated of stainless steel flat bars into a depth of not less than 30 mm, and 80cm × 150cm width and set in a recess provided in the floor. Polyvinyl chloride drainpipes shall be provided under the door mat recess.
- (f) Parapet ring
- Parapet ring specified below shall be provided where shown in the Contractor' design drawings.
- Material : Galvanized steel

Ring : Round bar 16 mm ϕ × 150 mm diameter

Anchor plate : Flat bar 6 mm thickness x 60 mm width × 200 mm length

(g) Kitchen sink units

- Kitchen sink units in the kitchen in the main control room shall consist of kitchen sink and cooking having dimensions as noted below. The counter tops and front surface shall be finished with ceramic tile, and the cabinet door and inside shelves shall be of wooden fabrication finished with melamine or polyester resin. The kitchen sink shall be of stainless steel sheet 0.6 mm thick.

Size of unit (length at minimum, width, height): 1,800 × 600 × 800 mm.

Size of sink (length, width, depth): 650 × 400 × 180 mm.

(h) Room name plates

Room nameplates shall be provided on the entry door of each room in the powerhouse and in the outgoing terminal. The plates shall be made of acrylic resin plate and fixed with stainless screws or other approved fixing devices. Size of the plates shall be approximately 8 cm × 35 cm. The name of the room shall be engraved on the plate as directed by the Employer.

(i) Venetian blinds

Venetian blinds shall be of a vertical type made of incombustible glass cloth. The blind shall consist of complete set of head roller and aluminum rail, bottom chains and operating devices. The blind shall have adequate dimensions to cover the whole area of the required window. The blind shall be fixed securely in the wood blind box with flat screws. The Contractor shall submit samples or catalogues of the blind to the Employer for his approval.

15.8. PLUMBING SYSTEM

15.8.1. Scope of Work

- (a) The works under this Chapter shall comprise waste water and sewage drainage. The water supply system and powerhouse drainage systems are included in the Electromechanical Specifications.
- (b) The plumbing system shall be designed by the Contractor in accordance with the requirements specified herein and site conditions. Detailed drawings of proposed deviations due to actual field conditions or other causes shall be submitted to the Employer for his approval. Materials and equipment installed in the plumbing system shall be suitable for the pressures and temperatures encountered. Installation shall be as required by the applicable national plumbing code of Nepal and local regulations around the Site and as specified herein.
- (c) Installation shall be accomplished by the workmen skilled in this type of work.

15.8.2. Codes and Standards

- (a) Following standards shall be used unless otherwise Nepalese relevant standards such as Nepal National Building Code (NBC) specified:
- Indian Standard (IS)
 - Japanese Industrial Standard (JIS)
 - Heating, Air-conditioning and Sanitary Standard in Japan (HASS)
 - Other approved standard or codes
- (b) The Contractor shall obtain the approval of the Employer if he proposes to deviate from the above codes or standards.

15.8.3. Submissions

- (a) The Contractor shall submit to the Employer for his approval drawings on general arrangement of equipment, piping, etc. as part of the Contractor's detailed design drawings specified in Chapter 1 in this Specification.
- (b) At least fifty Sixty (60) days prior to starting installation of any materials or equipment, the Contractor shall submit to the Employer for his approval the following shop or working drawings:
- ◆ Layout drawings of equipment including a list of equipment and materials to be incorporated,
 - ◆ Details of piping and valving,
 - ◆ Details of sleeves for piping,
 - ◆ Details of supports, hangers, attachments and anchoring,
 - ◆ Details of foundations for equipment,
 - ◆ Detailed layout of electric wiring and conduiting,
 - ◆ Complete electrical connection diagrams, and
 - ◆ Other drawings as required by the Employer.

15.8.4. Data and samples

- (a) The Contractor shall submit for approval of the Employer a complete list of materials and equipment to be incorporated in the works under this Chapter including sufficient descriptive materials such as catalogues, diagrams, performance curves, charts, layout drawings and other data published by the manufacturer to demonstrate the conformance to the Specification and the Contractor's detailed design approved by the Employer before placing or confirmation of orders.

15.8.5. Operation and Maintenance Manuals

- (a) Six complete sets of operation and maintenance manuals for the domestic water supply and hydrant systems shall be furnished as specified hereinafter. The manuals shall be furnished at the time of performance tests of the system. The manuals shall include but not be limited to the following:
- Explanation of System
 - General description of system including function, design conditions, system

design and equipment incorporated,

- Schematic diagrams of piping including equipment, valves and controls,
- Schematic diagram of electric power supply and controls, and
- Layout plan of equipment.
- Operation and Maintenance Instructions
 - Method of operation including procedures for safe starting and stopping of equipment, preventive procedures, and checking methods,
 - Manufacturer's instructions on each piece of equipment including lubrication instructions,
 - Daily, weekly, monthly and yearly inspection items on each piece of equipment and systems, and
 - Method of finding causes of breakdown of each piece of equipment and systems and countermeasures to be taken.
- Manufacturer's Bulletins
 - Manufacturer's specifications, shop drawings and catalogues of each piece of equipment,
 - Manufacturer's certifications, and
 - Any guarantee, test data and engineering data furnished by the manufacturers.
- Spare Parts List
 - List of spare parts and consumables furnished with the equipment as standard appurtenances as required by the Specifications.
- Service and Maintenance Organizations
 - Name and address of nearest recommended service and maintenance agent who can be contracted by the Employer at the time of breakdown of any item of equipment.

15.8.6. Attachments and Spare Parts

- (a) The Contractor shall furnish with each piece of equipment standard attachments and spare parts which the manufacturer supplies under normal commercial transactions. In addition to these, the Contractor shall furnish spare parts, consumables or standby equipment as specified hereinafter. The Contractor shall also furnish a complete list of spare parts as recommended for

operation of each piece of equipment for a period of one year, with current prices and source of supply.

15.8.7. Tools

- (a) The Contractor shall provide sufficient special tools as recommended by manufacturers for field maintenance of the system. One complete set shall be provided at no extra cost to the Employer.

15.8.8. Field instructions

- (a) Upon completion of the work, the services of one or more instructors shall be provided by the Contractor for a total period of not less than one (1) week to instruct a representative of the Employer in operation and maintenance of the equipment and the systems. These field instructions shall cover all the items contained in the bound instructions as specified for operation and maintenance manuals, and all costs for the services shall be borne by the Contractor.

15.8.9. Tests

- (a) The Contractor shall submit his proposed testing programs and procedures at least Thirty (30) days prior to the scheduled tests and obtain the Employer's approval. All tests shall be conducted in the presence of the Employer. Any materials, equipment, instruments, personnel, water and electricity required for the tests shall be provided by the Contractor.
- (b) Accurate data of each test shall be recorded and reports of test data shall be submitted to the Employer.

15.8.10. Floor, Wall and Ceiling Escutcheons

- (a) Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floor, walls or ceilings. Escutcheons shall be fastened securely to pipe or pipe covering and shall be of chromium plated iron or chromium plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

15.8.11. Concrete Structure

- (a) All foundations, tanks and basins made of reinforced concrete for the system shall be designed by the Contractor.

15.8.12. Power Supply

- (a) The plumbing system will be fed with AC 3 phase 4 wires 400V 50 Hz and AC 1 phase 2 wires 230V 50Hz. The Contractor shall design, supply and installation of the power source panel for the plumbing system and wiring and conduiting between the power source panel design, supply and installation of the power source panel for the illumination system and wiring and conduiting between the power source panel and distribution boards installed under Electromechanical Works of the Contract.

15.9. WASTE WATER AND SEWAGE DRAINAGE

15.9.1. System Description

- (a) Waste water and Sewage system shall be provided in the powerhouse and other buildings as designed by the Contractor and the Specification.
- (b) Soil water from the lavatories shall flow into a separate septic tank and soak pit and be treated in it. Waste water from the kitchen, pantries and lavatories shall flow separately into the separate sump pit leading to the soak pit.
- (c) Ventilation pipe shall be provided connecting with the soil water and waste water pipes in order to give smooth water flow and keep the water in drain traps.

15.9.2. Material and Installation

- (a) Septic Tank

- General

The septic tank for the powerhouse and outgoing terminal shall consists of sewage treatment plant and of sedimentation, separation and contact aeration method type which shall have sufficient capacity for 10 persons (powerhouse) and 20 persons (switchyard and other building as required) and appropriate shape to accomplish the required performance stipulated below:

- Rate of sewage treatment in Biological Oxygen Demand (B.O.D): 65% or more
- Target B.O.D after treatment: 90 ppm or less

- Construction

The septic tank shall be made of fiber reinforced plastic (FRP) or approved type having sufficient strength to withstand earth and water pressure, and shall be of such a construction as easy in maintenance and cleaning. The tank shall consist of following chambers and equipment:

- Two sedimentation and separation chambers
- Two contact and aeration chambers with contact panels
- Sedimentation chamber and chemical feeder
- Blower
- Ventilation stack
- Water and air tight type manhole cover for each chamber

The septic tank in the outgoing terminal shall be installed on the concrete foundation and after backfilling, the tank shall be covered by concrete slab.

- Blower

The air pumps shall be electromagnetic diaphragm type, with aluminum alloyed body and corrosion resistant rigid plastic casing. The pump shall operate smoothly, with low vibration and noise.

(b) Effluent Storage Tank

- The treated effluent storage tanks shall be fabricated types, made of fiber reinforced plastics (FRP) or approved type. The tanks shall be provided with covers, manholes, ladders, pipe connections, a water level sensing switch vent pipe base frame and supported by steel support at a height of 0.6 m from the floor level.
- All components of the tanks which are in contact with water shall be corrosion proof and shall not exude harmful substances into the water.
- The Contractor shall enlarge the tank as the case may require in conformity with his septic tank without extra cost to the Employer.

(c) Soak Pit

- Soak pit shall be provided. Soak pit for the same number of people required in septic tank and sump pit shall be constructed for the sewage system of powerhouse and all other buildings. Overflow from septic tank shall be connected to the soak pit which is ultimately drained to the ground below.

15.9.3. Sanitary Fixtures

(a) General

- Sanitary fixtures shall be obtained from a reputed supplier and the Contractor shall submit catalogues to the Employer for his approval before placing the order.
- Generally, all fixtures except water closets shall have the water supply above the rim. Angle stops, straight stops, stops integral with the faucets and the like for supplies shall be furnished and installed with fixtures. Exposed fixture trimming and fittings shall be chromium-plated or nickel-plated brass with polished and bright surfaces.
- Urinal screen shall be provided where a urinal abuts another urinal or lavatory sink on either side. The screen shall be of vitreous China and wall mounted.

(b) Material

- Water Closet - European Type
Material : White vitreous China
Trap : Single siphon, P or S trap
Cistern : 10 liters low level flushing
Others : 40 mm flush pipe, 20 mm overflow pipe with mosquito proof coupling
- Water Closet - Indian Type
Material : White vitreous China
Trap : Single syphon, P or S trap (cast iron)
Cistern : 10 liters high level flushing

Others : 32 mm flush bend, 20 mm overflow pipe with mosquito proof coupling

Shape & Size: W. C. pan 580 × 440 mm

- Urinal
Material : White vitreous China
Type : Flat back type
Size : 630 × 400 × 420 mm (Height, Width, Width)
Cistern : 5 liter automatic flushing
- Lavatory (Shower Room)
Material : White vitreous China
Type : Under-counter
Size : 550 × 400 × 200 mm (Width, Width, Depth)
- Slop Sink (Wash basin)
Material : White vitreous China
Type : Pedestal-type lavatory sink
Size : 600 × 450 × 200 mm (Width, Width, Depth)
- Paper Holder
Material : Vitreous China
- Shower Head
Type : Fixed type

15.9.4. Installation

(a) Fixture Connections and Support

Wall-hung fixtures shall be fastened to the wall with through bolts where appearance of the bolts is not objectionable. For solid concrete or brick masonry and where through bolting is objectionable; fixtures shall be fastened with machine-bolt expansion shields or stud type expansion bolts. For masonry unit construction, fixtures shall be fastened with through bolts or toggle bolts as required. Exposed bolt heads in finished areas shall be hexagonal. Exposed nuts shall be chromium-plated hexagonal cap nuts. Washers shall be painted or chromium-plated to match bolt heads or nuts.

(b) Connections to Equipment and Fixtures

The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with an integral stop, shall be equipped with a cutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures.

15.10. WATER PUMPS AND CONTROLS

15.10.1. General

- (a) The pumps shall have capacities, characteristics and ratings as approved by the Employer.

- (b) The pumps shall be provided with all necessary fittings, common base, anchor bolts and pipe connections.
- (c) All parts of pumps and motors shall be designed to withstand the maximum mechanical and electrical forces to which they may be subject to in the course of operation including full reverse runaway without failure, distortion and injury.
- (d) Impellers shall be statically and dynamically balanced to eliminate vibration and effect minimum bearing load. Motors shall be drip-proof type unless otherwise specified and shall be provided with safety overload cut-off switches. Suction and delivery pipes shall be provided with check valves, gate valves, flexible joints, air release valves, pressure gauges or foot valves with strainer as shown on the approved drawings.
- (e) The pumps shall be rigidly anchored to the foundation in an accurate alignment to eliminate vibration.
- (f) The pumps shall be controlled through "Automatic and Manual" modes. When on automatic operation, the pump shall be controlled by water level sensing switches, or pressure switches as shown on the drawings approved by the Employer.

15.10.2. Material and Installation

- (a) Centrifugal and Volute Pumps
 - The pumps shall be single or multistage, single suction centrifugal or volute pumps.
 - The direction of impeller rotation shall be marked on it. The casing shall be horizontal or vertical split type of cast iron construction. The interior of the casing shall be easily inspected by removing upper half or removing dowel bolts. Each section shall be sealed with a pre-cut gasket.
 - The impeller shall be of single suction enclosed type made of bronze.
 - The shaft shall be made of stainless steel heat treated, ground to accurate dimensions, and adequately sized to minimize deflection.
 - Bearing housing shall be removable from the pump casing and shall be accurately machined and dovetailed to the casing. Proper alignment between the impeller and bearing housing and the motor frame shall be provided to ensure full support of the shaft and vibration free operation. Bearings in the pump which are in contact with pumped water shall be of bronze and water lubricated. Other bearings shall be grease lubricated.
- (b) Submersible Pump
 - The pump shall be centrifugal pump complete in one unit consisting of a submersible motor, impeller, and guide vane, strainer and delivery connection.
 - All components of the pump shall be made of corrosion resistant materials, and electric components shall be perfectly insulated, sheathed and coated. Impeller casing shall be made of cast iron, and impeller shall be made of bronze. Shaft shall be made of stainless steel. Motor shall be of complete water filled type or hermetically sealed type.

- Electric cable shall be waterproof, durable and the connection shall be perfectly watertight.
- (c) Water Level Sensing Switch
 - Water level sensing switch shall be of an electrode type. It shall be included in "Automatic-Off- Manual" control and where required sequence selection switch to allow alternate operation of the pumps.
 - The electrode shall be encased in a tube which shall extend below the lowest water level to prevent foreign matter from entering into the tube. Non conducting spacers shall be provided to hold the electrodes in the tube. All contacts shall be suitably rated and enclosed in rugged moisture proof enclosure.
- (d) Operation Panel
 - The operation panels for pumps shall have following function and equipment:
 - Leakage breaker
 - Ammeter
 - Over load protector
 - Phase missing protector
 - Phase missing condenser
 - Sign lamp : Power (White), Operation (Red), Stop (Green) and Over current (Orange): Full water level, Low water level
 - Terminals: Water level switches
 - Switch: Manual - Stop – Automatic
 - Single line diagram of the operation panel shall be installed in the drawing holder of the panel. The operation panel shall be of wall mount type.
 - Ammeters shall be capable of accepting the starting characteristics of the corresponding motor and shall be suitably calibrated to indicate the full load running current at three quarter full scale deflection.
- (e) Conduit Piping and Wiring
 - Conduit piping and wiring for the plumbing system shall be designed and supplied by the Contractor compiling with the applicable provisions in "Lighting and Illumination System" of the Electromechanical Specification.

15.11. PIPING

15.11.1. General

- (a) All pipes, fittings and fixtures shall be of the kind, grade, type and qualities as shown on the drawings approved by the Employer and as specified herein.
- (b) All pipes shall be jointed with fittings compatible with the pipe and of the suitable type for the intended service.
- (c) Union joints shall be properly provided in piping to allow disassembly of the piping for maintenance services or for any modification of the system.

- (d) Flanges shall be provided for pipes 75 mm diameter and larger. The flanges shall be compatible with and shall have the same rating as the companion flange of the valve or the fittings. Full face rubber gaskets shall be provided to all flanged joints.
- (e) All piping shall be fitted and assembled to introduce minimum stress to the pipe and fittings. All pipes shall be supported where shown on the approved drawings and as required. Polyvinyl chloride (PVC) pipe shall be supported at the spacing recommended by the pipe manufacturer.
- (f) The same standard of thread shall be used throughout the works.
- (g) All piping to be embedded shall be tested and approved by the Employer prior to being embedded. Sleeves or check-outs shall be provided where pipe passes through concrete or brick structures. The space shall be filled or caulked with suitable materials. Where pipe passes through a wall or floor where water tightness is required, the space shall be filled with an approved material or with approved expanding grout.
- (h) Cleanouts and manholes shall be provided as shown on the approved drawings.
- (i) All pipes embedded in the ground shall be at the pipe top a minimum 60 cm below the grade where no heavy traffic is expected and minimum 90 cm below the grade at road crossings and where heavy traffic is expected. Pitch of the pipe line shall comply with the applicable code and regulations.
- (j) Change in pipe size shall be made with reducing fittings. The use of bushings will not be allowed.
- (k) Change in direction shall be made with fittings except that bending of galvanized steel pipe 100 mm or smaller will be permitted, provided that a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than 6 times the diameter of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted.
- (l) Exposed piping shall be run in parallel with the lines of the buildings unless otherwise indicated.
- (m) Connections between ferrous and nonferrous metallic pipe installed underground shall be made with dielectric unions or flanges.

15.11.2. Material and Installation

(a) Material of Pipes

- PVC pipes

Polyvinyl chloride pipes shall conform to JIS K-6741, Type VP or equivalent and shall be laid and jointed in accordance with the manufacturer's instructions.

- Galvanized Steel Pipes

Water pipes shall be of standard weight seamless galvanized screwed and

socketed pipe conforming to JIS G 3302 or equivalent. Threaded joints shall be sealed with an approved graphite compound or with jointing tape applied to the male threads only.

Water pipes whose water pressure is over 10 kg/cm² shall be galvanized steel pipes conforming to JIS G 3302 or equivalent, and installed and jointed in accordance with manufacturer's instructions.

- Copper Pipes

Copper pipes shall conform to JIS or equivalent and shall be installed and jointed in accordance with the manufacturer's instructions.

(b) Application of Pipes

Application	Pipe
Indoor water supply pipe	SGP
Indoor water supply pipe	STPG-sch 40
Outdoor water supply pipe	SGP/PVC/uPVC
Hot water supply pipe	Polybutelene/Copper (I)
Soil water pipe	uPVC/PVC
Waste water pipe	uPVC/PVC
Ventilation pipe	uPVC/PVC

(c) Pipe Insulation

- Pipe insulation in the plumbing work shall be made only for the hot water supply pipes. The insulation material shall be mineral fiber or fibrous cloth of 24 kg/m³ in nominal density with 20 mm thick or approved by the Employer.
- The insulation shall be provided with field-applied or factory-applied non-combustible vapor-barrier jacket. The jacket shall consist of lamination of aluminum foil glass fiber reinforcement and kraft paper where exposed to view, and where concealed the kraft paper may be omitted. The kraft paper shall be enamel painted.
- After pressure tests have been completed in the piping system, insulation shall be applied to the pipe with end joints tightly butted and the vapor-barrier jacket lapped not less than 38 mm at longitudinal joint and adhered with adhesive.
- At circumferential laps, a 75 mm wide strip of jacketing material shall be applied and adhered with the adhesive. On jacket facing to receive finish painting, the aluminum foil shall not be exposed.
- The insulation shall be continuous through pipe hangers and pipe sleeves.
- Unless otherwise indicated on the Drawings, all flanges, unions, valves, anchors and fittings shall be insulated with factory-pre-molded, or pre-

fabricated or field-fabricated segments of insulation of the similar material and thickness as the adjoining pipe insulation.

(d) Valves

- Gate valves and check valves of 50 mm in diameter or smaller shall be of bronze construction. Valves of 65 mm in diameter or larger in the pipe line shall have a cast iron body and bronze trim. Valves of 75 mm in diameter or larger shall be flanged.
- Gate valves shall be of solid wedge disc type and may have a rising stem or non-rising stem. Check valves shall be horizontal swing type having a lightweight brass disc. Globe valves shall have replaceable resilient plugs and shall have rising stems. Globe valves for use in regulating flow shall have replaceable seats.
- Air vent valves shall be of float type, ball type or combined float and heat sensing or diaphragm type to be selected according to the service intended.
- All valves throughout this Section shall be of the same manufacture in principle.

(e) Unions and Hose Faucets

- Unions on ferrous pipe of 50 mm in diameter or smaller shall be malleable iron zinc-coated. Unions shall not be concealed in walls, ceilings or partitions.
- Hose faucets shall be brass or bronze with male inlet threads, hexagon shoulder and hose connection.

(f) Flexible Joints

- The flexible joint shall be either of the following:
 - A rubber tube type formed with a flexible reinforced rubber tube with bolted flanges and split backing flanges for attachment to the pipe.
 - A bellows type formed with copper or stainless steel, activated by internal pressure and retained by flange rings and tension lug bolts.

(g) Traps

- Each fixture, floor drain and piece of equipment requiring connection to the drainage system, except grease interceptors, shall be equipped with a trap. Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tube shall be recess-drainage pattern, or tube type. Traps for acid-resisting waste shall be of the same material as the pipe.

(h) Pipe Cleanouts

- Pipe cleanout shall be the same size as the pipe except that cleanout plugs

larger than 100 mm will not be required. A cleanout installed in connection with cast iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place indicated.

- Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90 degree branch drainage fittings with screw plugs. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks. Cleanouts on pipe concealed in partitions and walls and where installed in finished floors subject to foot traffic shall be provided with chromium plated cast-brass covers secured to plugs.

(i) Pipe Hangers, Inserts and Supports

- The Contractor shall submit to the Employer for his approval detailed drawings of the type of inserts, hangers and supports for the piping that he proposes to provide.
- The location of hangers and supports shall be coordinated with the structural work to assure that structural members will support the intended load. Hangers and supports shall be provided at intervals specified below, at locations not more than 1.0 m from the ends of each run out and not over 30 cm from each change in direction of piping. Hangers shall be adjustable.
- Underground piping shall be laid on a firm bed for its entire length, except where support is otherwise provided.

(j) Drain Basins

- Drain basins such as waste water basin, soil water basin and rain water basin shall be of prefabricated concrete basin. The size and depth of basins shall be designed by the Contractor according to the size and slope of connecting pipes shown in the approved drawings and estimated water flow volume. Invert shall be made at the bottom of basins by waterproof mortar, having smooth surface for the water flow. Following covers shall be provided.

- Waste water basin: Precast concrete cover

- Soil water basin: Cast iron manhole cover, water and air tight type

- Rain water basin: Steel grating cover

(k) Painting

- All hangers, supports and other iron works shall be painted with one coat of anti-corrosive primer and with two coats of oil paint. All galvanized steel pipes exposed to view shall be painted with two coats of oil paint. Color code shall be as approved by the Employer.
- When steel pipes and fittings are buried in the ground, they shall be provided

with jute impregnated with asphalt paint.

(l) Expanding Grout

- An expanding grout shall be applied into the space between pipe and structure where the pipe penetrates. The work shall be in accordance with Sub-Clause 15.3 "Plastering".

(m) Earthing of Metal Parts

- Contractor shall ensure electrical continuity of all pipe line network and all metal appliances installed by him and to which all other metal parts of the installation have been connected.

(n) Disinfection

- The entire water supply system shall be thoroughly flushed and disinfected with liquid chlorine or hypochloride before placed in operation.
- Chlorination agent shall be introduced into the water lines in a manner approved by the Employer and left in the system for a period of not less than sixteen (16) hours and the heavily chlorinated water shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 ppm.
- All valves in water lines being sterilized shall be opened and closed several times during the sixteen (16) hour chlorinating period.

15.11.3. Testing of Pipe Lines

- (a) The Contractor shall test all pipe lines as approved by the Employer. If the pipe fails in test, the Contractor shall repair, replace and retest the piping until accepted by the Employer. All piping systems shall be flushed clean before testing.
- (b) Pressure testing of water service pipe
- (c) Pipes shall be subject to a hydraulic pressure test of 10 kg/cm^2 above the normal working pressure. If piping is tested in sections, temporary cap shall be fitted. Each section shall be slowly filled with water, and air inside the pipe shall be carefully expelled.
- (d) For acceptance, the test pressure shall remain constant for twenty four (24) hours without additional water.
- (e) Testing of soil water and waste water pipe
- (f) No pipe shall be covered or concealed before it is tested. If any sections of pipe lines are tested, the Contractor shall obtain approval of the Employer before covering.
- (g) All openings and pipe ends shall be securely plugged and filled with water up to the top of the highest opening. This water shall remain at the same level for twenty

four (24) hours.

- (h) All pipes shall also be inspected visually to ensure that there are no projections in the pipe, and the pipe line is straight and devoid of abrupt kinks. At least, three quarter of the pipe opening of any sections between manholes shall be visible when viewed from the opposite end the pipe section.
- (i) Exposed pipes shall further be subject to a leakage test. Leakage tests shall be made after a minimum of 24 hours after the pipe line has been filled with water. The line will be accepted if no leakage is found for the duration of another 2 hours on the pipe line.

15.11.4. Spare Parts and Consumables

- (a) The Contractor shall furnish the following spare parts for each equipment and hand them over to the Employer at the time of field instruction services.

(1)	For a raw water tank	One set of water level sensing switch
(2)	For a septic tank	Sterilization tablets for one year use

15.11.5. Maintenance during Construction

- (a) The plumbing system shall be maintained and protected by the Contractor in a satisfactory condition until final acceptance by the Employer. Defective materials and equipment damage in the course of installation or testing shall be replaced or repaired at the expense of the Contractor in a manner approved by the Employer.

15.12. VENTILATION AND AIR CONDITIONING

15.12.1. General

1. Scope

- The work under this Chapter shall comprise the ventilation system and the air conditioning system in the headrace tunnel, adit tunnel, outgoing terminal and Powerhouse.
- The Contractor shall submit to the Employer for his approval drawings on general arrangement of equipment as part of the Contractor's detailed design drawings specified in Chapter 1 in this Specification. Detailed drawings of proposed deviations due to actual field conditions or other causes shall be submitted to the Employer for his approval. Materials and equipment to be installed in the system shall be suitable for the intended purpose. Installations shall satisfy and meet the applicable codes specified herein.
- Installation shall be accomplished by the workmen skilled in this type of work.

2. Codes and Standards

- Following standards shall be used unless otherwise Nepalese relevant standards exist.
 - Indian Standard (IS)
 - Japanese Industrial Standard (JIS)

- Heating, Air-conditioning and Sanitary Standard in Japan (HASS)
 - Other approved standard or codes
- The Contractor shall obtain the approval of the Employer if he proposes to deviate from the above codes or standards.

15.12.2. Shop Drawings and Working Drawings

- (a) At least Sixty (60) days prior to starting installation of materials and equipment. The Contractor shall submit to the Employer for his approval the following shop and working drawings:
- ◆ Layout drawings of equipment including list of equipment and materials to be incorporated,
 - ◆ Details of piping,
 - ◆ Fabrication details of ducts and detailed layout,
 - ◆ Details of sleeves and opening for piping and ducting,
 - ◆ Details of supports, hangers, attachments and anchoring,
 - ◆ Details of vibration isolation,
 - ◆ Details of foundations for equipment,
 - ◆ Detailed layout of electric wiring and conducting,
 - ◆ Complete electrical connection diagrams,
 - ◆ Single line diagrams and functional drawings and
 - ◆ Other drawings as required by the Employer.

15.12.3. Safety Requirements

- (a) Belts, pulleys, chains, gears, coupling, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.

15.12.4. Electrical Work

- (a) Electric motor-driven equipment specified herein shall be provided complete with motors, motor starters and controls. Electrical equipment and wiring shall be in accordance "Outdoor Lighting and Illumination System" described in the Electromechanical Specification. Electrical characteristics shall be as indicated. Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motor control specified. Manual or automatic control and protective or signal devices required for the operation as specified herein and any control wiring required for controls and devices, but not shown on the electrical plans, shall be provided.

15.12.5. Other Particulars

- (a) The provisions set out in the foregoing Chapter 15.8 "Plumbing System" shall be applied here as applicable in its spirit regardless of the wording as listed below:
- ◆ Shop drawings and working drawings,
 - ◆ Data and samples,
 - ◆ Operation and maintenance manuals,

- ◆ Attachments and spare parts,
- ◆ Tools,
- ◆ Field instructions,
- ◆ Tests,
- ◆ Floor, wall and ceiling escutcheons and
- ◆ Concrete structure.

15.12.6. Basic Design Data and Conditions

(a) Design Conditions

Ventilation and air-conditioning systems shall meet the following requirements:

Rooms	Inside design condition
GIS Room, Power Transformer Room., IPB & Cable Gallery, Generator Floor, Work shop, Turbine Floor. Valve Floor. Pump Floor	Less than 40°C
Local Control Room. & Entrance, AC/DC Room., Battery Room,	25°C dry-bulb 19°C wet-bulb Relative humidity: less than 65% at maximum temperature

(b) Power Supply

The ventilation and air-conditioning system will be fed with AC three phase 4 wires 400V 50 Hz and AC single phase 2 wires 230 V 50 Hz. The Contractor shall provide conduit pipes from the cable tray to the power source panel of the ventilation and air conditioning system. Prior to design and make the panel, the Contractor shall submit the breakers performance to the Employer for approval.

15.12.7. Ventilation Systems

System Description

Ventilation System in Powerhouse

- The ventilation system in powerhouse consists of several sets of air supply fans, exhaust fans and air ducts. The outside air is blown inside and absorbs heat produced by the electrical equipment and exhaust to outside by the fans. All fans connected with air ducts are centrifugal type.
- The dampers of the main transfer room shall be automatically closed by receiving the signal from the fire alarm system, when fire alarm notices a fire in the powerhouse.
- Ventilation system for battery room shall be separately installed from that for the other rooms, and air from the battery room shall be exhausted to outside.

Material and Installation

(a) Centrifugal Fan

- Motors for V-belt drives shall be provided with adjustable rails or bases. Fans shall be provided with personnel screens or guards on both suction and supply ends except where ducts or dampers are connected to the fan. Fans and motors shall be provided with vibration isolation supports or mountings. Vibration isolation units under floor mounted equipment shall be standard products with published loading ratings, and shall either be single rubber-in-shear, double rubber-in-shear springs, or springs under inertia base. Each fan shall be selected to produce the specified capacity at outlet velocity not exceeding the recommendations of an applicable code unless otherwise indicated.
 - The centrifugal fan shall be well balanced both dynamically and statically, and shall operate with low noise and vibration.
 - The runner vanes shall be made of steel plate, with sufficient protection against corrosion, shall be formed precisely in a uniformly curved shape and shall be attached sturdily to the side plates which are either rivetted or welded to the cast iron boss. The runner shall have sufficient strength to withstand high speed operation without deforming. The side plate of runner shall be reinforced with stay rods as required.
 - Housing of the fan shall be made of steel plate and shall be so fabricated by riveting or welding as not to permit any leakage, vibration and deformation. A water drain outlet shall be provided at the lower portion of the housing.
 - Shaft of runner shall be made of high grade carbon steel or special steel of sufficient strength.
 - Bearings shall be capable of withstanding radial and thrust loads and shall be durable for long and continuous operation for 20,000 hrs.
 - The following accessories shall be provided:
 - ◆ Belt cover: complete set
 - ◆ Flanges for connecting air duct : complete set
 - ◆ Channel base with bolts : complete set
 - ◆ Other necessary accessories : complete set

(b) Axial Fan

- The axial fan shall be well balanced both dynamically and statically, and shall operate with low noise and vibration. Protection guard shall be attached to the axial fan.
- The runner vanes shall be of steel plate, with sufficient protection against corrosion, shall be formed precisely in a uniformly curved shape and shall have sufficient strength to withstand high speed operation.
- Housing of the fan shall be made of steel plate and shall be so fabricated by riveting or welding as not to permit any leakage, vibration and deformation. A water drain outlet shall be provided at the lower portion of the housing.
- Shaft of runner shall be made of high grade carbon steel or special steel of sufficient strength.

- Bearings shall be capable of withstanding radial and thrust loads and shall be durable for long and continuous operation for 20,000 hrs.
- The following accessories shall be provided:
 - Flanges for connecting air duct : complete set
 - Bolts : complete set
 - Other necessary accessories : complete set

(c) Propeller Fan

- Propeller fans and motors shall be supported on heavy metal frames designed for wall opening mounting. Fan wheels less than 60 cm in diameter shall be directly connected to the motor. Motors shall have totally enclosed enclosures. Motor starters shall be of manual type with general purpose enclosures. Gravity dampers and rain-hood shall be provided on the exterior side of wall. Remote manual switch with pilot indicating light shall be provided.

(d) Air Flow Balancing and Testing

- Cleaning and adjusting
 - Inside of ducts, plenums and casing shall be thoroughly cleaned of all debris and blown free of all small particles and dust before the operation commence. Equipment shall be wiped clean free of traces of oil, dust, dirt or paint spots.
 - Bearings shall be properly lubricated, belts tightened to proper tension and control valves adjusted. Fans shall be adjusted to the speed indicated by the manufacturer to meet the specified conditions.
- Testing
 - All supply, return and exhaust ducts, plenums and casings shall be tested and made substantially air-tight before being covered with insulation or concealed in masonry. Substantially air-tight shall mean that no air leakage is noticeable through the senses of feeling or hearing at all duct joints.
- Balancing
 - Duct systems shall be balanced to produce air quantities within 10% of that indicated.
- Performance tests
 - Performance tests to demonstrate the capacity specified and general operating characteristics of all equipment shall be conducted including the items below. The tests shall cover a period of not less than Three (3) days for each system under normal operating conditions of the plant.

Fans: -Air quantity and static pressure

-Electric power output

Air outlets and inlets: - Air quantity

- Air velocity

Controls: Setting and performance of automatic or safety controls

- Other than above, abnormal vibration, noise etc. if any, shall be observed during testing and shall be rectified them if those are beyond the allowable limits.

15.12.8. Air-Conditioning Systems

1. System Description

- (a) The system shall be made of multi type package air conditioner consisting of indoor unit and outdoor unit.
- (b) The indoor units shall be of ceiling mounted cassette type which shall have cooling coils and fan, etc.
- (c) The outdoor units shall be of air-cooled type housing condenser coils, fan and compressor, connected with the indoor units with refrigerant piping and control wiring system.
- (d) The room controller shall be provided in each room which shall enable an automatic control of the indoor unit in air flow rates, temperature setting, on/off timer, self-diagnosis function, etc.

2. Material and Installation

(a) General

- Multi type package air-conditioner shall consist of indoor units, outdoor unit, refrigerant piping, drainage piping, power and control cables, remote controller and other accessories, etc.
- The machines shall be of such a construction as operate with low noise and vibration and shall have good maintainability.
- All materials and equipment shall be approved by the Employer.

(b) Indoor unit

- The indoor unit shall be of ceiling recessed type and consisting of following specified devices.

Fan : Centrifugal

Cooling coil : Copper pipe and aluminum fin

Refrigerant controller: Electronic expansion valve and capillary tube

Air filter : Polypropylene

Drainage pump : Water head with 6m or more

Casing : Galvanized steel sheet and melamine baked paint

Diffuser : 4 directions diffusing with automatic swing

Compressor: Inverter control compressor

(c) Outdoor unit

- The outdoor unit shall be of floor type and consisting of following specified devices.

Coil : Copper pipe and aluminum fins

Fan : Propeller fan

Refrigerant controller: Mechanical expansion valve

Type of refrigerant : Non-Freon

Casing: Galvanized steel sheet and melamine baked paint

- Copper pipe with heat insulation shall be used for the refrigerant piping.

(d) Copper tubing

Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required.

(e) Fittings for copper tubing

Fittings for flare joints shall be standard forged-brass flare type with short-shank flare units. Fittings for brazed joints shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type fittings shall not be allowed for brazed joints.

(f) Pipe insulation

Refrigerant pipes shall not be insulated until after the pipe has been proven tight under the required pressure test. The insulation material shall be mineral fiber or flexible foamed plastics. The insulation thickness shall be as recommended by the manufacturer of the air-conditioning equipment. Exposed insulated piping in traffic areas shall be enclosed with a metal jacket to protect insulation.

(g) Drainage pipe

Polyvinyl chloride (PVC) pipe with heat insulation shall be used and the minimum diameter of drainage pipes shall be 25 mm.

(h) Wall mounted control unit with a remote control device

Control unit shall be of wired type and shall have following functions and devices.

- Operation mode selection and display: Cool, fan, dry
- Fan speed selection and display: 3 steps
- Timer programming and display
- Temperature setting and display
- Room temperature display
- Diffuser automatic swing: on/off
- Filter change sign and reset
- Trouble sign and reset

(i) Cleaning and adjusting

Pipes shall be cleaned to free from scale and thoroughly flushed of all foreign matter before operations commence. Temporary bypass arrangements shall be provided for all coils to prevent flushing gas from passing through coils. Equipment shall be wiped clean, free of all traces of oil, dust, dirt, or paint spots. It shall be the responsibility of the Contractor to maintain the system in this clean condition until the issuance final taking over certificate. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

(j) Balancing

Refrigerant systems shall be balanced to meet the temperature and relative humidity at different operation conditions.

3. Testing

(a) General

- Upon the Contractor's request after completion of installation of the air-

conditioning system, the entire system shall be performance-tested as specified hereinafter. The test shall be conducted in the presence of the Employer. Procedures for conducting of the tests shall conform to the applicable standard. The Contractor shall furnish all instruments, test equipment, electricity, required gas and personnel that are required for the tests at no extra cost to the Employer.

(b) Performance

- The Contractor shall conduct tests to demonstrate the capacity specified and general operating characteristics of all equipment by a competent experienced engineer in the presence of the Employer. The tests shall cover a period of not less than Three (3) days for each system and shall demonstrate that the entire system is functioning in accordance with the approved design and the Specifications. Corrections and adjustments shall be made as necessary to produce specified conditions under normal operating conditions.

Air conditioner: -Air temperature

-Air quantity

-Relative humidity

-Electric power consumption of fan

Controls: -Setting and performance of automatic or safety controls

15.12.9. Duct Work

1. General

Duct shall be constructed of galvanized steel sheets. Ducts, unless otherwise approved, shall conform to the dimensions indicated and shall be straight and smooth on the inside, with joints neatly finished. All edges and lips shall be hammered down to leave a smooth interior duct finish. Ducts shall be so constructed and installed as to be completely free from vibration under all conditions of operation. Joints shall be made substantially air-tight at all joint connections, grilles, register, or diffusers. Ducts shall be securely supported by the building structures. Where supports are required between structural members, suitable intermediate metal framing shall be provided. During construction, openings in the air duct shall be covered with a suitable material to prevent dust from accumulating in the ducts. All materials used for duct work shall be approved by the Employer.

2. Material and Installation

(a) Air Duct

- Curved elbows shall have a centerline radius of not less than 1.5 times the width or diameter of the duct.

- Laps at the joints shall be made in the direction of air flow. Button punch or bolt connections in standing seams shall be spaced at fixed centers not greater than 150 mm. Horizontal locks or seams of the type known as "Button Punch Snap Lock" may be used in lieu of "Pittsburgh Lock".
- Transformations shall be made with sides pitched not to exceed a maximum of 20 degrees and 40 degrees included angle for diverging air flow.
- Other details of duct construction, access doors, hangers, anchors and supports, duct joint, volume dampers, and hood construction shall be as indicated in the approved design.
- Duct supports shall be not less than two steel hangers spaced one on each side of duct in accordance with the following table. Supports on the risers shall allow free vertical movement of the duct.

Galvanized Sheet Gauge (thickness in mm)	Angle Support in mm	Max. Spacing in cm
26 (0.5)	25 × 25 × 3	300
24 (0.6)	25 × 25 × 3	300
22 (0.8)	30 × 30 × 3	300
20 (1.0)	40 × 40 × 3	300
18 (1.2)	40 × 40 × 5	300

Notes: Hangers shall be steel rod 9 mm in diameter.

(b) Air Deflectors

- Air deflectors shall be provided in all square elbows, duct-mounted supply outlets, take-off of extension collars to supply outlets, and tap-in branch-takeoff connections. Air deflectors shall be factory-fabricated and factory or field assembled units consisting of curved turning vanes or louver blades for uniform air distribution and change of direction with minimum turbulence and pressure loss.
- Square elbows shall be provided with curved vanes.

(c) Diffusers, Registers and Grilles

- General
 - Diffusers, registers, and grilles shall be the approved products of a manufacturer regularly engaged in the manufacture of such products, and shall be factory-fabricated of steel or aluminum, and shall distribute the specified quantity of air evenly over space intended, without causing noticeable drafts, or dead spots anywhere in the conditioned area. The Contractor shall be responsible for diffusion, spread, drop, and throw. If, according to the certified data of the manufacturer of the proposed units, if the sizes indicated will not perform satisfactorily, the units shall be reselected to perform quietly

and effectively in accordance with the manufacturer's approved recommendations. A schedule of all air inlets and outlets shall be submitted indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop for registers, and maximum and minimum diffusion range for diffusers. Diffusers and registers shall be provided with an opposed-blade volume controller with accessible key operation unless otherwise indicated or, if standard with the manufacturer, an automatically controlled device.

- Diffusers
 - Diffusers shall be round. Diffusers shall be provided with air deflectors of the type indicated. Ceiling mounted units shall be installed with rims tight against ceiling whether flushed, recessed or surface mounted. Sponge-rubber gasket shall be provided between ceiling and surface mounted diffusers. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be air-tight and shall not interfere with volume controller.
- Registers
 - Registers shall be four-way directional control type except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 15 cm below the ceiling, unless otherwise indicated. Return and exhaust registers shall be located 15 cm above the floor unless otherwise indicated. Four-way directional control may be achieved by grille face which can be rotated in four positions or by adjustment of horizontal and vertical vanes.
- Grilles
 - Grilles shall be of type as specified herein for registers, without volume-control damper.
- Louvers
 - Louver blades shall be fabricated from aluminum or stainless steel sheets, and shall be provided with frame of structural shapes. Blades shall be accurately fitted and firmly secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Louver shall be provided with bird screen.) Sheet metal thickness shall be as indicated in the approved design drawings.
- Dampers
 - General

All damper frames shall be constructed of No. 16 gage galvanized sheet metal, and shall have flanges for duct mounting. The blades shall be parallel or opposed, as required, and suitable for the air velocities to be encountered in the system.

– Manual dampers and splitters

Manual dampers with locking quadrants, multiple-blade dampers, and splitter dampers shall be installed where indicated or necessary for proper control and balancing of air distribution. All dampers shall have an accessible operating mechanism. Exposed parts of operating mechanism occurring in finished portions of the building shall be chromium plated with all exposed edges rounded. Splitter dampers shall be operated by quadrant operators or steel rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 200 mm. Manual volume-control dampers shall be operated by locking type quadrant operators. The gauge of sheet metal used for dampers and splitters shall be two gages heavier than the duct in which the dampers and splitters are installed. Unless otherwise indicated, multileaf dampers shall be opposed-blade type with maximum blade width of 300 mm. Two or more blades shall be used when the blade width is more than 300 mm. Splitter dampers shall be sufficient length to close off either branch duct. Volume dampers shall be provided where indicated.

(d) Flexible Connections

Where sheet-metal connections are made to fan or where ducts of dissimilar metal are connected, a noncombustible flexible connection of approved noncombustible material shall be installed having an gap of approximately 150 mm. Flexible connections shall be securely fastened by zinc-coated iron clinch-type draw bands, for round ducts. For rectangular ducts the flexible connections locked to metal collars shall be installed using normal duct construction methods.

(e) Duct Painting

Ducts for exposed surface shall be painted with one coat of primer and two coats of vinyl paint approved by the Employer.

3. Maintenance during Construction

- (a) The ventilation and air-conditioning system shall be maintained and protected by the Contractor in a satisfactory condition until the issuance of the final taking over certificate by the Employer. Defective materials and equipment damage in the course of installation or testing shall be replaced or repaired at the expense of the Contractor in a manner as approved by the Employer. Filters shall be changed by the Contractor whenever necessary during the maintenance period.

15.13. CONCRETE BLOCKWORK CONSTRUCTION

15.13.1. General

- (a) The Contractor shall furnish and install concrete blockwork as required and approved.

- (b) In accordance with the requirements for Contractor's Documents to allow for the initial review period of at least Sixty (60) days before commencing any concrete blockwork construction, the Contractor shall submit a description of manufacture, and/or the source of supply of the concrete blocks and produce sufficient evidence that the blocks comply with this Technical Requirements.

15.13.2. Materials

- (a) The blocks shall be solid or hollow concrete blocks of 200 mm nominal thickness manufactured in accordance with BS 6073 and shall be sound, dry, clean, crack free and adequately cured before delivery. Cutting of blocks shall be avoided by setting out to avoid irregular and broken bond. Any necessary cutting shall be carried out with a masonry saw.
- (b) The mortar shall consist of a homogeneous mixture of ingredients and shall conform to the requirements of Chapter 10 of this Technical Requirements. Mortar shall be mixed in the following proportions:

Cement One (1) part by volume

Hydrated Lime One-tenth (1/10) part by volume

Fine Aggregate Five (5) parts by volume

15.13.3. Workmanship

- (a) The Contractor shall perform all operations necessary for the proper execution of the work, such as cutting, chasing, filling, bonding and making good.
- (b) Blocks shall be laid on a full bed of mortar with full perpends. Mortar beds shall be kept level and arises and wall faces shall be kept plumb.
- (c) The Contractor shall allow for all necessary closures and bats to maintain the dimensions with joints of even widths.
- (d) All walls shall be built in stretcher bond and all return walls shall be built in.
- (e) All walls will be tied into abutting walls or columns with approved galvanised steel straps similar to that specified for brickwork.
- (f) Blockwork joints shall generally be even and of equal thickness in both perpends and bed joints. Perpends shall be kept vertical and head joints shall be grouted flush and solid at the completion of each course. Internal face blockwork joints shall be ironed with a 15 mm diameter round tool to produce a hard dense finish.
- (g) Reinforced blockwork shall be constructed to the requirements of BS 5628.
- (h) All workmanship shall be carried out in accordance with the requirements of BS 5628 Part 3.

15.13.4. Laying Blockwork

All blockwork shall be laid dry and shall not be permitted to be wetted, except in extremely hot and dry conditions when, on approval, it may be permitted to lightly

spray the bonding surface with water immediately prior to laying.

15.14. BRICKWORK

15.14.1. General

The Contractor shall furnish and install clay brickwork as required and approved.

15.14.2. Materials

- (a) Bricks shall be sound, sharp, well-burnt clay common bricks of good, even, rectangular shape.
- (b) In accordance with the requirements for Contractor's Documents to allow for the initial review period of at least Ninety (90) days before ordering bricks, the Contractor shall submit to the Employer for approval samples of the bricks to be used and the name and address of the brickworks.
- (c) Mortar shall consist of 1 part cement, 1/10 part hydrated lime or approved plasticiser and 5 parts of fine aggregate, by volume. Mortar shall be used within one hour of initial mixing.

15.14.3. Workmanship

- (d) Workmanship shall be first class and the tradesmen shall:
 - confer and co-operate with other trades;
 - perform all operations necessary for the proper execution of the work, such as cutting, corbelling, chasing, bonding and making good;
 - build-in as necessary all flashings, damp proof course, reinforcement, arch bars, lintels, frames, straps, bolts, lugs, wall ties, metalwork, precast units, sills, partitions, joints and the like;
 - carefully set out and leave openings for other trades to eliminate cutting;
 - keep beds level and perpends vertical, keep arises, quoins, jambs, reveals and wall faces plumb. Carry no part of the work up more than 1 m above any adjoining work and then only if raked back at ends;
 - flush up all vertical joints solid with mortar;
 - build-in lugs and fixing devices supplies with metal frames specified elsewhere. Protect frames from damage during construction.
- (e) Bricks shall be wetted as necessary to achieve satisfactory bond with the mortar.
- (f) All joints shall be left rough to provide a key for finishes.
- (g) Unless otherwise approved by the Employer, brick rod shall be as follows:

Vertical rod: 4 courses and 4 joints: 340 mm

Horizontal rod: such that perpends are equal in thickness to bed joints.

15.14.4. Bond

Brick walls shall be half brick 110 mm thick or full brick 230 mm thick in stretcher bond, as approved.

15.14.5. Reinforcement

(a) Joint reinforcement

Hot-dip galvanised woven wire brick reinforcement, 75 mm wide, shall be laid in every fifth joint, lapped full thickness of the wall at intersections and 300 at splices. Reinforcement shall not continue across control joints.

(b) Column straps

Column straps shall be provided at all abutments of brickwork with steel or concrete columns or walls. Straps shall be 25 mm by 1.6 mm galvanised steel 400 mm long overall, crimped and forked, with 75 mm turn up. One strap to each half brick thickness of wall every five courses, fixed by bolts or masonry anchors to the structure and built into bed joints.

(c) Lintels

Unless otherwise approved, mild steel lintels shall be built in to support brickwork over openings, one to each half brick thickness of wall, and conforming to the following table:

Span	Lintel	Length
up to 1 200 mm	75 x 9 mm bar	230 mm longer than opening
1 200 mm to 1 500 mm	75 x 75 x 9 mm angle	230 mm longer than opening
1 500 mm to 2 400 mm	100 x 75 x 9 mm angle	450 mm longer than opening

(d) Lintels shall be hot-dipped galvanised in accordance with this Technical Requirements.

15.15. GENERAL ROOFING AND CEILING SYSTEMS

15.15.1. General

- (a) The Contractor shall furnish and install the various roofing work where required and approved by the Employer.
- (b) The Contractor shall furnish and install various ceiling systems as as specified.

15.15.2. Gypsum Board

- (a) The Contractor shall furnish and install water resistant Gypsum boards ceilings where required and approved by the Employer.
- (b) 12.5 mm Gypsum board tiles of 610 x 610 mm size (or as per design) conforming to IS 2095: 1982 & 2542-1981. The tiles shall have plain, textured or designed with design patterns as approved by the Employer. These are to be backed by non-woven lining to absorb unwanted sound.
- (c) The suspenders are galvanized mild steel straps of 28G and horizontal and transverse members are galvanized mild steel channel of 16 G.
- (d) The acoustic ceilings are suspended from the truss and purlins by steel hangers to suspend the horizontal steel channels. The horizontal members are screwed with steel screws and grip in the wall. The suspenders are clamped to the truss and purling with steel screws. After the framing is completed the engineer in

charge shall check the framing before allowing fixing the ceiling boards.

- (e) The ceiling boards free of damages are fixed to the framing in perfect line and level. The joints are sealed with plaster of Paris and non-woven paper tapes without forming any bubble.
- (f) Once laying of ceiling is completed the dust and floors are cleaned for the painting works.

15.15.3. Aluminium Ceilings

- (a) The Contractor shall furnish and install aluminium panel ceilings where required and approved by the Employer.
- (b) The aluminium panels shall be lightweight building panels as approved. Panels shall be nominally 200 mm x 600 mm x 50 mm thick with 17 mm x 25 mm deep rebates all round, with edges and faces machine cut square and true. Panels shall be set out evenly with equal length panels to each bay and opposite bay ends, equal bay panel widths with equal opposite bay widths to each side, all in a staggered stretcher bond pattern.
- (c) The suspended ceiling suspension system shall be capable of fully supporting the ceiling panels, fire detectors and luminaires without movement or deflection. The grid members shall be extruded aluminium tee bar sections with matching wall angles which shall support each slab on all sides and suit the slab pattern previously specified. The system shall be adjustable and shall be braced as necessary. The individual panels shall be removable without disturbance to the adjoining panels.
- (d) The aluminium panels, supporting tee bars and wall angles shall be prepainted in accordance with Sub-clause 15.16 of this Technical Requirements on all exposed edges and faces before delivery to a colour as approved.

15.15.4. Fire Rated Ceilings

- (a) The Contractor shall furnish and install 2 hour fire rated ceilings as approved.
- (b) The system shall consist of four layers of approved 16 mm thick plasterboard arranged as two strata each of two layers. The ceiling shall be installed in accordance with the manufacturer's instructions.
- (c) The ceiling suspension system shall be capable of fully supporting the ceiling, fire detectors and luminaires without movement or deflection.

15.15.5. Installation

- (a) In accordance with the requirements for Contractor's Documents to allow for the initial review period, the Contractor shall prepare fully dimensioned and detailed workshop drawings of the ceiling and shall submit these together with samples of the ceiling panels or materials for approval. The workshop drawings shall include fully dimensioned reflected ceiling plans showing the set out of all panels, details of all junctions and full details showing sizes and gauge of all members of the suspended ceiling grid system. The manufacture of the panels shall not commence until this approval has been received.

- (b) The Contractor shall cut and reinforce the ceiling as necessary around ventilation ductwork and elsewhere as approved.
- (c) All slabs and metal sections shall be packaged and protected from damage as recommended by the manufacturer and as approved.
- (d) The ceiling shall be fixed only by a firm accredited by the manufacturer. Ceilings shall be straight and true to line with all joints square to each other and on the whole neatly finished to the satisfaction of the Employer.
- (e) The Contractor shall furnish additional ceiling panels of the same type and size equal to two (2) per cent of the number installed. These panels shall be packed and labelled suitable for storage.

15.16. PAINTING

15.16.1. General

- (a) The Contractor shall perform the painting works where required and as approved. Paint shall be applied to produce the specified dry-film thickness as directed by the range listed on the paint manufacturer's data sheet.

15.16.2. Preparation and priming of surfaces

- (a) Concrete and Cement rendered surfaces shall be smooth and free from defects and shall be allowed to dry out thoroughly. Surfaces shall be thoroughly brushed down and left free from all efflorescence, dirt and dust.
- (b) All such surfaces, which are to be finished with oil or enamel paint, shall be primed with two coats of alkali resisting primer.
- (c) Plaster surfaces shall be perfectly smooth and free from defect. All such surfaces shall be allowed to dry for a minimum period of four weeks. Surfaces shall be stopped with approved plaster compound, rubbed down flush, thoroughly brushed down and left free from all efflorescence, dirt and dust.
- (d) Fair-faced surfaces shall be dry, brushed down and free from dust or dirt and shall be treated with an approved alkali resisting primer (for plastic emulsion).
- (e) Metal work generally shall be thoroughly wire brushed to remove all scale, rust, and through sand papering shall be done before any painting is done. Where severe rust exists, the special anti-rust primer must be used. After painting it shall be stored in covered shed and 60cm above ground.
- (f) Shop primed surfaces shall have bare places touched up with an approved metal primer.
- (g) Un-primed surfaces shall be given one coat of primer as last.
- (h) Galvanized surfaces, which are thoroughly weathered, shall be, brushed down with white spirit, washed down and given one coat of zinc chromate primer.
- (i) Bituminous-coated surfaces shall be given as isolating coat of shellac knotting followed by an approved metal primer.

- (j) Woodwork generally shall be rubbed down, given one coat shellac knotting, one coat wood self knotting primer, and all cracks, nail holes, defects, and uneven surfaces, etc., stopped and faces up with hard stopping rubbed down flush.
- (k) Before oiling woodwork all stains must be removed and uniform color obtained and filled.

15.16.3. Paint Application

- (a) Painting Items as described hereafter shall comprise the following, and shall all include for preparing and priming surfaces as above described: -

Cement Paint	: Apply two coats.
Plastic Emulsion	: Apply a minimum of three coats, using a thinning medium or water only if and as recommended by the manufacturer. An approved plaster primer tinted to match may be substituted for the first coat.
Paint	: Apply two undercoats and one finishing coat of enamel gloss oil paint.
Flat oil paint	: Apply two coats of flat oil paint, using thinning medium in accordance with the manufacturer's instructions.
Oil	: Apply two coats of linseed oil.
Wax Polish	: Apply a minimum of two coats to approval.
Lacquer	: Apply three coats of Polythene lacquer as described, to approval.
Prime	: Prepare and prime only before fixing.

15.16.4. Cement Paint

- (a) Cement paint shall be of ready mixed type in sealed container of Approved brand. It shall be procured either in 50 kg container or 25 kg container. All such container shall have unbroken seal with manufacturer's name and trade marks as well as a description of contents all clearly marked. Such paint shall be mixed and applied strictly in accordance with the manufacturer's instructions and with the approval of site In-charge. All materials shall be stored in dry place.
- (b) Only fresh cement paint shall be used, hard or set paint shall not be used. The container shall be made loose by rolling and shaking the container before opening.
- (c) First a paste shall be prepared by mixing 2 parts of cement paint powder with one part of water by volume and immediately this shall be thinned by adding another part of water to have uniform solution of consistency of paints.
- (d) Before application of paint all dust and foreign materials shall be removed from the surface by use of wire brush. The surface shall be allowed to run off. The fresh

mixed point shall be frequently stirred during application and no mixture (paint) shall be used after an hour of mixing. The first coat shall be kept wetted for at least 24 hours before the second coat is applied. The surface shall be thoroughly wetted before the second coat is applied.

- (e) The final painted surface shall exhibit uniform and good finished appearance. Measurement shall be square meter of actual covered area. No extra shall be allowed for scaffolding, curing and painting corners, plaster strips etc.

15.16.5. Enamel Paint

- (a) The enamel paint shall be of Approved Brand. All surfaces to be painted shall be planed and thoroughly sand papered, first by using No. 120 sandpaper. Ordinary putting shall fill up nail holes, cracks or other inequalities. Putting shall be made up of 2 parts of best quality whiting (absolutely dead stone lime) 1 part of white lead mixed together in linseed oil and kneaded (3 oz. of linseed oil to 1 lb. of whiting). A primer coat shall be locally applied in holes, cracks etc. before putty is applied.
- (b) After the surface is dry, it shall be sand papered by using No. 60 sandpaper.
- (c) Surface so prepared shall be painted with one coat of primer. The primed surface when dry shall be sand papered by using No. 100 sand paper.
- (d) The primed surface so prepared shall be painted with one coat of selected enamel using bristle brush and not horsehair ones. The paint shall be applied in thinnest possible layers with parallel strokes.
- (e) Care shall be taken to ensure the surface being free from dust or other foreign material before priming or enamelling the surface. No paint shall splash on the floor, wall jambs, sill or other part of the building.
- (f) Primers and paints shall be of first class approved quality and of approved manufacturer as specified. These materials shall be ready mixed and in sealed tins with manufacturer's name, color and instruction clearly painted in the container.

15.16.6. Washable Distemper

- (a) Washable distemper shall be of approved Brand. The Engineer shall examine the paints before seal is broken.
- (b) Only fresh distemper shall be used, hard or set shall not be used.

15.16.7. Plastic Emulsion Paint

- (a) Approved brand of plastic emulsion paint shall be used in the plaster of Paris or lime punned surfaces.

15.16.8. Bituminous Aluminium Paint

- (a) Bituminous Aluminium paint shall be of approved Brand. The Engineer shall examine the paints before seal is broken.

15.16.9. Red Lead Primer

- (a) Red Lead primer paint shall be approved brand. The lead content in the paint shall be less than 60% by weight. The site in charge shall examine the paints before seal is broken.

15.16.10. Chapra Polish

- (a) Before application of Chapra polish, the timber surfaces shall be thoroughly sand papered to obtain smooth surfaces and all the dust are removed from the surfaces. A coat of primer of chalk power mixed with resin is applied and sand papered to fill in the voids and joints.
- (b) The chapra polish is prepared from the chapra mixed with spirit. The chapra must completely dissolve in the spirit. Over the primed surfaces, two layers of resin is applied by the smooth cotton clothes and dried.

15.16.11. Polyurethane Paint

- (a) Approved polyurethane or equivalent eggshell clear lacquer applied in accordance with the manufacturer's instructions.
- (b) Polish shall be an approved brand of wax polish.
- (c) Oil shall be best quality linseed oil.
- (d) Filler for polished or oiled surfaces to be Beeswax filler.

15.16.12. White Washing

- (a) Fresh white lime slaked at Site of Work shall be mixed with clean water to make thin cream. It shall be screened through a coarse cloth, and gum (glue) in the proportion of 100 grams to 16 liters of water shall be added.
- (b) The surface to be white washed must be dry and thoroughly cleared from dust and dirt. The wash shall be applied with "Babio" or brush, vertically and horizontally alternately, and the wash kept stirring in the container while using as per standard code of practice.
- (c) No paint should splash on floor or door/window frames and panels.

15.17. FLOOR FINISH-WEAR RESISTANCE, METALLIC AGGREGATE

15.17.1. General

- (a) The Contractor shall furnish and place the wear resistant metallic aggregate floor finishes where required and as approved. The wear resistant metallic aggregate floor finish shall be Masterplate 200 pre mixed as manufactured by Embecon Pty Limited or approved equivalent. The colour shall be as approved.
- (b) The floor finish shall be spread, floated and trowelled by tradesmen approved by the manufacturers of the material to give a fine non slip finish.
- (c) The floor finish shall be laid using the monolithic (single course) or topping (two course) method as approved. Where the monolithic method is required to be used the Contractor shall ensure that the finish is adequately protected from the wind

and sun during the placing and finishing operations.

15.17.2. Colouring

- (a) The colour of the floor finish shall be as approved and the floor finish shall be applied at the rate of 7 kg per square metre of floor area.
- (b) As soon as the floor will not be marked by its application, coloured concrete floors shall be cured with Embecon Floor Coar or approved equivalent of the same colour as the floor. Preparation of surfaces, quantities used, application procedures and precautions shall be followed in strict compliance with the manufacturer's recommendations and directions.

15.17.3. Manufacture's supervision

- (a) The Contractor shall call upon the manufacturer to make available the services of a qualified full time field representative to make clear to the user the application of the product under prevailing job conditions.

15.18. FLOOR FINISH

15.18.1. General

- (a) The Contractor shall furnish and install the various floor finishes, as specified in this Clause, or as approved.
- (b) The Contractor shall be responsible for ensuring that the background or sub base to which the specified finish is to be applied, has properly cured, has the correct moisture content, is properly finished and is completely adequate to receive the specified finish. Any faulty work resulting from non compliance with the above shall be replaced and such replacement may be extended at the Employer's sole discretion to include the whole of the room or area affected.

15.18.2. Preparation of Sub-base

- (a) The sub bases of all concrete floors specified to receive a finish shall be constructed to the approved lines and grades.
- (b) The Contractor shall maintain the prepared sub base in a satisfactory condition until the time of application of the specified finish, and will ensure that:
 - All materials likely to reduce adhesion of the finish, including curing compounds and surface retarders, shall be removed prior to the application of the specified finish and the surface left dust free and clean and the surface shall be protected from contamination until time of laying finish.
 - Surfaces to receive adhesives and fixatives shall be thoroughly dry.
 - All traffic and loads shall be kept off completed work at least until bonding has set.
 - Surfaces that are to receive cement mortars shall be roughened and dampened prior to the application of an approved mortar.
 - If possible, areas shall be locked up on completion of finishing work.
 - The finished floors shall be protected by taping down building paper over finished surfaces, lifting and relaying as required for cleaning, sealing and polishing and removing immediately prior to handing over.

- (c) Immediately prior to laying vinyl floors the concrete sub base shall be acid etched with hydrochloric acid, diluted 1 part acid to 10 parts water and applied at the rate of 0.5 L/m², left for 5 minutes or until reaction has ceased, and then thoroughly flushed with clean water until all traces of acid have been removed and left to dry. The prepared acid etched sub base shall be primed with a thin layer of epoxy resin. Before the primer sets the floors shall be levelled with a self levelling floor screed to correct design levels within a tolerance of + 1 in 2000. The screed shall consist of sand and two part epoxy resin with a maximum sand: epoxy ratio of 3:1 by volume. The epoxy resin shall be as described in Sub-clause 15.19. The sand shall be washed, processed sand, with 0.4 mm to 1.4 mm particle size. The sand and the two parts of the epoxy resin shall be mixed in a slow speed mechanical mixer in quantities small enough to be used within 30 minutes, spread and allowed to level. After a 24 hour curing period, the screed shall be inspected, high points knocked off with a carborundum block, and low points patched with the epoxy resin. The Contractor shall take adequate precautions to contain acid and epoxy at expansion joints, hatches, and other openings in floors.

15.18.3. Vinyl Sheet

- (a) The sub base of surfaces with vinyl sheet finish shall be prepared as specified.
- (b) Vinyl sheet shall be alkali resistant, fully flexible homogeneous PVC of selected colour, 2.0 mm thick and shall be of the best quality available in Thailand and approved by the Employer. Adhesive shall be an approved water emulsion latex or as recommended by the manufacturer. Stripper and polish shall be as recommended by the manufacturer.
- (c) Vinyl sheeting shall be laid in continuous sheets as approved and adjacent sheets shall be heat welded together with a filler strip providing a seamless covering over the complete area of floor and/or wall. The filler strip shall match the sheeting in colour and shall be finished smooth and level. Joints shall be continuous, straight, true and level, compatible with the tolerance in thickness. Neat cut outs shall be formed for benchings, obstructions, door openings, fittings etc. as required. After laying, sheets shall be progressively rolled in both directions with a minimum 40 kg roller. This work shall be carried out approximately 30 minutes after laying.
- (d) All adhesive shall be removed at the completion of the work.
- (e) Vinyl sheet shall be kept clean with a soft broom during the first 48 hours after laying. After 48 hours, the flooring shall be cleaned with a damp mop. Not less than 2 weeks after laying of sheet, the surface shall be stripped and 3 coats of polish applied.

15.18.4. Vinyl Tiling

- (a) The sub base of surfaces with vinyl tile finish shall be prepared as specified.
- (b) Tiles shall be approved by the Employer and shall be 200 mm x 200 mm x 2 mm thick as a minimum size, best quality, and selected colour, composed of blended PVC/copolymer resin with plasticisers, stabilisers, fillers and pigments, and reinforced with synthetic fibre. Stair tread nosings shall be extruded PVC type of approved profile and colour. Tiles with asbestos fibre shall not be used.
- (c) Tiles shall be laid with approved water emulsion latex adhesive as recommended

by the tile manufacturer, with adjacent tiles butted tightly to form straight continuous joints to an even, approved pattern, setting out from the centre of the area to give equal perimeter margins. Tiles shall be neatly cut against walls, obstructions and fittings and into openings and recesses.

- (d) Tiles shall be rolled in both directions with a 85 kg roller 30 minutes after laying and the work performed in accordance with the tile manufacturer's printed recommendations. After rolling, all excess adhesive shall be cleaned off the work.
- (e) The tiles shall be kept clean with a soft broom during the first 48 hours and thereafter with a damp mop.
- (f) The tiles shall be sealed with a coat of approved synthetic resin emulsion tile sealer.
- (g) Skirtings for vinyl tiling shall be 100 mm x 100 mm x 1.6 mm thick of the same quality, colour and composition as the vinyl tiles used on adjacent floors.

15.18.5. Ceramic Tiling

- (a) The Contractor shall submit for approval, loose samples of each type of tile or other unit finish specified. Samples shall be sufficient in number of illustrate the extremes and average of the ranges of colour, size and texture.
- (b) The Contractor shall prepare in suitable positions, or where approved, sample panels of sufficient area, i.e. not less than 2 m² of each type of finish specified. Examples of specified junction details and trim shall be included. Each panel shall be preserved until all work of its type is complete. Approved panels may form part of the completed work.
- (c) Tiles shall be approved and selected plain colour, glazed ceramic tiles, 200 mm x 100 mm x 9 mm or other approved sizes of local manufacture.
- (d) Tiles shall be bedded on a cement mortar composed of 4 parts sand: 1 part cement and water proofing agent added in accordance with manufacturer's instructions. The bed shall be 25 mm minimum thickness layed to the required falls. At junctions with adjoining finishes, the finished surfaces shall be flush. Tiles shall be soaked in water for one hour then drained for 15 minutes before laying. Tiles shall be laid on the mortar bed and tamped into place. Closure tiles, and tiles around upstands, pipes, etc. shall be neatly cut and set in. Joint width shall be a uniform width of 2 mm throughout. A 20 mm x 5 mm brass strip embedded flush with finished floor level shall be provided at junctions with adjoining finishes. Where changes in finish occur at doorways, the change shall be located directly beneath the closed door. Tiles shall be cured a minimum of 24 hours before grouting.
- (e) Control joints shall be provided to full perimeter of each area and at 4.5 m maximum centres and so as to divide tiles into 10 square metre maximum panels. Control joints shall be 5 mm wide, extending through the bed, filled with polythene encased polyurethane foam strips and pointed up with silicone rubber or polysulphide sealant.
- (f) After the specified curing time all joints in tiles, except control joints shall be grouted up with cement grout coloured to match tiles.

15.18.6. Rubber Flooring

- (a) Rubber tiles shall be approved 1000 mm x 1000 x 7 mm thick, studded profile, selected colour and composed of a homogeneous mix of natural and synthetic rubber, vulcanisers, mineral fillers and colour pigments equal to Pirelli 40 Heavy Duty Rubber Flooring.
- (b) Tiles shall be laid with an approved epoxy adhesive, all in accordance with the tile manufacturer's recommendations by approved specialist rubber flooring fixers.
- (c) Tiles shall be set to an evenly approved pattern, from the centre of the area to give equal perimeter margins.
- (d) Tiles shall be kept free of traffic for a minimum period of 24 hours after laying.
- (e) Protection following laying shall be adequate to withstand all damage.
- (f) The Contractor shall clean and polish the flooring using wax emulsion in water solution as recommended by the manufacturer.

15.18.7. Spare Materials

- (a) The Contractor shall furnish additional spare materials of the same type, quality and colour, equal to two (2) per cent of the quantity of each type laid. These sheets and tiles shall be packed and labelled suitable for storage.

15.19. EPOXY RESIN FLOOR, WALL AND CEILING FINISH

15.19.1. General

- (a) The Contractor shall furnish and apply oil resistant epoxy resin finish, in accordance with the requirements of this Technical Requirements, to the concrete where required and approved.

15.19.2. Materials and Application

- (b) The epoxy resin shall be oil resistant, solvent free, and shall be pigmented to an approved colour.
- (c) The method of application shall conform to the manufacturer's recommendations.
- (d) Pigment shall be incorporated in the formulation to ensure uniformity.
- (e) Epoxy resin which has commenced to set and cannot be applied uniformly and smoothly shall not be used.
- (f) Surfaces to be treated with the epoxy resin finish shall be prepared as specified.
- (g) The epoxy resin shall be applied in two coats by brushing or spraying at a coverage rate of 5 to 6 square metres per kg for each coat. The first coat shall be allowed to harden before the application of the second coat, and then the second coat shall be allowed to harden for the required period.

15.20. JOINERY FIXTURES AND FITMENTS

15.20.1. General

The Contractor shall furnish and install the best quality, heavy duty joinery fittings and fitments where required and approved.

15.20.2. Materials

- (a) Softwood: Softwood shall be disease and insect free sound local softwood free from sapwood, shakes, large or loose knots and other defects.
- (b) Laminated Plastic Facing: Laminated plastic facing shall be 1.5 mm thick semi gloss approved melamine laminate sheet fixed to surfaces with an approved adhesive. All external corners shall be chamfered.
- (c) Plywood: Plywood shall be of approved waterproof quality.
- (d) Cupboard Parts: Cupboard parts specified for laminated plastic facing shall be 20 mm plywood with bonded laminated plastic with balancing laminate on other face.
- (e) Paint: Paint materials shall be as specified.
- (f) Fittings and Fitments: Fittings and fitments shall be constructed to the required size, shall be square and complete with all necessary fixings, jointing and hardware. All moving parts shall work freely.
- (g) Fixing Points: Glue blocks and timber fixing rails and posts shall be provided at particle board junctions.

15.20.3. Bench Cupboards

- (a) Bench cupboards shall be constructed as follows:
 - ◆ Bench tops shall be plywood with 50 mm by 25 mm soft wood front edge with laminated plastic sheet on top and exposed edges.
 - ◆ Bottom shelves shall be 20 mm plywood with 10 mm edge strip on front edge, set behind doors.
 - ◆ Intermediate frames shall be 50 mm by 30 mm ladder frames set back behind doors.
 - ◆ Free ends shall be plywood with laminated plastic sheet on exposed face and edges.
 - ◆ Doors shall be 12 mm plywood.
 - ◆ Drawers shall have false fronts of plywood with plastic laminate sheet on the front and edges. The front shall be fixed to drawers of 19 mm thick softwood front, sides and back. The drawers shall be fitted with hardwood runners and 100 mm chromium plated handle, all as approved.
 - ◆ Sinks shall be built in where required.
 - ◆ Cupboards shall be set up on 100 mm high concrete plinths set back 50 mm from the face of doors and with plinth front finished skirting in accordance with this Technical Requirements.

15.20.4. Bench Seats

- (a) Bench seats shall be 275 mm by 50 mm approved dressing grade local hardwood.
- (b) Seats shall be fixed to 78 mm by 38 mm rectangular hollow section angle brackets, 300 mm by 300 mm. Ends of sections shall be capped and galvanised.
- (c) Brackets shall be fixed through terrazzo partitions or tiles to concrete, blockwork or brickwork with 2 bolts into expansion or other approved type of masonry

anchors.

- (d) Front of seats shall be set out from terrazzo partitions a distance of 300 mm and from tiled walls 375 mm.
- (e) Timber shall be finished with 2 coats of clear gloss polyurethane. Metal shall be finished with gloss paint as specified in Section 15 of this Technical Requirements.

15.21. SEALS

15.21.1. General

The Contractor shall furnish and install seals to contraction and expansion joints in the structures where required and approved.

15.21.2. Materials

Seals shall consist of:

- a backing rod equal to P.E.F. with approved equivalent of a diameter as recommended by the manufacturer for the width of the particular joint; and
- a skin forming sealant compatible with the backing rod and adjoining surfaces as approved.

15.21.3. Installation

- (a) Seals shall be installed in accordance with the manufacturer's standard printed instructions with backing rods in maximum lengths available and with sealant swathed neat and excess sealant removed all to approval.
- (b) Where required and approved, the seal shall be covered by a joint strip in accordance with this Technical Requirements.

15.22. STEEL ROLLER SHUTTER DOORS

15.22.1. General

- (a) The Contractor shall furnish and install steel roller shutter doors where shown on the Drawings.

15.22.2. Steel Shutter

- (a) The curtain shall comprise interlocking 76 mm by 1.40 mm slats roll formed from galvanised steel strip. Nylon end clips shall secure slats laterally and take up end and side wear in guides. The end of each slat shall be sandwiched between the nylon end clip and a special hard wearing plastic friction pad.
- (b) Bottom rails shall be fabricated with 63 mm by 6 mm Tee section and shall be used to reinforce the lower edge of the shutter curtain and provide fixing for locking devices, overrun stops and other fittings.
- (c) Roller drum shall comprise of seamless drawn steel tubing encasing helical springs of super grade spring wire revolving on a steel axle. Drum shall be designed to give minimum deflection over the particular span.

- (d) Gearing shall comprise sprocket reduction gearing with a high quality malleable iron sprocket chain, the reduction being varied to suit the size of the shutter and ensure ease of operation. Sprocket chains shall run smoothly.
- (e) Brackets shall be fabricated from 12 mm mild steel plate and angle. Drive end bracket shall carry self aligning ball race in housing.
- (f) Capstan wheel shall be fitted to enable convenient and fractional adjustment of counterbalance springs within roller drum.
- (g) Bearings shall be sealed, self aligning ball races and shall support the roller drum stub shaft.
- (h) Guides shall be accurately formed cold rolled steel channel sections, with suitable provision for fixing. Overall guide section dimensions shall be 100 mm by 35 mm by 3 mm.
- (i) Locking bolts with provision for padlocks shall be supplied.
- (j) Roller shutters shall be installed in accordance with the manufacturer's printed instructions.

15.23. POWERHOUSE ROOF AND CEILING

15.23.1. General

- (a) The Contractor shall furnish and install roofing and false ceiling works of the powerhouse where required as per detailed design and drawing approved by the Employer. The roof and false ceiling system shall be waterproof and proper drainage system (gutters) shall be provided for the water to be conveyed to the appropriate outlet. The steel roof truss and formed steel roof sheeting shall be as per Chapter 13.4 of Standard Technical Specification.

15.21 MISCELLANEOUS CONSTRUCTION AND EQUIPMENT

- (a) The Contractor shall carry out miscellaneous construction in or about the Plant and Switchyard Control Building as required to complete the Facility in all respects and as approved by the Employer.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 16
ROAD CONSTRUCTION**

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CHAPTER 15 - ROAD CONSTRUCTION

16.1. GENERAL

16.1.1. Scope

- a) This Chapter covers all roads included in the Scope of Work. Road work consists of the construction of sub-base course, base course, surface course and drainage works. Excavation, backfill and banking are specified in Chapter 6 "Surface Excavation and Earthworks".

16.1.2. Standards and Codes

- a) The following standards shall be used for design and construction of the access roads:
- ◆ Nepal Road Standard 2070, July 2013, Department of Roads
 - ◆ American Association of State Highway and Transportation Officials (AASHTO)
- b) The following standards and codes or equivalent standards and codes accepted by the Employer shall be applied to quality control testing for the road works:
- ◆ ASTM C88 Soundness of Aggregate
 - ◆ ASTM C131 Los Angeles Abrasion Test
 - ◆ ASTM D422 Test Method for Particle –Size Analysis of Soils
 - ◆ ASTM D977 Standard Specifications for Emulsified Asphalt
 - ◆ ASTM D1556 Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - ◆ ASTM D1557 Density-Water Content Relationship
 - ◆ ASTM D1559 Resistance to Plastic Flow of Bituminous Mixture
 - ◆ ASTM D2027 Specification for Cutback Asphalt (Medium - Curing Type)
 - ◆ ASTM D2028 Specification for Cutback Asphalt (Rapid - Curing Type)
 - ◆ ASTM D2041 Maximum Specific Gravity of Bituminous Paving Mixture
 - ◆ ASTM D2049 Relative Density of Cohesionless Soil
 - ◆ ASTM D 2167 Density and Unit Weight of Soil in Place by Rubber Balloon Method.
 - ◆ ASTM D2922 Density of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth)
 - ◆ ASTM D3017 Water Content of Soil and Rock in place by Nuclear Methods (Shallow Depth)
 - ◆ ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soil

- ◆ AASHTO T193 Californian Bearing Ratio
- ◆ AASHTO M20-63 Standard Specification or Asphalt Cement

16.1.3. Submissions

- a) The Contractor shall conduct detailed design of the access roads and submit design document and drawings in accordance with Chapter 3 "Detailed Design by the Contractor".
- b) At least Sixty (60) days prior to commencement of the road works, the Contractor shall submit to the Employer for his approval the method statement including, but not be limited to, the followings:
 - Work schedule of sub-base course, base course and surface course
 - Setting out methods for alignment and slope of the road.
 - All materials to be used for sub-base course, base course and surface course.
 - Work procedure and equipment of asphalt concrete surfacing.

16.2. MATERIALS

16.2.1. Sub-base Course

- a) The material for sub-base course shall be obtained from selected excavation for the Works and/or from borrow areas, and shall consist of approved granular fill free of rock and stones smaller than 75 mm.

Sieve Size (mm)	Percentage Passing (by weight)
75	100
37.5	75 to 100
19.0	25 to 60
9.5	15 to 45
4.75	15 to 40
2.36	5 to 25
0.075	3 to 12

- b) If the material conforming to the gradation specified above cannot be obtained from selected excavation for the Works or borrow areas, the material shall be processed.
- c) The materials shall also comply with following requirements:
 - ◆ Organic matter content: not containing
 - ◆ Plasticity Index: ≤ 6
 - ◆ Los Angeles abrasion $< 40\%$
 - ◆ 5 Cycles of the sodium sulfate soundness $\leq 12\%$
 - ◆ California Bearing Ratio $\geq 60\%$ when compacted to 95% of maximum

dry density determined by ASTM D1557

16.2.2. Base Course

- a) Base course shall be constructed of hard, durable particles of both fine and coarse fragments of crushed rock or gravel. The material shall have a percent of wear of not more than 35% by weight for 500 revolutions as determined by ASTM C131 and shall not show a total loss greater than 12% when subjected to 5 Cycles of the sodium sulphate soundness test as determined by ASTM C88.
- b) The gradation of the material shall conform to the following:

Sieve Size (mm)	Percentage Passing (by weight)
50	100
37.5	93 to 100
20.0	66 to 84
14.0	53 to 74
10.0	44 to 64
5.00	30 to 49
2.36	20 to 37
0.600	10 to 24
0.075	5-12

- c) The plasticity index shall be "nonplastic (NP)" when tested in accordance with ASTM D4318. The material shall obtain a minimum CBR value of 80, tested in accordance with AASHTO T193, when compacted to 100% of maximum dry density as determined by ASTM D1557.
- d) If the material does not contain a sufficient quantity of natural cementitious material to bond readily under the action of traffic, a binder consisting of rock screenings or other cementitious material obtained from approved sources shall be added to and incorporated in it. After the binder has been added, the combined grading of the mixture shall be within the limits specified above. The binder may be incorporated in the material at the point where the material is produced or may be incorporated uniformly in the base during the progress of the work and in the amount specified.

16.2.3. Asphalt Concrete

- a) The asphalt concrete shall consist of crushed aggregate, mineral filler and asphalt. The quality of aggregate shall conform to the requirements for concrete aggregate specified in Chapter 10 "Concrete Production and Construction". Mineral filler shall consist of limestone dust or dolomite dust or similar rock dust, Portland cement, hydrated lime or other non-plastic mineral matter. It shall be thoroughly dry and free from lumps. Asphalt cement shall conform to the requirements of Standard Specification for asphalt cement, ASSHTO M20-63, and its penetration value shall be 60-70. No additives shall be included in the asphalt.

The asphalt concrete shall have the following characteristics:

- Marshall Stability (50 blows) not less than 750lb
- Marshall Flow (0.01 inch) not less than 8 and not more than 18.
- Air voids in Mix: 3-5 %
- Voids filled with Asphalt: 75-80 %
- Voids in Mineral Aggregate; 15-20 %

- b) All cleared material shall be disposed of in designated or approved disposal areas.
- c) Prime Coat and Tack Coat: Cut back asphalt shall for prime and tack coats conform to the requirements of MC-70 designated in ASTM D2027. Primer protection material shall be clean dry sand from a source approved by the Employer and it shall be free of clay, silt and organic matter.
- d) Asphaltic Concrete: The asphaltic concrete shall consist of crushed aggregate, mineral filler and asphalt. The quality of aggregate shall conform to the requirements for concrete aggregate in accordance with the provisions of Chapter 10 of this Technical Requirements. Mineral filler shall consist of limestone dust, dolomite dust, or similar rock dust, Portland cement, hydrated lime or other non-plastic mineral matter approved by the Employer. It shall be thoroughly dry and free from lumps. Asphalt shall conform to the requirements given in AASHTO Standard Specification for Asphalt Cement, designation M20-63, and its penetration value shall be 60:80. No additives shall be included in the asphalt.

16.2.4. Gravel

- a) The material shall be selected by the Contractor from sources approved by the Employer and shall consist of metasediments or other suitable local material approved by the Employer.
 - The grading shall be within one of the ranges listed in Table below.
 - The portion passing the 425 μ m sieve shall, if it is plastic have a liquid limit not greater than 35 and a plasticity index not greater than 11.
- b) The material shall be free from vegetable matter and other deleterious substances and shall be of such quality that it will compact thoroughly to a hard even surface free from loose or uncompacted materials when watered and rolled.

TABLE - GRADING RANGES

Passing BS sieve	Percentage by Mass Passing	
	(A)	(B)
37.5 mm	100	-
19 mm	80-100	100
9.5 mm	55-90	80-100
4.75 mm	40-70	55-90
2.36 mm	30-55	40-70
425 µm	12-30	20-40
75 µm	5-20	8-25

16.2.5. Material for Surface Dressing

- Surface dressing shall be executed as per Nepal Road Standard 2045.
- One application of bituminous binder followed immediately by a surface layer of surface chippings shall be applied as shown on the Drawings or as directed by the Employer over the full carriageway width, plus hard shoulders. A second surface dressing shall be placed over the full carriageway width.

16.2.6. Bituminous Material

- Cut-Back Asphalt:

Cutback asphalt shall be of the rapid curing type conforming to the requirement for RC-250, RC-800, RC-3000 designated in ASTM D2028 as applicable.

- Emulsified Asphalt:

Emulsified asphalt shall be of the anionic type conforming to the requirement for rapid setting grade RS-1 designated in ASTM D977.

- Bituminous Material for Prime Coat

Bituminous material for prime coats shall be medium curing cutback asphalt conforming to the requirements of MC-70 designated in ASTM D2027. Primer protection material shall be clean dry sand and it shall be free of clay, silt and organic matter.

- Three samples of bituminous material each weighing not less than 1 kg shall be taken from the delivery vehicles at intervals corresponding to the supply of each consignment. They shall be obtained in accordance with AASHTO T40 for each type of material delivered to site. Additional samples shall be taken if the source of supply is changed. The samples shall be sealed in metal cans with friction lids and labelled with the date, delivery note number, grade and source (refinery). One sample shall be retained by the Contractor until the Defects Liability Certificate has

been issued, one sample shall be passed to the Employer and one sample shall be submitted to all the tests listed in the table following:

Material	Test	Place of Sampling	Frequency of Testing	Remarks
MCO + MC5	All tests required by IS 217	Delivery Vehicles	Each Consignment	No materials may be used in the works until all tests have been carried out and the materials approved by the Employer

- (e) A consignment shall be defined as the total quantity of material manufactured in one continuous operation and delivered to site over a period not exceeding seven days.
- (f) Bituminous material shall be stored and handled in such a manner that the risks of fire and other hazards are minimised. No bitumen is to be heated by wood fuel. The Contractor shall make adequate arrangements for the storage of bitumen on site until approval for its incorporation into the Works is given by the Employer (including the provision of separate storage tanks) and this requirement shall also be allowed for in its construction programme.

16.2.7. Additives

- (a) No approved additives of any kind will be allowed to be mixed with the prime coat. Heat-stable adhesion or anti-stripping agents may be added to the penetration grade bitumen and shall be accurately proportioned and in accordance with the manufacturer's recommendations.

16.2.8. Blotting

- (a) Blotting material, where required, shall be to the approval of the Employer and shall consist of clean, dry sand or stone screenings free from any cohesive material and containing no organic matter. It shall be obtained from a source acceptable to the Employer. Blotting material will not be paid for as a separate item.

16.2.9. Aggregate

- (a) Aggregate shall consist of hard clean, dry, crushed stone of uniform quality, free from dust, clay, dirt and other deleterious matter and from excess of flat or laminated pieces. Aggregate shall be tested for bitumen adhesion in accordance with the Immersion Tray Test (TRRL Overseas Roads Note 3) and if the coated area retained is less than 90% the aggregate will have failed the test.
- (b) The grading of the aggregates shall fall within the limits specified below:

AGGREGATE FOR SURFACE DRESSING

Sieve Size, mm	Percentage Passing by Weight	
	First Course	Second Course
14	100	-
10	85 – 100	100
6.3	0 – 30	85 – 100
5	0 – 10	-
3	-	0 – 30
2	0 – 2	0 – 10
0.5	-	0 – 2
0.075	0 – 1	0 – 1

16.2.10. Guardrail Fencing

- Guardrail fencing shall be flex-beam guardrail (Type II) as manufactured by Armco Corporation (Australia) or approved equivalent, supported on concrete, timber or steel posts. The ends of each run of guardrail fencing shall be provided with terminal end sections.
- The guardrail, bolts, washers and nuts required for the erection of the fencing shall be furnished hot-dipped galvanised.
- The posts shall be set to the depths recommended by the guardrail manufacturer and approved and shall be held firstly in place by concrete. Each installed fence shall be true to line, level and grade.

16.2.11. Guide Posts

- Timber for the guide or fender posts shall be an approved sawn hardwood, free from large knots, shakes, flaws or other imperfections. The posts shall be 100 mm by 50 mm in cross-section and 1.5 m in length.

16.3. EXECUTION

16.3.1. Road Survey

- Immediately after the issue of the Order to Commence the Contractor shall undertake a detailed survey for the road alignments. The proposed final alignment shall be submitted to the Employer for approval comprising the following:
 - Horizontal alignment in scale 1:500.
 - Vertical road alignment in scale 1:100 horizontally and 1:50 vertically.
 - Cross sections every 20 m in scale 1:100 horizontally and vertically.

16.3.2. Preparation and Surface Treatment of Formation

- (b) Preparation and surface treatment of the formation shall be carried out only after completion of any specified sub-grade drainage and unless otherwise agreed by the Employer, immediately prior to laying the sub-base or the road base where no sub-base is required. The sequence of operations shall be as follows:

16.3.3. Formations of soft materials

- (a) All surfaces below carriageways and hard shoulders shall, after reinstatement of any soft areas, be well cleaned and freed from mud and slurry.
- (b) The surface shall be compacted by at least 4 passes of a smooth wheeled roller
- (c) The trimmed formation shall be rolled by a smooth wheeled roller or a vibratory roller.

16.3.4. Formation of rock fill

- (a) The trimmed formation shall be rolled by a smooth wheeled roller or a vibratory roller.

16.3.5. Formations of rock cuttings

- (a) Surface irregularities remaining after the trimming of the rock excavation shall be regulated with concrete type B15 according to DIN.

16.3.6. Horizontal Alignments, Surface Levels and Surface Regularity of Pavement Courses

- (a) Horizontal alignments shall be determined from the centerlines of the carriageway pavement surface as shown on the Drawings. The edges of the carriageway as constructed and all other parallel alignments shall be correct within a tolerance of ± 30 mm therefrom.
- (b) The levels of pavement courses shall be determined from the true pavement surface, which shall be the surface of wearing course for flexible pavements or of the slab for concrete pavements, calculated from the carriageway vertical profile and crossfalls as shown on the Drawings. The vertical depth below the true pavement surface of any point on the constructed surface of the formation or pavement courses shall be within the appropriate tolerances stated hereunder:
 - ◆ Base course : ± 10 mm.
 - ◆ Sub-base course : ± 15 mm.
 - ◆ Formation : ± 15 mm.
- (c) For lengths of less than 75 m the laid pavement surface and the surface of the base course shall be tested with a 3 m straight - edge placed parallel to the centre line of the road. The laid pavement surface of the base course shall have no greater depression under the straight - edge than 5 mm and 10 mm respectively.
- (d) Where any tolerance is exceeded the Contractor shall determine the full extent of the areas, out of tolerance and shall make good by rectifying the surface of the pavement course or formation in the manner described below:

- Formation Level

If the surface is too high it shall be re-trimmed and re-compacted. If the surface is too low the deficiency shall be corrected by the addition of fresh suitable material of the same classification laid and compacted to Specification.

- Road base and Sub-bases

Where these consist of unbound material the top 75 mm shall be scarified, reshaped, with additional material as necessary, and re-compacted all to Specification. The area treated shall normally be not less than 30m long and 2 m wide or such less length to be determined by the Employer as necessary to obtain compliance with the Specification.

Coated Macadam or asphalt road bases shall have the full depth of the top layer removed and replaced with fresh material laid and compacted to Specification. Any area so treated shall be at least 5 m long and not less than one lane wide. The Contractor may at its own expense make up low areas with the material of the layer immediately above the one being rectified.

- Wearing Courses

These shall have the full depth of the layer removed and replaced with fresh material laid and compacted to Specification. Where the surface level is too high or too low the area rectified shall not be less than one lane wide and at least 15 m long for the wearing course.

16.3.7. Use of Surfaces by Constructional Traffic

- (a) Constructional traffic used on pavements under construction shall be suitable in relation to the thickness of the courses it traverses so that damage is not caused to the sub-grade or the material already constructed.
- (b) The wheels or tracks of plant moving over the various pavement courses shall be kept free of deleterious materials.
- (c) Bituminous base course material shall be kept clean and uncontaminated for so long as it remains uncovered by a wearing course or surface treatment. The only traffic permitted access to base course material shall be that engaged in laying and compacting the wearing course or, where the base course is to be blinded and/or surface dressed that engaged on such surface treatment. Should the base course become contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Employer, and if this proves impracticable, by removing the layer and replacing it to Specification.

16.3.8. Clearing and Grubbing

- (a) The ground to be occupied by the Works Routes, to a width 5 m outside the tops of cuttings and 5 m outside the toes of embankments, and the ground along the lines of catch drains shall be cleared of trees, brush, rubbish and other

objectionable matter. The ground surface under all embankments shall be grubbed of all stumps and roots. Except in areas to be excavated the stump holes shall be backfilled with suitable material and compacted to the density of the adjacent area. The clearing shall be carried out in accordance with Chapter 6.

- (b) All cleared material shall be disposed of in designated or approved disposal areas.

16.3.9. Earthwork for work routes

- (a) Stripping: Stripping shall be carried out in accordance with Chapter 6 of Standard Technical Requirements.

16.3.10. Excavation

- (a) All excavation shall be carried out in accordance with Chapter 6 of Standard Technical Requirements.
- (b) In sloping ground steeper than 1 vertical to 2 horizontal, the whole of the formation shall be excavated in the solid.
- (c) Batters in other than fresh rock, as determined by the Employer, shall not exceed 5 m in height without benching, the benching being a minimum of 3 m wide and sloping inward (on a grade of 1 vertical to 10 horizontal).
- (d) As far as is practicable excavated material shall be used in the construction of road embankments, or for refill of road excavation below formation.
- (e) Surplus material not required for the Works shall be disposed of in approved disposal areas.

16.3.11. Embankment

- (a) After stripping, the exposed surface shall be scarified to a depth of not less than 200 mm. Benching will be required on slopes greater than one vertical to four horizontal. Benches shall be 3 m wide with 1.5 horizontal to 1 vertical side slopes. After scarifying the area shall be compacted to the requirements of Paragraph b. of this Subclause.
- (f) Suitable embankment material, approved by the Employer, shall be placed in approximately horizontal layers for the full width of the embankment to a thickness of not more than 300 mm after compaction. Each layer shall be compacted for its full width until the dry density is in excess of ninety (90) per cent of the maximum dry density obtained from the compaction test carried out in accordance with ASTM D698 and in the moisture range of optimum to two (2) per cent dry of optimum. The Contractor shall carry out testing at a rate of not less than one for every 1 000 m³ of material placed at the locations determined by the Employer for control of the embankment. The material in the top 450 mm of the embankment shall be compacted in three layers of equal thickness to not less than ninety five (95) per cent of its maximum dry density and trimmed to the specified slopes or slopes.

16.3.12. Gravel Surfacing

- (a) The Contractor shall supply and place gravel surfacing on the unsealed Works Routes including parking areas and turning bays, in road shoulders and elsewhere as required to a compacted thickness of not less than 100 mm.

16.3.13. Construction

- (a) A road base 150 mm minimum thickness together with a sub base, if required by CBR tests, shall be provided for all unsealed roads prior to placing the surfacing. The road base shall be constructed in accordance with Clause 18.4.
- (b) The road surfacing shall be constructed to have a minimum thickness after compaction of 100 mm with additional thickness where required. The Contractor shall compact the material thoroughly in layers of 100 mm to a dry density of not less than ninety five (95) per cent of the maximum dry density determined in accordance with ASTM D1557. The method of compaction shall be subject to the approval of the Employer.
- (c) During compaction, the material shall be bladed to line and grade. Segregation of the fine and coarse materials shall be avoided and the surface of the material kept free from corrugations during compaction. The finished surface shall not show any departure from the true surface of more than 10 mm in any length of 3 m.

16.3.14. Preparation of Subgrades

- (a) Immediately prior to the construction of the road sub-base, the Contractor shall ensure that the formation is shaped to the approved lines and grades and the entire surface of the formation is compacted to the density specified.
- (d) Spray watering or drying out by harrowing and respreading, as the case may be, may be required to improve compaction characteristics.
- (e) Soft and yielding material which will not dry out readily or compact satisfactorily shall be removed and the material replaced with approved material compacted as above. Any holes or depressions shall also be filled with approved material.
- (f) After compaction and levelling, the Contractor shall carry out such maintenance as is necessary to preserve and keep the surface of the subgrade in its approved condition until the sub-base is placed.

16.3.15. Road Base and Sub-Base Construction

- (a) The pavement of the Works Routes shall be constructed in accordance with the Employer's Requirements.
 - i. Preparation of Formation
 - ♦ The preparation of formation shall be carried out only after completion of all subgrade drainage, piped drains, services and ducts or any other drainage work that might affect the pavement works, and such preparation shall be

carried out immediately prior to the laying of the sub-base, or the road base where no sub-base is required.

- ◆ The surface of the formation shall be substantially uniform in density throughout its entire width and shall conform to the density requirements for compaction. It shall be trimmed to conform to the lines, cambers, grades and typical cross-sections shown on the Drawings. Where ruts or other objectionable irregularities occur as a result of construction traffic or other causes, the Contractor shall reshape and recompact the formation to the required density before the sub-base or base is placed.
- ◆ The surface of the subgrade before the construction of the sub-base shall be within 20 mm of the correct levels.

ii. Base and Sub base

- ◆ The base and sub base shall be obtained from approved sources and constructed according to the conditions laid out in this Subclause.
- ◆ The thickness of the base and sub base shall be determined by the Contractor from subgrade strength tests and submitted to the Employer for approval. Unless otherwise approved these tests shall be California Bearing Ratio tests and the design thickness shall be in accordance with Road Note 31, A Guide to the Structural Design of Bitumen Surfaced Roads in Tropical and Sub tropical Countries, Transport and Road Research Laboratory, UK.
- ◆ Base and sub base construction may be of in situ or imported material as proposed by the Contractor and approved by the Employer. Imported material shall be spread evenly over the whole width of the formation required prior to construction.
- ◆ Construction of base and sub base layers shall comprise sufficient scarifying, pulverising, even mixing with water, shaping and compacting to produce a dry density of the treated material for the total depth of the layer not less than ninety five (95) per cent of the maximum dry density as defined in ASTM D1557 with moisture content not greater than ninety (90) per cent of optimum moisture content. If the moisture content is too low for satisfactory compaction, moisture shall be added.
- ◆ Unless otherwise approved, base and sub base construction shall be carried out in layers not exceeding 150 mm each in compacted depth. All material shall be placed and spread evenly to the full width of the roadbed. Each layer shall be compacted to the required density before the next layer is placed. Care shall be taken to prevent segregation of the material into the coarse and fine fractions. Segregated surface areas of a base constructed or base material contaminated to such an extent that it no longer complies with the requirements of this Technical Requirements shall be removed and replaced with well graded and satisfactory material.

- ◆ The surface of the base and sub-base shall be well drained at all times.
- ◆ Compaction shall be completed as soon as possible after each layer has been spread and shaped satisfactorily. Each layer shall be thoroughly compacted with suitable compaction equipment. Table 16.1 shows a list of equipment considered to be the minimum desirable or suitable, however, if test requirements cannot be achieved different or heavier equipment shall be used.
- ◆ The finished base and sub-base surface shall be even, free from irregularities, loose material or fines and true to cross section, line and level. The finished base surface shall not show any departure from the true surface of more than 12 mm in any length of 3 m in either the longitudinal or transverse direction. Correction shall be by loosening, adding or removing material, reshaping and recompaction.
- ◆ Checking of pavement layers
 - The Contractor shall test the compaction of the base and sub-base. The frequency of such testing shall be not less than two (2) tests in any 100 m length of road for each layer of sub-base and base material. In addition the Contractor shall check the thickness of the base and sub-base with not less than five measurements made in any 100 m length of road. The average thickness of the sub-base shall not be less than the required thickness and no single measurement shall be less than ninety (90) per cent thereof. The Contractor shall rectify any areas of the work where tests fail to meet the requirements of the Technical Requirements and shall re-test where directed by the Employer.
- ◆ If the material does not contain a sufficient quantity of natural cementitious material to bond readily under the action of traffic, a binder consisting of rock screenings or other cementitious material obtained from approved sources shall be added to and incorporated in it. After the binder has been added, the combined grading of the mixture shall be within the limits specified above. The binder may be incorporated in the material at the point where the material is produced or may be incorporated uniformly in the base during the progress of the work and in the amount specified.

TABLE 16.1: MINIMUM COMPACTION EQUIPMENT REQUIREMENTS FOR GRANULAR MATERIALS

Type of Compaction Equipment	Category	Less than 110 mm Layer	Number of Passes Between 110 mm and 150 mm Layer	Between 150 mm and 230 mm Layer
Smooth-wheeled roller	Mass per m width 2 700 kg-5 400 kg over 5 400 kg	16 8	Unsuitable 16	Unsuitable Unsuitable
Pneumatic-tyred roller	Mass per wheel 4 000 kg-6 000 kg over 6 000 kg-8 000 kg over 8 000 kg-12 000 kg over 12 000 kg	12 12 10 8	Unsuitable Unsuitable 16 12	Unsuitable Unsuitable Unsuitable Unsuitable
Vibrating roller	Mass per m width of vibrating roller over 700 kg-1 300 kg over 1 300 kg-1 800 kg over 1 800 kg-2 300 kg over 2 300 kg-2 900 kg over 2 900 kg-3 600 kg over 3 600 kg-4 300 kg over 4 300 kg-5 000 kg over 5 000 kg	16 6 4 3 3 2 2 2	Unsuitable 16 6 5 5 4 4 3	Unsuitable Unsuitable 10 9 8 7 6 5
Vibrating plate compactor	Mass per unit area of base plate kg/m ² 1 400-1 800 over 1 800-2 000 over 2 000	8 5 3	Unsuitable 8 6	Unsuitable Unsuitable 10
Vibro tamper	Mass kg 50-65 over 65-75 over 75	4 3 2	8 6 4	Unsuitable 10 8
Power rammer or dropping weight compactor	Mass kg 100-500 over 500	5 5	8 8	Unsuitable 12

16.3.16. Asphaltic Concrete Surfacing

- (a) The Contractor shall prime, tack coat and apply asphaltic concrete surfacing on the Works Routes specified to be sealed with asphaltic concrete, as approved.

- (b) Such surfacing work shall consist of the production, transport and placement of a pavement surfacing comprising one course of dense graded asphaltic concrete to be constructed on the prepared binder course. The asphaltic concrete course shall be constructed to the approved design lines, levels, grades, dimensions, respective thicknesses and cross sections as shown on the Drawings.
- (c) Work to be undertaken prior to the placement of asphaltic concrete surfacing shall comprise the application of an asphaltic prime coat to pavement base course prepared and approved by the Employer in accordance with Clause 18.3 and the application of an asphaltic tack coat to the prepared primed base course.

1. Design of Asphaltic Concrete Mixes

The design of asphaltic concrete mixtures shall be undertaken by the Contractor. The design of the mixtures shall be carried out in a materials testing laboratory approved by the Employer. The design of the asphaltic concrete mixtures shall be undertaken on the basis of trial mixtures prepared and tested according to standard Marshall methods:

i. The mixture parameters:

- percentage and grading of coarse aggregate;
- percentage and grading of fine aggregate;
- filler content and
- asphalt content as a weight percentage of the total mix,

shall be chosen within the limits and to yield mixture characteristics acceptable to the Employer. In selecting the asphalt content of the respective final mixtures, due regard shall be given to optimising the bulk density of the compacted mix.

ii. The limits for the mixture characteristics shall be:

Stability	: 900 kg
Flow	: 2.5 to 4.0 mm
Air voids in mix	: 3 to 5%
Minimum voids in mineral aggregate	: 14%
Asphalt content	: 5 to 7% by mass
Asphalt penetration grade	: 60: 80

iii. The submission of the job mixture or mixtures for the approval of the Employer shall follow the carrying out of mixture design as specified in this Clause.

iv. The manufacture and testing of trial mixtures as well as the testing of individual mixture components will be carried out in the presence of the Employer. All testing undertaken in the course of mixture design shall follow current ASTM test procedures including:

ASTM D1559 - Preparation and testing of Marshall Cylinders

ASTM C128 - S.G. of fine aggregate

ASTM C127 - S.G. of course aggregate

ASTM D2041 - Asphalt absorption by aggregate

2. Construction Methods

i. Prime Coat

- The prime coat shall be applied only to a dry surface of base course which has been thoroughly swept to the satisfaction of the Employer using mechanical brooms. The prime coat shall be applied only when the road surface temperature is at least 24°C and no rain is threatening. The application rate shall be between 1.2 and 1.5 litres/m² and the temperature of application for the prime coat shall be as approved. The use of primer protection sand shall be limited to areas designated by the Employer, elsewhere the prime coat shall be left uncovered to penetrate and to cure completely.

ii. Tack Coat

- Application of a tack coat shall be carried out as a preliminary operation on the day when a placement of asphaltic concrete is scheduled. Mechanical brooming to thoroughly clean the surface of the prime coat, to the satisfaction of the Employer, shall in all cases form part of the surface preparation.
- The application rate and the temperature of application for the tack coat shall be as approved. The asphaltic material for tack coat shall be applied at a rate in the range of 0.2 litres/m² to 0.5 litre/m², and the asphalt distributing equipment shall be capable of spreading at these rates.

iii. Asphaltic Concrete

- Asphaltic concrete surfacing shall be placed in one course which shall comprise asphaltic concrete having a maximum aggregate size of 20 mm placed to a compacted thickness of not less than 50 mm.
- The delivery temperature of the mixture shall be within the absolute limits of 140°C and 163°C. Breakdown compaction of the mat shall commence as soon as working clearance exists behind the paver for the breakdown roller. Materials deposited on the road behind the paver and not in the course of being compacted by the roller, may be rejected should its temperature be less than 120°C.
- Asphaltic concrete surfacing shall be placed using self-propelled tamper/spreader paving machines. Each paving machine used shall work in conjunction with two road rollers, a steel drummed roller for breakdown rolling and a multi-tyred roller for finish rolling. The steel drummed roller shall have a mass of at least eight (8) tonne. The multi-tyred roller shall have a mass of at least ten (10) tonne and shall have at least nine (9) tyres each capable of inflation to a pressure of 830 kPa (8.0 kg/cm²). Each roller shall incorporate a means of keeping the drums (tyres) wet during operation to prevent picking up

of the asphaltic concrete mat. Only experienced operators shall be used on the rollers. Sharp turns and sudden reversals of travelling direction will not be permitted on the asphaltic concrete surface.

- Placement of asphaltic concrete shall be continuous. In the event of an interruption of placement due to the weather or plant failure or any other cause, the Contractor shall form a construction joint in the mat before placement resumes.
- Control testing shall be undertaken by the Contractor on days when asphaltic concrete is being placed. All control testing shall be in accordance with current ASTM procedures.

3. Tests on Asphaltic Concrete Surface

- (a) Tests for conformity with the specified crown, grade and width shall be made by the Contractor immediately after initial compaction. Any deviation shall be corrected by removal or addition of materials and continuous rolling.
- (b) After completion of final rolling, the smoothness of the course shall again be tested along the whole distance. Humps or depressions that exceed the specified tolerances or that retain water on the surface shall be immediately corrected by removing defective work and replacing with new asphaltic concrete.
- (c) Finished surfaces shall not vary from the design elevations by more than 2.5 mm when tested with a crown template and a 3 m straight-edge furnished by the Contractor. Tests shall be performed at 25 m intervals along the road centreline or as approved.
- (d) The width shall not be less than 25 mm of the design section measured at 50 m intervals.
- (e) The total thickness of the asphaltic concrete shall be determined by core tests conducted by the Contractor taken at places approved by the Employer. At least one core test is required for every 1 000 m² of area paved with a minimum of one core test for each day's production. The thickness shall not be greater than 5 mm less than the designed depth for any one test and not greater than 2.5 mm less for an average of 10 consecutive tests.
- (f) When deficiencies in either elevation or thickness exceeds the specified tolerance, the Contractor shall carry out additional testing to verify the extent of the deficiency and remove and replace the asphaltic concrete surfacing with new material to the Employer's approval.

16.3.17. Drainage for Roads Requirements

- (a) Provisions for drainage of Work Routes, parking areas and turning bays shall include the design and construction of catch drains, windrows, table drains, chutes, lead-off drains, subsoil drains, culverts and headworks, all in accordance with the provisions of the Employer's Requirements.
 - I. Catch Drains

- Catch drains shall be constructed not less than 3 m from the edges of cuttings and shall have a cross sectional area of not less than 0.5 m²; a bed width of not less than 600 mm and a gradient sufficient to be self cleaning. They shall lead water, without obstruction, to the nearest culvert or other effective outlet. Protection of the drains against erosion shall be provided by stone pitching or other approved means.

II. Soil Bunds

- The Contractor shall construct adequate soil bunds or side windrows on all embankments of the road to prevent drainage from passing down the fill slope, except in cascade drains constructed with stone pitching or other approved means.

III. Table Drains

- Table drains shall be aligned and evenly graded parallel to the shoulders of the roadway. They shall be free of obstructions and be diverted via head off drains into side drains, culverts or water courses at frequent intervals. Protection of the table drains against erosion shall be provided generally by stone pitching or other approved lining.

IV. Chutes

- Chute drains shall be constructed down the face of batters or other steep slopes and shall be protected against erosion generally by stone pitching or other approved lining.

V. Culverts

Culverts shall be designed and constructed as follows:

- Culverts shall be designed by the Contractor and shall be located at all natural water courses and at other locations where surface drainage is concentrated. Unless otherwise approved by the Employer the distance between any adjacent culverts shall not be greater than 150 m measured along the road centreline where the road is constructed in sidecut or the natural drainage is modified by an embankment.
- Culverts shall be designed by the Contractor to be at an elevation to permit the full thickness of the sub-base to be placed over the top based on the approved road design. The culverts shall be designed for construction traffic loads at the sub-base elevation.
- Concrete headwalls shall be provided for each culvert. Inlet and outlet channels for culverts shall be suitably protected against erosion, to the Employer's approval.
- Concrete pipes for culverts shall conform to the requirements of ASTM C14 and shall have flush joints. Pipes shall be laid in accordance with ASTM C891.

VI. Culvert Sizing

- Concrete pipe culverts shall be not less than 450 mm in diameter and shall be of sufficient diameter to pass the design flows without flooding of the road surface at sub-base elevation.

- The design flows shall be flows resulting from the following floods:
 - For minor drainage structures - 1 in 5 year return period flood.
 - For major drainage structures and bridges - 1 in 100 year return period flood.

16.3.18. Guard Rail Fencing

The Contractor shall furnish and install continuous guardrail fencing as required and approved.

I. Materials and installation

Reflector strips shall be attached to the posts in accordance with the Table.

TABLE - REFLECTOR STRIPS

Radius of Curve (m)	Spacing of Reflectors on Guardrail Fence (m)	
	Outside of Curve	Inside of Curve
30-90	5	10
91-180	10	20
181-270	15	30
271-370	20	30
Over 370 (incl straight road)	30	30

Each reflector strip shall consist of a 150 mm by 75 mm piece of 14 gauge type 575 (hard) aluminium alloy, to one side of which is firmly affixed a 75 mm by 75 mm piece of red retro-reflecting material and on the other side is a 50 mm by 50 mm piece of white retro-reflecting material. The reflector strip shall be attached vertically to the side of the post, and shall be immediately behind the guardrail, so that the red reflector is above the guardrail, and faces towards traffic proceeding along that side of the road nearest to the guardrail fence. The white reflector shall be in the upper left hand corner of the post, as viewed by traffic proceeding along the side of the road farthest from the guardrail fence. The reflective material shall meet the requirements of AS 1906.

16.3.19. Guide and Fender Posts

- (a) The Contractor shall furnish and install guide and fender posts where required and approved.

I. Installation

- The guide and fender posts shall be set plumb, to the approved depth and to accurate alignment and spacing. The post holes shall be excavated to the prescribed depth, not less than 400 mm and the posts shall be set firmly in place by compacted earth as directed.
- The posts shall be treated with good quality creosote over the length to be embedded in earth and for 150 mm above that portion. The creosote shall comply with ASTM D391. Treatment shall consist of twice dipping the timber, when dry, into creosote for at least one minute. The timber shall be allowed to dry between

dipping. The portions of the posts above ground level shall be cleaned thoroughly and painted with three coats of an approved white paint.

16.3.20. Surface Dressing

I. Construction Plant

(a) Bitumen distributors

The contractor can use either the truck mounted bitumen distributors or hand spray equipment for the distribution of bitumen. However, use of truck mounted bitumen distributor is encouraged to apply. If such equipment is used it may have sufficient power to maintain uniform speeds for the proper application of the binder. It shall be equipped with heaters capable of maintaining temperatures up to 1500 C. The circulation system shall permit pumping around the tank and around the spray bar without actually spraying. Spray bars shall be available for spraying in widths varying from 0.5 m to 5.5 m and shall be adjustable transversely so that the operator can follow the required edge independently. The spray nozzles shall be arranged to give a uniform spray and the shut-off shall be quick acting with an antidrip device. The pressure in the spray bar shall be sufficient to give a good distribution and spraying of the binder.

(b) Chip-spreaders

The contractor can use either the mechanical spreaders or hand spreader equipment for chip spreading. If mechanical chip-spreaders used, it may be capable of spreading the chippings uniformly over variable widths, from 0.5 to 3.5m, at the rates specified. The number and output of chip-spreaders shall be sufficient to ensure that the chippings are spread immediately after the bituminous binder has been applied. Chip-spreaders shall be checked and calibrated before starting any work or when required by the Employer.

(c) Rollers

The main rolling shall be carried out with self-propelled pneumatic tyred rollers, having a wheel-load of more than 2 tonnes.

Steel-wheeled rollers shall not be used until approved by the Employer all excess chippings have been removed and insufficiently chipped areas have been chipped over and then only in tandem with pneumatic tyred rollers or where approved by the Employer. Only steel-wheeled rollers weighing less than 8 tonnes (total weight) will be accepted.

The number and output of rollers shall be sufficient to ensure that rolling does not lag behind spreading. Two pneumatic tyred rollers shall be used for each chip-spreader.

(d) Miscellaneous equipment

Sufficient trucks and loading machinery shall be employed to ensure an adequate, prompt and continuous supply of chippings. Rubber tyred mechanical rotary

brooms towed by or mounted on rubber tyred vehicles shall be provided. All labour working with or on bitumen shall be provided with protective clothing and footwear.

II. Trials

- (a) Before surfacing dressing is applied to any area of the permanent works, the Contractor shall carry out trials to determine the rates of spread of bitumen and cover aggregate for each course to be laid and for type of pavement layer to be treated. The trials shall also demonstrate the suitability of the methods and plant the contractor proposed to adopt.
- (b) Prior to the commencement of such trials the Contractor shall submit in writing to the Employer its proposals for applying surface dressing materials and on receipt of the Employer's approval, the Contractor shall proceed with the trials, but in the absence of such approval the Contractor shall submit fresh proposals to the Employer.
- (c) In the course of such trials the Employer may call upon the Contractor to modify its method of working, to employ other items of plant, which are available on site and to amend the rates of spread at which the various materials are applied.
- (d) Following the completion of such trials the Employer shall approve the Contractor's method of working and the finish to the surface dressing and no variation in the approved procedures shall be made without the Employer's prior consent in writing. Satisfactory trials shall have been completed at least Fourteen (14) days prior to the date at which the contractor intends to commence surface dressing operations.
- (e) None of the foregoing provisions shall prevent the Employer from requiring the Contractor to vary its materials, plant or methods of working at any time during the execution of the works should it consider this to be essential to the proper application of surface dressing. Notwithstanding the Employer's approval of any of the materials, plant or methods of working the Contractor shall at all times be solely responsible for the soundness of the construction and compliance with the requirements of this Specification and the Drawings.

III. Cleaning and Preparation of Surface

- (a) Prior to the application of prime-coat, loose and other objectionable material shall be removed from the surface by thorough brushing and/or washing or other acceptable methods.
- (b) Adherent patches of objectionable material shall be removed from the surface and shall be washed down with water and hand broomed. A light application of clean fresh water may be made just before the application of the prime coat. Spraying of the prime coat shall not be carried out if water is ponding on the surface of the gravel base or if it is overly wet.
- (c) Within 24 hours of the application of prime coat it shall have penetrated into the base course by between 3 mm and 10 mm. Where the primer has not been

completely absorbed by the base within this time, sufficient blotting material shall be spread over the surface to blot up the excess prime and prevent it from picking up under traffic. Prior to placing the next pavement layer all loose blotting material shall be swept from the surface. All work and materials in conjunction with the requirements of blotting material and sweeping shall be provided at the Contractor's expense.

IV. Application of Binder and Cover Aggregate

(a) General

Immediately following completion of the preparation of the surface, binder shall be applied either by the mechanical distributor or by hand spray equipment, at a temperature between 165°C – 180°C if 60/80 penetration grade bitumen is used.

(b) Application

The material shall be applied so that uniform distribution is obtained at all points of the surface. At the junction of previous and subsequent applications and to prevent double application of binder, building paper or other protective material shall be spread on the surface for a sufficient distance back from the ends of each application so that flow through the sprays will be operating at full force on the surface to be treated and the distributor shall be moving at the correct speed for the rate of application. Immediately after the application, the building paper shall be removed and destroyed. All spots unavoidably missed by the distributor shall be properly treated with binder by use of the hand spray attachment. The surface of structures and vegetation adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred. No binder shall be discharged into a borrow pit or channel.

(c) Binder

Quantities of bitumen in excess of requirements shall not be heated nor shall it be held at temperatures within the range of application temperatures for periods in excess of ten hours. Any bitumen that has been heated for an excessive period of time or overheated shall be rejected.

- The area to be sprayed with binder shall be limited to that which can be covered with aggregate at the specified rate within 20 minutes of the time of spraying or such shorter period as the Employer shall direct.
- Provision shall be made for 10 percent of the rated capacity of the distributor tank to be retained in the tank at the completion of each run, or such other percentage as may be determined by the Employer, so as to avoid air entrainment within the delivery system and provide for any minor excess in the rate or application.
- After each application, the quantity of material sprayed shall be checked against the area covered, and any necessary adjustments shall be made to ensure that the specified or ordered rate of applications maintained in

subsequent runs. Spraying shall cease immediately if any defect develops in spraying or spreading equipment and it shall not recommence until the fault has been rectified.

(d) Thinner (Paraffin)

- The following maximum amounts of thinner (paraffin) may be added with the permission of the Employer to the basic 80/100 penetration bitumen depending on the road surface temperature at the time of spraying. Lesser amounts than those indicated may be used in conditions on Site allow the development of sufficient adhesion between binder, aggregate and existing surface. On no account shall diesel or fuel oil be used for cutting back of bitumen.

Range of Road Surface Temperature (o C)	Maximum Addition of Paraffin by Volume (%)	Range (approximate) of Corresponding Ambient Air Temperature (o C)
22 – 29	7	10 – 16
29 – 36	5	16 – 21
36 – 43	3	21 – 26
43 – 50	1	26 – 31
Above 50	Nil	Above 31

- The temperature of the bitumen, when the paraffin is introduced shall not be higher than 120° C.
- The thinner (paraffin) shall be sucked from 200 litre drums in measured quantities through the bitumen pump and circulated with the bitumen for a minimum of 45 minutes. During this process all burners shall be shut off and no open flames allowed near the distributor.

(e) Cover Aggregate

- Before the binder is applied, sufficient cover aggregate shall be available in trucks at the site of the work to provide the full cover for the area to be sprayed. The application of the aggregate shall proceed immediately after application of binder commences and shall be completed within 20 minutes of the completion of spraying or such smaller period of time as the Employer shall direct.

(f) Rolling and Brooming

- Immediately after spreading, the aggregate shall be rolled with one or more pneumatic tyred rollers until the aggregate is firmly embedded in the binder. Where required to ensure an even distribution of aggregate, the surface shall be hand broomed after the initial rolling. Rolling shall be continued for as long as is necessary to ensure a thorough bedding of the aggregate into the bitumen.

- Immediately after the binder has hardened to the stage at which no more aggregate can be pressed into it by rolling, any remaining loose particles shall be removed. If, after spreading, the aggregate is found to contain moisture and weather conditions are suitable for drying, the Employer may allow rolling the spread aggregate to be deferred for a short time to permit the moisture to evaporate, providing that satisfactory adhesion of the binder to the aggregate is obtained. If the Employer considers that the adhesion of the binder to the aggregate is unsatisfactory, it shall reject the work and direct that no further work be carried out until the conditions improve.

(g) Weather Limitations

- Surface dressing shall not be applied when the weather conditions are, in the opinion of the Employer, likely to adversely affect the operation. Such conditions may include but shall not necessarily be limited to rain or low temperatures.

(h) Aftercare and Control of Traffic

- The road shall not be opened to traffic until the binder has attained sufficient viscosity to prevent the surface chipping being removed. The Contractor shall erect temporary restriction signs, barriers and removable bumps or any other device, as instructed by the Employer, to prevent vehicles travelling too fast over the newly laid surface dressing. Vehicle speed shall be restricted to a maximum of 30 km/h, until there is sufficient adhesion to ensure that the rows of loose chippings will not be dislodged by faster vehicles. After traffic has been permitted to run on the surface dressing for a period of at least two weeks and when instructed by the Employer, all loose chippings shall be swept and taken away. Windrows of loose chippings shall not be allowed to accumulate at the sides of the road.

(i) Tolerances

- The final average overall width of the surface dressing measured at six equidistant points over a length of 100m shall be at least equal to the width specified or instructed. At no point shall the distance between the centerline of the road and the edge of the surface dressing be narrower than that instructed by more than 13 mm. The rate of application of binder across the lane width shall not vary by more than 10% of the rate ordered and for each length of lane sprayed in a single pass the average rate of binder application shall be not less than the rate ordered. The average rate of application of chippings along and across the lane width for each single pass of chip-spreader shall not vary by more than 10% of the rate ordered.

16.4. QUALITY CONTROL TESTS

16.4.1. General

- (a) The Contractor shall be responsible for the quality control of fill materials, and shall perform tests in the field and laboratory on samples of uncompacted and compacted fill to determine if such materials before and after compaction meet requirements of this Specification. Deficiencies in the quality of materials or construction shall be remedied by such measures, including additional measures to increase density, lower or raise moisture content, and complete removal of portions of banking which fail to meet the requirements of this Specification.

16.4.2. Uncompacted Material

- (a) Quality control test on uncompacted material shall be carried out by the Contractor according to the frequency given in the following table to determine whether all fill material produced by the method employed satisfies the requirements of this Specification.

Test Item (1 test per each quantity)	Materials			
	General fill	Sub-base Course	Base Course	Stone aggregates
- Grading analysis	4000 m ³	500 m ³	500 m ³	50 m ³
- Atterberg limit	4000 m ³	500 m ³	500 m ³	-
- Natural moisture content	4000 m ³	500 m ³	500 m ³	-
- ASTM D1557 density test	-	1000 m ³	1000 m ³	-
- Organic matter content	5000 m ³	3000 m ³	3000 m ³	-
- Los Angeles abrasion	-	1000 m ³	1000 m ³	-
- 5 Cycles of the sodium sulfate soundness	-	1000 m ³	1000 m ³	-
- California bearing ratio (laboratory)	-	1000 m ³	1000 m ³	-

16.4.3. In-situ Test

- (a) The following controls shall be made on materials either placed or in situ:

Test	Sub-base Course	Base Course	Foundation
California bearing ratio (in-situ)	1 per 500 m	1 per 500 m	1 per 500 m
Density of soil in place	1 per 200m ³	1 per 200m ³	1 per 200 m ³

16.4.4. Field Density Test

- (a) Bulk density will be determined in field in accordance with ASTM D1557 with dimensions and apparatus modified to suit the soil tested or with ASTM D2167, whichever is most suitable in the opinion of the Employer, to obtain representative density of fill tested. Particle size distribution test will be performed in accordance with ASTM D422 modified as required to suit the material tested.

16.4.5. Nuclear Apparatus

- (a) The Contractor may use a nuclear apparatus to determine density and moisture content in accordance with ASTM D2922 and ASTM D3017, if materials of consistent gradation are being placed.

16.4.6. Cutback Asphalt

- (a) Cutback Asphalt shall be subject to testing in accordance with the ASTM Standards. Samples shall be provided in accordance with ASTM D140 in reasonable quantities as may be required for independent testing purposes.

16.4.7. Surface Course (Asphalt Concrete Surfacing)

- (a) The frequency of the quality control testing is one test per every 500m in distance in general. The deviation of the thickness of asphalt concrete shall not be more than 0.7cm from the design thickness at every test, and shall not be more than 0.2cm from the design thickness in average of ten consecutive test results. The compaction degree shall be more than 96% in consecutive 10 samples.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 17
WATER SUPPLY AND SEWERAGE**

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CHAPTER 17 - WATER SUPPLY AND SEWERAGE

17.1. GENERAL

17.1.1. Scope of Work

- (a) The works under this Chapter shall comprise water supply, wastewater and sewage drainage.
- (b) The plumbing system shall be designed by the Contractor in accordance with the requirements specified herein and site conditions. Detailed drawings of proposed deviations due to actual field conditions or other causes shall be submitted to the Employer for his approval. Materials and equipment installed in the plumbing system shall be suitable for the pressures and temperatures encountered. Installation shall be as required by the applicable national plumbing code of Nepal and local regulations around the Site and as specified herein.
- (c) Installation shall be accomplished by the workmen skilled in this type of work.

17.1.2. Codes and Standards

- (a) Following standards shall be used unless otherwise Nepalese relevant standards such as Nepal National Building Code (NBC) specified:
 - a. Indian Standard (IS)
 - b. Japanese Industrial Standard (JIS)
 - c. Heating, Air-conditioning and Sanitary Standard in Japan (HASS)
 - d. Other approved standard or codes
- (b) The Contractor shall obtain the approval of the Employer if he proposes to deviate from the above codes or standards.

17.1.3. Submissions

- (a) The Contractor shall submit to the Employer for his approval drawings on general arrangement of equipment, piping, etc. as part of the Contractor's detailed design drawings specified in this Specification.
- (b) At least Sixty (60) days prior to starting installation of any materials or equipment, the Contractor shall submit to the Employer for his approval the following shop or working drawings:
 - Layout drawings of equipment including a list of equipment and materials to be incorporated,
 - Details of piping and valves,
 - Details of sleeves for piping,
 - Details of supports, hangers, attachments and anchoring,
 - Details of foundations for equipment,
 - Detailed layout of electric wiring and conduiting,
 - Complete electrical connection diagrams, and
 - Other drawings as required by the Employer.

17.1.4. Data and Samples

- (a) The Contractor shall submit for approval of the Employer a complete list of materials and equipment to be incorporated in the works under this Chapter including sufficient descriptive materials such as catalogues, diagrams, performance curves, charts, layout drawings and other data published by the manufacturer to demonstrate the conformance to the Specification and the Contractor's detailed design approved by the Employer before placing or confirmation of orders.

17.1.5. Operation and Maintenance Manuals

- (a) Six complete sets of operation and maintenance manuals for the domestic water supply and hydrant systems shall be furnished as specified hereinafter. The manuals shall be furnished at the time of performance tests of the system. The manuals shall include but not be limited to the following:
- **Explanation of System**
 - General description of system including function, design conditions, system design and equipment incorporated,
 - Schematic diagrams of piping including equipment, valves and controls,
 - Schematic diagram of electric power supply and controls, and
 - Layout plan of equipment.
 - **Operation and Maintenance Instructions**
 - Method of operation including procedures for safe starting and stopping of equipment, preventive procedures, and checking methods,
 - Manufacturer's instructions on each piece of equipment including lubrication instructions,
 - Daily, weekly, monthly and yearly inspection items on each piece of equipment and systems, and
 - Method of finding causes of breakdown of each piece of equipment and systems and countermeasures to be taken.
 - **Manufacturer's Bulletins**
 - Manufacturer's specifications, shop drawings and catalogues of each piece of equipment,
 - Manufacturer's certifications, and
 - Any guarantee, test data and engineering data furnished by the manufacturers.
 - **Spare Parts List**
 - List of spare parts and consumables furnished with the equipment as standard appurtenances as required by the Specifications.
 - **Service and Maintenance Organizations**
 - Name and address of nearest recommended service and maintenance agent who can be contracted by the Employer at the time of breakdown of any item of equipment.

17.1.6. Attachments and Spare Parts

- (a) The Contractor shall furnish with each piece of equipment standard

attachments and spare parts which the manufacturer supplies under normal commercial transactions. In addition to these, the Contractor shall furnish spare parts, consumables or standby equipment as specified hereinafter. The Contractor shall also furnish a complete list of spare parts as recommended for operation of each piece of equipment for a period of one year, with current prices and source of supply.

17.1.7. Tools

- (a) The Contractor shall provide sufficient special tools as recommended by manufacturers for field maintenance of the system. One complete set shall be provided at no extra cost to the Employer.

17.1.8. Field Instructions

- (a) Upon completion of the work, the services of one or more instructors shall be provided by the Contractor for a total period of not less than one (1) week to instruct a representative of the Employer in operation and maintenance of the equipment and the systems. These field instructions shall cover all the items contained in the bound instructions as specified for operation and maintenance manuals, and all costs for the services shall be borne by the Contractor.

17.1.9. Tests

- (a) The Contractor shall submit his proposed testing programs and procedures at least Thirty (30) days prior to the scheduled tests and obtain the Employer's approval. All tests shall be conducted in the presence of the Employer. Any materials, equipment, instruments, personnel, water and electricity required for the tests shall be provided by the Contractor.
- (b) Accurate data of each test shall be recorded and reports of test data shall be submitted to the Employer.

17.1.10. Floor, Wall and Ceiling Escutcheons

- (a) Escutcheons shall be provided at finished surfaces where exposed piping, bare or insulated, passes through floor, walls or ceilings. Escutcheons shall be fastened securely to pipe or pipe covering and shall be of chromium plated iron or chromium plated brass, either one piece or split pattern, held in place by internal spring tension or set screw.

17.1.11. Concrete Structure

- (a) All foundations, tanks and basins made of reinforced concrete for the system shall be designed by the Contractor.

17.1.12. Power Supply

- (a) The plumbing system will be fed with AC 3 phase 4 wires 400V 50 Hz and AC 1 phase 2 wires 230V 50Hz. The Contractor shall design, supply and installation of the power source panel for the plumbing system and wiring and conduiting between the power source panel design, supply and installation of the power source panel for the illumination system and wiring and conducting between the power source panel and distribution boards installed under Electromechanical Works of the Contract.

17.2. PIPING

17.2.1. General

- (a) All pipes, fittings and fixtures shall be of the kind, grade, type and qualities as shown on the drawings approved by the Employer and as specified herein.
- (b) All pipes shall be jointed with fittings compatible with the pipe and of the suitable type for the intended service.
- (c) Union joints shall be properly provided in piping to allow disassembly of the piping for maintenance services or for any modification of the system.
- (d) Flanges shall be provided for pipes 75 mm diameter and larger. The flanges shall be compatible with and shall have the same rating as the companion flange of the valve or the fittings. Full face rubber gaskets shall be provided to all flanged joints.
- (e) All piping shall be fitted and assembled to introduce minimum stress to the pipe and fittings. All pipes shall be supported where shown on the approved drawings and as required. Polyvinyl chloride (PVC) pipe shall be supported at the spacing recommended by the pipe manufacturer.
- (f) The same standard of thread shall be used throughout the works.
- (g) All piping to be embedded shall be tested and approved by the Employer prior to being embedded. Sleeves or check-outs shall be provided where pipe passes through concrete or brick structures. The space shall be filled or caulked with suitable materials. Where pipe passes through a wall or floor where water tightness is required, the space shall be filled with an approved material or with approved expanding grout.
- (h) Cleanouts and manholes shall be provided as shown on the approved drawings.
- (i) All pipes embedded in the ground shall be at the pipe top a minimum 60 cm below the grade where no heavy traffic is expected and minimum 90 cm below the grade at road crossings and where heavy traffic is expected. Pitch of the pipe line shall comply with the applicable code and regulations.
- (j) Change in pipe size shall be made with reducing fittings. The use of bushings will not be allowed.
- (k) Change in direction shall be made with fittings except that bending of galvanized steel pipe 100 mm or smaller will be permitted, provided that a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than 6 times the diameter of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted.
- (l) Exposed piping shall be run in parallel with the lines of the buildings unless otherwise indicated.
- (m) Connections between ferrous and nonferrous metallic pipe installed underground shall be made with dielectric unions or flanges.
- (n) All hot and cold water reticulation shall be laid throughout the Powerhouse and

Head pond Control Building where shown on the Drawings.

- (o) All hot water piping in walls or floors and not exposed to view shall be wrapped with 10 mm thick extruded foam insulation.
- (p) Cast iron pipe laid in a trench shall be embedded on the barrel on a 150 mm layer of fine aggregate and shall be surrounded with 150 mm of fine aggregate before backfilling the trench. Backfilling for pipe trenches shall be compacted. All cast iron pipe shall be laid with a minimum cover of 750 mm above the top of the pipe where it crosses roadway and parking areas, and 600 mm elsewhere, or it shall be embedded in concrete. The pipe shall be retained in its true position in the trench by embedding it in concrete at all bends, junction or crosses.
- (q) Isolating valves and non-return valves shall be installed in the location shown on the Drawings.

17.2.2. Material and Installation

1. Material of Pipes

- PVC pipes

Polyvinyl chloride pipes shall conform to JIS K-6741, Type VP or equivalent and shall be laid and jointed in accordance with the manufacturer's instructions.

- Galvanized Steel Pipes

- I. Water pipes shall be of standard weight seamless galvanized screwed and socketed pipe conforming to JIS G 3302 or equivalent. Threaded joints shall be sealed with an approved graphite compound or with jointing tape applied to the male threads only.
- II. Water pipes whose water pressure is over 10 kg/cm² shall be galvanized steel pipes forming to JIS G 3302 or equivalent and installed and jointed in accordance with manufacturer's instructions.

- Copper Pipes

Copper pipes shall conform to JIS or equivalent and shall be installed and jointed in accordance with the manufacturer's instructions.

2. Application of Pipes

Application	Pipe
Indoor water supply pipe	SGP
Indoor water supply pipe	STPG-sch 40
Outdoor water supply pipe	SGP/PVC/uPVC
Hot water supply pipe	Polybutelene/Copper (I)
Soil water pipe	uPVC/PVC
Waste water pipe	uPVC/PVC
Ventilation pipe	uPVC/PVC

3. Pipe Insulation

- (a) Pipe insulation in the plumbing work shall be made only for the hot water supply pipes. The insulation material shall be mineral fiber or fibrous cloth of 24 kg/m³ in nominal density with 20 mm thick or approved by the Employer.
- (b) The insulation shall be provided with field-applied or factory-applied non-combustible vapor-barrier jacket. The jacket shall consist of lamination of aluminium foil glass fiber reinforcement and kraft paper where exposed to view, and where concealed the kraft paper may be omitted. The kraft paper shall be enamel painted.
- (c) After pressure tests have been completed in the piping system, insulation shall be applied to the pipe with end joints tightly butted and the vapor-barrier jacket lapped not less than 38 mm at longitudinal joint and adhered with adhesive.
- (d) At circumferential laps, a 75 mm wide strip of jacketing material shall be applied and adhered with the adhesive. On jacket facing to receive finish painting, the aluminium foil shall not be exposed.
- (e) The insulation shall be continuous through pipe hangers and pipe sleeves.
- (f) Unless otherwise indicated on the Drawings, all flanges, unions, valves, anchors and fittings shall be insulated with factory-pre-molded, or pre-fabricated or field-fabricated segments of insulation of the similar material and thickness as the adjoining pipe insulation.

4. Valves

- (a) Gate valves and check valves of 50 mm in diameter or smaller shall be of bronze construction. Valves of 65 mm in diameter or larger in the pipe line shall have a cast iron body and bronze trim. Valves of 75 mm in diameter or larger shall be flanged.
- (b) Gate valves shall be of solid wedge disc type and may have a rising stem or non-rising stem. Check valves shall be horizontal swing type having a lightweight brass disc. Globe valves shall have replaceable resilient plugs and shall have rising stems. Globe valves for use in regulating flow shall have replaceable seats.
- (c) Air vent valves shall be of float type, ball type or combined float and heat sensing or diaphragm type to be selected according to the service intended.
- (d) All valves throughout this Section shall be of the same manufacture in principle.

5. Unions and Hose Faucets

- (a) Unions on ferrous pipe of 50 mm in diameter or smaller shall be malleable iron zinc-coated. Unions shall not be concealed in walls, ceilings or partitions.
- (b) Hose faucets shall be brass or bronze with male inlet threads, hexagon shoulder and hose connection.

6. Flexible Joints

The flexible joint shall be either of the following:

- A rubber tube type formed with a flexible reinforced rubber tube with bolted flanges and split backing flanges for attachment to the pipe.
- A bellows type formed with copper or stainless steel, activated by internal pressure and retained by flange rings and tension lug bolts.

7. Traps

- (a) Each fixture, floor drain and piece of equipment requiring connection to the drainage system, except grease interceptors, shall be equipped with a trap. Each trap shall be placed as near the fixture as possible, and no fixture shall be double trapped. Traps installed on cast iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tube shall be recess-drainage pattern, or tube type. Traps for acid-resisting waste shall be of the same material as the pipe.

8. Pipe Cleanouts

- (a) Pipe cleanout shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place indicated.
- (b) Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90 degree branch drainage fittings with screw plugs. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks. Cleanouts on pipe concealed in partitions and walls and where installed in finished floors subject to foot traffic shall be provided with chromium plated cast-brass covers secured to plugs.

9. Pipe Hangers, Inserts and Supports

- (a) The Contractor shall submit to the Employer for his approval detailed drawings of the type of inserts, hangers and supports for the piping that he proposes to provide.
- (b) The location of hangers and supports shall be coordinated with the structural work to assure that structural members will support the intended load. Hangers and supports shall be provided at intervals specified below, at locations not more than 1.0 m from the ends of each run out and not over 30 cm from each change in direction of piping. Hangers shall be adjustable.
- (c) Underground piping shall be laid on a firm bed for its entire length, except where support is otherwise provided.

10. Drain Basins

- (a) Drain basins such as wastewater basin, soil water basin and rainwater basin shall be of prefabricated concrete basin. The size and depth of basins shall be designed by the Contractor according to the size and slope of connecting pipes shown in the approved drawings and estimated water flow volume. Invert shall be made at the bottom of basins by waterproof mortar, having smooth surface for the water flow. Following covers shall be provided.

- Waste water basin : Precast concrete cover
- Soil water basin : Cast iron manhole cover, water and airtight type
- Rainwater basin : Steel grating cover

11. Painting

- (a) All hangers, supports and other iron works shall be painted with one coat of anti-corrosive primer and with two coats of oil paint. All galvanized steel pipes exposed to view shall be painted with two coats of oil paint. Color code shall be as approved by the Employer.
- (b) When steel pipes and fittings are buried in the ground, they shall be provided with jute impregnated with asphalt paint.

12. Expanding Grout

- (a) An expanding grout shall be applied into the space between pipe and structure where the pipe penetrates. The work shall be in accordance with Chapter 15 of Standard Technical Requirements.

13. Earthing of Metal Parts

- (a) Contractor shall ensure electrical continuity of all pipeline network and all metal appliances installed by him and to which all other metal parts of the installation have been connected.

14. Testing of Pipelines

- (a) The Contractor shall test all pipelines as approved by the Employer. If the pipe fails in test, the Contractor shall repair, replace and retest the piping until accepted by the Employer. All piping systems shall be flushed clean before testing.
 - Pressure testing of water service pipe
 - a) Pipes shall be subject to a hydraulic pressure test of 10 kg/cm^2 above the normal working pressure. If piping is tested in sections, temporary cap shall be fitted. Each section shall be slowly filled with water, and air inside the pipe shall be carefully expelled.
 - b) For acceptance, the test pressure shall remain constant for twenty-four (24) hours without additional water.
 - Testing of soil water and wastewater pipe
 - a) No pipe shall be covered or concealed before it is tested. If any sections of pipelines are tested, the Contractor shall obtain the approval of the Employer before covering.
 - b) All openings and pipe ends shall be securely plugged and filled with water up to the top of the highest opening. This water shall remain at the same level for twenty-four (24) hours.
 - c) All pipes shall also be inspected visually to ensure that there are no

projections in the pipe, and the pipeline is straight and devoid of abrupt kinks. At least, three quarter of the pipe opening of any sections between manholes shall be visible when viewed from the opposite end the pipe section.

- d) Exposed pipes shall further be subject to a leakage test. Leakage tests shall be made after a minimum of 24 hours after the pipeline has been filled with water. The line will be accepted if no leakage is found for the duration of another 2 hours on the pipeline.

15. Disinfection

- (a) The entire water supply system shall be thoroughly flushed and disinfected with liquid chlorine or hypochloride before placed in operation.
- (b) Chlorination agent shall be introduced into the water lines in a manner approved by the Employer and left in the system for a period of not less than sixteen (16) hours and the heavily chlorinated water shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 ppm.
- (c) All valves in water lines being sterilized shall be opened and closed several times during the sixteen (16) hour chlorinating period.

17.3. SPARE PARTS AND CONSUMABLES

- (a) The Contractor shall furnish the following spare parts for each equipment and hand them over to the Employer at the time of field instruction services.

(1)	For a raw water tank:	One set of water level sensing switch
(2)	For a septic tank	Sterilization tablets for one year use

17.4. MAINTENANCE DURING CONSTRUCTION

- (a) The plumbing system shall be maintained and protected by the Contractor in a satisfactory condition until final acceptance by the Employer. Defective materials and equipment damage in the course of installation or testing shall be replaced or repaired at the expense of the Contractor in a manner approved by the Employer.

17.5. WATER PUMPS AND CONTROLS

17.5.1. General

- (a) The pumps shall have capacities, characteristics and ratings as approved by the Employer.
- (b) The pumps shall be provided with all necessary fittings, common base, anchor bolts and pipe connections.
- (c) All parts of pumps and motors shall be designed to withstand the maximum mechanical and electrical forces to which they may be subject to in the course of operation including full reverse runaway without failure, distortion and injury.

- (d) Impellers shall be statically and dynamically balanced to eliminate vibration and effect minimum bearing load. Motors shall be drip-proof type unless otherwise specified and shall be provided with safety overload cut-off switches. Suction and delivery pipes shall be provided with check valves, gate valves, flexible joints, air release valves, pressure gauges or foot valves with strainer as shown on the approved drawings.
- (e) The pumps shall be rigidly anchored to the foundation in an accurate alignment to eliminate vibration.
- (f) The pumps shall be controlled through "Automatic and Manual" modes. When on automatic operation, the pump shall be controlled by water level sensing switches, or pressure switches as shown on the drawings approved by the Employer.

17.5.2. Material and Installation

1. Automatic Filters

- (a) The backwash filters shall be suitable for operation from a 415 V, three phase, 50 Hz supply. The Contractor shall supply an enclosure to house the control equipment for the strainer. The Contractor shall provide all wiring between the motor(s) control and alarm initiating devices and the electrical enclosure. Another contractor will provide the 415 V power supply and alarm cables to the Powerhouse Alarm Board and terminate them in the electrical enclosure.
- (b) Scour pipes shall be provided to direct dirty water and silt deposits to the external drain.

2. Motorized Valves

The motorised valves shall be suitable for operation from a 415 V, three phase, 50 Hz supply. The Contractor shall supply an enclosure to house the control equipment for the valve including local test facilities and open / close position indicator. The Contractor shall provide all wiring between the motor's control and alarm initiating devices and the electrical enclosure. Another contractor will provide the 415 V power supply and alarm cables to the Powerhouse Alarm Board and terminate them in the electrical enclosure.

3. Pressure Pumps

The pumps shall be suitable for operation from a 415 V, three phase, and 50 Hz supply. The Contractor shall supply an enclosure to house the control equipment for the water pump. The Contractor shall provide all wiring between the pump control and alarm initiating devices and the electrical enclosure. Another contractor will provide the 415 V power supply and alarm cables to the Powerhouse Alarm Board and terminate them in the electrical enclosure.

4. Raw Water Storage Tank

- (a) The Contractor shall furnish and install two raw water storage tank, 8,000 L capacity, fabricated from 2.5 mm thick copper sheeting,
- (b) A water level indicator and pressure switch shall be provided on the raw water storage tank to control the pump in the Water Supply Services Building to

automatically refill the raw water storage tank at the pre-determined levels in the tank. The Contractor shall provide all wiring between the float switch and the controls for the pump.

- (c) The tank shall be supported on a steel frame at the elevation shown on the Drawings or as directed.
- (d) All associated pipework, manholes, inspection covers, ventilation and access ladders shall be provided as appropriate.

5. Inlet Strainer Backwash Pump

- (a) The Contractor shall furnish and install inlet strainer backwash pump shall be furnished and installed at the locations shown on the Drawings.
- (b) The pump shall have a capacity of 10 litres / sec at 40 m head and shall be suitable for operation from a 415 V, three phase, and 50 Hz supply. The Contractor shall supply an enclosure to house the control equipment for the water pump. The Contractor shall provide all wiring between the pump control and alarm initiating devices and the electrical enclosure. Another contractor will provide the 415 V power supply and alarm cables to the Powerhouse Alarm Board and terminate them in the electrical enclosure.

6. Centrifugal and Volute Pumps

- (a) The pumps shall be single or multistage, single suction centrifugal or volute pumps.
- (b) The direction of impeller rotation shall be marked on it. The casing shall be horizontal or vertical split type of cast iron construction. The interior of the casing shall be easily inspected by removing upper half or removing dowel bolts. Each section shall be sealed with a precut gasket.
- (c) The impeller shall be of single suction enclosed type made of bronze.
- (d) The shaft shall be made of stainless-steel heat treated, ground to accurate dimensions, and adequately sized minimize deflection.
- (e) Bearing bucket shall be removable from the pump casing and shall be accurately machined and doweled to the casing. Proper alignment between the impeller and bearing housing and the motor frame shall be provided to ensure full support of the shaft and vibration free operation. Bearings in the pump which are in contact with pumped water shall be of bronze and water lubricated. Other bearings shall be grease lubricated.

7. Submersible Pump

- (a) The pump shall be centrifugal pump complete in one unit consisting of a submersible motor, impeller, and guide vane, strainer and delivery connection.
- (b) All components of the pump shall be made of corrosion resistant materials, and electric components shall be perfectly insulated, sheathed and coated. Impeller casing shall be made of cast iron, and impeller shall be made of bronze. Shaft shall be made of stainless steel. Motor shall be of complete water filled type or hermetically sealed type.

- (c) Electric cable shall be waterproof, durable and the connection shall be perfectly watertight.

8. Water Level Sensing Switch

- (a) Water level sensing switch shall be of an electrode type. It shall be included in "Automatic-Off- Manual" control and where required sequence selection switch to allow alternate operation of the pumps.
- (b) The electrode shall be encased in a tube which shall extend below the lowest water level to prevent foreign matter from entering into the tube. Non conducting spacers shall be provided to hold the electrodes in the tube. All contacts shall be suitably rated and enclosed in rugged moisture proof enclosure.

9. Operation Panel

- (a) The operation panels for pumps shall have following function and equipment:
- ◆ Leakage breaker
 - ◆ Ammeter
 - ◆ Overload protector
 - ◆ Phase missing protector
 - ◆ Phase missing condenser
 - ◆ Sign lamp : Power (White), Operation (Red), Stop (Green) and over current (Orange)
 - : Full water level, Low water level
 - ◆ Terminals : Water level switches
 - ◆ Switch : Manual - Stop – Automatic
- (b) Single line diagram of the operation panel shall be installed in the drawing holder of the panel. The operation panel shall be of wall mount type.
- (c) Ammeters shall be capable of accepting the starting characteristics of the corresponding motor and shall be suitably calibrated to indicate the full load running current at three-quarter full-scale deflection.

10. Conduit Piping and Wiring

- (a) Conduit piping and wiring for the plumbing system shall be designed and supplied by the Contractor compiling with the applicable provisions in "Lighting and Illumination System" of the Electromechanical Specification.

17.6. WASTE WATER AND SEWAGE DRAINAGE

17.6.1. System Description

- (a) Waste water and Sewage system shall be provided in the powerhouse and other buildings as designed by the Contractor and the Specification.
- (b) Soil water from the lavatories shall flow into a separate septic tank and soak pit and be treated in it. Waste water from the kitchen, pantries and lavatories shall flow separately into the separate sump pit leading to the soak pit.
- (c) Ventilation pipe shall be provided connecting with the soil water and

wastewater pipes in order to give smooth water flow and keep the water in drain traps.

17.6.2. Material and Installation

1. Septic Tank

◆ General

The septic tank for the powerhouse and outgoing terminal shall consist of sewage treatment plant and of sedimentation, separation and contact aeration method type which shall have sufficient capacity for 10 persons (powerhouse) and 20 persons (outgoing terminal) and appropriate shape to accomplish the required performance stipulated below.

- Rate of sewage treatment in B.O.D: 65% or more
- Target B.O.D after treatment: 90 ppm or less

◆ Construction

- (a) The septic tank shall be made of fibre reinforced plastic (FRP) or approved type having sufficient strength to withstand earth and water pressure and shall be of such a construction as easy in maintenance and cleaning. The tank shall consist of following chambers and equipment.
 - Two sedimentation and separation chambers
 - Two contact and aeration chambers with contact panels
 - Sedimentation chamber and chemical feeder
 - Blower
 - Ventilation stack
 - Water and airtight type manhole cover for each chamber
- (b) The septic tank in the outgoing terminal shall be installed on the concrete foundation and after backfilling, the tank shall be covered by concrete slab.

2. Blower

- (a) The air pumps shall be electromagnetic diaphragm type, with aluminium alloyed body and corrosion resistant rigid plastic casing. The pump shall operate smoothly, with low vibration and noise.

3. Effluent Storage Tank

- (a) The sewer mains shall drain to two separate holding tanks. Each tank shall be fitted with a surface type grinder pump designed to macerate domestic sewage. The pumps shall discharge separately into force mains, through a swing check non-return valve and gate valve into the sewage package plant.
- (b) The sewer pipes from the individual plumbing fixtures and fittings shall be constructed of UPVC pipes complying with British Standards.
- (c) All UPVC pipes shall be jointed with solvent cement supplied by the pipe manufacturer and in accordance with the relevant Standard, with exception that the first joint at manholes shall be jointed with a rubber ring joint supplied by the pipe manufacturer.
- (d) The treated effluent storage tanks shall be fabricated types, made of fibre

reinforced plastics (FRP). The tanks shall be provided with covers, manholes, ladders, pipe connections, a water level sensing switch vent pipe base frame and supported by steel support at a height of 0.6 m from the floor level.

- (e) All components of the tanks which are in contact with water shall be corrosion proof and shall not exude harmful substances into the water.
- (f) The Contractor shall enlarge the tank as the case may require in conformity with his septic tank without extra cost to the Employer.

4. Soak Pit

- (a) Soak pit shall be provided. Soak pit for the same number of people required in septic tank and sump pit shall be constructed for the sewage system of powerhouse and all other buildings. Overflow from septic tank shall be connected to the soak pit which is ultimately drained to the ground below.

17.7. SANITARY FIXTURES

17.7.1. General

- (a) Sanitary fixtures shall be obtained from a reputed supplier, and the Contractor shall submit catalogues to the Employer for his approval before placing the order.
- (b) Generally, all fixtures except water closets shall have the water supply above the rim. Angle stops, straight stops, stops integral with the faucets and the like for supplies shall be furnished and installed with fixtures. Exposed fixture trimming and fittings shall be chromium-plated or nickel-plated brass with polished and bright surfaces.
- (c) Urinal screen shall be provided where a urinal abuts another urinal or lavatory sink on either side. The screen shall be of vitreous china and wall mounted.

17.7.2. Material

◆ Water Closet - European Type

Material : White vitreous China
Trap : Single siphon, P or S trap
Cistern : 10 litres low level flushing
Others : 40 mm flush pipe, 20 mm overflow pipe with mosquito proof coupling

◆ Water Closet - Indian Type

Material : White vitreous China
Trap : Single syphon, P or S trap (cast iron)
Cistern : 10 liters high level flushing
Others : 32 mm flush bend, 20 mm overflow pipe with mosquito proof coupling
Shape & Size: W. C. pan 580 × 440 mm

◆ Urinal

Material : White vitreous China
Type : Flat back type
Size : 630 × 400 × 420 mm (Height, Width, Width)

Cistern : 5 liter automatic flushing

◆ **Lavatory (Shower Room)**

Material : White vitreous China

Type : Under-counter

Size : 550 × 400 × 200 mm (Width, Width, Depth)

◆ **Slop Sink (Wash basin)**

Material : White vitreous China

Type : Pedestal-type lavatory sink

Size : 600 × 450 × 200 mm (Width, Width, Depth)

◆ **Paper Holder**

Material : Vitreous China

◆ **Shower Head**

Type : Fixed type

17.7.3. Installation

◆ **Fixture Connections and Support**

Wall-hung fixtures shall be fastened to the wall with through bolts where appearance of the bolts is not objectionable. For solid concrete or brick masonry and where through bolting is objectionable; fixtures shall be fastened with machine-bolt expansion shields or stud type expansion bolts. For masonry unit construction, fixtures shall be fastened with through bolts or toggle bolts as required. Exposed bolt heads in finished areas shall be hexagonal. Exposed nuts shall be chromium-plated hexagonal cap nuts. Washers shall be painted or chromium-plated to match bolt heads or nuts.

◆ **Connections to Equipment and Fixtures**

The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with an integral stop, shall be equipped with a cut-off valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures.

17.8. POTABLE WATER SUPPLY SYSTEM

17.8.1. General

- (a) The potable water supply system comprises:
- the potable water treatment plant,
 - pressure main to the treated water storage tank(s) and
 - valves to the potable water outlets as shown on the Drawings

17.8.2. Water Treatment Plant

- (a) The layout of the plant shall be as recommended by the treatment plant manufacturer. The Contractor shall submit details of the proposed water treatment plant system for approval not less than Sixty (60) days before placing orders.
- (b) The water treatment plant shall consist of necessary component parts, accessories and appurtenances including:

- a compact, self-contained, factory-built water treatment package unit that performs coagulation, flocculation, clarification, filtration and sterilisation.
 - discharge pumps, motors and starters mounted on the unit to transfer water to the treated water storage tanks and closed-circuit cooling water tanks. Duplicate pumps each of 100% capacity shall be provided;
 - valves, control valves, drain valves, float valve, piping and fittings;
 - treated water holding tank
 - controls and instruments;
 - chemical feed system; and
 - connections for inlet supply, discharge, backwash and waste; chemical feed system; and lifting lugs.
- (c) The electrical equipment shall be complete and shall be suitable for operation from a 415 V, three phase, and 50 Hz supply. The Contractor shall provide all wiring between the electrical enclosure on the plant and motors and the associated control and alarm initiating devices.
- (d) Water treatment shall be a factory assembled packaged water treatment plant. The plant shall be capable of producing potable water to World Health Organisation Standards. The pH values shall be in the range 7.5 to 8.5.
- (e) To support the design of the plant, chemical analyses of the raw water extraction facility shall be used for the design in accordance with the drinking water standards.
- (f) All materials used shall be suitable for the chemicals and the quality of the water. Chemical feed tanks shall be made of chemical resistant material, polyethylene or approved equivalent. Interior coating shall be non-toxic and suitable for potable water.
- (g) Complete electric controls for operation of motors, pumps and valves shall be provided for each tank. Controls shall be provided to automatically refill the storage tanks at pre-determined water levels. This shall include float level switches, electrical wiring, automatic shut-off valves, pump and accessories to control water inlet, chemical feeds, and water outlet to storage tanks.
- (h) Controls shall be provided to backwash the water treatment plant. This shall include head loss gauges calibrated in SI units and head loss switches to operate backwash automatic valves.
- (i) A group flag relay shall be provided for the following alarms:
- pump motor overload operated; and
 - abnormal storage tank level.
- A voltage free contact of this relay shall be wired out to terminals for connection into the plant alarm system.
- (j) The chemical feed tanks, normally for alum, hypochlorite and polyelectrolyte, shall be equipped with mixer and feed pumps. Chemical feed rates shall be adjustable, and necessary piping shall be provided.
- (k) The Contractor shall supply the quantity of chemicals, as recommended by the

manufacturer, for a quantity of water to be treated equivalent to six (6) months continuous operation of the plants at maximum rating.

17.8.3. Electrical Equipment

- (a) The electrical equipment associated with the water supply system shall be complete and suitable for operation from a 415 V, three-phase, 50 Hz power supply.
- (b) The Contractor shall provide distribution boxes for the connection of the operation mechanisms, position sensors and alarm/status indicators to the distributed control system of the plant.
- (c) The Contractor shall be responsible for cabling the above operation circuits terminals, status and alarms to the Distributed Control System of the Plant.

17.8.4. Spare Parts

- (a) Spare Parts to be supplied for the water supply system shall include:
 - 20% of limit switches, but at least one of each type
 - 1 electric motor of each type
 - 1 motor-driven pump of each type
 - 2 sets of fuses
 - 1 set of indicating lights
- (b) The Contractor shall indicate other parts he may consider necessary for trouble-free operation for 10 years.

17.8.5. Operation and Maintenance Manuals

- (a) The Contractor shall provide operation and maintenance manuals, the scope of which shall be suitable for fully informing the powerhouse operating staff on all aspects of the operation and maintenance of the Plant, as defined in this Clause. The manuals shall be provided in provisional and final forms according to the requirements of the Technical Requirements.

17.8.6. Testing and Commissioning

- (a) The components of the systems covered by the present Clause shall be subject to tests during manufacture in accordance with the following requirements:
 - Pressure tests shall be performed in accordance with the relevant Standards for all parts subject to water pressures.
 - The Contractor shall conduct tests or produce type test certificates to prove the performance of the equipment offered, including pumps, motors, automatically operated valves etc.
 - Test Certificates for those Tests shall be forwarded to the Employer.
- (b) The components of the systems covered by the present Clause shall also be subject to tests at site.

17.9. SEWERAGE AND SEPTIC SYSTEM

- (a) The contractor shall design separate septic tank with soak pit for soil water and sump pit with soak pit for other wastewater as shown in the Contractor's drawing approved by the Employer. The size shall be according to occupancy

numbers residing and utilizing the buildings based on the prevalent standard norms and rules of Nepal or equivalent International Standard.

17.9.1. Powerhouse and Other Buildings

- (a) The permanent sewerage and sewage installations for soil water from lavatories shall comprise of all, but not limited to, works as listed below:
- Civil works of Septic tank, soak pit and its connecting lines with associated inspection chambers/manholes with CI covers
 - UPVC pipelines from toilet to septic tanks leading to soak pit and inspection chambers/manholes covered with CI (Cast Iron) medium duty cover
 - Ventilating pipe and cowl of suitable size
 - Baffle walls, internal water proofing treatment of tank
- (b) The permanent sewerage and sewage installations for wastewater from the kitchen, pantries and lavatories shall comprise of all, but not limited to, works as listed below:
- Civil works of Sump pit, soak pit and its connecting lines with associated inspection chambers/manholes with CI covers
 - UPVC pipelines from kitchen, pantries and lavatories to sump pit leading to soak pit and inspection chambers/manholes covered with CI (Cast Iron) medium duty cover
 - Ventilating pipe and cowl of suitable size
 - In manholes internal water proofing treatment shall be provided

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS FOR CIVIL
WORKS**

**CHAPTER 18
INSTRUMENTATION**

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CHAPTER19 - INSTRUMENTATION

19.1. GENERAL

19.1.1. Requirements

- (a) The Contractor shall complete all in accordance with this Section 19:
- supply, install, calibrate, test and survey, as required, and maintain instrumentation
 - supply and install all ancillary measuring equipment;
 - construct protective surrounds for instruments, tubes and cables;
 - supply and install conduit and concrete cable pits for permanent power supply and protective pipe for cables;
 - construct cable risers and shafts;
 - drill holes for groundwater observation holes and borehole standpipe piezometers; and
 - excavate pits and trenches.
- (b) The extent, type, location of the individual instruments shall be determined by the Contractor and approved by the Employer. The number and location of the instruments may be altered by the Employer during the construction period according to site requirements.

19.1.2. Instruments and Ancillary Items

- (a) The instrumentation to be supplied, installed, calibrated, tested and surveyed, as required, and maintained includes:
- Electrical instrumentation for pore pressure gauges, borehole extensometers, stress meters, strain meters, no stress-strain meter, temperature monitoring devices and joint meters;
 - Surface settlement points;
 - Borehole standpipe piezometers;
 - Uplift measuring devices;
 - Water level measuring gauges;
 - Strong motion equipment.

19.1.3. Climate and Power Rating

- (a) All instruments and associated equipment shall be suitable for operation in the Himalayan region.
- (b) All electrical equipment shall operate on 220 V to 240 V single phase 50 Hz power supply.
- (c) All steel parts shall be furnished hot dip galvanised, provided with a long-term corrosion protection coating or of stainless steel of first quality.

19.1.4. Extent of Instrumentation, Testing and Storage on Delivery

- (a) The Contractor shall supply the type and number of instruments (including spares) as indicated in the Technical Requirements.
- (b) All instrumentation operating on electrical or hydraulic systems shall be accompanied by certified test certificates for each such instruments. These instruments shall also be tested in the presence of the Employer before

installation. All instrumentation shall be stored on site, before installation, in a secure, weatherproof and lockable building and fitted with facilities for testing and partial assembling of the instrumentation.

19.1.5. Approval of Instrumentation and Construction Procedures

- (a) The Contractor shall, not less than Ninety (90) days before installation of instrumentation, submit for approval details of the instruments proposed for installation. These will be consistent with the general information on the instrumentation submitted by the Contractor with his Bid as well as any modifications agreed to by the Employer and the Contractor and shall include:
- detailed description of the instrumentation including the ancillary measuring equipment the Contractor proposes to install;
 - evidence of the successful performance of the instrumentation the Contractor proposes to install, which have been installed and operated for a period of at least 5 years in other excavations;
 - procedures prepared by the manufacturers of the instrumentation for the installation, testing and operation of the instruments;
 - details of the layout of all the equipment and accessories to be installed in each switchbox and observation room;
 - details of protective surrounds, recesses in concrete structures, cable shafts, etc. proposed for the installation of instrumentation and switchboxes; and
 - experience of the supervisor and technicians who will install the instruments.
- (b) During the execution of the Works, the Contractor shall submit to the Employer for approval any further details regarding the instrumentation that the Employer may require. The Contractor shall prepare surveys and as-built drawings of all installed instruments.
- (c) The installation of instruments may interfere with the overall construction progress. The Contractor shall make provision for such interferences in his construction planning. The Contractor will not be entitled to any compensation or extension of the Time to Completion by reason of any such delays, including repair and replacement of damaged instruments.
- (d) No materials shall be purchased prior to the Employer's approval. However, approval by the Employer of the Contractor's proposals and drawings or data shall not relieve the Contractor from his sole responsibility to meet all the requirements of the Contract.

19.1.6. Skilled Personnel

- (a) The whole of the instrumentation work shall be under the direct supervision of a senior supervisor, approved by the Employer, and employed by the Contractor who is well experienced in the installation of the instruments and who have a sufficient knowledge of the purpose and function of the particular instruments being installed.

- (b) Installation and calibration shall be carried out by skilled technicians, acceptable to the Employer, well experienced in the installation of the instruments and who have a sufficient knowledge of the purpose and function of the particular instruments being installed.

19.1.7. Installation

- (a) The Contractor shall:
- install and calibrate instrumentation in the presence of the Employer;
 - carry out all survey work required to locate such instruments before and after instrument installation;
 - tag all cables, tubes and movement gauges with identification tags at intervals of approximately 15 m horizontally or at such closer intervals as necessary to provide continuous identification;
 - install cables and tubes without joints, in the maximum lengths practicable;
 - where permitted, splice and couple cables and tubes in accordance with the manufacturer's recommendations as approved by the Employer;
 - keep plugged or sealed the open ends of all incomplete lines of tubing and casing;
 - at all times during installation keep the insides of casing and tubes free from foreign matter; and
 - protect all cables, tubes etc. from degradation due to ultraviolet light by storing in an adequate building or, during construction, by covering with suitable material.
- (b) The Contractor shall install all instrumentation in accordance with the manufacturer's instructions.
- (c) The instrumentation shall be put into operation at the earliest practical time during construction in order to obtain information relating to the performance of the structure, its foundation and abutments.

19.1.8. Care of instrumentation

The Contractor shall protect all instruments from damage and displacement during the progress of the work and for the duration of the contract period. If, as determined by the Employer, there has been any damage to, or displacement of the instruments and connections during the progress of the work, they shall be repaired or the instrument replaced immediately to the satisfaction of the Employer by and at the expense of the Contractor.

19.1.9. Reading instruments

- (a) An initial set of readings on all instruments installed at any particular elevation will be taken immediately by the Contractor after the Contractor has completed their installation and prior to embedment in concrete.
- (b) The Contractor shall program his work to allow the reading of the instruments as soon as possible after their installation.
- (c) The Contractor shall read the instruments at regular intervals. The Contractor shall inform the Employer when reading of the instruments will take place.

- (d) The Contractor shall retain a qualified and experienced engineer to monitor all instrumentation from the time of their installation until the Taking Over of the Works.
- (e) The Contractor's engineer shall read all instrumentation at intervals no greater than those stated in Table. When abnormal readings are observed the reading shall be repeated and both results shall be recorded together with an explanation. All data will be recorded in a Surveillance Manual which shall be submitted to the Employer on a weekly basis and any abnormal readings shall be reported immediately to the Employer.
- (f) All other instruments shall be monitored and recorded as required for the safety of the Works and to obtain the information necessary for design purposes. The frequency shall be agreed with the Employer. The records of all such monitoring shall be submitted to the Employer on a weekly basis when such monitoring is in progress and any abnormal readings shall be reported to the Employer immediately.

TABLE: FREQUENCY OF INSTRUMENTATION READINGS Instrumentation	Reading Interval
Crest and surface settlement points	monthly
Thermometers	daily
Borehole standpipes	weekly
Groundwater observation holes	weekly
Seepage measuring weirs	daily
Strain meters	weekly
No stress strain meters	weekly
Joint meters	weekly
Strong motion accelerographs	continuously
River levels	daily

19.1.10. Operation and Maintenance Manual

- (a) The Contractor shall furnish an operation and maintenance manual for all the instrumentation installed in the Works.
- (b) The manual shall include the as-built for all instrumentation installed in the Works.
- (c) The manual shall include all necessary reference data furnished by the manufacturer of each item of instrumentation.

19.2. ELECTRICAL INSTRUMENTS

19.2.1. General

- (a) Electrical instruments shall be of vibrating wire type or approved equivalent.
- (b) The instruments shall be provided with over voltage surge arrester to protect the gauges against damage.
- (c) Where applicable, a suitable thermistor shall also be incorporated in the sensor for temperature sensing and for temperature - zero reading correlation.
- (d) Electrical instruments shall have stainless steel outer casings and hermetically

sealed by welding with a vacuum or insert gas inside it.

19.2.2. Pore Pressure Gauges

- (a) The pore pressure gauges shall have the following characteristics:
- | | |
|------------------------|------------------------------|
| Measuring range | 0-1 MPa |
| Accuracy | + / - 2 kPa |
| Resolution | 0.1 % of Full Scale (FS) |
| Over range capacity | 150% |
| Temperature range | -25°C to 60°C |
| Thermal effect on Zero | less than 0.05% of FS per °C |
- (b) The cells shall be installed as shown on the Drawings or elsewhere as directed by the Employer.
- (c) For installations in boreholes, the following procedures shall apply:
- After the hole has been prepared, the lowest cell shall be placed and embedded in an approximately 1 m thick sand layer.
 - This layer shall be sealed off from the other water bearing areas with bentonite palettes in a thickness of 1-2 m.
 - In the same manner, the cell located at higher levels shall be successively installed.
- (d) The end of the cable shall be kept during constriction in protective boxes and later permanently installed in the terminal structures or switchboxes.

19.2.3. Pressure Cells (Stress Meters)

- (a) The cells shall have the following characteristics:

Measuring range	5 MPa
Overload Capacity	150% of FS
Accuracy	±0.5 % of FS
Operating temperature	-25°C to 60°C

19.2.4. Borehole Extensometers

- (a) Borehole extensometers are single and multipoint borehole extensometers which are securely anchored at locations along the lengths of the borehole. The relative movement, between the individual anchors and the excavated surface in the surface excavations will be measured during and after completion of the excavation operation.
- (b) The Contractor shall supply and install borehole extensometers in the surface excavations in the locations shown on the Drawings or as directed. The extensometers shall be installed in accordance with the manufacturer's recommendations and the surface excavation shall be not lower than 2 m below

the required level of the extensometer at the time of installation. It is anticipated that boreholes extensometers up to 40 m long will be installed.

- (c) Borehole extensometers shall be designed, manufactured and installed to:
- yield an accuracy of readings to within 0.1 mm;
 - provide a measuring range of 150 mm;
 - provide a resolution of 0.1% of FS
 - Operate within a temperature range of -25°C to 60°C.
- (d) Each borehole extensometer shall consist of a down-hole assembly of one or three individual anchors, each attached to a non-corrosive stainless steel rod with protective casing, all assembled into a single bundle, and a mechanical readout head. Borehole extensometers will be grouted to the excavation surface and set in a galvanised steel pipe fitted with a galvanised steel waterproof protective cover. All extensometers shall first be prepared for mechanical reading. Later readings will be made via a portable electrical read out unit.
- (e) Cement grout and use of an expansion agent, shall be according to the borehole extensometer manufacturer's recommendations to produce a permanent non-shrink grout.
- (f) Grout used shall be neat cement.
- (g) The diameter of the boreholes shall be as recommended by the manufacturer of the extensometers. The use of drilling mud, oil, rod dope or any other material in the hole that will adversely affect the bond between the rock, grout and extensometer anchors will not be permitted. Recovery of drill core will not be required unless otherwise directed by the Employer.
- (h) Once grouting of an extensometer has begun it shall not be interrupted until completed. Should grouting be interrupted the work will be deemed unsatisfactory and the Contractor shall replace the hole and anchor assembly at no additional expense to the Employer.
- (i) If any extensometer fails to work correctly, then it will be replaced by the Contractor at a location determined by the Employer.

19.2.5. Strain Meters

- (a) The strain meters shall be used to measure the internal strain in concrete and shall be fitted on a rosette to measure strain in different directions in one plane at an inclination of 0°, 45°, 90°, and 135° (with the horizontal) and for installing the fifth strain meter perpendicular to the common plane of the four strain meters.
- (b) The strain meter shall be provided with protective housing. It shall also be provided with two "o" rings root prevent leakage of water through the holes for the setscrews. The gauge shall be completely waterproof.
- (c) The strain meters shall also measure temperature in the concrete.

- (d) The strain meter shall be a Carlson type strain meter or approved equivalent.
- (e) Each strain meter shall be adjusted to half the total extension of the strain meter so that equal tensile and compressive strains can be measured.
- (f) The strain meters shall have the following characteristics:
 - Minimum gauge length (mm) 250
 - Range (x10⁻⁶) in Tension (mm) 400
 - Range (x10⁻⁶) in Compression (mm) 800
 - Least Reading, Strain (x10⁻⁶) 5
 - Temperature range (°C) -25°C to +70°C
 - Linearity and Hysteresis (full scale) +/-2%
 - Least reading, temperature (°C) +/-1

19.2.6. No-stress Strain Meter

- (a) The no-stress strain meters shall provide data on strain due to thermal stress and autogenous growth in the concrete face.
- (b) The general arrangement of the no-stress strain meters shall be as approved. They shall consist of strain meters of the same make and type as used elsewhere in the concrete face embedded in a case to keep the specimen concrete under no stress, but under the same temperature and humidity as that for the surrounding concrete.
- (c) The strain meters shall be adjusted to fifty (50) per cent of their range during installation.

19.2.7. Thermocouples and Thermometers

- (a) The thermocouples measuring device shall be capable of measuring across the range of -25°C to 60°C to an accuracy of 0.5°C.
- (b) Each thermocouple shall be connected to its appropriate length of cable and shall be calibrated before being embedded in the concrete. A table and graph of the calibration data for each thermocouple shall be submitted to the Employer.
- (c) The thermocouples shall be embedded in the fresh concrete during construction of the diversion weir and headrace intake structure, together with the necessary lengths of cable connecting to the face of the formwork.
- (d) After concrete temperatures have stabilised the thermocouple leads shall be cut and the surface of the concrete shall be repaired.
- (e) Temperature gauges are required to monitor the temperatures in concrete structures. These gauges are in addition to those the contractor may need to control the placement temperature of the concrete.

19.2.8. Load Cells

- (a) Local cells are required to measure and monitor loads of bolts and anchors.
- (b) The capacities of the load cells shall be 300 and 600 KN and they shall be suitable for 25 mm rock bolts or 32 mm grouted bars.
- (c) The cells shall have the following characteristics:
 - Overload Capacity 150% of FS
 - Accuracy $\pm 0.05\%$ of FS
 - Resolution 0.1% of FS

19.2.9. Joint Meters

- (a) Electrical, one directional joint meters are required to measure movements normal or parallel to joints in the concrete structures.
- (b) The joint meters shall also measure temperature.
- (c) The general arrangement of the joint meters shall be as approved. Adequate provision must be made to avoid shear on the joint meter due to movement normal to its axis.
- (d) Measurement of movement of the joint shall be made by Carlson type joint meter or approved equivalent.
- (e) The joint meter and its housing shall be installed in the first pour to be cast at the vertical contraction joint.
- (f) The extension rod target and associated items shall be installed in conjunction with the next pour at the vertical contraction joint.
- (g) The joint meter shall be adjusted to twenty (20) per cent of its range during installation.
- (h) The joint meters shall have the following characteristics:
 - Minimum range 50mm
 - Accuracy ± 0.1 mm
 - Resolution 0.01 mm

19.2.10. Cables

- (a) All cabled instruments, except borehole extensometers, shall be supplied complete with the required length of cable. Splicing of cables on the site shall be avoided wherever possible. No splicing of cables on site may be performed without the prior approval of the Employer.
- (b) The general cable routes shall be shown on the Drawings.
- (c) All instrument cables shall be of the heavy duty insulated type suitable for direct placing in concrete and shall have the following characteristics:
 - Cables shall be of dual windings composed of one layer of chloroprene or neoprene cable covered with rubber and metallic tubes for protection. The cables shall have distinctly coloured cores.

- No. of core: 4
- Conductor nominal section 0.5 mm²
 - Composition 20/0.18 mm
 - outer diameter 1.0 mm
- Strand diameter approx. 5.1 mm

Thickness of

- separator 0.5 mm
- rubber 0.5 mm
- chloroprene sheath 1.3 mm
- armouring steel 0.3 mm
- anti-corrosive vinyl 2.5 mm
- Finished outer diameter approx. 19.7 mm
- Conductor resistance at 20°C 39.8 ohm/km
- Test voltage 1 000 V/min
- Insulation resistance, at 20°C 400 M ohm/km
- Approx. weight 435 kg/km

- (d) No solder shall be applied to the conductor joints without the approval of the Employer.
- (e) At joints the insulating layers shall be joined by vulcanising unless the use of self-adhering synthetic rubber tape is approved. A polysulphide or urethane adhesive compound shall be applied to the connecting part of conductor and the connecting part shall be covered with protecting tape.
- (f) The tapes for connecting parts shall satisfy the following specifications:

	Self-adhering Tape	Protecting Tape
Thickness	More than 0.5 mm	More than 0.2 mm
Width	More than 15 mm	More than 19 mm
gth	More than 2 kV/1 min	More than 5 kV/1 min
Volume inherent resistance	More than 1 x 10 ¹⁵ ohm/cm	More than 2 x 10 ¹² ohm/cm
Tensile strength	More than 0.07 kg/cm ²	More than 0.7 kg/cm ²
Elongation	More than 200%	More than 100%
Bond strength	-	More than 3.0 kg

- (g) All earth wires shall consist of 19/1.53 mm bare hard drawn copper conductors.
- (h) The Contractor shall supply samples of all cables and earthwires to the Employer for approval.

19.2.11. Switchboxes

- (a) Switchboxes shall be monitored in recesses in concrete structures, in instrument houses or at temporary read out points.
- (b) They shall be of weatherproof and dust proof construction and all metal parts including terminals shall be of rust proof material.
- (c) Each switchbox shall permit the installation of 12 cables.

19.2.12. Portable Readout Units

- (a) The Contractor shall supply sets of portable readout units suitable to readout all cabled instruments.
- (b) The readout unit shall be capable of being set to a resolution of up to two decimal points.
- (c) The readout unit shall be capable of storing the calibration coefficients of around 100 vibrating wire transducers.
- (d) The readout shall be capable of displaying the temperature of the transducer directly in °C from the thermistor incorporated in the sensor.
- (e) The readout units shall have the following provisions:
 - Digital reading
 - Storage of last reading
 - RS-232 interface to transmit readings to a computer.
- (f) The readout units shall be powered by DC batteries and be light, robust and durable.

19.3. UPLIFT PRESSURE GAUGES

19.3.1. Requirement

- (a) Uplift measuring devices shall be installed on top of boreholes or piezometers.
- (b) They shall consist of tubes connected to the borehole or piezometers, a valve to release toe pressure and to measure the discharge and a readout manometer. The manometer shall permit readings up to 10 bars with an accuracy of 0.05 bar.

19.4. SURFACE MOVEMENT POINTS

19.4.1. General

The Contractor shall supply, install and survey all surface movement points including pipes, pipe fittings, survey pins, and concrete. The Contractor shall also supply six approved survey targets for temporary mounting on the survey pins.

19.4.2. Material and Installations

- (a) Pipe and fittings for surfaces movement points shall be galvanised mild steel in accordance with Standard Technical Requirements. The survey pins shall be stainless steel.
- (b) The Contractor shall carry out all work necessary for the installation of surface movement and points within 0.5 m of the required position and shall complete the installations as soon as practicable after completion of the excavation support at the locations at which surface movement points are required.
- (c) Immediately after installation of any point, its position and level shall be precisely surveyed and co-ordinates calculated to the nearest 5 mm and this data reported to Employer in writing.

19.5. GROUNDWATER OBSERVATION HOLES

19.5.1. General

- (a) The Contractor shall drill 75 mm diameter groundwater observation holes and install slotted PVC casing in, and galvanised steel covers over the holes as directed by the Employer. The Contractor shall supply an electrical-signal type measuring device for measuring water levels in these holes.

19.5.2. Materials

- (a) The PVC casing shall be an approved type which is capable of being installed without deformation. The external diameter of the casing shall be of size such that will occupy the full diameter of the hole but allow sufficient clearance for installation. The size, location and spacing of the slots in the casing shall be as approved by the Employer.
- (b) The covers over the top of the groundwater observation holes shall be constructed from 100 mm diameter galvanised steel pipe and fitted with lockable caps.

19.5.3. Installation

- (a) The groundwater observation holes shall be drilled to the full-length using bits and methods adapted to the material being drilled so that caving of holes is minimised. Immediately after each hole has been drilled, the slotted PVC casing shall be installed for the full length of the drilled hole. The lower end of the casing shall be pointed or shaped to assist installation and prevent any material from entering.
- (b) Immediately following installation of the slotted casing in all holes, the Contractor shall grout in the covers and after the grout has set, survey the covers.

19.6. BOREHOLE STANDPIPE PIEZOMETERS

19.6.1. General

- (a) The Contractor shall supply, install, test and survey borehole standpipe piezometers and ancillary measuring equipment in the locations as shown on the Drawings.
- (b) The borehole standpipe piezometers shall measure the groundwater level at various locations as shown on the Drawings or as directed by the Employer.

19.6.2. Instrument Specification

- (a) The borehole standpipe piezometers shall consist of an approved PVC standpipe tube with a Cassagrande ceramic piezometer tip or equivalent.
- (b) The Cassagrande piezometer tips shall be fitted with fine grained porous ceramic elements having:
 - a soil contact surface area not less than 30 000 mm².
 - a maximum overall diameter of 60 mm.
- (c) The piezometers shall be connected to the ancillary measuring equipment at the top of the borehole by tubing meeting the specified requirements.

- (d) The ancillary measuring equipment will consist of a Dip-meter or approved equivalent. The Dip-meter shall be portable and be operated by dc battery.

19.6.3. Installation and Testing

- (a) Borehole standpipe piezometers are to be installed in drill holes and the Contractor shall drill and case, where necessary, holes of 100 mm minimum diameter into the excavation for the installation of the piezometers.
- (b) After installation of the borehole standpipe piezometers in the boreholes, the Contractor shall withdraw any required casing, taking all precautions against damaging the piezometer installations. The Contractor shall backfill grout around the standpipe in accordance with the details shown on the Drawings.

19.7. WATER LEVEL MEASURING GAUGE

19.7.1. Requirement

- (a) The Contractor shall supply and install water level measuring gauges near upstream of the diversion weir.
- (b) The gauges shall be enamelled ironware with melamine resin coating and shall be subject to the approval of the Employer. The principal division shall be in meters above sea level which will be further divided into centimetres. The lettering shall be every 10 cm with large, clearly legible letters.
- (c) The Contractor shall set the gauges by accurately levelling from a designated benchmark. The gauges shall be fixed properly.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**INTERNATIONAL COMPETITIVE BIDDING (ICB)
[Single Stage Two Envelope Bidding Procedure]**

**VOLUME – 2 of 5
EMPLOYER’S REQUIREMENTS**

**SECTION III - STANDARD TECHNICAL REQUIREMENTS
FOR
HYDROMECHANICAL WORKS**

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
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LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS

CHAPTER 1
GENERAL

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1 GENERAL

- (a) The "Standard Technical Requirements for Hydromechanical Works" describes the hydromechanical equipment and associated auxiliaries to be designed and installed for the Ghunsa Khola 77.5 MW Hydroelectric Project.
- (b) Indications of limits of supply and activities, indicated in these requirements, are intended to give only guidelines for possible sub-contracting of the various works composing the plant but the Contractor shall remain responsible for the supply of the whole plant and the coordination of the various works and activities.
- (c) Even if the materials or works which are obviously necessary for the proper and safe construction, operation, and maintenance of the plant are not present in requirements and/or drawings of the documents, all such materials and works shall be deemed to be included in the supply.

2 DESIGN

- (a) The design and supply of hydromechanical equipment shall comply with latest DIN, ISO, BS, ASME, ASTM, IS, GB or other approved standards subject to no-objection of the Employer.
- (b) All supporting structural parts and connections of the hydromechanical equipment shall be calculated based on the most unfavorable load assumptions. Structural parts subjected to buckling, overturning and bulging strains shall be analyzed to DIN EN 1993, or similar standards.
- (c) Where multi-axial stresses occur, it shall be proved that the comparative stresses according to the hypothesis of deformation energy are not exceeded. Deformation of structural parts shall be permissible to an extent, consistent with the operational requirements.
- (d) For dimensioning of hoists, all unfavorably occurring load cases shall be taken into account. The lifting forces shall be calculated according to the latest DIN 19704 - part 1, 2 and 3, under consideration of all dead weights, friction forces, acceleration forces, efficiency of hoists, etc.
- (e) The material to be used for manufacturing of hydraulic steel structures shall conform to DIN EN 10025 or equivalent ASTM approved standards.
- (f) The Contractor, however, shall use only the structural steel types S235JRG2 and S355J2G3 or ASTM A 36. For these structural steels and relevant bolts, rivets and welds, the permissible stresses shall be in accordance with the latest DIN 19704.
- (g) The design of the steel pipe and accessories shall be carried out according to American Society of Civil Engineers (ASCE) – "Steel Penstock Manuals and Reports on Engineering Practice No.79".
- (h) The codes and standards used during the design, manufacturing, erection, installation, testing and commissioning shall be made available to the Employer in English

(i) In case the Contractor intends to supply other than the above-mentioned materials, he can do so, provided their equivalence to the specified material standards is verified by the Contractor and approved by the Employer. The safety factors in relation to the yield point as stated in the latest DIN 19704 shall be adhered to.

(j) For all structural parts which are acting underload against the concrete structures, the following permissible stresses (viz. DIN 1045) shall not exceed the following values:

- Mean permissible compressive stresses 6 N/mm²
- Permissible compressive stresses on edges 8.5 N/mm²
- Permissible bond and shear stresses 0.8 N/mm²

(k) All information related to the supplies shall be based upon the International System of Units (SI) and in English language. All text on instrument indicator scales shall be written in the English language and in SI units. Other units and languages in addition of SI units and English can be used upon the approval from the Employer.

(l) As far as possible, measures shall be taken to standardize certain parts of the plant to be installed in order to facilitate for keeping stock, maintenance, replacements, interchanging etc. The Employer, therefore, reserves the right to request the Contractor to use a certain type or make of small material. The Contractor shall not be entitled to extra payment because of this request. This request shall apply to small mechanical and electrical equipment such as valves, thermometers, pressure gauges, flow meters, water levels gauges, sight flow indicators, terminals and terminal racks, indicating instruments and meters, auxiliary relays, contactors and miniature breakers, motor protections, control devices and control switches, lamps, bulbs, plug, sockets, fuses, oil and lubricants etc. The types or makes to be used shall be decided by the Employer in cooperation with the Contractor.

(m) The noise level caused by the plant shall not exceed the following value:

- Machine hall or any place 2 m distant from operating plant 80 dB(A)
- Offices, control rooms, etc. 55 dB(A)
- First aid rooms, canteens, etc. 55 dB(A)
- Residential areas: day time 50 dB(A)
night time 35 dB(A)

- (n) The measurement of noise shall be carried out in accordance with ISO and IEC standards. The 'operating plant' includes hydraulic units and other permanently installed equipment including cranes, and hoisting equipment.
- (o) All rotating and moving parts shall be designed to operate without undue vibration. Special precaution is to be taken to run the equipment smoothly. The rotating and moving parts shall be properly covered for safe operation.
- (p) The balancing shall be done to a maximum extent at the works. Trim balancing shall not be carried out at site to bring down vibration level to acceptable limits.

3 DOCUMENTATIONS

- (a) The documentation relevant to the design, testing during manufacture, transport, storage, installation, site testing, erection, operation and maintenance manuals, lists of spare parts and special tools and any other necessary document for the hydromechanical and relevant electrical and control equipment shall be submitted for approval, or for information when specifically accepted by the Employer.
- (b) A complete list of the documentation shall be timely submitted for approval by the Contractor. For the design, at least the following documents shall be submitted to the Employer for approval.

3.1 Documents to be Submitted during Bidding

- (a) During submission of bidding documents, the followings shall be submitted:
 - Information as specified in Tender Documents/Technical Requirements,
 - Quality Assurance Manual,
 - Preliminary Programme of Works,
 - Layout drawings of all main plant and assemblies and process flow diagrams,
 - Preliminary transport and erection information.

3.2 Design and Manufacturing Documentations

- (a) During engineering and manufacturing, the following documents shall be submitted by the Contractor for the approval by the Employer:
 - Preliminary design data
 - Intermediate design data
 - Final design data
 - Complete plant data

- (b) Preliminary Design Data: Within Twenty-eight (28) days after the Commencement Date, following sets of basic drawings and design data that influence on other works than hydro-mechanical works shall be provided:
- Overall layout,
 - Equipment arrangement and outline drawings,
 - Weights and foundation forces,
 - Power supply requirements,
 - Motor schedules,
 - Instruments schedules,
 - Control, indication and operation principles,
 - Manufacture and inspection schedule,
 - Other relevant drawings and documents.
- (c) Intermediate Design Data: Within 240 days after the Commencement, following sets of drawings and design data in updated form shall be provided:
- Equipment arrangement drawings,
 - Control room arrangement,
 - Foundation plans with frames, sole plates, anchoring iron etc. to be embedded in first stage concrete, with grouting information if applicable,
 - Block diagrams and process flow diagrams,
 - Piping and instrumentation diagrams,
 - Electrical circuit diagrams for power and data distribution,
 - Supervisory apparatus wiring diagrams,
 - Interconnection schedules and cable lists,
 - Earthing system,
 - Process signal interface diagrams (loop diagrams),
 - Alarm, protection, and trip schedules,
 - Component data sheets,
 - Installation drawings (Hook-up),

- Arrangement of terminal boxes and auxiliary cubicles,
 - Manufacturing and testing schedule,
 - Shipment schedule,
 - Other relevant drawings and documents.
- (d) Final Design Data: At the end of the design period, at least the following documents (from e to j) with at least 4 hard copies and an electronic copy shall be submitted to the Employer for approval.
- (e) Trash Racks
- Specification
 - Dimension drawing
 - Execution drawings for:
 - Embedded parts
 - Trash rack panel
 - Traverse beams
 - Loading drawings
 - Execution drawings for erection/handling facilities
 - Foundation drawings
 - Calculations
- (f) Maintenance gates
- Specification
 - Dimension drawings
 - Execution drawings for:
 - Gate panel
 - Gate seals
 - Embedded parts
 - Arrangement drawing
 - Loading drawings
 - Execution drawings for erection/handling facilities
 - Foundation drawings

- Calculations
- (g) Gates and Valves
- Specifications
 - Dimension drawings
 - Execution drawings for:
 - Gate panel
 - Seals
 - Embedded parts
 - Arrangement drawings
 - Loading drawings
 - Hoisting details
 - Schematic diagram for gate /valve control
 - Execution drawings for erection/handling facilities
 - Foundation drawings
- (h) Calculations: Steel Bend, Steel Linings, Penstock and Accessories
- Specification
 - Dimension drawings
 - Execution drawings for:
 - Bellmouth transition
 - Straight pipes
 - Bends
 - Trifurcation manifolds
 - Reducers
 - Branch pipe and bends
 - Steel lining
 - Manifolds
 - Flanges
 - Surge tank throttle

- Man doors/ Manholes
- Winch machine
- Scaffolding carriage (with guide pulleys)
- Arrangement drawings
- Circuit diagram for scaffolding carriage
- Loading drawings
- Execution drawings for erection/handling facilities
- Foundation drawings

(i) Calculations: Hoists, Cranes and Accessories

- Specifications
- Dimension drawings
- Execution drawings for:
 - Runway
 - Crane bridge
 - Trolley with hoist
 - Carriage
 - Hook
 - Jib crane
 - Operator's cabin
 - For crane controls:
 - Circuit diagram
 - I/O Lists
 - Loading drawings
 - Execution drawings for erection/ handling facilities
 - Foundation drawings

- Calculations

(j) Electrical Items

- Single Line Diagrams

- Circuit Diagrams
 - Schematic Diagrams
 - Cable lists
 - Cable Connection Diagrams
 - Block Diagrams
 - Terminal Block Diagram
 - Arrangement Drawings
 - Equipment Outline Drawings
 - Part List
 - Voltage drop, short circuit calculation
 - Selectivity verification
 - Illumination level calculation
- (k) Complete Plant Data: On or before 14 days; before starting site erection, testing, and commissioning, complete data for plant operation shall be handed over to the Employer. The documents shall be divided in at least the following sections:
- Functional descriptions, with all relevant calculations and diagrams,
 - Installation, erection, and disassembly/reassembly descriptions,
 - Operational instructions,
 - Maintenance instructions,
 - Site test and commissioning schedule.

3.3 Final Documentation

- (a) This requirement describes the data and information required by the Employer as As-Built Documentation. Delivery of this documentation in the form specified herein is part of the overall Contract. The documentation requirements are applicable for all work classified as permanent work. The As-Built Documentation shall comprise all work under the contract.
- (b) Final plant documentation shall be handed over to the Employer not later than 120 days after Taking Over. The final documentation shall consist of the complete documents incorporating all modifications carried out during the erection and installation of the Works.

- (c) Spare parts catalogues shall be supplied, giving all necessary data for ordering of spare parts directly from the manufacturers.
- (d) Following the final documentation, the Contractor shall submit the Commissioning Report bound in a separate volume.
- (e) Documents that provide direct evidence of the quality (conformance to requirements) of delivered plant and work performed shall be retained by the Contractor for a minimum period of 10 years. All information in these records shall be traceable from documents included in the As-Built Documentation.
- (f) Within this period, the Contractor is responsible for meeting all Employer's requirements for retained documentation and related information.
- (g) The Contractor is responsible for co-ordinating his subcontractor's traceability systems to make them comply with the project requirements and make sure that all subcontractor documentation, as required in the requirement, is identified.
- (h) The final documentation shall be arranged in the following groups:
 - A - Drawing file
 - B - Test Reports & Certificates
 - C - Plant Data
 - D - Operation and Maintenance Manuals
- (i) All drawings and documents should reflect the As-Built stage including all modifications and/or adjustments performed during engineering, fabrication and installation if applicable.
- (j) Additional to paper copy deliverance described below, all written documentation shall also be delivered on softcopy version.
- (k) The softcopy version of documentation shall be compatible with the Employer's software, Microsoft Word and Excel and the Auto CAD or equivalent software.
- (l) Group A: Drawing File
 - The Drawing file shall contain all necessary drawings and diagrams for identification, installation, testing, operation and maintenance purposes including the above describe components.
 - Drawings should be reduced to A3 size, folded to A4 size with the title visible, inserted two by two in plastic wallets (opening on top) and bound in A4 binders.
 - A drawing index shall be incorporated at the start of the drawing file and the drawings shall be filed in drawing number sequence.
- (m) Group B: Test Reports and Certificates

- Group B shall contain all computer analysis documentation, test and certification documentation relating to the plant which has to be produced according to contract, i.e.:
 - Specifications and procedures
 - Test Reports
 - Certificates
- A detailed index shall be incorporated in the beginning of the book and the documentation should be collated in the sections indicated above and presented by plant name/tag number. All documentation shall be collated in document number sequence within the sections.

(n) Group C: Plant Data

- Group C shall contain all relevant technical data relating to the plant. The documentation should be structured as below:
- List of plants (i.e. list of separately tagged items together with the plant serial number and the name of the supplier of sub-supplier as appropriate)
 - Consumption List
 - Data Sheets
 - Calculations
 - Other relevant technical information
- A detailed index shall be incorporated in the beginning of the book and the documentation should be collated in the sections indicated above.
- All documentation shall be collated in document number sequence within the sections.

(o) Group D: Operation and Maintenance Manuals

- Operation and maintenance manuals shall give information of safe, correct and efficient operation and maintenance of the plant. All manuals and descriptions shall be in English language.
- Maintenance and trouble-shooting instructions shall be included together with a detailed description of manual start procedures. System descriptions that are only to be used by specialists shall also be in English language.
- Maintenance documentation for all plant included in the Contract shall be submitted. The documentation shall be completed with regard to all kinds of components and assemblies, detailed repair work at component level, and testing and adjustment of the plant.

- The relevant data/information shall be collated and presented in the following sections and sequence as applicable:
 - Technical specification and reference data
 - Handling, installation, storage, and transit
 - Operating information
 - Technical description
 - Maintenance information
 - Parts list - spare parts
- A detailed index shall be incorporated at the beginning of the book. All documents shall be collated in document number sequence within the sections.
- The maintenance documentation shall also be handed over in electronic form for implementation in a future computer assisted maintenance management system and shall contain the following information:
 - Maintenance instructions for routine maintenance, indicating all periodic inspections required, the inspection procedure and the period between inspections.
 - "Trouble shooting" instructions describing procedures for error diagnosis and identification of faulty modules and assemblies and the replacing of such modules or assemblies.
 - Condition monitoring with respect to levels of vibration.
 - Repair instructions describing procedures for repair work at sub-module and sub-component level, using fault-tree diagnosis diagrams, logic signature and analysis, oscilloscope patterns, logic bit patterns, etc., and any necessary diagnostic programs and instruction manuals, etc.
 - Detailed maintenance drawings shall be supplied enabling the Employer to carry out proper maintenance and repair work. These drawings shall indicate sufficient details, dimensions, tolerances, clearances, and material specifications to enable the repair or replacement of such parts as is common practice to perform.
 - Testing and adjustment instructions describing procedures for testing and adjusting plant, modules or sub-modules during operation, as routine maintenance work or after repair work.
- The maintenance instructions shall provide lists of required test instruments and maintenance tools, diagrams showing test instruments connections and instruments setting, and detailed step-by-step procedures for identifying faulty

plant where at each step are specified the instrument set-up, the correct measurement at this stage and the route(s) to follow when incorrect measurements.

- The detailed technical descriptions, diagrams and charts which are required as reference documentation for the detailed fault identification, repair and tests and adjustment procedures, are assumed included in the system documentation.
- It is further assumed that those parts of the maintenance instructions which cover the preventive and routine maintenance and "first-aid" maintenance of the computer systems, and which do not require specific test instruments or maintenance tools except for such plant that may be built into the particular computer assembly, shall be incorporated in the user documentation as well as in the maintenance documentation.

REMIT HYDRO LIMITED
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BIDDING DCOUMENT
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LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS

CHAPTER 2
TRASHRACKS

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1 GENERAL

- (a) The intake of large floating debris and other injurious materials shall be prevented by use of trashracks. The trashracks sometime may act as safety device to prevent the ingress and/or access of human beings.
- (b) The specific requirements of the trashracks at each location is given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified sets of trashrack, each trashrack set comprises specified number of panels for installation.
 - Specified sets of embedded parts including trashrack sills and lintel for trashrack with supporting plate strips embedded in streamlined shaped concrete columns.
 - Specified sets of horizontal intermediate support beams with their embedded parts transferring load from trashrack panels to the concrete columns/walls.
 - One set of all special tools and special equipment necessary for operation, repair and maintenance of the supply. The equipment includes but not limited to ladders, hammers, safety harnesses, diving equipment etc.
 - Spare parts and tools as mentioned in Clause 7 of this Chapter.
- (b) All other equipment, accessories, frames, fixed or movable parts, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the trashracks.
- (c) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The design calculation for the trashrack equipment shall be based on latest version of DIN 19704 Parts 1, 2 and 3 - "Basis for Calculation of Hydraulic Steel Structures" or equivalent International Standards.

- (b) The stress analysis shall be based on two (2) separate operation load cases and conducted for all structural parts as well as connections.
- (c) The different operation load cases shall consider the following data:
- Normal operation load case,
 - Extraordinary operation load case with earthquake forces with the maximum acceleration magnitude specified by national regulations and maximum load on the rack.
- (d) The stress analysis shall be executed for the governing load case, on the basis of the permissible stresses stated in latest DIN 19704.
- (e) Special attention shall be paid to the problems of flow-induced vibration and fatigue in the design of the trashrack. The trashrack shall not fail under choking condition during operation. The Contractor shall design, manufacture, and erect the trashracks to avoid these failures.
- (f) The average flow velocities shall be calculated for flow conditions across the effective Trashrack area.
- (g) Unless otherwise specified, the following normal loading conditions of the Trashrack shall be considered:
- Temporary loads during handling, transport, assembly and erection, for which no permanent deformations and detrimental stresses shall occur.
 - Uniform load (differential water head) of 6.0 m to be applied to the entire developed area of trashrack panels. In case of Intake trashrack, however, head on sill water level shall be taken.
- (h) Each panel shall be provided with at least two fixation points at each side of the section to restrain lateral movement of the panel. For the fixation, stainless steel bolts, nuts and washers shall be used.
- (i) At least two bearing pads shall be provided on the top and bottom of the trashrack panel to avoid direct contact of the panel members with other panels. Similarly, at least four bearing pads shall be provided on back side of the panel to avoid direct contact of the panel members with the support structure.
- (j) To ensure proper seating of one panel over another, pilot pins shall be provided. Bars of any panel shall be fabricated/installed in such a way that they shall be directly in line with the corresponding bar above or below, so that there is no problem for operating cleaning rake while passing up and down the screen.

- (k) Provision for corrosion allowance of 2 mm shall be provided for the trashrack bars.
- (l) The steel used for the construction of the trash rack panels, beams, frame and embedded parts shall comply with EN 10025 or equivalent national/international standard.
- (m) Bolts, nuts, washers, pins, and similar items shall, in general, be made up of stainless steel.
- (n) The Contractor shall submit test certificates from steel manufacturers to the Employer. However, Employer has the right to take the sample piece of the material for testing of Mechanical and Chemical properties in witnessing the Employer. All expenses of such testing shall be in account of the Contractor.
- (o) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4 SPECIFIC REQUIREMENTS

4.1 Trashrack Assembly

- (a) Trashracks at each location shall consist of the required number of trashrack sets and each trashrack set shall consist of the required number of the trashrack panels.
- (b) Each of the panels shall be fixed to the embedded parts (sill, lintel and the intermediate support) by bolting.
- (c) The trashracks assembly shall be designed to ensure minimum head losses at the given design parameters.
- (d) The trashrack panels shall be identical/interchangeable to ensure easy installation and replacement.
- (e) Basic normal load assumption for the trashracks assembly shall be a uniform maximum differential head of 6.0 m.

4.2 Trashrack Panels

- (a) The depth of trash bar shall not be more than 12 times the thickness. The distance from the face of the rack to the stiffening rods or other horizontal members shall be at least 40 mm for the ease of raking.
- (b) The laterally unsupported length of the trashrack bars shall be less than or equal to 70 times the thickness. The minimum unsupported length shall be the least one between this requirement and the length determined based on vibration requirements.

- (c) The trashrack panel shall be provided with bearing pad having thickness more than or equal to 10 mm to protect protective coating of the panel from abrasion.
- (d) In order to assure safety against rack bar resonance and developing vibrations of harmful magnitudes, the distance between the lateral stiffeners representing the unsupported length of the rack bars, shall be determined suitable.
- (e) A natural frequency of the rack bars of at least 2.5 times the vortex shedding frequency shall result. This also applies in case the calculation of strength alone might permit larger distances between the horizontal stiffeners.
- (f) Further, supplementary spacers shall be inserted between the rack bars in order to modify the natural frequency of the unsupported length of each individual rack bar.
- (g) Hooks shall be provided in each trashrack panels to enable lifting of the rack, whenever necessary.

4.3 Trashrack Supporting Structure

- (a) Each trashrack section shall be supported by at least one horizontal supporting beam and to the sill and lintel embedded steel construction.
- (b) The cross-section of the supporting beams shall be hydraulically shaped in order to obtain minimum head losses and to avoid vortex shedding.
- (c) The supporting beams shall be secured with end covers and thrust plates transmitting the horizontal forces into the side walls.

4.4 Embedded Parts

- (a) The embedded parts shall be fabricated and installed in such a way that the tolerances are maintained, before and after concreting, within 1.5mm of the dimensions indicated on the drawings.
- (b) Each power intake opening shall be equipped with a horizontal sill and lintel beam for embedding in concrete and at least one intermediate horizontal support.
- (c) The embedded parts shall be designed for load transfer to the concrete structure.
- (d) The trashrack frames shall be continuous and suitable for guiding both the trashacks and the lifting frame. The trashrack frames shall be capable of being assembled in blocks with anchor bolts or pads embedded in first stage concrete. After assembly, the frames shall be accurately located and aligned and then embedded in second stage concrete. All working surfaces shall be free of twists and warps.
- (e) The second stage concrete shall be of at least M 25 grade.

- (f) To ensure satisfactory earthing, each embedded frame shall be electrically continuous at all joints.

4.5 Corrosion Protection

- (a) The Trashrack shall be galvanized in agreement with the requirement specified in the General Technical Requirement, chapter-16.

4.6 Tolerances

- (a) The following manufacturing and installation tolerances shall apply. The manufacture of the various parts shall be such that the installation tolerances can be achieved by adjustment of the anchor bolts without additional jacking, straightening, correcting or grinding during erection and installation.

Parts in first stage concrete	Anchor bolts or pads and other parts embedded in first stage concrete shall be to location and level within ± 6 mm.
Guides	Faces of guides shall be within ± 1 mm. Gaps or offsets at joints shall not exceed 0.03mm.

4.7 Earthing

- (a) Earthing connections from the equipment to the embedded earthing grid shall be provided. Anchor bolts shall be used for welded connection to the embedded earth bars.

5 INSTALLATION

- (a) Top and bottom supporting frames and beams shall be installed in their block-outs in accordance with the final approved drawings, brought to line and grade with the erection tolerance specified and firmly secured in place.
- (b) Alignment bolts of other necessary device shall be used to install the supporting frames accurately. Placement of concrete in the block-out shall not proceed until the trashrack supporting frames have completely been installed and secured.
- (c) The trashracks panels shall be installed in accordance with the details shown on the final approved drawings.
- (d) Sampling inspection shall be made on the pitch of the bars prior to installation and during installation to ensure accurate alignment with the trash-rack rails.

6 TESTS

6.1 Test on Completion

After completion of the installation works at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.

6.1.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
- Radiographic or ultrasonic examination of any site weld in load carrying members, other than seal welds.
 - Inspection of satisfactory installation of all components.
 - Verification of correct tightening of all bolts.

6.1.2 Commissioning Tests

A detailed commissioning test procedure shall be submitted to the Employer's approval. The commissioning tests shall be carried out according to said procedure.

The Commissioning Tests shall include, but not be limited to the following:

- Measurement of operation speeds
- Check of limits of travel
- Check of manual operation of hoisting equipment
- Check of general satisfactory operation
- Check of satisfactory operation for handling the rake under an acceptable reservoir water level

7 MANDATORY SPARE PARTS AND TOOLS

- (a) The following spare parts shall be furnished:
- The spare parts for the trashracks shall consist of ten (10) % of the all bolts, nuts, screws and washers.
 - 5 (five) grease nipples and/or cups for each size and type and grease gun with appropriate nozzle
 - Minor items to ensure the operation for not less than five years from the Taking over Certificate.

- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

8 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They shall be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, shall read these Technical Schedules with care and complete them most conscientiously and with every necessary detail.

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BIDDING DOCUMENT
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CHAPTER 3
TRASHRACK CLEANING MACHINE

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1 GENERAL

- (a) For the automatic and rapid removal of trashes from a trashrack, trashrack cleaning machine (TRCM) are used. The machines may be used for the installation and removal of the trashrack panels. Grapples are used for the removal of the large size objects, if available.
- (b) The specific requirements of the TRCM at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of trashrack cleaning machine at each location consisting of:
 - One (1) set of trash rack cleaner, complete with rake, rake hoist, hoisting beam etc.
 - One (1) set of rails and power supply with all anchorages, bumpers and other essential embedded parts.
 - One (1) set of all necessary anchors, bolts, ribs, foundation plates, feet, lugs, temporary internal strengthening structures and any other device for alignment and fixing to the concrete.
 - One (1) set of equipment for the hoisting boom, grapplers, hooks etc.
 - One (1) set of control cabinet.
 - One (1) set of trolley for transportation of the trash.
 - One (1) set of all tools and special equipment necessary for operation, repair and maintenance of the supply.
 - Spare parts and tools as mentioned in Clause 7 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) In designing, all relevant factors that have a bearing on the calculations and design must be considered, e.g., water velocity in all directions, gross and net loads, erection procedures etc. The most unfavourable situation shall be taken as the basis and governing factor for the final design.
- (b) The TRCM shall as far as applicable be designed according to the various FEM-rules as used for cranes.
- (c) When the TRCM is out of operation, it shall be positioned and secured in the parking position.
- (d) The machine shall be equipped with load cells and limit switches for safe operation. Device for head loss measurement across the trashrack shall also be supplied and installed along with the TRCM.
- (e) All the rotating and moving parts shall be protected by sheet metal guards, wireframe, or other convenient protection devices.
- (f) The TRCM shall be designed for outdoor operation. During design, manufacturing and installation, care shall be given that the TRCM operates in remote area and requires high reliability of operation.
- (g) The material to be used for construction of the structural parts shall be structural steel according to EN 10025 or equivalent.
- (h) All hinged joints, wheel spindles, gears, etc. shall be equipped with self-lubricating bushings/bearings. All spindles/axles shall be made from stainless steel.
- (i) The Contractor shall submit detailed information about the types and the grades of materials which he proposes to supply for the major parts of the delivery with reference to relevant standards. If special materials are used, information about chemical composition, possible heat treatment and mechanical properties shall be included.
- (j) In addition to these requirements, some specific requirements are given in Particular Technical Requirements. A standard TRCM is foreseen, but a detailed equipment specification is not possible. The Contractor shall suggest for the possible better solutions, which should be used after the approval of the Employer.

4 SPECIFIC REQUIREMENTS

4.1 Trashrack Cleaner

- (a) The supply shall include a complete trash rack cleaning machine including hoist, rake, grapple, controllers, and rails.

- (b) The TRCM shall travel along the whole width of the trash rack. Travelling mechanism shall be electrically operated, lateral positioning of the rake and the operation of the cleaner shall be manually controlled. Hoist shall be operated hydraulically or operate otherwise as per the Employer's approval.
- (c) The collected trash shall be dumped into a trolley running under the TRCM.
- (d) The TRCM shall be sturdy dimensioned to carry the load of the hoist machinery. If the machine frame is subdivided during transportation, major joints shall be dowelled and bolted.
- (e) The roller shall have double flanges and the wheel carriages shall have buffers at the outer side as well as sturdy retainers to prevent the cleaner from tilting at adverse conditions, i.e., both maximum rake and hoist boom load. Sufficient counterweights for either the maximum rake load or the maximum hoist boom loads shall be provided.
- (f) The rake shall travel the total height from top to of the intake structure to the bottom sill of the trash rack.
- (g) No part of the structure shall interfere with the trash racks itself.
- (h) The teeth shall close automatically towards the trash rack when the bucket reaches the lowest point of its run and the teeth shall match perfectly with the trash rack bars.
- (i) Collected trash shall be firmly held by/in the basket when the bucket is running upwards.
- (j) Special guide plates with stiffeners etc bolted to the TRCM frame shall allow the bucket to travel to the upper-most position.
- (k) The hoisting and cleaning mechanism shall rest on the main structure of the cleaner when not in use.
- (l) The cabinet shall contain all parts of the operating machinery, electrical components and ample room for inspection and maintenance. Electric light shall be included as well as door locks.

4.2 Hoist and Hoisting Boom

- (a) A hoisting boom shall be supported on the TRCM frame, being able to swivel nearly a full circle by an electric motor.
- (b) The hoist shall have a double lifting system, and shall be used for the following purposes:
 - With a grappler, remove larger logs and similar from in front of the intake. If the headwater is drawn down, it should also be suitable for removing larger stones from the under-sluicing trash racks.

- With the raking system, trashrack cleaning.
 - With the raking system (with special attachments/modifications, if necessary), set and remove the trashrack panels. Hence, the trashrack panel design shall be duly considered.
 - General maintenance purpose within the hoist boom capacity and operating area.
- (c) The hoist boom might also be used in assisting the erection of some of the other items at the intake.
- (d) The hoist and the hoist boom shall be operated from the TRCM operating platform, or from a movable pendant.
- (e) The supply includes a suitable grapple with operating mechanism. The hoist boom shall be provided with a flood light at the outer end.

4.3 Rails and Electrical Supply

- (a) The rails shall be erected on the deck, with anchorage to withstand possible uplifting forces from the TRCM or the hoist. The rails shall be provided with sturdy brackets and/or buffers at each end.
- (b) The heavy duty, corrosion resistant hand-safe electrical supply, protected at least to IP 23, shall be supplied, being protected against mechanical damage. At a point near the suitable end of the rails, there shall be an electrical terminal box, having protection class IP 65, with an emergency switch in front. Electrical supply up to this box shall be the part of the Electrical Works.
- (c) The rails and the electrical conductor will cross some expansion/contraction joints in the concrete, to be considered during the design.
- (d) There may be adjustments of the lengths of the rails and the electrical connector.

4.4 Trolley

- (a) The supply shall include a trolley, designed for running on dam crest. The trolley shall have rubber tires with ball bearings, usually connected to following the lateral movement of the cleaner. In addition, the trolley shall have a standard connection for pulling or pushing by a tractor, the latter not being a part of the supply. The trolley shall be designed to allow easy, manual emptying to both sides and on rear side.

4.5 Control and Monitoring

- (a) The trashrack cleaning machine shall be equipped with a control desk for operation from the operator's cabin, and for the control of the travelling, hoisting and cleaning operations.

- (b) The desk shall be equipped with an emergency mushroom switch for tripping of the main circuit breaker, with key switch acting on the main circuit breaker with overload warning lights for the hoist and with a slack rope warning light ampere meter, and an indicating instrument for the depth of the relevant trashrack elements during operation.
- (c) The trashrack cleaning machine shall be equipped with control circuit transformers, motor starters and thermal overload protection for each motor. Adjustable limit switches of inductive type actuating the circuit breaker shall be provided for limitation of the lifting and lowering range of trash collecting bucket.
- (d) The hoist/s of- the trashrack cleaning machine shall also be equipped with a cut-off switch for loads exceeding the rated capacity.

4.6 Wiring

- (a) All wiring on the crane and on its components shall be completed at the contractor's plant, except the wiring which disturbs the manufacturing, transportation, and erection.
- (b) However, a sufficient -quantity of cable and associated materials of the proper sizes and types shall be included with the supply to permit completion of the crane wiring in the field.
- (c) Electrical wiring within the equipment shall be neatly arranged, properly supported, uniformly colour coded, and terminated so that all external connections can be made to terminal blocks inside the equipment or in terminal boxes. Control circuits and power circuits shall be completely separated by use of divided or separate terminal boxes.
- (d) Marking strips shall have wire designations as used on the wiring diagram or as designated by the Employer. No more than 2 wires shall be connected to any one terminal block screw.

4.7 Lighting and Convenience Outlets

- (a) The inside of the operating cabin and the upper platform shall be suitably lighted and the minimum lighting intensity (measured 80 cm above the floor) shall be 500 Lux.
- (b) Outdoor lighting of the trashrack cleaning machine shall include minimum:
 - 2 watertight swivelling LED floodlights with at least 160 W capacity located in such a position that they can illuminate the rail track of the TRCM,
 - 2 watertight swivelling LED floodlights with at least 160 W capacity in order to illuminate the cleaning operations.

- (c) The control of the outdoor lighting shall be at the foot of the entrance ladder and in the operator's cabin. At least four 230 Volt convenience outlets shall be provided; at least two of them shall be at the operator's station.

4.8 Fire Protection

- (a) Provision shall be made for two portable dry powder fire extinguishers of approximately 6 kg weight fitted in the following locations:
- Inside the operating cabin,
 - At the main switchboard.
- (b) The instructions for use shall be clearly marked on each extinguisher.

4.9 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter "Surface Treatment and Painting" of General Technical Requirements, chapter-16.

5 INSTALLATION

- (a) The Contractor is responsible for the total installation of the trashrack cleaning machine. He shall furnish all materials and devices required for supporting and holding parts in position during installation and while the concrete is being placed.
- (b) The Contractor shall perform the following for the installation of each TRCM:
- Install all second stage concrete embedded items of the TRCM rail system,
 - Install all non-embedded parts,
 - Prepare a permanent record of elevations, clearances, tolerances, and similar measurements established at the time of erection. This record shall be checked and if necessary, supplemented by additional measurements taken by the Contractor at the direction of the Employer before the TRCM is commissioned.

6 TESTS

6.1 Shop Assembly and Test

- (a) The trashrack cleaning machine shall be completely assembled at the shop and respectively divided into suitable sub-assemblies to allow final inspection and performance of functional tests.
- (b) In particular, the following tests shall be carried out under the supervision of the Employer:
- Checking of the main dimensions,

- Full load and 25% overload test shall be done at manufacturer's work on TRCM.
 - Operation of brakes.
 - Operational test of all drives, including measurement of operating speeds, cleaning mechanisms and load switch adjustments,
 - Function tests of the complete control system, measurement of stator winding insulation resistance on all driving motors, voltage test and insulation test on electrical installations.
- (c) The test equipment and instrumentation shall be provided by the Contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled, touch-up painted and packed for shipment.

6.2 Test on Completion

After completion of the installation works at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.

6.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
- Radiographic or ultrasonic examination of any site weld in load carrying members, other than seal welds.
 - Inspection of satisfactory installation of all components.
 - Rail-track position shall be checked before and after its definitive setting and clamping,
 - No-load test.
- (b) During the testing manoeuvres, the following items shall be checked:
- Correct operation of the brakes and limit switches,
 - Vertical and horizontal travelling distances and approach measurement,
 - Operating speeds,
 - Operation and characteristics of the manual emergency control,
 - Examination of the paintwork.

6.2.2 Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:

- The operations of raising, lowering, holding in any position, and transporting the test loads. The test load for each component will be 125% of the rated load.
 - Operation of the hoists with 100% of the rated loads and rated speeds and determination that the hoisting and cleaning mechanism can be controlled within specified limits.
 - The deflection test shall be carried out with test load i.e., rated load with the main hook in the center of bridge span. The measurement shall not be taken on the first application of load.
 - Brake Tests: All brakes shall be tested under full load condition from maximum speed to rest in less than 5mm, three times in quick succession without overheating.
 - Bumper Tests: The TRCM shall be tested without load and at 30% of the rated speed.
- (b) The contractor is responsible to make all arrangements necessary for the load and operational test and to provide the test weights. During the manoeuvres, the following shall be checked:
- Measurement of operational speeds,
 - Check of the limits of travel,
 - Check of the power consumption of motors and driving equipment,
 - Check of the accuracy of indication and the limit switch setting,
 - Check of the manual operation of the cleaning equipment,
 - Correct the general operation of the safety mechanisms and accessories,
 - Temperature raise of the motors, bearings etc.,
 - Correct behaviour of the trash collecting bucket and travel mechanism along its rolling track: the framework shall remain perpendicular to the track and shall under no circumstances give evidence of any undue deformation,
 - Correct operation and efficiency of the brakes.
- (c) The bearings and other mechanical parts shall also be checked for temperature rises.

7 MANDATORY SPARE PARTS AND TOOLS

- (a) The following spare parts shall be furnished for each trashrack cleaning machine:
- One (1) set of Detachable stainless steel/ high strength polypropylene sheet combing rake teeth strip with stainless steel fasteners

- One (1) set of motor of each type,
 - Three (3) sets of gaskets and seals, if any,
 - One (1) set of bearings, bushes, and pins of each type used,
 - One (1) set of solenoids, controllers, and contactors of each type,
 - One (1) set of overload switches, position indicators,
 - One (1) set of electronic print cards of each type,
 - One (1) set of limit switches of each type,
 - Ten (10) sets of lamps, fuses, indicators, etc.
 - Two (2) sets Oil filters used
 - One (1) set of Solenoid, valves, pressure gauge, and pressure switch of each type.
 - 10% (ten per cent) of all nuts, bolts, screws, and washers.
 - 5 (five) grease nipples and/or cups for each size and type and grease gun with appropriate nozzle
 - Minor items to ensure the operation for not less than five years from the Taking over Certificate.
- (b) Any other general spare parts to ensure the operation for not less than five years from the Taking Over Certificate shall be supplied.
- (c) All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment shall be included in the Supply.

8 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They shall be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, shall read these Technical Schedules with care and complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 4
MAINTENANCE GATES/STOPLOGS**

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1 GENERAL

- (a) To allow the operation of the powerplant and to ensure safety during maintenance, maintenance gates shall be used in front of specified service gates.
- (b) The specific requirements of the maintenance gates/stoplogs at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of maintenance gates at each location consisting of:
 - maintenance gate/stoplog composed, when required of various sections; the complete supply of parts required for the sealing of the maintenance gate elements and couplings elements for the maintenance gate sections, if more than one, connected in-between.
 - Lifting beam with required lifting capacity.
 - Embedded parts including maintenance gate sill, lintel and slots guides with all necessary components, dogging device with operating mechanism.
 - Structures, equipment, and device for the maintenance gates storage.
 - Sill and guide embedded parts for the maintenance gate storage area.
 - All necessary anchors, bolts, screws, framing, pipes, lubricants, temporary and permanent items for alignment and fixing to concrete.
 - One (1) set of all tools and special equipment necessary for operation, repair and maintenance of the supply.
 - All necessary structures and devices (including but not limited to ladders, cages, safety harnesses, handrails, etc.) for the access of the major parts of the maintenance gates, embedded parts, and hoisting system.
 - Spare parts and tools as mentioned in Clause 7 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (c) The design calculation for the maintenance gates shall be based on latest version of DIN 19704 – "Basis for Calculation of Hydraulic Steel Structures" or equivalent International Standards.
- (d) The stress analysis shall be based on two (2) separate operation load cases and conducted for all structural parts as well as connections.
- (e) The different operation load cases shall consider the following data:
 - Normal operation load case;
 - Extraordinary operation load case with earthquake forces with the maximum acceleration magnitude specified by national regulations and maximum load.
- (f) The stress analysis shall be executed for the governing load case, on the basis of the permissible stresses stated in the latest DIN 19704.
- (g) The maintenance gate shall be installed and removed only under balanced hydrostatic conditions.
- (h) The maintenance gate sections shall be heavy enough to overcome all friction, inertial and hydraulic forces to travel down under gravity. The down pull effect, if any, shall not be considered in the calculation of the weight required for the gravity closure. Therefore, the weight of the maintenance gate sections shall be at least 20% in excess of calculated forces resisting the motion. Necessary closing/seating load shall be calculated considering the net cross-sectional area of the bottom seal and maximum water pressure acting on it such that the lowering force is more than the seating load. However, the minimum closing/seating load shall be at least 2.5 kN/m, 5.0 kN/m, and 10.0 kN/m of length of maintenance gate for low head, medium head, and high head maintenance gate, respectively. Ballast shall be provided if self-closure is not sufficient, and the hoist cannot provide sufficient positive thrust. If ballast is used, the maintenance gate and hoist design shall be modified accordingly.
- (i) Provision for corrosion allowance of 2 mm shall be provided for the maintenance gate components exposed directly to water.
- (j) The steel used for the construction of the maintenance gate panels, frames and other structural components shall comply with EN 10025 or equivalent national/international standard.
- (k) Bolts, nuts, washers, pins, and similar items shall, in general, be made up of stainless steel.
- (l) All bushings and bearings shall be self-lubricated and sealed to protect from the environment, unless otherwise specified.
- (m) The Contractor shall submit test certificates from steel manufacturers to the Employer. However, Employer has the right to take the sample piece of the material

for testing of Mechanical and Chemical properties in witnessing the Employer. All expenses of such testing shall be in account of the Contractor.

- (n) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4 SPECIFIC REQUIREMENTS

4.1 Maintenance Gate/Stoplog Assembly

- (a) maintenance gate at each location shall consist of required number of the maintenance gates sets and each maintenance gate set shall consist of the required number of the maintenance gate panels.
- (b) The number/height of each maintenance gate section should be selected based on:
- The dry weight of each maintenance gate panel with the hoisting beam matching the hoisting mechanism capacity.
 - The largest size of panel for transportation and storage.
 - The number of panels should be as low as possible.

4.2 Maintenance Gate/Stoplog Sections

- (a) Each maintenance gate section shall be constructed of welded steel plate. Design and construction shall be conservative in order to withstand all normal and abnormal loading during the life of the power station without appreciable deflection or any deformation.
- (b) maintenance gate skin plate shall be mounted on the upstream side. The largest possible clearance shall be provided between vertical and horizontal stiffeners to allow for easy maintenance of corrosion protection. The section shall be provided with holes to drain off water when lifting the sections.
- (c) Each maintenance gate section shall be provided with at least two side guide rollers at each side to allow free travel on the guideways during insertion and removal. The maintenance gate sections shall be provided with suspension for connection to hydraulic operated lifting beam.
- (d) Every profile of the maintenance gate panel shall have drain holes for draining when the gates are in open position, which also prevent buoyancy due to the downstream water level. The maintenance gate body should have a reduced thickness at the sides to minimize the width of the guide slots.
- (e) The upper maintenance gate section or the upper part of the maintenance gate, if a single element is foreseen, shall be provided with one, or two if required, balance pressure bypass valve/s, which will be opened by lifting beam. If downstream filling

without bypass valve is foreseen, the maintenance gate and the hoisting system shall consider the proper filling of the downstream of the maintenance gate such that the maintenance gate are operated in balanced condition.

- (f) The bypass valve/s shall be spring loaded type and be dimensioned to enable the balance condition of water at the downstream.
- (g) The inlet of the valves shall be protected by a bar screen to prevent ingress of debris to the valve.

4.3 Maintenance Gate/Stoplog Seals

- (a) All maintenance gate sections shall be provided with seals to prevent water leakage along the whole periphery of the sealing area and between individual maintenance gate sections, if foreseen. The seals shall be mounted on the upstream side of the maintenance gate.
- (b) The sides, the bottom, and the top of the maintenance gate shall be provided with rubber seals, resistant against wear and ambient conditions including UV rays, heat, ozone etc.
- (c) The seals shall consist of durable synthetic rubber with high resistance to wear. Hardness shall be approximately 50° to 70° by shore. Clamping bars shall have sufficient strength to press the rubber seals uniformly against their seats.
- (d) Spacing between fixing bolts/screws shall be sufficiently short to ensure uniform sealing. For end-to-end screws, anti-leakage washers, ferrules shall be provided to ensure water tightness. The seals shall be fixed to the maintenance gate by means of bolted sealing bars.
- (e) All bolts and fixing elements shall be of stainless steel, for easy replacement of all seals. All active sealing surfaces shall be manufactured of stainless steel and ground smooth after installation.
- (f) The seals shall have the following shapes, the Contractor may use other shapes after approval of Employer:
 - Top seal : Double stem type/ J-shaped (music note)
 - Side seals : Double stem type/ J-shaped (music note)
 - Bottom seal : Flat

The Contractor shall ensure that the seals shall not extrude through the gap under the hydrostatic head in any condition.

- (g) The seal surface, related to the maintenance gate panel and seat surface on the embedded sealing frame, shall not exceed an out-of-plane tolerance of ± 1.5 mm.
- (h) The seals shall be clad with fluorocarbon to reduce the friction coefficient and wear, non-clad seals may be used upon the approval of the Employer. The material for the fluorocarbon shall be approved before starting manufacturing of the

supply. The adhesive bond between the clad and the rubber shall not fail during the test, instead there shall be tearing of the rubber itself.

- (i) Only moulded seals shall be used, extruded seals shall not be accepted. All the corner seals shall be moulded; the seals joined by splicing at the corners by shop vulcanizing to provide a single continuous seal shall only be accepted on the approval of the Employer. Any other connecting surfaces which will not be subject to tensile loading during operation, installation, or removal of maintenance gate elements, may be glued, subject to the employer's approval.
- (j) The Contractor shall design, manufacture, and erect the components such that there is minimum seal leakage. There shall be a plan to handle/remove the water from seal leakage, if occur any, during repair and maintenance. The seal leakage, if occur any, shall not cause vibration to structure and shall not cause any damage to the adjacent structures. The maximum seal leakage of a maintenance gate set, in general, shall not exceed 6 litres/minutes per meter of the seal length in any case, unless otherwise specified.

4.4 Embedded Parts

- (a) Maintenance gate guides shall be manufactured of cold-formed steel plate in sections welded together. Welded joints between sections shall be ground flush to ensure smooth travel of the maintenance gate during insertion and removal.
- (b) The frames/embedded parts shall be designed to carry and transfer all loads during all design conditions from maintenance gate panels to the concrete structure. It shall provide smooth running surfaces during operation for the maintenance gate seals, wheels, and guide rollers without blockade or binding.
- (c) The cross section of the guides shall be of a suitable channel form to provide a positive and smooth guideway for the maintenance gate during insertion and removal, without any possibility of blockade or binding during travel.
- (d) The bars for the supports of the maintenance gate sections shall be machined and hardened to prevent excessive wear. Surface hardness of the supporting bars shall be higher than that of the tracking plates. maintenance gate shall be equipped with the horizontal sill and lintel beams for embedding in concrete.
- (e) The beams shall be designed conservatively to ensure that they can transmit all loads to the concrete structure without deflection. All active sealing surfaces shall be manufactured of stainless steel and ground smooth after installation.
- (f) To hold the embedded parts of the second stage concrete, anchorages shall be provided in the first stage concrete, with suitable structures. The anchor bolts/studs shall be provided with double nuts and washers for the adjustment of the embedded parts in second stage concrete. The diameter of anchor bolts and studs shall be at least 16 mm and the thickness of anchor plate shall be at least 10 mm.
- (g) Enlarged holes shall be provided for the adjustment of the embedded parts in the second stage concrete. The anchorage and embedded parts shall be so designed

that the required tolerance of the frame, sealing surfaces, and guiding and load bearing surfaces can be obtained by adjusting nuts only with easy access for this adjustment.

- (h) The seal seat shall be made up of stainless steel and shall be welded or screwed with the seal seat base. The seal seat shall be rigid and shall be supported by stiffeners, if necessary. The edges of seal seat shall be rounded or chamfered for prevention of damage to the seal during operation. The thickness of bottom seal seat shall not be less than 20 mm and that of other seal seats shall not be less than 8 mm.
- (i) The track plates shall be made up of stainless steel and shall be machined and hardened to prevent excessive wear. Surface hardness of the track plates shall be higher than that of the rollers by at least 50 HB.
- (j) Maintenance gate shall be equipped with the beams for embedding in concrete at sill and sides and at lintel, if necessary. The beams shall be designed in such a way that they can transmit all loads to the concrete structure with required safety factors for strength/deflection/stability according to national/international standards.
- (k) The second stage concrete shall be of at least M 25 grade.
- (l) To ensure satisfactory earthing, each embedded frame shall be electrically continuous at all joints.
- (m) To release air trapped during filling or to supply air during emptying between the maintenance gate and the corresponding gate, adequate size of air pipe/s shall be installed, between the maintenance gate and gate, if required. The outlet level of the air pipe shall be raised above the maximum water level above the maintenance gate.
- (n) Any other necessary lifting equipment required for handling the maintenance gate and their accessories shall be provided.

4.5 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter "Surface Treatment and Painting" of General Technical Requirements, chapter-16.

4.6 Ancillary Equipment

(a) Storage Racks

- The Contractor shall provide racks in a maintenance gate storage chamber for storing the maintenance gate when not in use, if specified. The racks shall be arranged so a maintenance gate can be stored in the rack or removed from the rack without causing damage to the maintenance gates seals or guides when stored or during lowering or lifting. The maintenance gate shall be stored so that they can be easily picked up by the hoist.

(b) Slot Covers

- The Contractor shall provide slot covers on the gate operating deck across the maintenance gate slot and the maintenance gates storage chamber. The covers shall have suitable lugs so they can be lifted by the hoist. The covers shall have adequate load capacity.
- All miscellaneous metalwork in the area shall be secured against inadvertent falling from the gate deck.
- All necessary embedded metalwork supports masonry anchors, anchor bolts, studs, bolts, screws, nuts, and washers shall be provided by the Contractor.

(c) Dogging Devices

- Each maintenance gate shall be equipped with dogging devices (for each slot), if necessary, with required bearing capacity and impact strength. The Employer may direct the Contractor for the supply and installation of the dogging device for a maintenance gate.
- Some maintenance gates may be stored using dogging device for long time, for these maintenance gates, proper analysis for long term loading shall be carried out.

(d) Maintenance gate Lifting Beam

- The maintenance gate lifting beam shall be of fabricated steel construction designed to carry the maximum load due to the combination of the dead weight of one maintenance gate, the load necessary to unseat a maintenance gate and any other related loads. Only one maintenance gate will be required to be lifted at any one time. The lifting beam shall be designed with ample safety factor to resist unforeseen and abnormal loads.
- The maintenance gate lifting beam shall be fitted with two lifting eyes for connection to the hoisting, and with self-latching and unlatching counter weighted lifting hooks which automatically engage or disengage with the maintenance gate when preselected to do so. Pins for moving parts shall be made from austenitic stainless steel with self-lubricating sleeve bearings. Locating holes shall be provided on the lifting frame to engage with the locating pins on the maintenance gate to ensure positive alignment of the lifting beam with the maintenance gate. The lifting beam shall be guided in the guides and slots provided for the maintenance gates.

5 INSTALLATION

5.1 Embedded Parts

- (a) The embedded parts shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.

- (b) Alignment bolts or other necessary device shall be used to install the guide frames at corresponding accurate position.
- (c) Connections between the guide frames, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the guide frames securely in position while concrete is being placed in the recesses. Additional bracing shall be provided where necessary to ensure the required alignment.
- (d) Extreme care shall be taken to ensure that the guide, bearing and sealing surfaces lie in a true plane within the tolerances specified.
- (e) Placement of concrete in the recesses shall not proceed until the guide frames have been completely assembled and secured. During placement of concrete, alignment tolerances shall be checked and remedial action taken if reading indicates that displacement has occurred.

5.2 Maintenance Gate/Stoplog

- (a) The maintenance gates complete with maintenance gate structure, seals, and side guiding blocks shall be assembled and erected in accordance with the details shown on the final approved drawings.
- (b) Joints shall be watertight where required. The bottom of the maintenance gate sections when erected shall be in true alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam.
- (c) The sides of the maintenance gate shall be in true alignment so that the rubber seals, when installed, shall have a tight and even support on the sealing faces embedded in the concrete.
- (d) The maintenance gate shall be assembled and erected within the shop tolerance necessary to meet the specified tolerances.

6 TESTS

6.1 Shop Assembly and Test

- (a) The maintenance gate including seals and bearing plates shall be assembled in the shop in the approximate position that they shall have after installation at site.
- (b) While assembled, the maintenance gate sections shall be checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall be promptly corrected.
- (c) The seals shall be fitted to their supports during the shop assembly. Parts shall be clearly match-marked before disassembly for transportation.
- (d) Sealing frames, track frames, side guide frames, front guide frames and sill beams for the guide frames shall be checked by means of straight edge and feeler gauge.
- (e) All dimensions of the guide frames that correspond to the maintenance gate dimensions shall be checked by means of straight edge and filler gauge. All

dimensions of the guide frames that correspond to the maintenance gate dimensions shall be checked, and any error or misalignment discovered shall be corrected.

6.2 Tests on Completion

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

6.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
 - Inspection of the maintenance gate embedded parts,
 - Radiographic or Ultrasonic examination of any site weld in load carrying members, other than seal welding seams;
 - Inspection by feeler gauge measurement of satisfactory sealing seat of all seals;
 - Insulation resistance tests on all site installed wiring and electrical connections,
 - Setting of limit switches, indicators, and controls,
 - Inspection of satisfactory installation of all components.

6.2.2 Commissioning Tests

- (a) The commissioning tests shall include, but not be limited to, the following:
 - Measurement of operation speeds;
 - Check of limits of travel;
 - Check of water leakage from closed maintenance gate (a noticeable leakage to be repaired at once);
 - Check of satisfactory operation for the handling of the maintenance gate by the lifting beam.

7 MANDATORY SPARE PARTS AND TOOLS

- (a) The following spare parts shall also be furnished for all maintenance gates:
 - One (1) complete set of rubber seals (undrilled) for all maintenance gates including 20% of the bolts and other fixation material with all necessary components.
 - One (1) complete set of rollers including bearings, axles etc. for each type.
 - One (1) set of maintenance gate guiding supports.

- One (1) set of Brake shoes with lining and brake coil for brakes of monorail hoist
- One (1) set of Rubber bushes for flexible couplings (if applicable)
- One (1) set of seals and gaskets for each by-pass valve diameter.
- One (1) set of Bearings of lifting pulley and lifting hook of lifting beam
- One (1) set of limit switches, relays, contactors, fuses, lamps, and position indicator of each type and size with cables.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

8 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS

CHAPTER 5
GATES

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1 **GENERAL**

- (a) Gates should be used when better operating reliability and flow performance are required.
- (b) The specific requirements of the gate at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 **SCOPE OF SUPPLY**

- (a) The supply shall consist of radial gate, vertical fixed wheel gates and vertical slide gates for under sluice structure, intake structure, sluice flushing chamber, gravel trap structure, desilting basin structure, tunnel inlet and tailrace outlets including their hoisting system.

Undersluice Gate

- (a) The supply shall consist of:
 - Specified set of radial gates, hydraulic hoist with its guide frame, sealing arrangement, steel support, embedded parts, dogging device with handling tools and all appurtenant parts complete.
 - Specified pressure oil supply system which shall include all pumps, oil tank, piping, flexible connections, shut-off, throttle and control valves, gauges, instruments, and appurtenances for the complete operation of the gates.
- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate

Trash Removal Gates

- (a) The supply shall consist of:

Specified sets of vertical slide type gate, electrically operated screw spindle hoisting with its guide frame, sealing arrangement, steel supports, embedded parts, with handling tools and appurtenant parts all complete with necessary accessories.

All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate.

Intake Service Gate

- (a) The supply shall consist of:

Specified sets of vertical fixed wheel gate with its guide frame, electrically operated rope drum hoisting with its guide frame, lifting beam, sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of Service gate.

Bottom Sluice Isolation Valves

- (a) The supply shall consist of:

Specified set of gate valves, electrically operated motor with gearbox with sealing arrangement, steel supports, embedded parts, with handling tools and appurtenant parts all complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate valve.

Gravel Trap Gate Valves

- (a) The supply shall consist of:

Specified set of gate valves, electrically operated motor with gearbox with sealing arrangement, steel supports, embedded parts, with handling tools and appurtenant parts all complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate valve.

Desilting Chamber Outlet Gate / Headrace Tunnel Inlet Gate

- (a) The supply shall consist of:

Specified sets of vertical fixed wheel gate with its guide frame, electrically operated rope drum hoisting with its guide frame, lifting beam, sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate.

Silt Flushing Gate

- (a) The supply shall consist of:

Specified set of vertical slide type bonneted gate, hydraulic hoisting with its guide frame, sealing arrangement, steel supports, embedded parts, with handling tools and appurtenant parts all complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate.

Tailrace Gate

- (a) The supply shall consist of:

Specified sets of vertical fixed wheel gate with its guide frame, electrically operated rope drum hoisting with its guide frame, lifting beam, sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate.

Adit Tunnel Bulkhead Gate

- (a) The supply shall consist of:

Specified sets of hinged type bulkhead gate with its sealing arrangement, door handle, embedded parts, with handling tools and appurtenant parts complete with necessary accessories.

- (b) All other equipment and accessories, even if not mentioned above, required for trouble- free, safe and reliable operation, inspection and maintenance of gate.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The gates with the appertaining drives have to be designed according to the standards for hydraulic steel structures DIN 19704 (Criteria for design and calculation) and DIN 19705 (Recommendations for the design, construction and erection of hydraulic steel structure equipments), or equivalent standards.

The following standards apply for the design of the hoist:

- Steel construction to DIN 15018, group H 1 and B 2
- Cable drive to DIN 15020, group 1 Am, all-steel-cable 1800 N/cm²
- Electrical equipment to "VDE-Vorschriften"

When these Specifications differ from the standards referred to above, the criteria in the Specification still prevail unless otherwise directed by the Employer.

- (b) The stress analysis shall be based on two (2) separate operation load cases and conducted for all structural parts as well as connections.
- (c) The different operation load cases shall consider the following data:
 - Normal operation load case;
 - Extraordinary operation load case with earthquake forces with the maximum acceleration magnitude specified by national regulations and maximum load.
- (d) The stress analysis shall be executed for the governing load case, on the basis of the permissible stresses stated in the latest DIN 19704.
- (e) Each gate system shall be designed to withstand the load resulting from either the development of maximum oil pressure under jammed conditions or loss of pressure in one of the two cylinders, resulting in maximum hydraulic pressure being applied to one side of the gate, without exceeding 75 per cent of the yield strength of the actuators components and the gate and embedded components.
- (f) The gates shall be heavy enough to overcome all friction, inertial and hydraulic forces to travel down under gravity. The down pull effect, if any, shall not be considered in the calculation of the weight required for the gravity closure. Therefore, the weight of the gate sections shall be at least 20% in excess of calculated forces resisting the motion. Necessary closing/seating load shall be calculated considering the net cross-sectional area of the bottom seal and maximum water pressure acting on it such that the lowering force is more than the seating load. However, the minimum closing/seating load shall be at least 2.5 kN/m, 5.0 kN/m, and 10.0 kN/m of length of gate for low head, medium head, and high head gate, respectively. Ballast shall be provided if self-closure is not sufficient, and the hoist cannot provide sufficient positive thrust. If ballast is used, the gate and hoist design shall be modified accordingly.
- (g) Provision for corrosion allowance of 2 mm shall be provided for the gate components exposed directly to water.
- (h) The steel used for the construction of the gate leaves, frames and other structural components shall comply with EN 10025 or equivalent national/international standard.
- (i) Bolts, nuts, washers, pins, and similar items shall, in general, be made up of stainless steel.
- (j) All bushings and bearings shall be self-lubricated and sealed to protect from the environment, unless otherwise specified.
- (k) The maximal lifting forces resulting from the above mentioned stress analysis shall be increased by a safety margin of 25%.

- (l) The Contractor shall submit test certificates from steel manufacturers to the Employer. However, Employer has the right to take the sample piece of the material for testing of Mechanical and Chemical properties in witnessing the Employer. All expenses of such testing shall be in account of the Contractor.
- (m) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4 SPECIFIC REQUIREMENTS

4.1 Vertical Gates

4.1.1 Gate Construction

- (a) The gate panel shall be of a welded construction, consisting of main components as listed:
 - Skin plate,
 - Horizontal crossbeams,
 - Vertical bracing members,
 - Vertical end beams for arrangement of fixed wheels.
- (b) Gate body with skin plate of minimum 10 mm thickness having minimum of two wheels on each side, or minimum total 4 wheels shall be supplied. The skin plate shall be strengthened by girders, ribs and bracings as required.
- (c) Every profile of the gate shall have drain holes for draining when the gates are in open position, which also prevent buoyancy due to the downstream water level. The gate body should have a reduced thickness at the sides to minimize the width of the guide slots.
- (d) The skin plate shall be designed to protect the bottom seal. The lower, downstream section shall be designed to ensure free air access during throttling and vibration free operation.
- (e) The ends of each gate section shall have a sturdy design, supporting Stainless-Steel axles with supports for the gate wheels. Gate wheels with self-lubricated bearings, duly protected by rubber seals against sediment-loaded water shall be used. The bearing assembly can additionally be protected by grease filling and drain and nipples for additional grease filling. The combination wheel/bearing shall be designed to obtain an even loading on the roller track even during deflections of gate and the track. Cylindrical wheels and self-aligning bearings are preferred.
- (f) At least two guide rollers on each side for lateral guidance of the gate. The rollers shall have Stainless-Steel axles, adjustable brackets and self-lubricated bearings, well protected by rubber seals. With the gate in top position, the two lower guide wheels on each side shall still be engaged.

- (g) Horizontal and vertical rubber seals fixed to the gate with clamping bars and bolts in Stainless-Steel. The seals shall be well protected, adjustable and replaceable. When closed, the gate rests upon the bottom sill. Enough sealing pressure shall be maintained at the bottom seal when the gate deflects due to water pressure, and concrete filling might be used for the bottom seal if necessary. The bottom seal and the lower part of the gate shall be shaped to avoid vibrations and resonance during partial openings. Side seals shall preferably be made from J-type rubber profiles connected to the rectangular profiled bottom seal. The top seal shall preferably be of the-type with the same bulb dimension as the side seals.
- (h) Two suspension brackets or lugs needed for lifting the gate shall be provided. In addition to this, all required lifting lugs and brackets as required during transportation and erection. Special connections for hydraulic hoist or screw spindle shall be provided as per the requirements.

4.1.2 Wheels and Axles

- (a) The gate section shall be equipped with minimum of two (2) fixed wheels on each side. Wheels shall be cast or forged steel, with shrunk-on stainless steel treads of a suitable high-tensile grade of steel to resist contact stresses.
- (b) Treads shall be at least 10 mm thick and of at least 50 BHN different hardness to the tracks. Tread widths shall be greater than the maximum theoretical contact ellipse length plus twice the tread thickness.
- (c) All wheels shall be fitted with roller bearings (preferred) or with self-lubricating spherical bushings. The wheel axles shall be of corrosion-resistant steel. The bearings shall be carefully sealed against water penetration.

4.1.3 Gate Seals

- (a) All gate panels shall be provided with seals to prevent water leakage along the whole periphery of the sealing area and between individual gate sections, if foreseen. The seals shall be mounted on the downstream side of the gate.
- (b) The sides, the bottom, and the top of the gate shall be provided with rubber seals, resistant against wear and ambient conditions including UV rays, heat, ozone, etc. All seals shall be arranged in one line on the downstream side.
- (c) Clamping bars shall have sufficient strength to press the rubber seals uniformly against their seats. Spacing between fixing screws shall be sufficiently short to ensure uniform sealing. For end-to-end screws, anti-leakage washers, ferrules shall be provided to ensure water tightness.
- (d) The seals shall consist of durable synthetic rubber with high resistance to wear. Hardness shall be approximately 50° to 70° by shore. The seals shall be fixed to the gate by means of bolted sealing bars. Seal clamping bars shall have enough strength to press the rubber seals uniformly against their seats. All bolts and fixing elements shall be of stainless steel, for easy replacement of all seals. The construction of the lintel seal shall avoid that water can bypass the gate through

the gap at the lintel for the open gate. The weight of the gate must be transmitted to the sill through the skin plate only.

- (e) The seals shall have the following shapes, the Contractor may use other shapes after approval from the Employer:

• Top seal	Double stem/ J-shaped (music note)
• Side seals	Double stem/ J-shaped (music note)
• Bottom seal	Flat

The Contractor shall ensure that the seals not extrude through the gap under the hydrostatic head in any condition.

- (f) The seal surface, related to the gate panel and seat surface on the embedded sealing frame, shall not exceed an out-of-plane tolerance of ± 1.5 mm.
- (g) The bottom seal and the lower part of the gate shall be shaped to avoid vibrations and resonance during partial openings.
- (h) The seals shall be clad with fluorocarbon to reduce the friction coefficient and wear, non-clad seals may be used upon the approval of the Employer. The material for the fluorocarbon shall be approved before starting manufacturing of the supply. The adhesive bond between the clad and the rubber shall not fail during the test, instead there shall be tearing of the rubber itself.
- (i) Only moulded seals shall be used, extruded seals shall not be accepted. All the corner seals shall be moulded, the seals joined by splicing at the corners by shop vulcanizing to provide a single continuous seal shall only be accepted on the approval of the Employer. Any other connecting surfaces which will not be subject to tensile loading during operation, installation, or removal of gate elements, may be glued, subject to the Employer's approval.
- (j) The Contractor shall design, manufacture, and erect the components such that there is minimum seal leakage. There shall be a plan to handle/remove the water from seal leakage, if occur any, during repair and maintenance. The seal leakage, if occur any, shall not cause vibration to structure and shall not cause any damage to the adjacent structures. The maximum seal leakage of a gate set, in general, shall not exceed 6 litres/minutes per meter of the seal length, in any case, unless otherwise specified.

Note: The seals may be fabricated from aluminium/bronze (Cu/Al alloy steel) if required and will be agreed during the contract execution by the employer. However, in this case the contractor will not be entitled for an extra payment.

4.1.4 Embedded Parts

- (a) The gate embedded part shall include the slot constructions of working and non-working zones, sill and lintel beam etc.

- (b) The embedded parts shall be of sturdy design, in order to provide the required rigidity. All parts shall be equipped with stud bolts.
- (c) The stud bolts will be site-welded to dowel plates, being cast into first stage concrete by the Contractor.
- (d) Dowel plates and stud bolts shall be arranged in such a manner that all parts to be embedded in second stage concrete will be rigidly fixed.
- (e) All reinforcing bars, anchor rods, and other supporting mild steel parts shall have a concrete cover of at least 6 cm. The minimum plate thickness of embedded parts shall be 12 mm.
- (f) The gate slots shall be completely steel lined. The gate slots shall form an integral part of the sealing frame.
- (g) All surfaces in contact with the seals shall be of corrosion-resistant steel, carefully machined and polished. The required block-out in first stage concrete shall be minimized.
- (h) The design of slot details and the arrangement in the respective block outs shall facilitate as much as possible the pouring of the second stage concrete.
- (i) The lateral guide ways of corrosion-resistant steel shall be circular curved and arranged in such a manner that the gate's top seal will not slide on concrete. The lateral guideways shall be extended from the gate slots up to the operation platform.
- (j) The gate slots in the structure on both sides shall be completely steel lined up to 0.5 meter height above the lintel beam. The stainless steel wheel tracks for the gate wheels and counter tracks shall extend up to 0.5 meter above the top of the gate wheel in the lifted position of the gate.
- (k) Provisions shall be made for the installation of dogging devices for the handling of the gates during installation and removal.
- (l) Above the installed dogging devices, all the gate openings shall be closed by chequered plated steel covers with the required load capacity.

4.2 Radial Gate

4.2.1 Gate Construction

- (a) Each gate shall be of welded steel construction consisting of an upstream skin plate, seals and downstream beams, diaphragms, and gate arms.
- (b) To maintain sideways alignment and to protect the seal, each gate shall be fitted with guide rollers. A minimum of 2 guide rollers on each side shall contact the curved tracks when the gate is fully open. Provision shall be made for adjustment of the rollers to limit the lateral movement of the gate. Guide rollers shall have self-lubricating bushings and austenitic stainless-steel shafts.

- (c) The design shall provide for adjustment during installation to compensate for settlement of the concrete structure and shall provide for a gate to twist to allow the side guides or rollers to contact the guide paths and support the gate in the event of failure of the actuator at one side of the gate.
- (d) The bottom edges of the gates and seal arrangement shall be so shaped that satisfactory performance and freedom from harmful vibration and erosion will be prevented under all conditions of operation.
- (e) Pockets or depressions that would hold water shall be provided with effective drain holes.
- (f) Each gate shall be fitted with a locking device independent of the actuators to secure the gate in the fully open position for maintenance purposes.
- (g) Parts having bolted field connections not subject to field adjustment shall be shop assembled to permit drilling and reaming of the bolt holes.
- (h) Field welds on gate arms shall not be permitted.
- (i) Each gate shall be provided with suitable lifting lugs for transportation and erection purposes.

4.2.2 Trunnions and Trunnion Anchorages

- (a) The trunnions shall be provided with either self-lubricated bushings or spherical plain bearings housed in a fabricated or cast steel structure fixed to the gate arms by a stress relieved and machined flange connection. The type of bearing that is being used shall be notified to the Employer.
- (b) The self-lubricated bushing, if used, shall be of a bronze alloy. Both the bushing and bearings shall be from a reliable manufacturer having adequate experience of manufacturing bushing/bearing for radial gates.
- (c) Antifriction bearings shall be of standard type most suitable for this application and shall have both inner and outer races. Bearing seals shall be conveniently replaceable without removing the bearings or arms from the trunnions.
- (d) If antifriction bearings are selected the trunnions shall be provided with greasing lines extending to the deck immediately above the gate. The trunnions shall also have outlet plugs for the grease which can be observed when the trunnions are being lubricated.
- (e) Trunnion pins shall be either austenitic stainless steel (preferred) or stainless steel clad (minimum thickness 3 mm).
- (f) The trunnion pin shall be assembled to welded steel brackets with ribs, anchorages and bracings as required. The brackets shall be stress relieved prior to machining and shall be designed for easy replacement of the journal. The bracket base plate shall have a thickness not less than 50 mm.

- (g) The trunnions shall be bolted to sole plates to be embedded in each trunnion beam. The gate supplier shall provide the sole plates to be embedded into the trunnion beams.
- (h) The Contractor shall design, construct, and test the suitable radial gate trunnion anchorage system for transferring of the loads to the concrete. The design shall include all possible gate operation scenarios and corresponding load combinations. The Contractor shall submit the design of the anchorage system and temporary and permanent embedded parts for the erection supports for the approval of the Employer. The design shall be of well proven in practice under similar loads and operating conditions. The Contractor shall closely collaborate with the construction of piers or trunnion support for the design and construction of the anchorage.
- (i) For each gate bearing at each gate, one angular indicator, having IP 68 class, with necessary cables and interfaces, shall be supplied. The supply shall preferably be factory sealed with factory mounted cables, long enough to reach the terminal block in the local control unit.

4.2.3 Radial Gate Arm

- (a) Each gate shall be equipped with two radial arms duly strengthened and bolted to the gate body and the bearing arrangement, designed as welded, sturdy structures of the framework or box type. The arms shall with moderate strains take the compressive forces, any bending moments and any vibration from the water. They shall offer good access to any point of inspection and maintenance without dismantling.
- (b) The arms shall have sturdy flanges for the bolted connection to the gate body and for the bolted connection to the bearing housing assembly in the downstream end. The flanges shall be machined, and the whole connection shall be assembled and adjusted in the workshop. Possible adjustment plates shall be machined and welded to one of the flanges.

4.2.4 Gate Seals

- (a) All gates shall be provided with seals to prevent water leakage along the whole periphery of the sealing area.
- (b) The rubber seals shall be resistant against wear and ambient conditions including UV rays, heat, ozone etc.
- (c) The seals shall consist of durable synthetic rubber with high resistance to wear. Hardness shall be 60° to 70° by shore. Seal clamping bars shall have enough strength to press the rubber seals uniformly against their seats.
- (d) Spacing between fixing bolts/screws shall be sufficiently short to ensure uniform sealing and ferrules shall be provided for even clamping. Anti-leakage washers and gaskets shall be provided to ensure water tightness whenever applicable. The seals shall be fixed to the gate by means of seal clamping bars.

- (e) All bolts, screws, clamps, and fixing elements shall be of Stainless-Steel, for easy replacement of all seals. All active sealing surfaces shall be manufactured of stainless steel and ground smooth after installation.
- (f) The seals shall have the following shapes, the Contractor may use other shapes after approval:
- Top seal Double stem/J-shaped (music note)
 - Side seal Angle
 - Bottom seal Flat

The Contractor shall ensure that the seals shall not extrude through the gap under the hydrostatic head in any condition.

- (g) The seals shall be clad with fluorocarbon to reduce the friction coefficient and wear, non-clad seals may be used upon the approval of the Employer. The material for the fluorocarbon shall be approved before starting manufacturing of the supply. The adhesive bond between the clad and the rubber shall not fail during the test, instead there shall be tearing of the rubber itself.
- (h) Only moulded seals shall be used, extruded seals shall not be accepted. All the corner seals shall be moulded, the seals joined by splicing at the corners by shop vulcanizing to provide a single continuous seal shall only be accepted on the approval of the Employer. Any other connecting surfaces which will not be subject to tensile loading during operation, installation, or removal of gate elements, may be glued, subject to the Employer's approval.
- (i) The Contractor shall design, manufacture, and erect the components such that there is minimum seal leakage. There shall be a plan to handle/remove the water from seal leakage, if occur any, during repair and maintenance. The seal leakage, if occur any, shall not cause vibration to structure and shall not cause any damage to the adjacent structures. The maximum seal leakage of a gate set, in general, shall not exceed 6 litres/minutes per meter of the seal length, in any case, unless otherwise specified.

4.2.5 Embedded Parts and Anchors

- (a) The frames/embedded parts shall be designed to carry and transfer all loads during all design conditions from gate to the concrete structure. It shall provide smooth running surfaces during operation for the gate seals, wheels, and guide rollers without and blockade or binding.
- (b) Guides shall be manufactured of welded structural steel sections. Welded joints between sections shall be ground flush to ensure smooth travel of the gate during insertion and removal.

- (c) To hold the embedded parts of the second stage concrete, anchorages shall be provided in the first stage concrete, with suitable structures. The anchor bolts/studs shall be provided with double nuts and washers for the adjustment of the embedded parts in second stage concrete. The diameter of anchor bolts and studs shall be at least 16 mm and the thickness of anchor plate shall be at least 10 mm.
- (d) Enlarged holes shall be provided for the adjustment of the embedded parts in the second stage concrete. The anchorage and embedded parts shall be so designed that the required tolerance of the frame, sealing surfaces, and guiding and load bearing surfaces can be obtained by adjusting nuts only with easy access for this adjustment.
- (e) The seal seat shall be made up of stainless steel and shall be welded or screwed with the seal seat base. The seal seat shall be rigid and shall be supported by stiffeners, if necessary. The edges of seal seat shall be rounded or chamfered for prevention of damage to the seal during operation.
- (f) The track plates shall be made up of stainless steel and shall be machined and hardened to prevent excessive wear. Surface hardness of the track plates shall be higher than that of the rollers by at least 50 HB.
- (g) The gate shall be equipped with the beams for embedding in concrete at sill and at sides and lintel, if necessary. The beams shall be designed in such a way that they can transmit all loads to the concrete structure with required safety factor for strength/deflection/stability according to national/international standards.
- (h) The second stage concrete shall be of at least M 25 grade.
- (i) To ensure satisfactory earthing, each embedded frame shall be electrically continuous at all joints.
- (j) The guides shall be provided with two adjustable limit switches with cables, class IP 68, for indication of closed/open gate position. Stainless Steel cams can be at the gate body. The limit switches are a part of the supply and shall preferably be factory sealed with factory mounted cables, long enough to reach the terminal block in control cabinet. The switches shall be protected against mechanical damage.

4.3 Bulkhead Gate

4.3.1 Gate Construction

- (a) The gate panel shall be of a welded construction, consisting of main components as listed:
 - Skin plate,
 - Horizontal beams,
 - Vertical bracing members,
 - Vertical end beams.

- (b) Gate body with skin plate of minimum 10 mm thickness, horizontally subdivided not only as required for transportation, but also ensuring an even hinge load. The skin plate shall be strengthened by girders, ribs and bracings as required.
- (c) Every profile of the gate shall be drained when the gates are in open position, also preventing buoyancy.
- (d) The ends of each gate section shall have a sturdy design, transferring load from gate body to the civil structures.
- (e) At least one guide roller of stainless steel at the bottom of the gate shall be provided for guidance of the gate during opening and closing. The roller shall have stainless steel spindles, adjustable brackets and self-lubricated bronze bearings, well protected by rubber seals. The guide roller shall be adjusted to approximately 2 mm clearance to frame and guides. The guide wheel at the bottom shall always be engaged.
- (f) Horizontal and vertical rubber seals shall be fixed to the gate with clamping bars and bolts in stainless steel. The seals shall be well protected, adjustable, and replaceable. Enough sealing pressure shall be maintained at the seals when the gate deflects due to water pressure. All seals shall preferably be made from J-type or double stem rubber profiles as per the head on the gate.

4.3.2 Gate Hinge

- (a) The gate section shall be equipped with minimum of two (2) hinges on one of the side. The hinge shall be of Stainless steel with corrosion resistant properties. The gate hinge shall be well protected and sealed for debris to damage the bearings.
- (b) Pins shall be fitted with roller bearings or with self-lubricating spherical bushings. The bearings shall be carefully sealed against water penetration.
- (c) The gate hinge shall open the gate perpendicularly.

4.3.3 Gate Seals

- (a) The sides, the bottom, and the top of the gate shall be provided with rubber seals, resistant against wear and ambient conditions. All seals shall be arranged in one line on the downstream side.
- (b) Clamping bars shall have sufficient strength to press the rubber seals uniformly against their seats. Spacing between fixing screws shall be sufficiently short to ensure uniform sealing. For end-to-end screws, anti-leakage washers, ferrules shall be provided to ensure water tightness.
- (c) The seals shall consist of durable synthetic rubber with high resistance to wear. Hardness shall be approximately 50° to 70° by Shore. The seals shall be fixed to the gate by means of bolted sealing bars.
- (d) Only moulded seals shall be used, extruded seals shall not be accepted. All the corner seals shall be moulded, the seals joined by splicing at the corners by shop

vulcanizing to provide a single continuous seal shall only be accepted on the approval of the Employer. Any other connecting surfaces which will not be subject to tensile loading during operation, installation, or removal of gate elements, may be glued, subject to the Employer's approval.

- (e) All bolts, screws, clamps, and fixing elements shall be of stainless steel, for easy replacement of all seals. All active sealing surfaces shall be manufactured of stainless steel and ground smooth after installation.
- (f) The seals shall have the following shapes:
 - Top seal Double stem/J-shaped (music note)
 - Lateral seals Double stem/J-shaped (music note)
 - Bottom seal Double stem/J-shaped (music note)

The Contractor shall ensure that the seals shall not extrude through the gap under the hydrostatic head in any condition.

- (g) The Contractor shall design, manufacture, and erect the components such that there is minimum seal leakage. There shall be a plan to handle/remove the water from seal leakage, if occur any, during repair and maintenance. The seal leakage, if occur any, shall not cause vibration to structure and shall not cause any damage to the adjacent structures. The maximum seal leakage of a gate set, in general, shall not exceed 6 litres/minutes per meter of the seal length, in any case, unless otherwise specified.

4.3.4 Embedded Parts

- (a) The frames/embedded parts shall be designed to carry and transfer all loads during all design conditions from gate to the concrete structure. It shall provide smooth mating surfaces during operation for the gate seals without blockade or binding.
- (b) Gate guides shall be manufactured of welded structural steel sections. Welded joints between sections shall be ground flush to ensure smooth surface.
- (c) To hold the embedded parts of the second stage concrete, anchorages shall be provided in the first stage concrete, with suitable structures. The anchor bolts/studs shall be provided with double nuts and washers for the adjustment of the embedded parts in second stage concrete. The diameter of anchor bolts and studs shall be at least 16 mm and the thickness of anchor plate shall be at least 10 mm.
- (d) Enlarged holes shall be provided for the adjustment of the embedded parts in the second stage concrete. The anchorage and embedded parts shall be so designed that the required tolerance of the frame, sealing surfaces, and guiding and load bearing surfaces can be obtained by adjusting nuts only with easy access for this adjustment.
- (e) The seal seat shall be made up of stainless steel and shall be welded or screwed with the seal seat base. The seal seat shall be rigid and shall be supported by

stiffeners, if necessary. The edges of seal seat shall be rounded or chamfered for prevention of damage to the seal during operation. There shall be arrangement such that the gate seals never slide on concrete.

- (f) Gate shall be equipped with the beams for embedding in concrete at sill and sides and at lintel, if necessary. The beams shall be designed in such a way that they can transmit all loads to the concrete structure with required safety factor for strength/deflection/stability according to national/international standards.
- (g) The second stage concrete shall be of at least M 25 grade.
- (h) To ensure satisfactory earthing, each embedded frame shall be electrically continuous at all joints.
- (i) At least two sets of locks shall be provided opposite side of the hinges which will provide necessary seal pre-compression before water-filling.
- (j) The guides shall be provided with two adjustable limit switches with cables, class IP 68, for indication of closed/open gate position. Stainless Steel cams can be at the gate body. The limit switches are a part of the supply and shall preferably be factory sealed with factory mounted cables, long enough to reach the terminal block in control cabinet. The switches shall be protected against mechanical damage.

4.4 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter "Surface Treatment and Painting" of General Technical Requirements, chapter-16.

4.5 Ancillary Equipment

- (a) Dogging devices
 - Each gate shall be equipped with dogging devices with required bearing capacity and impact strength.
 - Gates may be stored using dogging device for long time during lifted period, for these gates, proper analysis for long term loading shall be carried out.

5 INSTALLATION

5.1 Embedded Parts

- (a) The embedded parts shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.
- (b) Alignment bolts or other necessary device shall be used to install the guide frames at corresponding accurate position.
- (c) Connections between the guide frames, anchor materials and the alignment device shall be adjustable and firmly tightened to hold the guide frames securely in position

while concrete is being placed in the recesses. Additional bracing shall be provided where necessary to ensure the required alignment.

- (d) Extreme care shall be taken to ensure that the guide, bearing and sealing surfaces lie in a true plane within the tolerances specified.
- (e) Placement of concrete in the recesses shall not proceed until the guide frames have been completely assembled and secured. During placement of concrete, alignment tolerances shall be checked and remedial action taken if reading indicates that displacement has occurred.

5.2 Gates

- (a) The radial gate and vertical gates complete with their accessories shall be assembled and erected in accordance with the details shown on the final approved drawings. Joints shall be watertight where required.
- (b) The bottom of the gate when erected shall be in true alignment to ensure a tight and even bearing of the rubber seal on the sealing face at the sill beam. The sides of the gate shall be in true alignment so that the rubber seals, when installed, shall have a tight and even support on the sealing faces embedded in the concrete.
- (c) The gates shall be assembled and erected within the shop tolerance necessary to meet the specified tolerances.

6 TESTS

6.1 Shop Assembly and Test

Copies of all orders for materials and plant placed with suppliers and copies of the manufacturer's shop Test Certificates for materials and equipment shall be provided. These shall include the following:

- (a) Physical Tests and Chemical Analyses of steel and other principal metals used. Cutting plans for the plates shall also be submitted to enable identification of all principal components.
- (b) Hydraulic Pressure Tests on all parts (except drain piping, gates and penstocks) subject to air, oil or water pressure. The hydraulic test pressures shall be in accordance with the appropriate DIN or such other Standard.
- (c) Proving Tests on spindle hoist, steel wire ropes, servomotors, etc.
- (d) Insulation Tests, Running Tests, Heating Tests, Operating Tests, Full Load and Overload Tests, etc. on electric motors, starters, transformers, and other electrical and mechanical equipment.
- (e) Operating and control gear with electric motor, starter, etc. and, where practicable, limit switches, shall be tested to ensure that all parts work satisfactorily.

- (f) Each section of the work such as gate and screen reception frames and guides, screens, gates, valves, pump and motor assemblies, motor and hand operated gear assemblies with supporting beams, servomotors, motors, etc. shall be assembled in the shop. All brakes shall be tested under maximum rated load conditions.
- (g) Welds shall be physically, radio-graphically, or ultrasonically tested as specified.
- (h) The vertical wheel gates including seals, main wheels and side rollers shall be assembled in the shop in the approximate position that they shall have after installation at Site.
- (i) While assembled, the gate shall be checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall be promptly corrected.
- (j) The seals shall be fitted to their supports during the shop assembly. Parts shall be clearly match-marked before disassembly for transportation.
- (k) The hydraulic cylinders together with the hydraulic control units shall be pressure tested and subsequently a functional test over its full operating range is to be performed to confirm the design conditions.

6.2 Tests on Completion

All equipment shall be carefully inspected and tested at site after erection to show that it is satisfactory.

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

Testing shall include the following:

- Gates and valves shall be tested at full opening and at various partially opened positions for vibrations, noise or other similar phenomena. Flow conditions downstream of the bifurcation shall be tested at various flow rates up to the maximum flow rate for pressure or flow oscillations, which may have an incidence on turbine operation.
- All gates shall be tested to show that the seals are operating satisfactorily, the clearances in the guides are adequate, and that the gates work correctly under all specified conditions.
- The gates shall be operated by the push button controls to show that they open and close satisfactorily and the limit switches and position indicators checked for correct setting.

- All electrical and hydraulic equipment shall be checked for correct connection and installation, electric motors and control gear checked for insulation resistance between the circuits and to earth, and for overheating.
- The monorail cranes including screen raking equipment shall be tested through all motions of hoisting, lowering, and travelling with the working load, and the limit switches and other protective devices checked for correct setting and functioning. Correct functioning of the automatic grappling beams shall also be tested.
- All valves shall be opened and closed to show that they operate satisfactorily under all specified conditions and the indicators, and the limit switches are correctly set, etc.
- All miscellaneous equipment shall be tested for correct alignment and installation, efficient and smooth running, and satisfactory operation.
- Site welds shall be tested as specified.

6.2.1 Pre-Commissioning Tests

(a) The pre-commissioning tests shall include, but not be limited to, the following:

- Inspection of the gate embedded parts,
- Radiographic or ultrasonic examination of site weld in load carrying members, other than seal welding seams,
- Inspection by feeler gauge measurement of satisfactory sealing seat of all seals,
- Insulation resistance tests on all site installed wiring and electrical connections,
- Setting of limit switches, indicators, and controls,
- Inspection of satisfactory installation of all components.

6.2.2 Commissioning Tests

- The commissioning tests shall include, but not be limited to, the following:
- Measurement of operation speeds,
- Check of accuracy of indication, limit setting and alarm signals etc.,
- Check of water leakage from closed gates (a remarkable leakage to be repaired at once),
- Check of limits of travel,
- Check of power consumption of motors,
- Temperature raise of motors, bearings etc.,
- Check of general satisfactory operation.

7 MANDATORY SPARE PARTS AND TOOLS

(a) Undersluice radial gate

The following spare parts shall also be furnished with the Undersluice gate:

- 1 (one) Sets of rubber seals for the gates
- 1 (one) Set of other seals, gaskets
- 10 (ten) Per cent of all bolts, nuts, etc. for the seals
- 1 (one) set of Limit switches with cables
- 1 (one) set of Position indicators with cables
- 1 (one) set of Self-lubricating bush and washer for trunnion assembly of radial gate
- 1 (one) set of seals and bushes for hydraulic cylinder and piston
- 1 (one) set of side guide roller assembly
- 1 (one) set of main bearing assembly
- 1 (one) set of Filter, control valve, pressure gauge, pressure switch of radial gate hoist power pack
- 1 (one) set of Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, switch and indication lamp of power pack
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply

(b) Trash Removal Gate

The following spare parts shall also be furnished with the trash removal gate:

- One (1) set of rubber seals (undrilled) for including 20% of the bolts and other fixation material or aluminium/bronze seals with all necessary components.
- One (1) set of fixed wheel rollers including bearings axles etc.
- Two (2) grease nipples and/or cups of each type and size to be used.
- One (1) set of Flexible coupling for hoist motor
- One (1) set of Starter assembly
- One (1) set of seals and gaskets used in all equipment.
- Ten (10) per cent of all nuts and bolts used.
- One (1) set of limit switches of each type used.

- One (1) set of relays of each type used.
- One (1) set of contactors of each size and type used.
- One (1) complete set of fuses.
- One (1) complete set of lamps.
- One (1) position transducer of each type used.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- Any other general spare parts as stipulated in the Standard Technical Requirements.

All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(c) Intake Service Gates

The following spare parts shall also be furnished with the intake service gates:

- One (1) set of rubber seals (undrilled) for each gate including 20% of the bolts and other fixation material or aluminium/bronze seals with all necessary components.
- One (1) set fixed wheel rollers for each gate including bearings axles etc.
- Two (2) grease nipples and/or cups of each type and size to be used for each gate.
- One (1) set of seals and gaskets used in all equipment for each gate.
- One (1) set of Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of hoist
- One (1) set of Brake shoes with lining and brake coil for brakes of hoist
- Ten (10) per cent of all nuts and bolts used for each gate.
- One (1) set of limit switches of each type used for each gate.
- One (1) set of relays of each type used for each gate.
- One (1) set of contactors of each size and type used for each gate.
- One (1) complete sets of fuses for each gate.
- One (1) complete set of lamps for each gate.
- One (1) position transducer of each type used for each gate.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.

- Any other general spare parts as stipulated in the Standard Technical Requirements.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(d) Desilting Chamber Outlet Gate / Headrace Tunnel Inlet Gates

The following spare parts shall also be furnished with the Desilting Chamber Outlet Gate / Headrace Tunnel Inlet Gate:

- One (1) set of rubber seals (undrilled) for each gate including 20% of the bolts and other fixation material or aluminium/bronze seals with all necessary components.
- One (1) set fixed wheel rollers for each gate including bearings axles etc.
- Two (2) grease nipples and/or cups of each type and size to be used for each gate.
- One (1) set of seals and gaskets used in all equipment for each gate.
- One (1) set of Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of hoist
- One (1) set of Brake shoes with lining and brake coil for brakes of hoist
- Ten (10) per cent of all nuts and bolts used for each gate.
- One (1) set of limit switches of each type used for each gate.
- One (1) set of relays of each type used for each gate.
- One (1) set of contactors of each size and type used for each gate.
- One (1) complete sets of fuses for each gate.
- One (1) complete set of lamps for each gate.
- One (1) position transducer of each type used for each gate.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- Any other general spare parts as stipulated in the Standard Technical Requirements.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(e) Silt Flushing Gates

The following spare parts shall also be furnished with the silt flushing gates:

- One (1) set of rubber seals (undrilled) for each gate including 20% of the bolts and other fixation material or aluminium/bronze seals with all necessary components.
- One (1) set fixed wheel rollers for each gate including bearings axles etc.
- Two (2) grease nipples and/or cups of each type and size to be used for each gate.
- One (1) set of seals, gaskets, and O -rings used in all equipment for each gate.
- Ten (10) per cent of all nuts and bolts used for each gate.
- One (1) set of limit switches of each type used for each gate.
- One (1) set of relays of each type used for each gate.
- One (1) set of contactors of each size and type used for each gate.
- One (1) complete sets of fuses for each gate.
- One (1) complete set of lamps for each gate.
- One (1) position transducer of each type used for each gate.
- One (1) set of Hydraulic cylinder seals and gaskets of silt flushing gate hoist
- One (1) set of Bearing for power pack motor of silt flushing gate hoist
- One (1) set of Filter, control valve, pressure gauge, pressure switch of silt flushing gate hoist power pack
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- Any other general spare parts as stipulated in the Standard Technical Requirements.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(f) Adit Tunnel Bulkhead Gate

- One (1) set of rubber seals (undrilled) for including 20% of the bolts, washer, nuts and other fixation material with all necessary components.

(g) Tailrace Gate

The following spare parts shall also be furnished with the tailrace gate:

- One (1) set of rubber seals (undrilled) for including 20% of the bolts and other fixation material or aluminium/bronze seals with all necessary components.
- One (1) set fixed wheel rollers including bearings axles etc.

- Two (2) grease nipples and/or cups of each type and size to be used.
- One (1) set of seals and gaskets used in all equipment.
- One (1) set of Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of hoist
- One (1) set of Brake shoes with lining and brake coil for brakes of hoist
- Ten (10) per cent of all nuts and bolts used.
- One (1) set of limit switches of each type used.
- One (1) set of relays of each type used.
- One (1) set of contactors of each size and type used.
- One (1) complete set of fuses.
- One (1) complete set of lamps.
- One (1) position transducer of each type used.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- Any other general spare parts as stipulated in the Standard Technical Requirements.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

8 LIST OF TOOLS AND TACKLES FOR HM EQUIPMENT "S MAINTENANCE

<u>SN</u>	<u>Description</u>	<u>Quantity</u>
1.	Chain Pulley Block-2 T Capacity (Heavy Duty)	2 sets
2.	Chain Pulley Block-5 T Capacity (Heavy Duty)	2 sets
3.	Tripod - 20' height (Heavy Duty)	2 sets
4.	Rope Fitted with thimble - 16 mm diameter x 10 m long	2 sets
5.	Chain - 3 T Capacity x 10 m Long (Heavy duty)	2 sets
6.	"D" Block - 3 T Capacity (Heavy Duty)	2 sets
7.	Manual Hydraulic Jack - 5 T Capacity (Heavy Duty)	2 sets
8.	Spanner Kit	2 sets
9.	Pipe Wrench - (Heavy Duty)	2 sets

10.	Screw Driver Set- (Size: Small, Medium, Large)	2 sets
11.	Hand Plier	2 sets
12.	Allen Key Set (Size: 5 mm to 10 mm)	2 sets
13.	Grease Gun	2 sets
14.	D' Clamps: (Size: Small, Medium, Large) (Heavy Duty)	2 sets
15.	Lifting Hook - eye end type- 5 T Capacity (Heavy Duty)	2 Nos.
16.	Wire Brush, Hand Gloves, Welder's Glass	2 Sets
17.	Welding Machine	2 No's.
18.	Hammer - 5 kg	1 No.
19.	Hammer - 7 kg	1 No.
20.	Rope Cutter Blade	2 Nos.
21.	Portable Grinder (W)	1 No.

9 **TECHNICAL SCHEDULES**

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 6
STEEL LINING AND PENSTOCK**

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1 GENERAL

- (a) Steel pipe and its accessories have been provided for the pressurized flow of water from one place to another place. They are used as steel tunnel liners, exposed or buried penstocks, environmental release pipe etc.
- (b) The specific requirements of the steel pipe sections and particular pipe accessories are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the pipe and pipe accessories are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete lane of steel pipe consisting of:
 - Steel pipe of necessary length and layout made up of steel tunnel liners, buried steel pipe and/or exposed steel pipe, including manifold pipe.
 - Pipe accessories including bell mouth transitions, manholes, pipe bends, seepage and stiffener rings, back strip plates, bifurcations/manifold, reducers, supports, air valves, cone valves, connection flanges etc.
 - All necessary anchors, bolts, screws, ribs, foundation plates, feet, lugs, temporary internal strengthening structures and any machines and devices for handling, alignment, and fixing during manufacturing, transportation, and installation.
 - All necessary structures and devices (including but not limited to ladders, cages, safety harnesses, etc.) for the access of the pipe during construction and maintenance.
 - Spare parts and tools as mentioned in Clause 8 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe, and reliable manufacturing, transport, testing, operation, inspection, and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN AND OPERATING CONDITIONS

- (a) The design of the supplied items shall be based on American Society of Civil Engineers (ASCE) – “Steel Penstock Manuals and Reports on Engineering Practice No.79”, (latest version) or equivalent international standards. The relevant calculations and shall be submitted to the Employer for approval.

- (b) Additionally, design conditions stipulated in the following standards and design codes are applicable.
- DIN 19704 Part 1, 2 and 3 - "Criteria for design and Calculations for Hydraulic Steel Structures" latest edition, or other approved international standards by the Employer.
 - Latest edition of CECT – "Recommendation for the Design, Manufacturing and Erection of Steel Penstocks of Welded Construction for Hydro Electric Installations".
 - Design procedures as suggested by S. Jacobsen and E. Amstutz from their various publications in the "Waterpower and Dam Construction" magazine, published in 1970, 1974 and in 1977.
 - American Society of Mechanical Engineers (ASME): "Boiler and Pressure Vessel Code", latest edition, or equivalent approved EN standard.
- (c) The penstock/steel lining shall be designed in every respect to meet safely all the requirements of the powerhouse.
- (d) The steel linings shall be designed taking into account the most critical combination of the following conditions, where applicable:
- i. Internal water pressure corresponding to the maximum water level in the reservoir.
 - ii. Water hammer overpressure linearly varying along the penstock and lining axis.
 - iii. Dead load (according to the erection procedure).
 - iv. Temperature variation of $\pm 10^{\circ}\text{C}$.
 - v. Stresses induced by external stiffeners (anchoring shapes or reinforcing beams).
 - vi. Longitudinal hydraulic thrust.
 - vii. Earthquake load as induced by the peak ground acceleration of MDE in any direction (only for the parts not embedded in concrete).
 - viii. External pressure due to cement grouting.
- (e) Comparison stress shall be calculated with Hencky von Mises equation and shall not exceed allowable values, obtained with the following equation:
- $$f = K \times F$$

Where, f is the allowable stress, F the lower yield stress point of the material under consideration, K a factor with the following values:

- Steel pipes and linings under load conditions as in i,ii,iii,iv,v,vi,vii of d:

where the rock cover is less than 25% of the static pressure head, the tensile stress in the steel at maximum internal pressure including water hammer shall not exceed 67% of the yield or 45% of the ultimate tensile strength whichever is the lower.

where the rock cover exceeds 25% of the static pressure head, the tensile stress in the steel including water hammer shall not exceed the yield or 67% of the ultimate tensile strength.

- Accessory parts such as terminal flanges expansion joint, auxiliary piping and valves, etc. under the worst possible conditions: $K = 0.33$.
- Steel pipes under load condition as in h) shall be verified by methods to be submitted to the Employer's Representative for approval. The average gap between concrete and steel pipe to be considered is $0.002xR$, where R is the steel pipe radius. Local big empty spaces between concrete and steel pipe shall also be considered to be possible before the cement grouting. The safety factor with respect to the critical pressure shall not be less than two. Should the steel pipe not be able to withstand the grouting pressure applied locally or uniformly on the external surface, without concrete co-operation, the Contractor shall reinforce the steel pipe during grouting with provisional internal structures to be designed, supplied, erected and dismantled by him. The Contractor shall be considered responsible for all the effects of any deformation of the steel pipe due to the above load condition.
- If external anchoring shapes are foreseen, it shall be verified that the maximum stress on the claw due to the internal or external pressure is lower than $0.6xF$.
- Thickness calculated in accordance with the above specified allowable stresses shall be increased of:
 - 2 mm, to take into account corrosion.
 - Under thickness tolerance of plates, unless it can be guaranteed that the actual rolled plate thickness is never lower than the nominal thickness.
- (f) The pipe shall be self-resistant and shall be able to bear all the loading without having any contribution to the surrounding concrete.
- (g) The external head is assumed to be taken from the highest reservoir water level. The Contractor shall use established methods for the determination of external head and shall use the head for stress and buckling check.
- (h) Design of the steel pipe and the accessories may be modified due to geological conditions. The Contractor shall co-ordinate with the Employer and other suppliers in this regard, incorporate the changes and approve the same with the Employer.
- (i) The steel lined bends shall be designed in such way, that the deviation angle between centerlines of adjacent bend sections does not exceed 10° . The bend radius should be at least 3 times the diameter of the pipe. The reducer angle should not exceed 7° .

- (j) The number of a pipe or pipe accessory section and the thickness of that section shall be painted on the outside and as well as inside with white paint.
- (k) The installation of steel pipes shall work closely with Civil works and co-ordinate and co-operate during design, fabrication, transportation, installation, testing and commissioning.

4 MATERIAL AND WORKMANSHIP

4.1 General

- (a) The material for steel tunnel liners and accessories shall be of pressure vessel grade steel according to ASTM A537 and ASTM A517 or equivalent international standard having a yield strength of 415 N/mm² and 690 N/mm².
- (b) Steel plate for headrace tunnel shall be equivalent to WELTEN 610R-TMCP, pressure shaft and unit pressure shaft steel liners and welded attachments shall be equivalent to grade WELTEN 610R/ 780S-TMCP or BS EN 10025: Part 2 or equivalent grade boiler quality steel plates having yield strength ≥ 450 MPa, ultimate tensile strength ≥ 610 MPa and/or yield strength ≥ 575 MPa, ultimate tensile strength ≥ 780 MPa.
- (c) Bolts, nuts, washers, pins, and similar items shall, in general, be made up of stainless steel. All bushings and bearings shall be self-lubricated and sealed to protect from the environment, unless otherwise specified.
- (d) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4.2 Material and Material Quality Requirements

- (a) The followings requirements are necessary, and the costs incurred have been deemed to be included in the Bid.
 - The material test certificates shall be international standard acceptable to the Employer, shall be furnished as supporting evidence.
 - All tests shall be performed at the Contractor's expense and shall be deemed to be included in the contract.
 - After successful testing, the selected material shall confirm the material characteristics according to the ASTM standard.

4.3 Quality Assurance Tests

- (a) Each steel plate shall be subject to the hereunder listed tests; the respective test specimen shall be from the top end of steel plate.

- Tensile Strength (R_m), Minimum Yield Strength (R_{eH}) and Minimum Breaking Elongation according to EN 10002-1 (specimen shall be taken from head end and transverse to rolling direction).
- Ladle Analysis showing carbon, silicon, manganese, phosphorous and maximum sulphur content etc.
- Three (3) times Notched Bar Impact Test according to Charpy V as per EN 10045-1 (specimen shall be taken from head end and transverse to rolling direction) test temperature 0°C, energy minimum 35 J.
- Three (3) times Notched Bar Impact Test according to Charpy V as EN 10045-1 (specimen shall be taken from head end and transverse to rolling direction) test temperature 0°C, artificially edged 7.5 % cold forming and annealing to ½ h at 250°C.
- Bead Bend Test according to DIN EN 10025, as longitudinal bend test for plates exceeding 25 mm thickness. The respective test specimen shall be from the top end of steel plate.
- Thickness tolerances as specified in DIN EN 10029 Class C; however, negative tolerances shall be zero. Plate thickness shall be measured at the plate edge according to latest DIN EN standards.
- The surface finish of the different plates shall be in accordance with EN 10163.
- Ultrasonic Lamination Test by the screen method, executed at the rolling mill with a screen pattern of 200 mm × 200 mm and edges 50 mm × 50 mm. The plate edges shall be tested separately. All ultrasonic testing shall be performed in accordance with EN 10160.

5 SPECIFIC REQUIREMENTS

5.1 Steel Bend & Penstock Construction

- (a) Pressure shaft shall be designed so as to comply with calculated head losses in order to meet the required performances. The lining shall be designed in order to withstand the anticipated maximum water velocities. The vertical shaft shall be designed to take on the anticipated pressure.
- (b) The steel bend & penstock sections shall be adequately stiffened and when the pipe sections are in their final positions they shall be adequately supported, and any steel packing pieces used for leveling shall be left permanently in position. Internal bracings shall be used, where necessary,
 - To bring adjacent sections into alignment when welding the circumferential joints.
 - During transportation of steel bend & penstock sections to their final position.

- (c) The pipe shall be anchored in position, strutted from the roof or otherwise restrained to prevent any possibility of them moving or rising during concreting on account of the buoyancy of the pipe in unset concrete.
- (d) The number of the section, the thickness of the pipe shall be painted on the outside and as well as inside in white paint.
- (e) The stiffener ribs with brackets shall be arranged based on structural and installation requirements. The appropriate details of each section shall be shown in an arrangement drawing.
- (f) The steel bend & penstock sections shall be prepared as far as practicable in the contractor's workshop. The preparation of sections will include:
 - Cutting the plates to exact size.
 - Preparing edges for welding.
 - Rolling to required shape.
- (g) The final assembly will be performed at site. The spiders or any other suitable devices shall be used to prevent distortions, after the steel plates have been welded to form pipe sections.
- (h) All internal butt welds shall be ground flush shall be free of undercuts or concavities of welds. The variation of plate thickness at section joints between adjacent plates is limited to 10% of the plate thickness, however, up to maximum 2 mm. The transition shall be leveled; the chamfer shall not exceed 1:4.
- (i) During fabrication, all plates shall be inspected by the Contractor's experts for laminations and other imperfections. Plates containing imperfections shall be rejected.
- (j) The shape tolerances shall be according to the CECT published in 1998 (latest version).
- (k) No shipment of materials shall be affected until all required tests, analyses and shop inspections have been satisfactorily completed or certified copies of test reports containing the Contractor's warranties have been accepted by the Employer.

5.2 Grouting Connections

- (a) Concreting should be done in such a way that grouting can be avoided.
- (b) Grout holes shall be provided where required. For the downstream pipe steel lining, one grout hole for each 3m² of lining area shall be provided, except for those areas which are wrapped or coated with compressible material.
- (c) Threaded grouting connections of approximately Ø60 mm (Ø 2 ½", DIN 259) shall be provided in the steel linings. The final number and location will be determined

jointly by the Contractor and the Employer. Besides the threaded plug, the following services shall be provided:

- Removal of threaded plugs.
 - Cleaning, fitting and removing grouting sleeves.
 - Final closing of grouting hole by threaded plug.
- (d) To avoid buckling, denting, or excessive deflection, care shall be given during grouting. The grouting pressure shall be monitored and controlled. Internal supports shall be provided to avoid the problem, if required.
- (e) The grouting connections shall be prepared during manufacturing of the different lining sections. Prior to any handling of the lining sections, the grout connections shall be protected by the respective plugs. In screwed-in position, the plugs shall be flushed with the inside face of steel lining.
- (f) Drilling and grouting sleeves as required for grouting operation will be supplied, fitted into and removed from the grout connections under this contract.
- (g) Once the grouting operation has been completed, the sleeves shall be removed, and the plugs screwed back in place. The plugs shall be seal welded.
- (h) The welds shall be ground smooth and flush to the inside face of steel lining.
- (i) If tapping of the lining with hammer (copper) indicates it to be necessary at any point, the contractor shall drill, tap and subsequently plug additional grout holes as directed ensure against cavities between the steel and the concrete surround.
- (j) When the pressure grouting is complete, the Contractor shall fill the grout holes in the lining with similar grout plugs and welded to give a flush surface on the inside of the lining.

5.3 Butt Straps

- (a) Butt straps are proposed for the steel bend & penstock to facilitate making the circumferential joints on site. Each complete butt strap should be arranged in two halves, the bottom half being welded in the shop to the erection section to be erected first, the other half of the butt strap being welded in the shop to the following erection section.
- (b) This arrangement facilitates placing the adjoining erection sections at the site as it would be necessary to enter a spigot into socket. When adjoining sections are in their final positions the butt straps should fit closely to the adjoining shell thereby enabling a satisfactory welded joint to be obtained.

5.4 Bifurcation/Manifold

- (a) A well accepted design method which results an adequate hydraulic performance, having minimum loss, with uniform stress distribution, and without any vibrations

shall be adopted. The bifurcation/manifold shall be subjected to a pressure test on site prior to installation and the test pressure shall be 1.5 times the design pressure.

- (b) Suitable stiffener rings and sickle plate shall be designed and dimensioned to resist the forces under maximum internal and external pressures. Tie rods shall not be used for internal reinforcement. The reinforcements shall be designed for least hydraulic resistance.
- (c) The Contractor shall provide the required accessories and shall be included in the Bid subsequently to the contract price.
- (d) A bifurcation/manifold shall be designed for minimized head loss. For the hydraulic analysis, whole manifold shall be considered. The analysis shall include all operating conditions including shut down of any turbine unit.
- (e) The hydraulic performance of the bifurcation/manifold shall be confirmed by Computational Fluid Dynamics (CFD) analysis. CFD analysis shall be carried out for the whole manifold. The reinforcement of the bifurcation/manifold shall be designed to minimize the high stress concentration as much as possible by using structural analysis. The structural design of the bifurcation/manifold assembly shall be confirmed by using Finite Element Analysis (FEA) including buckling analysis. The result of FEA and CFD analysis shall be incorporated in the final design. The design and drawing shall be approved by the Employer prior to fabrication and installation.
- (f) The Contractor shall submit a CFD and FEA design report to the Employer for approval. The design report shall consist at least the followings:
 - 3D model geometries (solid and fluid domain), orthogonal and isometric views, other views and important sectional views clearly showing geometry and dimensions,
 - 3D plot of mesh clearly showing the accuracy of model set out and mesh quality,
 - Complete 2D drawings,
 - Orthogonal, isometric, and sectional colour views showing maximum stress and deflection of all members for all load combinations and conditions,
 - Determination of the internal pressure at rupture and critical buckling pressure,
 - Reporting of the analysis defining the inputs including fluid properties, turbulence model, inflow flow profile, mesh quality, and explanation of the results to confirm the head loss coefficients and vortex shedding frequencies,
 - Head loss coefficient and value at different operating conditions, including colour views of the fluid flow,

- Colour images of stress distribution, deflection, buckling modes, fluid velocity, pressure distribution, turbulence energy, and video files demonstrating unsteady flow phenomena,
 - Other items required determined by the Contractor.
- (g) Approval of the bifurcation/manifold design and the FEA and CFD analysis shall not waive or modify the requirements of this topic, nor shall it relieve the Contractor of any part of his responsibility under the Contract for the correctness of his design.
- (h) FEA similar to the bifurcation/manifold should be carried out for the bell mouths, bends, reducers and other critical pipe/tunnel liner components. CFD analysis should also be carried out for these items. Reports similar to the bifurcation/manifold should be provided after carrying out FEA/CFD analysis.

5.5 Transitions

- (a) Changes in cross-sectional shape or change in diameter of a pipe is carried out by a transition piece. Reducers and bell mouth shall be used for this purpose when required.
- (b) Reducers
- The angle of the conical sections should be between 5° to 7° to reduce head loss.
 - Reducing bend, if used, shall have bend radius greater than or equal to three and meter angles at most 8°.
 - The components shall be adequately stiffened to bear the internal as well as external pressure arising acting on the shell.
 - Rectangular to circular bell mouth
 - The transition sections shall be designed for membrane stress as well as bending. Stiffening frames continuous around the perimeter of the pipe shall be used with spacing in such a way to limit bending stress of the shell between the stiffeners.
 - The length of the transition section shall be at least 1.5 times the diameter of the circular end.

5.6 Fittings and Accessories

The Works shall also include the provision of the following equipment:

- (a) Watertight doors
- Suitable watertight doors for access to the interior of each power tunnel designed and manufactured in order to guarantee sealing, and to withstand a maximum design pressure. Each door shall be equipped with pressure gauge.
- (b) Penstock and manifold manholes

Vertical access to the Penstocks will be located at the upper curve of the steel liner and shall be suitable for the insertion of the vertical penstock inspection equipment.

Manholes for the inspection of the manifold branches will be located immediately upstream of the main turbine inlet valves.

(c) Surge Shaft Orifice

The orifice shall connect the tunnel with each surge shaft and shall introduce high head losses during large transients.

(d) Flanged joints

Flanged joints shall be provided for the connection with turbine inlet valves.

(e) Pressure Taps

Pressure taps and manifolds shall be provided for the main penstocks upstream of the turbine. Each manifold shall connect four stainless steel taps (dimensions according to the IEC Code) and shall be made of stainless-steel pipe. All necessary water cut-off and air drainage valves, pressure gauges and transducers for the remote indication of the pressure shall also be provided.

(f) Drainage Pipes and other Connections

Piping, valves and connections for the systems indicated below shall be provided.

- Main Penstocks Dewatering
- Inlet Valves By-pass
- Penstock Inspection Hoists

5.7 Embedded Parts

- The embedded parts shall be of sturdy design, in order to provide the required rigidity.
- All parts shall be equipped with stud bolts. The stud bolts will be site-welded to dowel plates, being cast into first stage concrete by the Contractor.
- All embedded parts as well as the dowel plates shall be included in the scope of supply.
- Dowel plates and stud bolts shall be arranged in such a manner that all parts to be embedded in second stage concrete will be rigidly fixed.
- All reinforcing bars, anchor rods, and other supporting mild steel parts shall have a concrete cover of at least 60 mm. The minimum plate thickness of embedded parts shall be 12 mm.

5.8 Compressible Wrapping

- In order to minimize the additional bending stresses, the branch pipe entering the powerhouse shall be compressible wrapped along their circumference.

- (b) The length of wrapping shall be approximately 3 m each. The selected material shall not be hygroscopic nor subject to adverse shrinkage and ageing.
- (c) The compressibility shall be at least 2 mm, generated by a compressive stress of 0.6 N/mm². Detailed information and references regarding the proposed material shall be furnished by the Contractor.
- (d) The proposed wrapping material as well as its method of application will be subject to approval by the Employer.
- (e) The Contractor shall provide at least an extra length of about 500 mm of each brunch pipe at the end of the pipe, which shall be connected to the upstream flange of the butterfly valve. This additional length shall be removed if required by the Contractor as required.

5.9 Penstock Dewatering

- (a) A penstock dewatering system consisting of two (one for each manifold) discharge nozzles with reinforcement, at least 250 mm diameter, each provided with intake screen, two valves and piping for water drainage down to the tailrace channel. In order to assure full tightness and easy maintenance for each nozzle two manually operated gate type valves will be provided in cascade sequence.
- (b) An automatic air admission valve of suitable diameter shall be installed on the penstock in the Valve Chamber to facilitate the penstock dewatering

5.10 Welds

- (a) The longitudinal welds shall be made in a workshop and shall be such to have efficiency one; same welds with efficiency one shall be used for connection of pipe sections, in particular for terminal parts of downstream pipe, and in other parts if possible.
- (b) If not possible, back strip shall be used and reduced efficiency shall be considered in the calculations. The arrangement of welds shall assure that the weld root can be rewarded and refinished.
- (c) All welds shall be placed in such way as to achieve favorable stress flow. The steel sections shall be assembled and prepared under constraint-free conditions.
- (d) Auxiliary structural parts required for the assembly and installation of steel linings shall be weld connected to the respective sections wherever required. Special care shall be given to the execution of welds.
- (e) Once the installation has been completed, all auxiliary structural parts shall be removed by flame cutting, followed by grinding the affected areas flush with the plate. No additional thermal stresses shall be induced by aforementioned procedure.

- (f) Welding shall be carried out as far as possible by automatic welding sets. Overhead welding shall be kept to a minimum. Welding shall be carried out only by officially approved welders, certified for the materials and type of work.
- (g) The Contractor shall submit for approval to the Employer, a detailed description of the proposed welding procedure, giving at least information about:
 - weld profiles for each required weld type,
 - extent to which automatic welding techniques will be applied,
 - extent to which manual welding techniques will be applied,
 - extent to which it is the Contractor's intention to use pre-weld heat treatment, post-weld stress relieving, full anneal stress relieving or normalizing consistent with the thickness and types of material proposed,
 - weld electrodes, welding wire and flux intended to be used with the selected plate material or materials,
 - weld seam profiles, tolerances of the root gap.
- (h) The main tolerances of welding joints are specified in the CECT published in 1998 (latest version).

5.11 Supervision of Shop and Site Welds

- (a) All welders and welding operators' tests shall be witnessed and approved by the Employer before the welder or welding operator is permitted to work on the structure. The decision by the Employer regarding the qualification of any welder or welding operator shall be final. Evidence of previous qualification tests may be accepted solely at the discretion of the Employer.
- (b) The quality of shop and site welds shall be proved by conducting tests in accordance with the DIN EN 720 part 1 and 2. Detailed welding procedures for welding of plates and shapes shall be established and qualified in accordance with DIN EN 286/287.
- (c) Only qualified welders shall be employed during the fabrication including tack welding, structural welding and repair welding of any structural steel part. They shall only perform welding for positions and processes for which they are qualified. Backing materials shall not be used during testing.
- (d) The Contractor shall ensure that welders of any subcontractor or of any otherwise nominated contractor are qualified in accordance with this specification. The purpose of a welder qualification test is to verify that the welder can apply a qualified welding procedure making welds of satisfactory quality.
- (e) All inside welds shall be grounded to plate level or otherwise according to DIN EN 25817.

- (f) A Welding Procedure Specification (WPS) shall contain the following parameters with all explanatory details necessary:
- Material specification of the base metal.
 - Welding process, manual or semi-automatic.
 - Material thickness range for which the procedure is valid.
 - Geometry of welding grooves showing allowable tolerances.
 - Root gap showing allowable tolerances.
 - Welding position and direction.
 - Filler metal specification and brand.
 - Filler metal classification.
 - Specification of flux.
 - Gas shielding - flow, mixture and composition.
 - Number and sequence of passes.
 - Welding current, voltage, polarity and heat input (including ranges).
 - Travel speed and electrode run-out length for each pass and range.
 - Preheat and interpass temperature.
 - Post-weld heat treatment including heating and cooling rates.
 - Method of cleaning and gouging.
- (g) The specific facts from the WPS and test results from the Welding Procedure Qualification Test (WPQT) shall be recorded in the Welding Procedure Qualification Record (WPQR). The WPQR shall be submitted to the Employer for approval before any production welding is commenced.
- (h) The Contractor is obliged to maintain a "Section Book" for the each and every section of the complete steel bend & penstock which shall provide documentary evidence as follows.
- Steel bend & Penstock section number.
 - Material certificate number and plate thickness.
 - Identification of welding identification.
 - Name of welder, place and length of weld.
 - Results of the ultrasonic test.

- Results of the dye-penetrant test.
 - Date of test and justification.
 - Location of the weld has been corrected and the dated of correction (if any).
 - Enclose the test results, material certificates, welder qualifications etc.
- (i) This shall be maintained by the Contractor's qualified welding engineer and during the execution of the contract; the contractor shall submit the "Section Book" for approval at the end of each week.

5.12 Supervision of Shop and Field Welds

- (a) At least 5 % or one pipe section, whichever is greater, shall be hydrostatically tested for each different section of the pipe (whenever diameter or thickness changes). The test pressure shall be 1.5 times the design pressure. The test procedure shall follow the standard hydrostatic testing procedure.
- (b) The shop and site welds shall be such to guarantee the efficiency considered in the calculations, in accordance with the applicable Standards.
- (c) Inspection by the Employer does not relieve the Contractor of the responsibility of confirming to the regulations, project specifications, codes, and standards.
- (d) In any case, the welds shall be at least subject to the following non-destructive tests.

During fabrication in the workshop:

- 100% - Ultrasonic Test (UT) and Magnetic Partial Test (MT) on all circumferential welds.
- 100% - Radiographic Tests (RT) and Magnetic Particle Test (MT) on all longitudinal welds.
- 100% - Dye Penetration Test (PT) on all fillet welds.
- 100% - Visual inspection of all welds.

During installation inside the tunnel:

- 100% - Ultrasonic test (UT) and Magnetic Partial Test (MT) on all site welds.
- 100% - Dye Penetration Test (PT) on all fillet welds.
- 100% - Visual inspection of all welds.

5.13 Welding Requirement

- (a) The preparation for welding, welding procedure, welder's qualifications, etc. shall be as detailed in the Chapter "Welding" of General Technical Requirements.

5.14 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter “Surface Treatment and Painting” of General Technical Requirements, chapter-16.

6 INSTALLATION

- (a) Installation, testing and commissioning at site shall be performed in accordance with the stipulations established in the General Conditions. Furthermore, the requirements stated in this section shall be observed.
- (b) The proposed method and sequence of installation shall be submitted to the Employer for approval.
- (c) All facilities required for proper installation and handling of steel bend & penstock sections shall be provided by the Contractor. The scope of supply includes all anchors, stiffeners, bracings, ties, supports and any other provisions required to maintain the pipe section's foreseen shape/position during installation and concrete backfilling.
- (d) The following loads resulting from concrete backfilling shall be considered for dimensioning and design of steel bend & penstocks:
- Maximum uplift due to buoyancy in fluid concrete.
 - Unbalanced lateral loads due to level differences of fluid concrete up to 1 m during backfilling.
- (e) The Contractor shall be fully responsible for the installation of steel liners in such a way that no distortion or misalignment will occur during concrete backfilling. The final installation procedure shall be approved by the Employer.

7 TESTS

7.1 Shop Assembly Test

- (a) Assembly inspections and tests in the workshop shall be performed. The workshop tests shall be performed in the presence of the Employer.

7.2 Tests on Completion

- (a) At the completion of the works, at least the following checks shall be carried out.
- Examination of pipe finishing checking that no visual defect are present.
 - Examination of site painting works.
 - Functional test of inspection cage and the winch.
 - Any other examination employer deems necessary.

8 MANDATORY SPARE AND TOOLS

(a) The following spare parts shall be furnished.

- Adequate paint material to paint 50% of complete steel bend & penstock for maintenance purposes.
- Any other general spare parts as stipulated in the Standard Technical Requirements.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

9 ALLOWABLE TOLERANCES OF STEEL BEND & PENSTOCK

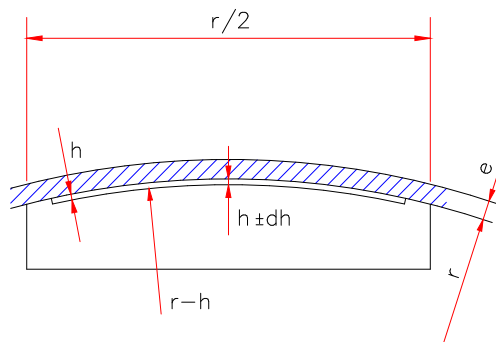
9.1 Shape

9.1.1 Ovality

(a) Greatest deviation of two diameters, positioned vertically upon each other, of a measure section = 0.5 % from the theoretical diameter (According to C.E.C.T., Appendix II E, Clause 7.1.4).

- **Variation from theoretical periphery**

$\Delta u < \pm (2 \cdot r/1000 + 2 \cdot \pi (e_{\text{eff}} - e_{\text{theor}}) + 4)$, according to C.E.C.T., Annex V, Table 1, Class 1



- **Out- of- Roundness**

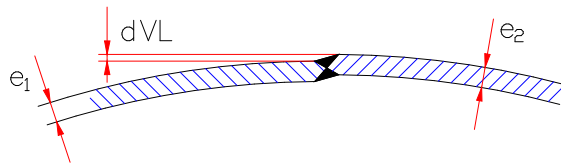
According to C.E.C.T., Annex V, Table 1, Class 1;

$$dh < + - \left(\frac{2 \cdot r}{1000} + \frac{20}{e} + 0,5 \right)$$

9.1.2 Welding Joints

- **Displacement of the longitudinal joint**

According to C.E.C.T., Annex IV, Table 3, Class 1;



$$dVL \leq \frac{e}{50} + 1 + \frac{de}{2}$$

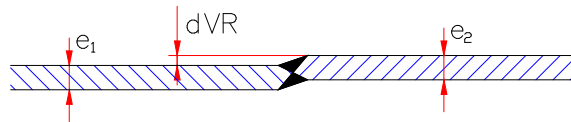
dVLmax = 2 mm at e ≤ 30 mm,

dVLmax = 3 mm at e > 30 mm,

de = difference between the actual thicknesses of the edges involved.

- **Displacement of the circumferential joint**

According to C.E.C.T., Annex IV, Table 3, Class 1;



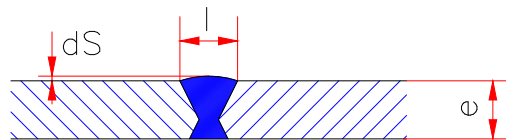
$$dVR \leq \frac{e}{50} + 2 + \frac{de}{2} + \frac{\Delta u}{2 \cdot \pi}$$

dVRmax = 3 mm at e ≤ 30 mm,

dVRmax = 4 mm at e > 30 mm,

Δu = Tolerance on the circumference as previously indicated.

- **Reinforcement of welds**



According to C.E.C.T., Annex IV, Table 3, Class 1;

$$dS \leq 1 + \frac{3}{100} \cdot (e + l)$$

dSmax = 2 mm at e ≤ 30 mm

dSmax = 3 mm at e > 30 mm

l = theoretical width between the edges of the chamfer

10 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 7
MONORAIL CRANE**

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1 GENERAL

- (a) Monorail hoists are used when multiple light gates/maintenance gates required to be lifted by one hoist.
- (b) The specific requirements of the monorail at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of monorail hoists at each location consisting of:
 - One (1) complete set of electrically operated monorail hoist.
 - One (1) set of rails/runway with all anchorages, bumpers, and other essential embedded parts.
 - One (1) set of complete power supply equipment.
 - One (1) set of electrical pendant/radio wave control system.
 - One (1) set of all necessary anchors, bolts, ribs, foundation plates, feet, lugs, temporary internal strengthening structures and any other device for alignment and fixing to the concrete.
 - Necessary load for static & dynamic load test of the monorail (static 140%; dynamic 125% of nominal load).
 - One (1) set of all tools and special equipment necessary for operation, repair, and maintenance of the supply.
 - Spare parts and tools as mentioned in Clause 6 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

3.1 Design Stresses

- (a) The design, calculation and manufacture shall be based on FEM standard and relevant international standards considering the dimensions, loads, operating conditions. The design shall not miss earthquake and wind factors as specified in the standards.

- (b) For operation of the monorail hoists, all friction, hydrodynamic forces, wind loads, silt load, shall also be considered.
- (c) The hoists shall be equipped with load cells and limit switches for safe operation.
- (d) The upper hook position, hoist capacity and other monorail hoist parameters shall be designed including the size and weight of the load and lifting beam, easy movement of the loads from storage area to destination, possible maintenance of the gate/stoplog while lifting etc.
- (e) During design, manufacturing and installation, care shall be given that the hoist operates in remote area and requires high reliability of operation.
- (f) The material to be used for construction of the structural parts shall be structural steel according to EN 10025 or equivalent.
- (g) All hinged joints, wheel spindles, gears, etc. shall be equipped with self-lubricating bushings/bearings. All spindles/axles shall be made from stainless steel.
- (h) The Contractor shall submit detailed information about the types and the grades of materials which he proposes to supply for the major parts of the delivery with reference to relevant standards. If special materials are used, information about chemical composition, possible heat treatment and mechanical properties shall be included.
- (i) A standard monorail hoisting equipment is foreseen, but a detailed equipment specification is not possible. The Contractor shall suggest for the possible better solutions, which should be used after the approval of the Employer.

3.2 Specific Requirements

3.2.1 General

- (a) The specific requirements indicated hereunder are in addition to and in completion of those arising from the Contractor's obligations to supply goods and designs suitable to fulfil the performance and the requirements of the complete supply covered by this section.

3.2.2 Monorail

- (b) The rails shall be provided over the full length of the travel shall confirms DIN 4132 and DIN 18800 or equivalent international standards subject to Employer approval with all holding down bolts, clamps, fishplates, separators, end buffer stops etc., and shall be gapped at any expansion joints in the concrete.

3.2.3 Bumpers

- (a) Spring or elastomeric bumpers shall be provided on each end of the crane sill beams and on each corner of the trolley. The bumpers shall consist of suitable springs, steel housings and rams or, alternately, of adequately sized elastomeric pads.

3.2.4 Hoist

- (a) The hoist shall consist of rope drums for pulley blocks with incorporated a non-turning lifting hook for operation with the lifting beam. The hoist shall be equipped with twist-free ropes.
- (b) All deflection of lifting elements, i.e., drums, shafts/axles, deflection sheaves, lifting hooks, etc., shall be designed adequately for continuous and reliable operation under all applicable conditions.
- (c) The main hoist consists of the following major parts: rope drum of welded steel provided with rope grooves and equipped with bearings, winding motor, closed oil bath lubricated reduction gear, hoist brake for normal operation, additional safety brake normally for retarding action other than the main brake operation, overload protection system, load cell, galvanised steel wire ropes of Warrington Seale type, steel pulley case with rope pulley and a hook of forged steel provided with a thrust bearing.
- (d) The brakes shall be designed to exert a torque at least 1.5 times the full load torque of the motors. The manual release of the brakes shall be possible in case of emergency. The brakes shall operate immediately after the power of the drive motor is cut off and shall be equally effective in both directions of travel.

3.2.5 Power Supply

- (a) The power to the hoist shall be supplied through a flexible (mining type) cable. A rope, for hanging the cable of the entire travel distance of the travelling hoist, shall be provided by the Contractor. The cable shall be protected against mechanical damage. The hoist shall operate on 400 V, 3-phase, 50 Hz power supply.
- (b) A main terminal box for power in-feed with a separate disconnect switch for the hoist shall be installed on the operating platform nearby a gate opening. The terminal box shall at least have protection class of IP 65. Electrical supply up to this box shall be the part of the Electrical Works.

3.2.6 Control and Monitoring

- (a) All operating manoeuvres shall be made from the pendant control. All control devices shall be weather-proof and dust tight.
- (b) The controls shall be equipped with an emergency mushroom switch for tripping of the main circuit breaker.
- (c) The hoist shall be equipped with motor starters and thermal overload protection for each motor. Adjustable limit switches actuating the circuit breaker shall be provided for limitation of the lifting and lowering range of the lifting beam, for the highest hook position, and for ends of travel of the hoist. The hoist shall also be equipped with a cut-off switch for overload protection. The hoist electrical systems shall be provided with the necessary circuit breakers, fuses, relays, switches, motor protection devices and other necessary control and protection devices.

3.2.7 Lighting and Fire Protection

- (a) Outdoor lighting of the monorail hoist shall include minimum:
 - 2 watertight swivelling LED floodlights with at least 160 W capacity in order to illuminate the hoisting operations.
- (b) At least two 230 Volt convenience outlets shall be provided from the main switchboard.
- (c) Provision shall be made for one portable dry powder fire extinguishers of approximately 6 kg weight fitted in the following locations:
 - At the main switchboard.
- (d) The instructions for use shall be clearly marked on each extinguisher.

3.2.8 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter "Surface Treatment and Painting" of General Technical Requirements, chapter-16 .

4 INSTALLATION

- (a) The contractor is responsible for the total installation of the hoist. He shall furnish all materials and devices required for supporting and holding parts in position while the concrete is being placed.
- (b) The contractor shall perform the following installations:
 - Install all second stage concrete embedded items of the crane rail system,
 - Install all non-embedded parts,
 - Prepare a permanent record of elevations, clearances, tolerances, and similar measurements established at the time of erection. This record shall be checked and if necessary supplemented by additional measurements taken by the contractor at the direction of the Employer's before the crane is commissioned.
 - Finish painting equipment as specified in the Chapter "Surface Treatment and Painting" of General Technical Requirements.

5 TESTS

5.1 Shop Assembly and Test

- (a) The hoist shall be completely assembled at the shop. In particular, the following tests shall be carried out under the supervision of the employer:
 - Checking of the main dimensions,
 - Operational test of all drives.
- (b) The test equipment and instrumentation have to be provided by the contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled touch-up painted and packed for shipment.

5.2 Tests on Completion

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract, Particular Conditions of Contract, and the General Technical Specification.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

5.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
- Inspection of satisfactory installation of all components,
 - Rail-track position shall be checked before and after its definitive setting and clamping,
 - No-load test.
- (b) During the testing manoeuvres, the following items shall be checked:
- Correct operation of the brakes and limit switches,
 - Vertical and horizontal travelling distances and approach measurement,
 - Operating speeds,
 - Operation and characteristics of the manual emergency control,
 - Examination of the paintwork.

5.2.2 Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:
- The operations of raising, lowering, holding in any position, and transporting the test loads. The test load for the hook will be 125% of the rated hook load;
 - Operation of the hoist with 100% of the rated hook load and rated speeds and determination that the main hook or lifting eye motions can be controlled within specified limits.
- (b) The contractor is responsible to make all arrangements necessary for the load test and to provide the test weights. During manoeuvres of the commissioning test, the following shall be checked:
- Measurement of operational speeds,
 - Check of the limits of travel,
 - Check of the power consumption of motors and driving and hoisting equipment,
 - Check of the accuracy of indication and the limit switch setting,
 - Correct behaviour of the general operation of the safety mechanisms and accessories,

- Correct operation and efficiency of the brakes.

6 MANDATORY SPARE PARTS

(a) The following spare parts shall also be furnished with the power intake gantry crane:

- One (1) coil of brake of each type for each monorail hoist.
- One (1) set of brake linings for each brake for each monorail hoist.
- One (1) motor of each type for each monorail hoist.
- One (1) drive roller of each type for each monorail hoist.
- Two (2) sets of three suspension clips with insulators for each monorail hoist.
- One (1) set of flexible straight and ring connections of each type for each monorail hoist.
- One (1) coil of each type for each monorail hoist.
- One (1) set of fuses, signal and lighting lamps for each monorail hoist.
- Two (2) relays of each type for each monorail hoist.
- One (1) set of contacts and carbon brushes for each monorail hoist.
- Two (2) Wire ropes of the rated capacities and lengths for each monorail hoist.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

7 TECHNICAL SCHEDULES

- (a) The Technical Schedules are technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 8
ROPE DRUM HOIST**

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1 GENERAL

- (a) Rope drum hoists are used when single heavy gates/stoplogs required to be lifted. The hoist always engages with the gate/stoplog leaf and thus eliminate engaging and disengaging operation.
- (b) The specific requirements of the rope drum hoist at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of rope drum hoists at each location consisting of:
 - One (1) complete set of electrically operated rope drum hoist.
 - One (1) set of hoist support platform, roof and side covers for environmental protection, with all anchorages and other essential embedded parts.
 - Necessary ladders, handrails, and safety equipment for access of the hoist.
 - One (1) set of complete power supply equipment.
 - One (1) set of all necessary anchors, bolts, ribs, foundation plates, feet, lugs, temporary internal strengthening structures, and any other device for alignment and fixing to the concrete.
 - One (1) set of equipment for the grabs, hooks etc.
 - One (1) set of control cabinet.
 - Necessary load for static & dynamic load test of the hoist (static 140%; dynamic 125% of nominal load).
 - One (1) set of all tools and special equipment necessary for operation, repair, and maintenance of the supply.
 - Spare parts and tools as mentioned in Clause 6 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

3.1 Design Stresses

- (a) The design, calculation and manufacturing of the hoist shall be based on FEM standard and/or equivalent international standards, considering the dimensions, loads and operation. The design shall not miss earthquake and wind factors as specified in the standards.
- (b) For operation of the hoist, all friction, dynamic forces, wind loads shall also be considered.
- (c) The hoists shall be equipped with load cells and limit switches for safe operation.
- (d) All the rotating and moving parts shall be protected by sheet metal guards, wireframe, or other convenient protection devices.
- (e) The maximum vertical deflection of a girder of the hoist caused by nominal load shall not exceed 1/1000 of the relevant span.
- (f) The height of operating platform, hoist capacity and other hoist parameters shall be determined including the size and weight of the load, possible maintenance of the gate/stoplog while lifting etc.
- (g) The height of the roof/superstructure shall be determined including the size of rope drum mechanism, height of an operator, and possible lifting/maintenance of the equipment.
- (h) The hoist shall be designed for the outdoor operation, with limited protection from the environment. During design, manufacturing and installation, care shall be given that the hoist operates in remote area and requires high reliability of operation.
- (i) The material to be used for construction of the structural parts shall be structural steel according to EN 10025 or equivalent.
- (j) All hinged joints, wheel spindles, gears, etc. shall be equipped with self-lubricating bushings/bearings. All spindles/axles shall be made from stainless steel.
- (k) The Contractor shall submit detailed information about the types and the grades of materials which he proposes to supply for the major parts of the delivery with reference to relevant standards. If special materials are used, information about chemical composition, possible heat treatment and mechanical properties shall be included.
- (l) In addition to these requirements, some specific requirements are given in Section 3.2. A combination of standard hoisting equipment placed on an operating platform is foreseen, but a detailed equipment specification is not possible. The Contractor shall suggest for the possible better solutions, which should be used after the approval of the Employer.

3.2 Specific Requirements

3.2.1 Hoist Operating Platform

- (a) The hoisting equipment shall be placed on hoist operating platform. The platform shall be supported by required number of columns. The platform shall be covered by roof and, if necessary, from the sides.
- (b) The platform shall be of concrete construction. Steel construction can be used (not preferred) after the approval of the Employer.
- (c) If multiple platforms are required for multiple gates/stoplogs on same line, one continuous platform should be used, and common structural members can be used for the platforms. For the analysis of such structure, in addition to individual hoists, cases of possible different operating conditions for the different hoists shall be taken.
- (d) The structure shall be designed based on accepted national/international standards. The design shall not miss all possible hoist-operating conditions, earthquake effect, wind effect and other possible load combinations.
- (e) Ladders with safety cages shall be provided for the access of the platform. Handrails shall also be provided at the edge of the platform.

3.2.2 Hoist Cover Roof

- (a) The hoisting equipment shall be protected by a roof structure from the environment. If required, the equipment and platform shall be protected from the sides.
- (b) The roof structure should be steel construction. Concrete structure can be used instead of steel structure, if required.
- (c) If multiple platforms are required for multiple gates/stoplogs on same line, one continuous roof should be used, and common structural members can be used for the roofs.
- (d) The structure shall be designed based on accepted national/international standards. The design shall not miss earthquake effect, wind effect and other possible load combinations.

3.2.3 Hoist

- (a) The hoist shall be mounted on the operating platform and shall consist of rope drums for pulley blocks with incorporated a non-turning lifting mechanism. The hoist shall be equipped with twist-free ropes.
- (b) All deflection of lifting elements, i.e., drums, shafts/axles, deflection sheaves, lifting hooks, etc., shall be designed adequately for continuous and reliable operation under all applicable conditions.
- (c) The hoist consists of the following major parts: rope drum of welded steel provided with rope grooves and equipped with bearings, winding motor, closed oil bath lubricated reduction gear, hoist brake for normal operation actuated by electro-hydraulic actuator, additional safety brake normally for retarding action other than the main brake operation,

overload protection system, load cell, galvanised steel wire ropes of Warrington Seale type, steel pulley case with rope pulley.

- (d) The brakes shall be designed to exert a torque at least 1.5 times the full load torque of the motors. The manual release of the brakes shall be possible in case of emergency. The brakes shall operate immediately after the power of the drive motor is cut off and shall be equally effective in both directions of travel. The wire rope ends shall be fitted with standard sleeve clamps.
- (e) The hoist bases shall be made of structural steel members. The base deck shall be covered with a raised pattern steel plate 6mm thick or greater, suitably stiffened. A free passage, 900mm wide, shall be maintained along one of the sides of the hoist bases, and free access shall be provided to all parts of the hoist machinery for maintenance and repair. The base deck shall be provided with handrails on all sides. Access from the hoist base to the top of the fully raised gates shall be provided. This access shall be provided through a covered hatchway in each hoist base. The hoist bases shall be fixed to the towers using high strength bolts.

3.2.4 Power Supply

- (a) The power to the hoist should be supplied through a cable, which shall be protected against mechanical damage. The hoist shall operate on 400 V, 3-phase, 50 Hz power supply.
- (b) A main terminal box for power in-feed with a separate disconnect switch for the hoist shall be installed at a point near the foot of the operating platform. The terminal box shall at least have protection class of IP 65. Electrical supply up to this box shall be the part of the Electrical Works.
- (c) The power supply system shall have provision of interconnection when there are multiple hoists at one location. In case of power failure of the one hoist, power supply to the hoist from other board shall be possible.

3.2.5 Control and Monitoring

- (a) The hoist shall be equipped with a control panel for operation from the operating platform. The hoist shall be connected to the SCADA system and shall be operable remotely from the control room in case of emergency. Relevant data of the gate and the hoisting system shall be shared, monitored, and stored using the SCADA system. The hoist shall be operable from pendant switch, which shall be operable from feet level of the hoist room.
- (b) The control panel shall be equipped with an emergency mushroom switch for tripping of the main circuit breaker. The panel shall also have key switch acting on the main circuit breaker, overload warning lights for the hoist, a slack rope warning light, ampere meter, and an indicating instrument for the depth of the relevant gate/stoplog panel during operation.
- (c) The gate shall be equipped with control circuit transformers, motor starters and thermal overload protection for each motor. Adjustable limit switches actuating the circuit breaker shall be provided for limitation of the lifting and lowering range of the hoist, and for the highest lifting position of the hoist.

- (d) The hoist shall also be equipped with a cut-off switch for loads exceeding the rated capacity. The hoist electrical systems shall be provided with the necessary circuit breakers, fuses, relays, switches, isolators, ammeters, motor protection devices and other necessary control and protection devices.

3.2.6 Operating Control Panel and Hoist Controls

- (a) All hoisting operations shall be made from the control panel and from the control room through the SCADA system. The control panel shall be designed for outdoor operation with limited protection from the environment.
- (b) The control panel shall include all the pushbuttons, switches, position indicators and signal lights required for the control of the lifting operations. These devices shall be located and arranged so that all control operating handles, switches, buttons, and pedals are within convenient reach of the operator. All control devices shall be weather-proof and dust tight.
- (c) The control panel shall also include the following:
- A main voltage switches lockable in the open position,
 - A warning horn and its push button control,
 - Switches controlling the working area and the lifting mechanism.

3.2.7 Switchboard

- (a) The switchboard containing all elements required for the lifting operations shall be installed on the foot of the rope drum hoist.
- (b) The switchboard shall be watertight and shall, as a general rule, include all necessary switchgears, relays and instruments for the power distribution, control, monitoring, signalling and protection of the hoist.

3.2.8 Wiring

- (a) All wiring on the hoist and on its component shall be completed at the Contractor's plant, except the wiring which disturbs the manufacturing, transportation, and erection.
- (b) However, a sufficient quantity of cable and associated materials of the proper sizes and types shall be included with the shipment to permit completion of the hoist wiring in the field.
- (c) Electrical wiring within the equipment shall be neatly arranged, properly supported, uniformly colour coded, and terminated so that all external connections can be made to terminal blocks inside the equipment or in terminal boxes. Control circuits and power circuits shall be completely separated by use of divided or separate terminal boxes.
- (d) Marking strips shall have wire designations as used on the wiring diagram or as designated by the Employer. No more than 2 wires shall be connected to any one terminal block screw.

3.2.9 Lighting and Convenience Outlets

- (a) The operating platform shall be suitably light and the minimum lighting intensity (measured 80 cm above the floor) shall be 500 Lux.
- (b) Lighting of the hoist shall include minimum:
 - 2 watertight swivelling LED floodlights with at least 160 W capacity in order to illuminate the hoisting operations.
- (c) The control of the lighting shall be at the foot of the entrance ladder and in the operating platform. At least six 230 Volt convenience outlets shall be provided; two at foot levels and four at the operating platform.

3.2.10 Fire Protection

- (a) Provision shall be made for three portable dry powder fire extinguishers of approximately 6 kg weight fitted in the following locations:
 - At the control panel,
 - Inside the hoist housing,
 - At the main switchboard.
- (b) The instructions for use shall be clearly marked on each extinguisher.

3.2.11 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter "Surface Treatment and Painting" of General Technical Requirements, chapter-16.

3.2.12 Manual Operation

- (a) Manual operation of the gate shall be provided for the emergency operation in the event of electric supply failure.
- (b) When the manual drive is engaged, the electrical operation shall be prevented using electrical interlocks. The manual drive shall be provided with suitable clutch mechanism for easy engagement and dis-engagement. To prevent self-falling during manual operation, suitable locking mechanism (such as ratchet mechanism) shall be provided.
- (c) The crank force, crank radius, speed of crank revolution, height of the crank, maximum number of persons, and other related parameters shall be determined based on the standard ergonomic requirements.
- (d) During manual operation, the dial gage/display instrumentation shall work, such that operators can see the position of the gate.

4 INSTALLATION

- (a) The contractor is responsible for the total installation of the hoist. He shall furnish all materials and devices required for supporting and holding parts in position while the concrete is being placed.

- (b) The contractor shall perform the following installations:
- Install all second stage concrete embedded items of the crane rail system,
 - Install all non-embedded parts,
 - Prepare a permanent record of elevations, clearances, tolerances and similar measurements established at the time of erection. This record shall be checked and if necessary supplemented by additional measurements taken by the contractor at the direction of the Employer's before the crane is commissioned.
 - Finish painting equipment as specified in the Chapter "Surface Treatment and Painting" of General Technical Requirements.

5 TESTS

5.1 Shop Assembly and Test

- (a) The hoist shall be completely assembled at the shop. In particular, the following tests shall be carried out under the supervision of the employer:
- Checking of the main dimensions,
 - Operational test of all drives.
- (b) The test equipment and instrumentation have to be provided by the contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled touch-up painted and packed for shipment.

5.2 Tests on Completion

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract, Particular Conditions of Contract and the General Technical Specification.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

5.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
- Inspection of satisfactory installation of all components,
 - Rail-track position shall be checked before and after its definitive setting and clamping,
 - No-load test.
- (b) During the testing manoeuvres, the following items shall be checked:
- Correct operation of the brakes and limit switches,
 - Vertical and horizontal travelling distances and approach measurement,

- Operating speeds,
- Operation and characteristics of the manual emergency control,
- Examination of the paintwork.

5.2.2 Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:
- The operations of raising, lowering, holding in any position, and transporting the test loads. The test load for the hook will be 125% of the rated hook load;
 - Operation of the hoist with 100% of the rated hook load and rated speeds and determination that the main hook or lifting eye motions can be controlled within specified limits.
- (b) The contractor is responsible to make all arrangements necessary for the load test and to provide the test weights. During manoeuvres of the commissioning test, the following shall be checked:
- Measurement of operational speeds,
 - Check of the limits of travel,
 - Check of the power consumption of motors and driving and hoisting equipment,
 - Check of the accuracy of indication and the limit switch setting,
 - Check of the manual operation of the hoisting equipment,
 - Correct the general operation of the safety mechanisms and accessories,
 - Temperature raise of the motors, bearings, and other mechanical and electrical components,
 - Correct operation and efficiency of the brakes.

6 MANDATORY SPARE PARTS

- (a) The following spare parts shall also be furnished with the power intake gantry crane:
- One (1) coil of brake of each type,
 - One (1) set of brake linings for each brake,
 - One (1) set of gear reduction unit of each type,
 - One (1) set of bearings of each type,
 - One (1) motor of each type,
 - Two (2) sets of three suspension clips with insulators,
 - One (1) set of flexible straight and ring connections of each type,

- One (1) set of fuses, signal and lighting lamps,
- Two (2) relays of each type,
- One (1) set of contacts and carbon brushes,
- Two (2) Wire ropes of the rated capacities and lengths,
- Complete box of tools required for operation and maintenance works,
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate.
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

7 TECHNICAL SCHEDULES

- (a) The Technical Schedules are technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

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GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
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**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
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**CHAPTER 9
HYDRAULIC HOIST**

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1 GENERAL

- (a) Hydraulic hoists are used when heavy gates/stoplogs are required to be operated with high reliability. These hoists are used when positive thrust is required during lowering. These hoists can easily be operated automatically remotely. The hoist always engages with the gate/stoplog leaf and thus eliminate engaging and disengaging operation.
- (b) The specific requirements of the hydraulic hoist at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of hydraulic hoists at each location consisting of:
 - One (1) complete lot of hydraulic servomotors having specified numbers of servomotors for each service gate/maintenance gate.
 - One (1) complete lot of hydraulic oil pumping unit (HPU) serving specified number of hydraulic servomotors.
 - One (1) set of embedded parts and foundations including all anchorages and containment building for each HPU.
 - One (1) complete set of control, and protection unit with indications alarms.
 - Necessary ladders, handrails, and safety equipment for access of the hoist.
 - One (1) set of complete power supply equipment.
 - One (1) set of all necessary anchors, bolts, ribs, foundation plates, feet, lugs, temporary internal strengthening structures, and any other device for alignment and fixing to the concrete.
 - Necessary load for static & dynamic load test of the crane (static 140%; dynamic 125% of nominal load).
 - One (1) set of all tools and special equipment necessary for operation, repair, and maintenance of the supply.
 - Spare parts and tools as mentioned in Clause 6 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The design, calculation and manufacture shall be based on DIN 19704 and other relevant international standards, considering the dimensions, loads and operation. The pressure vessels shall conform with the national regulations as well as latest edition of ASME Boiler and Pressure Vessel Code or EN 13445 or equivalent international codes and standards. The hydraulic system with related components shall conform with the requirements of ISO 4413 or equivalent standard. The design shall include an earthquake factor as specified.
- (b) The pressure vessels and piping shall be pressure tested to ensure the strength of the components.
- (c) For calculation of hoisting, all friction, hydrodynamic forces, silt and ice load, and seating load shall not be missed.
- (d) Each hoist shall be able to position and maintain the gate in a chosen position for extended periods of time.
- (e) All the rotating and moving parts shall be protected by sheet metal guards, wireframe, or other convenient protection devices.
- (f) When multiple hydraulic hoists are used at one location, the system shall be provided with interconnection possibilities for emergency applications. Necessary pumps, control devices and other equipment shall be provided for the interconnection. The units, however, shall be designed in such a way that the operation of one gate in no way disturbs the position or operation of any other gate.
- (g) The arrangement and design of the hoist and controls shall be such that at all times when the gate is above its sill level it shall be supported, unless locked in position, by the fluid in the hydraulic cylinders. The above also applies with a loss of pressure in one of the two cylinders leaving one cylinder to support the gate.
- (h) The hoist shall be able to raise and lower a gate at the specified operating speed under normal operating loads.
- (i) The hoist shall be able to be lifted and lowered even if the external power supply fails.
- (j) The hydraulic cylinders with piping, valves, and other necessary devices shall be designed for outdoor operation. During design, manufacturing and installation, care shall be given that the hoist operates in remote area and requires high reliability of operation.
- (k) The material to be used for construction of the structural parts shall be structural steel according to EN 10025 or equivalent. All the pressure vessels shall be made from pressure vessel grade steels and materials.
- (l) All hinged joints, wheel spindles, gears, etc. shall be equipped with self-lubricating bushings/bearings. All spindles/axles shall be made from stainless steel.
- (m) The Contractor shall submit detailed information about the types and the grades of materials which he proposes to supply for the major parts of the delivery with reference

to relevant standards. If special materials are used, information about chemical composition, possible heat treatment and mechanical properties shall be included.

- (n) In addition to these requirements, some specific requirements are given in the **Error! Reference source not found.** A hydraulic hoisting system is foreseen, but a detailed equipment specification is not possible. The Contractor shall suggest for the possible better solutions, which should be used after the approval of the Employer.

3.1 Specific Requirements

3.1.1 Hydraulic Cylinders

- (a) The design, fabrication, welding, stress relieving and radiography of the hydraulic cylinders shall conform to the requirements of the appropriate Standard.
- (b) The wall of the cylinder shall be of seamless steel or of flat steel plates formed into a cylindrical shell, joined with not more than two longitudinal welds and bored and honed to a smooth surface finish of 0.4 micrometres measured on the centreline average scale. The flanges of the cylinders shall be of forged steel of a quality which is suitable for butt welding to the cylinder shell. Flange joints shall have nitrile "O" ring or equivalent seals.
- (c) The bore of the cylinders shall be truly circular. The axis of the exterior surface of the cylinders shall be within 1 mm of the axis of the bore. The faces of the cylinder flanges shall be machined normal to the axis of the cylinder bore, and the flanges shall be drilled and bored accurately so that all parts will be in alignment and will operate without binding. The cylinders shall be provided with vent and drain hole plugs to facilitate filling and draining.
- (d) Piston seals shall be circumferential split metal rings or pressure actuated moulded type, or a combination of both, selected for maximum effectiveness and minimum leakage and maintenance. The piston seals shall be replaceable by removing the top cylinder head.
- (e) The bottom cylinder heads shall incorporate a gland and rod guide assembly fitted with "V" ring packing.
- (f) Each piston rod shall be austenitic stainless steel in one piece and rigidly attached to the piston. The rods shall be straight and the portion which passes through the packing gland shall be polished and shall have a hard chromium layer with a minimum thickness of 0.1 mm. Coatings other than hard chromium layer with better performance can be applied after the approval of the Employer.
- (g) If a cylinder is made of more than one section, the bore where the sections are joined shall be smooth and without discontinuity. Flanges shall be connected by high strength steel bolts.
- (h) The lower end of the piston rod and the cylinder body shall be fastened to the gate structure and cylinder mounting respectively by means of spherical bearings of rust resistant material. Clevis pins shall be made from austenitic stainless steel.
- (i) Suitable provision for adjustment to a cylinder mounting shall be incorporated to facilitate alignment of the rod and cylinder.

- (j) The mountings shall be designed to withstand the maximum forces that the actuators can impose without exceeding the allowable working stresses and shall permit the easy removal of the cylinders.
- (k) The cylinders shall be provided with lifting lugs to facilitate assembly.
- (l) For high hoisting height, extension rod(s) should be provided for the extension of the piston stem. The extension system shall be adequately supported for force transfer and prevent buckling/instabilities.
- (m) Adjustable flow control devices shall be provided in each system to positively limit the rate of closure of the gates to the maximum rate for which they have been adjusted. The flow control devices shall be mounted on the cylinders, to minimise the risk when a fault develop in the piping system.
- (n) To minimise the possibility of malfunction which could lead to serious damage to a gate, all valves and limit switches operated by gate movement shall be directly actuated by some part of the gate or actuator.

3.1.2 Hydraulic Oil Pump Units

(a) General

- The components of each oil-pumping unit shall form a compact assembly of duplicated pumps (service and standby), motors, oil tank and associated valves mounted within the gate control cabinet and be accessible for adjustment and maintenance. Each pumping unit shall include a hand pump for emergency operation with a maximum operating force of 10 kg.
- The oil pumps shall be a positive displacement type and direct motor driven through a flexible coupling.
- Relief valves of sufficient capacity to pass the delivery of the pump without chattering, at a pressure of not more than 10 per cent above the maximum rated system pressure, shall be provided.
- Full flow filters of adequate capacity shall be included in the circuits. It shall be possible to remove the filter element for cleaning without draining the system.
- Either nitrogen filled rubber bladder type accumulators or piston type accumulators with separate nitrogen flask, shall be designed, tested and installed.

(b) Oil Tanks

- The oil tanks shall have a minimum capacity not less than that required to contain all the oil that can be discharged back into the tank by completely discharging into the oil in the system. Each tank shall be provided with an access hole with removable cover and oil-resistant gasket.
- Oil tanks shall be weatherproof and fitted with a filler breather cap, an oil level sight gauge, a level switch, and a drain valve. The level switch shall stop the pump if the oil level falls

below a predetermined safe level. There shall be no escape of oil from the breather cap when the gate is closing at the maximum rate. Fine mesh strainer(s) shall be provided for filler hole, oil returning, and pipe ends/starts. The strainers shall be readily removable for cleaning.

- Before being painted, oil tanks shall be tested by an approved method to ensure that it is leak proof.

(c) Piping

- The pipe fittings and pipe for the actuator shall be in accordance with the appropriate Standard. The oil lines shall be made from black cold drawn seamless piping. The oil velocity in the pressure lines shall conform DIN 19704.
- The valves, piping and fittings shall be sized so that the pressure loss will not cause separation of the oil column in the piping and cylinder during gate closure.
- Piping systems shall be prefabricated where practicable, leaving only such connections as may be necessary for assembly or possible subsequent dismantling for repair.
- All necessary studs, bolts, screws, nuts, washers, gaskets, masonry anchors, anchor bolts and supports required in connection with the field assembly of the piping for the hydraulic system shall be supplied by the Contractor.

3.1.3 Controls, Indication Alarms and Protection

(a) General

- Gate controls shall function consistently and operate without creating oil pressure surges in the hydraulic system. Movement of the hydraulic control valves shall be regulated in a manner which will prevent oscillations and shocks within the piping system. These valves shall have maximum reliability and minimal inter port leakage.
- Manually controlled isolating gate valves shall be provided at all necessary points in the oil hydraulic circuit.
- For adjusting the pressure controls of the oil system, a pressure gauge (with gauge valve) and a bypass circuit, with a gate valve, discharging to the oil sump tank, shall be provided.
- Cables shall be laid in covered ducts or shall be installed in plastic or steel pipes embedded into the top layer of the concrete floor. Oil lines shall be installed in separate ducts from cables.

(b) Local Control Equipment

- The hydraulic and electrical control, indication, protection, and alarm equipment shall be totally self-contained for each gate and located in local control cubicles in the Gate Control Room. The control cubicles shall be of dust-proof, all-welded construction with rounded corners. All controls shall be convenient for operation and logically and neatly set out and identified.

- The gate control cubicle equipment shall include the following:
 - 3 phase, incoming supply isolating switch,
 - single phase control transformer,
 - Oil pump motor starter and ammeter,
 - Miniature circuit breakers (fuses shall not be permitted),
 - Gate and actuator control equipment,
 - Terminal blocks for power supply and control cables, including disconnect type terminals for control signals,
 - Cubicle lights and associated door switches,
 - Cubicle anti condensation heaters and thermostats,
 - 240 V, 10 A single phase, weatherproof socket outlet,
 - Gate hydraulic control valves, pipework, pressure gauges, pressure switches, isolating valves, etc.,
 - Cubicle earthing facilities,
 - Any other equipment necessary to complete the local control system.

(c) Control Facilities

- Local control facilities shall include:
 - control mode selection NORMAL/MAINTENANCE/OFF for each gate,
 - gate open initiation for each gate,
 - gate stop initiation for each gate,
 - gate close initiation for each gate,
 - gate emergency open initiation for all gates.

(d) Indications and Alarms

- Local indications and alarms shall include the following. All of these other than those marked “*” shall also be input to the powerhouse control systems:
 - Gate position (analogue) for each gate,
 - Gate fully open or gate fully closed for each gate,
 - Control mode off “NORMAL” for each gate,
 - Open circuit A or B faulty (with alarm) for each gate,
 - Mechanical lock engaged for each gate,
 - AC power supply failed (with alarm),
 - Gate control faulty (with alarm, e.g. if transducer faulty),
 - Local protection system open,

- Gate emergency open,
- Gate freeboard less than 200 mm for each gate,
- Gate position discrepancy (with alarm) for each gate,
- Gate position transducer discrepancy (with alarm) for each gate,
- Gate jammed (with alarm) for each gate,
- Gate travel incomplete (with alarm) for each gate,
- Oil pump motor thermal overload operated (with alarm),
- Oil receiver level low or high (with alarm),
- Oil receiver pressure low or high (with alarm),
- Oil sump tank level low or high (with alarm),
- Oil leakage tank level high (with alarm),
- Oil pump motor running *,
- Oil pump motor current (one phase only if 3-phase pump) *,
- Oil pump motor hours run (accumulated) *.

3.1.4 Hoist Supports and Miscellaneous Metalwork

- (a) The Contractor shall provide suitable hoist support beams, pedestals, or trunnion designed to accommodate the maximum actuator forces at overload.
- (b) The Contractor shall provide access ladders and platforms at the actuator, and access ladders between the gate service deck, the actuator deck, and the trunnion deck.
- (c) All miscellaneous metalwork in the area shall be secured against inadvertent falling from the structure.
- (d) All necessary embedded metalwork supports masonry anchors, sole plates, anchor bolts, studs, bolts, screws, nuts and washers shall be provided by the Contractor.
- (e) Equipment earthing facilities and earthing connections from the equipment to the embedded earthing grid shall be provided by the Contractor. Anchor bolts shall be used for welded connection to the embedded earth bars.
- (f) The HPU shall be protected from the environment by providing HPU room. The room shall be free of water, vented, and protected against condensation. The floor level shall be above the maximum water level. The room shall allow for the installation/removal of the equipment.
- (g) The HPU room should be steel construction. Concrete structure can be used instead of steel structure, if required.
- (h) If multiple HPUs are required for multiple gates/stoplogs on same line, one continuous HPU room should be used, and common structural members can be used for the building.

- (i) The structure shall be designed based on accepted national/international standards. The design shall not miss earthquake effect, wind effect and other possible load combinations.

3.1.5 Lighting and Convenience Outlets

- (a) The inside of the HPU room shall be suitably light and the minimum lighting intensity (measured 80 cm above the floor) shall be 500 Lux.
- (b) Outdoor lighting of the hydraulic hoist shall include minimum:
 - 4 watertight swivelling LED floodlights with at least 160 W capacity in order to illuminate the hoisting operations.
- (c) The control of the outdoor lighting shall be at the local control facility and in the Gate Control Room. Adequate number of 230 Volt convenience outlets shall be provided; at least three of them at the local control facility.

3.1.6 Fire Protection

- (a) Provision shall be made for three portable dry powder fire extinguishers of approximately 6 kg weight fitted in the following locations:
 - Inside the HPU room,
 - At the main switchboard.
- (b) The instructions for use shall be clearly marked on each extinguisher.

3.1.7 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the **Error! Reference source not found.**

3.1.8 Manual Operation

- (a) Manual operation of the gate shall be provided for the emergency operation in the event of electric supply failure.
- (b) During manual operation, electrical operation shall be prevented. Gate shall not self-lower during manual operation.
- (c) The crank force, crank radius, speed of crank revolution, height of the crank, maximum number of persons, and other related parameters shall be determined based on the standard ergonomic requirements.
- (d) During manual operation, the dial gage/display instrumentation shall work, such that operators can see the position of the gate.

4 INSTALLATION

- (a) The contractor is responsible for the total installation of the hoist. He shall furnish all materials and devices required for supporting and holding parts in position while the concrete is being placed.
- (b) The contractor shall perform the following installations:

- Install all second stage concrete embedded items of the crane rail system,
- Install all non-embedded parts,
- Prepare a permanent record of elevations, clearances, tolerances and similar measurements established at the time of erection. This record shall be checked and if necessary supplemented by additional measurements taken by the contractor at the direction of the Employer's before the crane is commissioned.
- Finish painting equipment as specified in the Chapter "Surface Treatment and Painting" of General Technical Requirements.

5 TESTS

5.1 Shop Assembly and Test

- (a) The hoist shall be completely assembled at the shop. In particular, the following tests shall be carried out under the supervision of the employer:
- Checking of the main dimensions,
 - Operational test of all drives, including measurement of operating speeds and load switch adjustments,
 - Function tests of the complete control system, measurement of stator winding insulation resistance on all driving motors, voltage test and insulation test on electrical installations.
- (b) The test equipment and instrumentation have to be provided by the contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled touch-up painted and packed for shipment.

5.2 Tests on Completion

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract, Particular Conditions of Contract and the General Technical Specification.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

5.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
- Inspection of satisfactory installation of all components,
 - Radiographic or ultrasonic examination of any site weld in load carrying members,
 - No-load test.
- (b) During the testing manoeuvres, the following items shall be checked:
- Correct operation of the brakes and limit switches,
 - Vertical and horizontal travelling distances and approach measurement,

- Operating speeds,
- Operation and characteristics of the manual emergency control,
- Examination of the paintwork.

5.2.2 Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:
- The operations of raising, lowering, holding in any position, and transporting the test loads. The test load for the hook will be 125% of the rated hook load.
 - Operation of the hoist with 100% of the rated hook load and rated speeds and determination that the main hook or lifting eye motions can be controlled within specified limits.
- (b) The contractor is responsible to make all arrangements necessary for the load test and to provide the test weights. During manoeuvres of the commissioning test, the following shall be checked:
- Measurement of operational speeds,
 - Check of the limits of travel,
 - Check of the power consumption of motors and driving and hoisting equipment,
 - Check of the accuracy of indication and the limit switch setting,
 - Check of the manual operation of the hoisting equipment,
 - Correct the general operation of the safety mechanisms and accessories,
 - Temperature raise of the motors, bearings, and other mechanical and electrical components,
 - Correct behaviour of the actuator cylinder, piping, trunnion, and hydraulic unit along its travelling path,
 - Operability from local, remote and SCADA system from powerhouse control room.

6 MANDATORY SPARE PARTS

- (a) The following spare parts shall also be furnished with the power intake gantry crane:
- One (1) set of hydraulic couplings for one gate, 25 % of the piping for one gate,
 - One (1) complete set of seals for the hand operated pumps,
 - Two (2) complete sets of seals for the electrical pumps,
 - One (1) complete set of filters and seals for the engine driven pump,
 - Two (2) sets of each type of pressure relief valves, non-return valves and other valves,

- One (1) complete electrical motor and pump of each type for each set of the hydraulic unit,
- One (1) set of bearings of each type,
- One (1) complete set of pressure switches,
- One (1) manometer of each type, including manometer valve,
- Four (4) sets of all types of filter cartridges,
- Two (2) sets of flange assemblies for main piping,
- Two (2) sets of branching assemblies with isolating valves,
- Four (4) sets of flange seals,
- One (1) set of contacts, fuses, signal, and lighting lamps,
- Two (2) relays of each type,
- One (1) set of carbon brushes,
- Complete box of tools required for operation and maintenance works,
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate,
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

7 TECHNICAL SCHEDULES

- (a) The Technical Schedules are technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYERS REQUIREMENTS

SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS

CHAPTER 10
SCREW SPINDLE HOIST

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1 GENERAL

- (a) Motorised screw spindle hoists are used when positive thrust is required for lowering of a service gate/maintenance gate.
- (b) The specific requirements of the motorised screw spindle at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall comprise, but not necessarily be limited to the design, manufacture, testing, transport, erection, and surface treatment and commissioning of the following:
 - Specified complete sets of motorized screw spindle hoists at each location consisting of:
 - One (1) complete set of motorized screw spindle hoist with manual operation provision.
 - One (1) set of hoist supporting structure with necessary embedded parts.
 - One (1) set of complete power supply equipment.
 - One (1) set of hoist control system.
 - One (1) set of all necessary anchors, bolts, ribs, foundation plates, feet, lugs, temporary internal strengthening structures and any other device for alignment and fixing to the concrete.
 - Necessary load for static & dynamic load test of the hoist (static 140%; dynamic 125% of nominal load).
 - One (1) set of all tools and special equipment necessary for operation, repair, and maintenance of the supply.
 - Spare parts and tools as mentioned in Clause 6 of this Chapter.
 - All other components, devices, items, and equipment, even if not mentioned above, required for trouble-free, safe, and reliable operation, inspection and maintenance of the Supply.
- (b) For this sub-section, specified means the requirements as given in Particular Technical Requirements.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The design, calculation and manufacture shall be based on relevant international standards, considering the dimensions, loads and operating conditions. The design shall include an earthquake factor as specified.

- (b) For operation of the screw spindle hoists, all friction, hydrodynamic forces, silt load, shall also be considered.
- (c) Motorized double screw spindle should be provided for a gate/stoplog having clear span of 2.0 m.
- (d) The hoists shall be equipped with load cells and limit switches for safe operation. The factor of safety against overturning under any combination of loadings shall be not less than 2.
- (e) The spindle shall be designed with at least a safety factor of 3 against buckling taking into all relevant forces.
- (f) The hoist shall be designed for the outdoor operation. During design, manufacturing and installation, care shall be given that the hoist operates in remote area and requires high reliability of operation.
- (g) The material to be used for construction of the structural parts shall be structural steel according to EN 10025 or equivalent. The material for the spindle shall be stainless steel.
- (h) The Contractor shall submit detailed information about the types and the grades of materials which he proposes to supply for the major parts of the delivery with reference to relevant standards. If special materials are used, information about chemical composition, possible heat treatment and mechanical properties shall be included.
- (i) In addition to these requirements, some specific requirements are given in the Particular Technical Requirement. A standard screw spindle hoisting equipment is foreseen, but a detailed equipment specification is not possible. The Contractor shall suggest for the possible better solutions, which should be used after the approval of the Employer.

3.1 Specific Requirements

3.1.1 General

- (a) The specific requirements indicated hereunder are in addition to and in completion of those arising from the Contractor's obligations to supply goods and designs suitable to fulfil the performance and the requirements of the complete supply covered by this section.

3.1.2 Screw Spindle

- (a) The screw spindles shall confirm to respective international standards subject to Employer's approval.
- (b) The stem capacity in lifting shall be at least 133% of the lifting loads including gate weight, friction loads, silt load, and hydraulic down pull.

- (c) The stem shall also be designed to withstand the 125% of the output thrust of the electric unit with the motor stalled.
- (d) For high hoisting height, extension rod(s) should be provided for the extension of the screw spindle. The extension system shall be adequately supported for force transfer and prevent buckling/instabilities.

3.1.3 Torque Shafts

- (a) The torque shaft shall be made up of carbon steel. The diameter of the shaft shall be large enough to bear the loads in usual conditions of operation.

3.1.4 Gear Reducer Units

- (a) Gear or worm gear reducers used for the hoist shall be standard high-grade reducing units of good efficiency suitable for long service life and the proportion of the parts therein shall be in accordance with the best engineering practice.
- (b) Gear shall be of cast or forged steel with machine cut teeth.
- (c) Gears or worm gears and their supports shall be sufficiently firm to withstand the load imposed under the most adverse operation of the hoist and shall be enclosed in oil-tight and weather-proof cases. Suitable lubrication system shall be furnished for the gear reducer units.

3.1.5 Manual Operating Device

- (a) The diameter of the hand wheel for manual operation shall be approximate 600 millimetres and manual handling force shall be less than 10-kilogram force per operator. The height of wheel from the operating level shall be approximately 700 mm.
- (b) The handle shall be so installed that the handle center is located at the range of 600 to 800-millimetre-high on the concrete deck. The handle shall be furnished with suitable locking device for locking the handle while the handle is out of work.
- (c) When the manual operation is carried out, the electrical operation shall be prevented using suitable devices.
- (d) During manual operation, the dial gage/display instrumentation shall work, such that operators can see the position of the gate.

3.1.6 Bearings

- (a) The bearings shall be of self-aligning greaseable ball, roll or plane type. The bearing shall be designed as per the latest national and international standards and approved by the Employer.

3.1.7 Power Supply

- (a) The power to the hoist shall be supplied through a cable which shall be protected against mechanical damage. The hoist shall operate on 400 V, 3-phase, 50 Hz power supply unless otherwise is approved by the Employer.
- (b) A main terminal box for power in-feed with a separate disconnect switch for the hoist shall be installed nearby the hoist on operating platform. The terminal box shall at least have protection class of IP 65. Electrical supply up to this box shall be the part of the Electrical Works.

3.1.8 Control and Monitoring

- (a) All operating manoeuvres of the hoist shall be made from the local control panel. All control devices shall be weather-proof and dust tight.
- (b) The controls shall be equipped with an emergency mushroom switch for tripping of the main circuit breaker.

3.1.9 Lighting and Fire Protection

- (a) Outdoor lighting of the monorail hoist shall include minimum:
 - 2 watertight swivelling LED floodlights with at least 100 W capacity in order to illuminate the hoisting operations.
 - At least two 230 Volt convenience outlets shall be provided from the main switchboard.
- (b) Provision shall be made for one portable dry powder fire extinguishers of approximately 6 kg weight fitted in the following locations:
 - At the main switchboard.
- (c) The instructions for use shall be clearly marked on each extinguisher.

3.1.10 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter-16 of General Technical Requirements.

4 INSTALLATION

- (a) The contractor is responsible for the total installation of the hoist. He shall furnish all materials and devices required for supporting and holding parts in position while the concrete is being placed.
- (b) The contractor shall perform the following installations:
 - Install all second stage concrete embedded items,
 - Install all non-embedded parts,

- Prepare a permanent record of elevations, clearances, tolerances and similar measurements established at the time of erection. This record shall be checked and if necessary supplemented by additional measurements taken by the contractor at the direction of the Employer's before the crane is commissioned.
- Finish painting equipment as specified in the Chapter "Surface Treatment and Painting" of General Technical Requirements.

5 TESTS

5.1 Shop Assembly and Test

- (a) The hoist shall be completely assembled at the shop. In particular, the following tests shall be carried out under the supervision of the employer:
 - Checking of the main dimensions,
 - Operational test of all drives, including measurement of operating speeds and load switch adjustments,
 - Function tests of the complete control system, measurement of stator winding insulation resistance on all driving motors, voltage test and insulation test on electrical installations.
- (b) The test equipment and instrumentation have to be provided by the contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled touch-up painted and packed for shipment.

5.2 Tests on Completion

- (a) After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract, Particular Conditions of Contract and the General Technical Specification.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

5.2.1 Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
 - Inspection of satisfactory installation of all components,
 - Location of the hoist shall be satisfactory to make the spindles alignment,
 - No-load test.
- (b) During the testing manoeuvres, the following items shall be checked:
 - Correct operation of the brakes and limit switches,
 - Vertical and horizontal travelling distances and approach measurement,

- Operating speeds,
- Operation and characteristics of the manual emergency control,
- Examination of the paintwork.

5.2.2 Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:
- The operations of raising, lowering, holding in any position, and transporting the test loads. The test load for the hook will be 125% of the rated hook load;
 - Operation of the hoist with 100% of the rated hook load and rated speeds and determination that the main hook or lifting eye motions can be controlled within specified limits.
- (b) The contractor is responsible to make all arrangements necessary for the load test and to provide the test weights. During manoeuvres of the commissioning test, the following shall be checked:
- Measurement of operational speeds,
 - Check of the limits of travel,
 - Check of the power consumption of motors and driving and hoisting equipment,
 - Check of the accuracy of indication and the limit switch setting,
 - Check of the manual operation of the hoisting equipment,
 - Correct the general operation of the safety mechanisms and accessories,
 - Temperature raise of the motors, bearings, and other mechanical and electrical components,
 - Correct behaviour of the actuator cylinder, piping, trunnion, and hydraulic unit along its travelling path,
 - Operability from local, remote and SCADA system from powerhouse control room.

6 MANDATORY SPARE PARTS

- (a) The following spare parts shall also be furnished with the power intake gantry crane:
- Two (2) complete sets of switches, push buttons, relay, circuit breakers of each hoist,
 - One (1) set of gear reduction box of each type,
 - One (1) set of bearings of each type,
 - Two (2) complete sets signal lamps, fuses etc. for the control board of each hoist,

- Complete box of tools required for operation and maintenance work.
- Minor items to ensure the operation for not less than five years from the Taking Over Certificate,
- All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

7 TECHNICAL SCHEDULES

- (a) The Technical Schedules are technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
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**BIDDING DOCUMENT
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LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 11
EOT CRANE FOR SILT FLUSHING CHAMBER**

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1. DESCRIPTION, REQUIREMENTS AND DATA

1.1 General

- (a) The bridge crane, provided with a hoist lifting capacity of 5 Ton capacity, shall allow installations, de-installation and maintenance of the Silt Flushing Chamber and auxiliary components within the flushing chamber.
- (b) The lifting capacities of the crane shall not be lower than those indicated above but, if necessary, higher capacity shall be considered if required by the weights of the parts to be lifted.
- (c) The crane shall be able to travel along the entire length of the flushing chamber.

1.2 Design and Operating Conditions

- (a) The bridge crane shall be designed in every respect to safely meet all the requirements of the power plant, project and relevant standards.

A Basic Parameters:

- Type of crane	Electrically Operated Overhead Travelling Crane
- Number of cranes	1
Preliminary Estimation	
- Hoist	5 Tn
- FEM group	A 1
- Crane span (between crane rails)	8.8 m (To be verified by the Bidder)
- Length of runway (approx.)	10.5m (To be verified by the Bidder)
- Elevation of runway rails	El 1947.10m (To be verified by the Bidder)
- Total lift of hoist (approx.)	22.0 m (To be verified by the Bidder)
- Maximum lift of hook above floor level	5.50 m
- Maximum drop of hook below floor level	16.5 m
- Speeds:	0 – 2.0 m/min
- Lifting speed of hoist (variable)	0 – 4.0 m/min
- Crane travelling speed (variable)	0.0 - 8.0 m/min
- Trolley travelling speed (variable)	0.0 – 12.0 m/min
- Intermittent rating for all motors	40%
- Load of static test (with test weight)	140% of nominal load

- Load of dynamic test (with test weight)	125% of nominal load

1.3 Specific Guarantees

- (a) The Contractor shall guarantee the specified hoisting capacities and the girder deflection shall be less than 1/1000 of the relevant span.

2. SCOPE OF WORK

2.1 General

- (a) In addition to the Standard Technical Requirements, this paragraph further specifies only the principal equipment and components to be supplied by the Contractor for the fulfillment of this section of this contract, covering the supply and the services necessary for one (1) bridge crane.
- (b) The Contractor shall, however, provide complete supply, even if equipment or services to be done are not mentioned specifically in the following description of the scope of supply.
- (c) The items enumerated under the following paragraphs refer to the minimum general requirements, but these requirements shall apply to each set to be supplied and any interface equipment deemed to be necessary between this chapter and other chapters, except where stated otherwise.

3. BRIDGE CRANE COMPONENTS

- (a) The supply shall include the following:
- one (1) electrically operated bridge crane with hoist;
 - one (1) set of crane rails with all anchorages, bumpers, etc.;
 - one (1) set of electrical feed posts;
 - Lightning,
 - Oil and grease,
 - one (1) radio wave control of crane;
 - one (1) weight display arrangement at least 16" size, including load cell arranged to display the weight of load lifted by hoist;
 - All members, devices, etc. which could otherwise trap water shall be provided with drain holes. All structural tubing and piping shall be seal welded to prevent entrapment of moisture.
 - necessary load for static & dynamic load test of the crane (140% static test & 125% dynamic test) of nominal load);

- all accessories necessary for the bridge crane to be complete and ready for operation when installation is finalized shall be furnished and included in the supply.

4. DESIGN, MATERIAL AND WORKMANSHIP

- (a) Adequate factors of safety shall be used throughout the design, especially in the design of parts subject to alternating stresses, vibration, impact or shock.
- (b) The Tenderer shall indicate in the calculation notes, the quality of the materials with reference to DIN, ASTM or equivalent standards, and their mechanical and chemical properties. The design of the equipment shall include an earthquake factor as specified and most adverse conditions which will have to be withstood by the equipment in operation or during manufacturing, transport and erection.
- (c) The design calculations and loading conditions shall conform to those given in the Rules for the Design of Hoisting Appliances (FEM), published by the Federation Européenne de la Manutention.
- (d) Under the most severe conditions of loading expected in normal operation, stresses in the materials shall not exceed the values listed except that appropriately lower values shall be used where loading characteristics could cause fatigue failure or excessive deflections. Maximum shear stresses in ferrous materials shall not exceed 60% of the allowable stresses in tension, except that the maximum torsional shear stresses in the main shafts shall not exceed 50% of the allowable stress in tension.
- (e) The design stresses for materials not listed herein shall be selected by the Contractor, but the maximum stresses in tension or compression shall neither exceed 33% of the yield strength or 20% of the ultimate strength.
- (f) The different operation load cases shall consider the following data:
 - Normal operation load case,
 - Extraordinary operation load case with earthquake forces with the maximum acceleration magnitude specified by national regulations and maximum load.
- (g) The stress analysis shall be executed for the governing load case, on the basis of permissible stresses stated in the latest FEM and DIN standards.
- (h) All electrically operated hoisting mechanisms shall be arranged such that hand operation can be used if required in case of any emergency, or during maintenance. Detachable hand cranks or wheels shall be provided for this purpose. An electric switch shall also be included that the electric motor cannot be operated while the hand crank is in position.

5. SPECIFIC REQUIREMENTS

5.1 General

- (a) The specific requirements indicated hereunder are in addition to and in completion of those arising from the Contractor's obligations to supply goods and designs suitable to fulfill the performance and requirements of the complete supply covered by this section.

5.2 Inching Operation

- (a) Inching operation for all motions shall be feasible for achieving slow operation of the crane for purpose of erection, lowering centering, alignment etc.

5.3 Bridge Structure

- (a) The bridge crane structure shall be of welded steel box design, with necessary cross girders and pairs of legs. Boogies for housing of travelling and driving rollers, wheel break supports, rails, tongs and stoppers and locking devices to block the crane in end position shall be provided. Walkways and ladders shall be installed for access.
- (b) The bridge structure shall include the rails and end stops for the crane trolley.
- (c) The wheels shall be made of cast steel and be provided with grease lubricated antifriction bearings. The motorized and non-driven wheels shall be interchangeable.

5.4 Girders

- (a) The crane shall be single girder type.
- (b) The girders shall be box-type welded from structural steel. The box girder's inside may be used for electrical installations. The deflection of the central supporting beam structures under normal design load shall not exceed 1/1000 of the span.
- (c) All welds of the bridge girders and cross girders shall be subjected to 100% X-ray examination as applicable, complemented by a 100% ultrasonic test.

5.5 Bumpers

- (a) Spring or elastomeric bumpers shall be provided on each end of the crane sill beams and on each corner of the trolley. The bumpers shall consist of suitable springs, steel housings and rams or, alternately, of adequately sized elastomeric pads. The end of the crane rails shall also facilitate end-stoppers at both end.

5.6 Trolley

- (a) The trolley frame shall be a rigidly fabricated steel structure to ensure uniform distribution of the loads to all wheels without undue deflection. The trolley frame shall be stress-relieved after fabrication.
- (b) Spring bumpers shall be designed to absorb impacts from forces that would arise when the trolley approaches the end stops of the bridge at maximum speed, with nominal load suspended. Separate drives on either side of the trolley with synchronized induction motors for two speeds, closed oil bath lubricated reduction gear, brake and steel pinions. The design of the drive elements and brakes of the trolley shall be similar to those of the bridge drive.

5.7 Crane Rails and Runway

- (a) The rails to be provided over the full length of the crane travel shall be designed in accordance with DIN 4132 and DIN 18800 or equivalent international standards subject to Employer's approval with all holding down bolts, clamps, fishplates, separators, end buffer stops etc., and shall be gapped at any expansion joints in the concrete.

- (b) The rail joints are to be cut at 45° to ensure a smooth load transfer. The rails shall be dismountable and be fixed by rail clamps which confirm DIN 4132 or equivalent international standards subject to Employer's approval.
- (c) The impact of concrete contraction joints shall be adequately considered in the rail track design.

5.8 Crane Travelling Gear

- (a) The separate drive of the crane shall be equipped with a drive motor, closed oil bath lubricated reduction gear, brake and steel pinion for the travelling roller drive. All the brakes shall have adequate capacity. The brakes for hoisting when applied shall arrest the motion and sustain the load up to the test load at any position of the lift. Provision shall be made to control with safety the lowering of any load up to the test load.
- (b) High speed and low speed operation shall be achieved using separate motors. The motor shall start progressively to avoid uneven starting and reduce swinging of the loads to the minimum.
- (c) Brakes in other motions shall be capable of bringing the relevant motions of the fully loaded crane safely to rest in the shortest possible time with the least possible shock and shall arrest the motion under all other service conditions. The brakes shall act progressively.
- (d) The various brakes shall be designed to exert a torque equal to 2 times of the full load torque of the motors. The brake torque may be increased if considered necessary by the manufacturer in order to ensure proper and safe application of the brakes. All electro- mechanical brake coils shall have continuous ratings. A minimum of four travelling rollers made of cast steel shall be provided with grease-lubricated anti-friction bearings.
- (e) Hoist shall be equipped with two independent brakes, i.e. and electromagnetic holding brake and a control brake. Control brake is preferably electric brake controlled by frequency transformer. An eddy-current brake or drum brake may also be acceptable.
- (f) The brakes shall be capable of operating 600 time per hour.

5.9 Hoist

- (a) The hoist shall be mounted on the hoist trolley and shall consist of two rope drums for pulley blocks with incorporated a double hook for operation with the hydraulic lifting beam. The hoist shall be equipped with twist-free ropes, preferably fibre core.
- (b) All deflection and lifting elements, i.e. deflection sheaves, lifting hooks, etc., shall be designed adequately for continuous and reliable operation under all applicable conditions. The hoist consists of rope drum of welded steel provided with rope grooves and equipped with bearings, winding motor, closed oil bath lubricated reduction gear, hoist brake for normal operation actuated by electro-hydraulic aggregates.
- (c) Additional safety brake normally with retarded action other than the main brake operation, overload protection, load cell, galvanized steel wire ropes Warrington Seal

type, steel pulley case with rope pulley and a hook of forged steel provided with a thrust bearing shall be also provided. The manual release of the brakes shall be possible in case of emergency. The wire rope ends shall be fitted with standard sleeve clamps. The trolley housing shall be of steel construction and the covering plates having a thickness of not less than 3 mm. Inside of the housing shall be isolated with heat resistant material. Lockable openings shall be provided.

- (d) The double hook of the hoist shall be made of forged steel, finish-ground. Maximum stress at load test shall not exceed two third of the ultimate strength. The hook shall be load tested to 150% of rated load and x-rayed or magnafluxed after testing to ensure that no hidden damage occurred to the hook. The hook shall rotate freely on anti-friction bearings and be provided with safety latch.

5.10 Power Supply

- (a) The power to the crane shall be supplied through a conductor together with slip rings. The slip ring consists with carbon brushes shall be in contact with the conductor during the full travel length of the crane. A main terminal box for power in-feed with a separate disconnect switch for the crane shall be installed on the downstream side.

5.11 Control and Monitoring

- (a) The crane shall be equipped with a control desk for operation and for the control of the travelling and hoisting operations. The crane shall be also equipped with a radio wave control box for the control of the travelling and hoisting operations.
- (b) The controls shall be equipped with an emergency mushroom switch for tripping of the main circuit breakers, and with all the push-buttons, switches, position indicators and signal lights required for the control of travels and lifting operations.
- (c) The crane shall be equipped with control circuit transformers, motor starters and thermal overload protection for each motor. Adjustable limit switches of inductive type actuating the circuit breakers shall be provided for limitation of the lifting and lowering range of the lifting beam with an additional safety limit switch for the highest hooks' position.
- (d) The hoists of the crane shall also be equipped with a cut-off switch for loads exceeding the rated capacity. The hoist shall be equipped additionally with a slack rope switch; in order to prevent further lowering of the load with slack ropes.

5.12 Operation and Crane Controls

- (a) All operating maneuvers may be made from the control desk/panel.
- (b) The hydraulic brake pedal shall be carefully located.
- (c) The control desk shall include all the push-buttons, switches, position indicators and signal lights required for the control of travel and lifting operations.
- (d) The control desk shall also include the following:
- A main voltage switch lockable in the open position;
 - A warning horn and its push button control;

- Switches controlling lighting of the operating cabin, the working area and the lifting mechanism.
- (e) A ladder shall be provided in the bridge walkway; minimum width of the ladder shall be 450 mm.
- (f) Handrails shall be provided for inspection and maintenance walkways or operation platforms on the girders, trolleys, cabin, etc.
- (g) The machine shall be operable both manually by an operator with pendant control as well.

5.13 Wiring

- (a) All wiring on the crane and on its component, assemblies shall be completed at the Contractor's workshop, except that wiring shall not be installed where it would be disturbed by or for shipment. However, a sufficient quantity of cable and associated materials of the proper sizes and types shall be included with the shipment to permit completion of the crane wiring in the field.
- (b) Electrical wiring within the equipment shall be neatly arranged, properly supported, and terminated so that all external connections can be made to terminal blocks inside the equipment, or in terminal boxes. Control circuits and power circuits shall be completely separated by use of divided or separate terminal boxes.
- (c) Marking strips shall have wire designations as used on the wiring diagram, or as designated by the Employer. No more than 2 wires shall be connected to any one terminal block screw.

5.14 Lighting

- (a) Four (4) 400 W floodlights shall be installed at the four corners of the crane girders to illuminate the working area. They shall be activated individually and jointly.

5.15 Corrosion Protection

- (a) The corrosion protection shall be as detailed in the Chapter-16 of General Technical Requirement.

6. Quality Assurance

6.1 Codes and Standards

- (a) The standards to be followed, but not limited to, shall be the ones mentioned herein.
 - "RULES FOR THE DESIGN OF HOISTING APPLIANCES" - Books 1 to 8 - 1982, issued by the Fédération Européenne de la Manutention (FEM) - Section I - Heavy Lifting Equipment referred as FEM code;
 - Crane Manufacturers Association of America (CMAA) Specification No. 70, "Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes, (Revised);
 - JIS standard B 8801 for Overhead Travelling Crane; and

- ASME B30.2 (2005) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).

6.2 Design Submittals

- (a) All pertinent technical documents as well as the design and an explanation in detail of the equipment operations shall be submitted to the Employer for approval.
- (b) The Contractor shall include in design submittals, designation and properties of the materials, with reference to EN, ASTM or equivalent standards, on which the proposed design is based.

6.3 Inspections and Tests

A Workshop Tests

- (a) The requirements of the General Requirements and Standard Technical Requirements shall apply.
- (b) The crane shall be completely assembled at the shop respectively divided into suitable sub-assemblies to allow final inspection and performance of functional tests. In particular, the following tests shall be carried out under the supervision of the Employer:
 - Checking of the main dimensions;
 - Operational test of all drives, including measurement of operating speeds and load switch adjustments;
 - Function tests of the complete control system, measurement of stator winding insulation resistance on all driving motors, voltage test and insulation test on electrical installations.
- (c) The test equipment and instrumentation have to be provided by the Contractor. When test equipment has passed the tests to the Employer's satisfaction, the equipment can be disassembled touch-up painted and packed for shipment.
- (d) The Contractor shall prepare an additional list with all components of the supply to be tested and the corresponding tests to be performed. The Employer reserves the right to request tests additional to those proposed by the Contractor, if he deems it necessary. For the raw material, test certificates have to be submitted to the
- (e) Employer.

B Installation

- (a) The Contractor is responsible for the installation of the cranes. The Contractor shall furnish all materials and devices required for supporting and holding parts in position while the concrete is being placed.
- (b) The Contractor shall perform the following for the installation:
 - Install all second stage concrete embedded items of the crane rail system;
 - Install all non-embedded parts;

- Prepare a permanent record of elevations, clearances, tolerances and similar measurements established at the time of erection. This record shall be checked and if necessary supplemented by additional measurements taken by the Contractor at the direction of the Employer before the crane is commissioned;
- Finish painting equipment as specified in the Standard Technical Requirement.

C Tests on completion

- (a) After completion of the installation work at site, no-load, pre-commissioning and commissioning tests shall be performed in accordance with the Conditions of Contract, Particular Conditions of Contract and the Standard Technical Requirement.
- (b) The tests on completion shall consist of pre-commissioning tests and commissioning tests.

D Pre-Commissioning Tests

- (a) The pre-commissioning tests shall include, but not be limited to, the following:
 - Radiographic or ultrasonic examination of any site weld in load carrying members, other than seal welds;
 - Inspection of satisfactory installation of all components;
 - Rail-track position shall be checked before and after its definitive setting and clamping;
 - No-load test.
- (b) During the testing maneuvers, the following items shall be checked:
 - Correct operation of the brakes and limit switches;
 - Vertical and horizontal travelling distances and approach measurement;
 - Operating speeds;
 - Operation and characteristics of the manual emergency control;
 - Examination of the paintwork.

E Commissioning Tests

- (a) The commissioning tests shall include but not be limited to:
 - Dynamic test load at 125% of rated hooks' load. The operations of raising, lowering, holding in any position, and transporting the test loads. Testing of the trolley by transporting the hook test load along the bridge a number of times. Deflection of the girders before applying the loads and under test load shall be measured.
 - Static test load at 140% of rated hooks' load. Deflection of the girders under hook test load shall be measured before & after applying the test load.
 - Operation of the hoists with 100% of the rated hook loads and rated speeds and determination that the hook or lifting eye motions can be controlled within specified limits. Deflection of the girders under rated load shall be measured.
- (b) The Contractor is responsible to make all arrangements necessary for the load test and to provide the test weights.

- (c) During the maneuvers, the following shall be checked:
- Measurement of operational speeds;
 - Check of the limits of travel;
 - Check of the power consumption of motors and driving hoisting equipment;
 - Check of the accuracy of indication and the limit switch setting;
 - Check of the manual operation of the hoisting equipment;
 - Correct the general operation of the safety mechanisms and accessories;
 - Temperature raise of the motors, bearings, etc.;
 - Correct behavior of the crane trolley and travel mechanism along its rolling track: The framework shall remain perpendicular to the track and shall under no circumstances give evidence of any undue deformation;
 - Correct operation and efficiency of the brakes.
- (d) The bearings and other mechanical parts shall also be checked for temperature rises.

7. MANDATORY SPARE PARTS, SPECIAL TOOLS AND INSTALLATION MATERIALS

7.1 Special Tools and Installation Materials

- (a) The supply shall include all special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply; in particular:
- (b) One (1) complete set of supports, eye-bolts, ropes, discs, screws, etc. for erection and maintenance of the main components.

7.2 Mandatory Spare Parts

A General

- (a) The required general spare parts as specified in the Standard Technical Requirements shall be included in the Bid for the equipment specified in this section.

B Special Spare Parts

- (a) The following spare parts shall also be furnished with the crane:
- One (1) coil of brake of each type;
 - One (1) set of thruster, brake shoe with linings for each brake;
 - One (1) motor of each type;
 - One (1) drive roller for crane translation;
 - One (1) drive roller for carriage drive;
 - One (1) free roller for the translation;
 - One (1) free roller for the carriage;
 - Two (2) sets of three suspension clips with insulators;

- One (1) set of flexible straight and ring connections of each type;
- One (1) coil of each type;
- One (1) set of fuses;
- One (1) set of signal and lighting lamps;
- One (1) set of limit switch of each type;
- Two (2) relays of each type;
- One (1) set each of fixed and moving contacts;
- One (1) set of carbon brushes;
- Four (4) sets of Current collection assembly (each type)
- 1 (one) solenoid for each type of brake used
- One (1) set of Couplings complete with coupling bolts, rubber sleeves etc. (each type and size)
- Insulators for travelling trolley wires for one line
- Two (2) wire ropes of the rated capacity and lengths;
- 1 (one) set of bearings, bearing bushings, wear pins, etc., of each type used
- 1 (one) set of gaskets and packings for each type used
- 1 (one) complete set of slings and lubricants used throughout the crane
- (b) Minor items to ensure the operation for not less than five years from the Taking Over Certificate.

C Recommended Spare Parts

- If any additional major spare parts are recommended by the Bidder for a five-year operation period, these shall be specified in the Technical Data Sheets and the unit price shall be quoted in the Price List for each item.

8. DATA SHEETS

- (a) The Technical Data Sheets in Volume 1, Section 4, Annex 1 include Guarantee and Technical Data and shall be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Data Sheets with care and to complete them most conscientiously and with every necessary detail.
- (c) The Bidder is also requested to complete for each additional lifting appliance, necessary to handle any equipment not served by any other already supplied lifting appliance in the Project Area, the relevant Guaranteed and Technical Data Sheet.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME III
EMPLOYER'S REQUIREMENTS**

**PART 3
STANDARD TECHNICAL REQUIREMENTS
HYDROMECHANICAL WORKS**

**CHAPTER 12
GEARED MOTOR**

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1 GENERAL

- (a) Valves should be used when better operating reliability and flushing performance are required.
- (b) The specific requirements of the valve at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall consist of bottom sluice isolation valves and garvel trap gate valves including their driving motors and gear system.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The Contractor shall design, manufacture, and erect the components such that there is minimum operational problem.
- (b) All valves shall be provided with seals to prevent water leakage along the whole periphery of the sealing area.
- (c) The embedded parts shall be of sturdy design, in order to provide the required rigidity.
- (d) All bushings and bearings shall be self-lubricated and sealed to protect from the environment, unless otherwise specified.
- (e) The Contractor shall submit test certificates from valve manufacturers to the Employer. However, Employer has the right to take the sample piece of the material for testing of Mechanical and Chemical properties in witnessing the Employer. All expenses of such testing shall be in account of the Contractor.
- (f) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4 CORROSION PROTECTION

- (a) The corrosion protection shall be as detailed in the Chapter 16 of General Technical Requirements.

5 INSTALLATION

- (a) The embedded parts shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.
- (b) Alignment bolts or other necessary device shall be used to install the embedded parts at corresponding accurate position.

6 ELECTRICAL SYSTEM

- (a) The power source for the valve motors fed from the Motor Control Center is located in the Control Building. All Control devices shall be constructed and tested as per the applicable IEC standards.

6.1 Control

- (a) Manual controls of the gate hoists shall be possible either from the Local Control Station located near the gate hoist at deck level and from the MCC Control compartment located in the Control Building.
- (b) Both local control stations shall be of the three-push button type, labelled "OPEN – CLOSE – STOP".
- (c) The MCC control panel shall have three LED type indicator lights for the following conditions:
- Red for gate fully closed.
 - Green for gate fully raised.
 - Amber for gate in operation.
- (d) Two push buttons labelled "TEST" – "RESET" shall be supplied and wired to the signaling circuit.
- (e) The switches and relays shall be so designed that the indicating lights are not off at the same time, except in case of a defective lamp.
- (f) A three-position selector switch shall be supplied and installed by the Contractor in the Motor Control Center. The switch shall transfer control between the two control stations and the off position. The switch position shall be labelled "MCC" for the manual control located at the MCC, "Local" for the manual local control located on the pier deck and "Off". The Contractor shall provide required auxiliary contacts (list attached) for remote alarm of each position.

7 TEST

Copies of all orders for materials and plant placed with suppliers and copies of the manufacturer's shop Test Certificates for materials and equipment shall be provided. These shall include the following:

- (a) Physical Tests and Chemical Analyses of steel and other principal metals used. Cutting plans for the plates shall also be submitted to enable identification of all principal components.
- (b) Hydraulic Pressure Tests on all parts subject to air, oil or water pressure. The hydraulic test pressures shall be in accordance with the appropriate DIN or such other Standard.

- (c) Proving Tests on motors and gears etc.
- (d) Insulation Tests, Running Tests, Heating Tests, Operating Tests, Full Load and Overload Tests, etc. on electric motors, starters and other electrical and mechanical equipment.
- (e) Operating and control gear with electric motor, starter, etc. and, where practicable, limit switches, shall be tested to ensure that all parts work satisfactorily.
- (f) Welds shall be physically, radio-graphically, or ultrasonically tested as specified.
- (g) While assembled, the valve shall be checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall be promptly corrected.
- (h) The seals shall be fitted to their supports during the shop assembly. Parts shall be clearly match-marked before disassembly for transportation.

7.1 Tests on Completion

- All equipment shall be carefully inspected and tested at site after erection to show that it is satisfactory.
- After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.
- The tests on completion shall consist of pre-commissioning tests and commissioning tests.
- Testing shall include the following:
 - Valves shall be tested at full opening and at various partially opened positions for vibrations, noise or other similar phenomena.
 - All valves shall be tested to show that the seals are operating satisfactorily and that the valves work correctly under all specified conditions.
 - The valves shall be operated by the push button controls to show that they open and close satisfactorily and the limit switches and position indicators checked for correct setting.
 - All electrical equipment shall be checked for correct connection and installation, electric motors and control gear checked for insulation resistance between the circuits and to earth, and for overheating.
 - All valves shall be opened and closed to show that they operate satisfactorily under all specified conditions and the indicators, and the limit switches are correctly set, etc.
 - All miscellaneous equipment shall be tested for correct alignment and installation, efficient and smooth running, and satisfactory operation.
 - Site welds shall be tested as specified.

7.2 Pre-Commissioning Tests

The pre-commissioning tests shall include, but not be limited to, the following:

- Inspection of the embedded parts,
- Radiographic or ultrasonic examination of site weld in load carrying members, other than seal welding seams,
- Inspection by feeler gauge measurement of satisfactory sealing seat of all seals,
- Insulation resistance tests on all site installed wiring and electrical connections,
- Setting of limit switches, indicators, and controls,
- Inspection of satisfactory installation of all components.

7.3 Commissioning Tests

The commissioning tests shall include, but not be limited to, the following:

- Measurement of operation speeds,
- Check of accuracy of indication, limit setting and alarm signals etc.,
- Check of water leakage from closed gates (a remarkable leakage to be repaired at once),
- Check of limits of travel,
- Check of power consumption of motors,
- Temperature raise of motors, bearings etc.,
- Check of general satisfactory operation.

8 MANDATORY SPARE PARTS AND TOOLS

(a) Sluice Isolation Valves

- One (1) set of seals and gasket used for each valve including 20% of the bolts and other fixation material with all necessary components.
- One (1) set of limit switches, contractor, fuses, relays, etc used of each type used for each valve.
- Two (2) nos. of motors used
- Two (2) nos. of gearbox used
- One (1) set of Rubber bushes for flexible couplings (if applicable)

Any other general spare parts as stipulated in the Standard Technical Requirements.

All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(b) Gravel Trap Flushing Valves

- One (1) set of seals and gasket used for each valve including 20% of the bolts and other fixation material with all necessary components.
- One (1) set of limit switches, contractor, fuses, relays, etc used of each type used for each valve.
- Two (2) nos. of motors used
- Two (2) nos. of gearbox used
- One (1) set of Rubber bushes for flexible couplings (if applicable)

Any other general spare parts as stipulated in the Standard Technical Requirements.

All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

9 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

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1 GENERAL

- (a) Valves should be used when better operating reliability and flushing performance are required.
- (b) The specific requirements of the valve at each location are given in the corresponding sections of Particular Technical Requirements.
- (c) General arrangement and location of the equipment are shown on the corresponding Hydro-Mechanical and Civil Engineering drawings.

2 SCOPE OF SUPPLY

- (a) The supply shall consist of bottom sluice isolation valves and garvel trap gate valves including their driving motors and gear system.

3 DESIGN, MATERIAL AND WORKMANSHIP

- (a) The Contractor shall design, manufacture, and erect the components such that there is minimum operational problem.
- (b) All valves shall be provided with seals to prevent water leakage along the whole periphery of the sealing area.
- (c) The embedded parts shall be of sturdy design, in order to provide the required rigidity.
- (d) All bushings and bearings shall be self-lubricated and sealed to protect from the environment, unless otherwise specified.
- (e) The Contractor shall submit test certificates from valve manufacturers to the Employer. However, Employer has the right to take the sample piece of the material for testing of Mechanical and Chemical properties in witnessing the Employer. All expenses of such testing shall be in account of the Contractor.
- (f) If special materials are used, information about chemical composition, possible heat treatment, physical and mechanical properties shall be submitted and can be used only after the approval of the Employer.

4 CORROSION PROTECTION

- (a) The corrosion protection shall be as detailed in the Chapter 16 of General Technical Requirements.

5 INSTALLATION

- (a) The embedded parts shall be assembled in their recesses in accordance with the final approved drawings, brought to line and grade within the tolerances specified and firmly secured in place.

- (b) Alignment bolts or other necessary device shall be used to install the embedded parts at corresponding accurate position.

6 ELECTRICAL SYSTEM

- (a) The power source for the valve motors fed from the Motor Control Center is located in the Control Building. All Control devices shall be constructed and tested as per the applicable IEC standards.

6.1 Control

- (a) Manual controls of the gate hoists shall be possible either from the Local Control Station located near the gate hoist at deck level and from the MCC Control compartment located in the Control Building.
- (b) Both local control stations shall be of the three-push button type, labelled “OPEN – CLOSE – STOP”.
- (c) The MCC control panel shall have three LED type indicator lights for the following conditions:
 - i. Red for gate fully closed.
 - ii. Green for gate fully raised.
 - iii. Amber for gate in operation.
- (d) Two push buttons labelled “TEST” – “RESET” shall be supplied and wired to the signaling circuit.
- (e) The switches and relays shall be so designed that the indicating lights are not off at the same time, except in case of a defective lamp.
- (f) A three-position selector switch shall be supplied and installed by the Contractor in the Motor Control Center. The switch shall transfer control between the two control stations and the off position. The switch position shall be labelled “MCC” for the manual control located at the MCC, “Local” for the manual local control located on the pier deck and “Off”. The Contractor shall provide required auxiliary contacts (list attached) for remote alarm of each position.

7 TEST

Copies of all orders for materials and plant placed with suppliers and copies of the manufacturer's shop Test Certificates for materials and equipment shall be provided. These shall include the following:

- (a) Physical Tests and Chemical Analyses of steel and other principal metals used. Cutting plans for the plates shall also be submitted to enable identification of all principal components.

- (b) Hydraulic Pressure Tests on all parts subject to air, oil or water pressure. The hydraulic test pressures shall be in accordance with the appropriate DIN or such other Standard.
- (c) Proving Tests on motors and gears etc.
- (d) Insulation Tests, Running Tests, Heating Tests, Operating Tests, Full Load and Overload Tests, etc. on electric motors, starters and other electrical and mechanical equipment.
- (e) Operating and control gear with electric motor, starter, etc. and, where practicable, limit switches, shall be tested to ensure that all parts work satisfactorily.
- (f) Welds shall be physically, radio-graphically, or ultrasonically tested as specified.
- (g) While assembled, the valve shall be checked for dimensions, tolerances and accuracy of alignment. Any error or misalignment discovered shall be promptly corrected.
- (h) The seals shall be fitted to their supports during the shop assembly. Parts shall be clearly match-marked before disassembly for transportation.

7.1 Tests on Completion

- All equipment shall be carefully inspected and tested at site after erection to show that it is satisfactory.
- After completion of the installation work at site, dry and wet tests shall be performed in accordance with the Conditions of Contract and Particular Conditions of Contract.
- The tests on completion shall consist of pre-commissioning tests and commissioning tests.
- Testing shall include the following:
 - Valves shall be tested at full opening and at various partially opened positions for vibrations, noise or other similar phenomena.
 - All valves shall be tested to show that the seals are operating satisfactorily and that the valves work correctly under all specified conditions.
 - The valves shall be operated by the push button controls to show that they open and close satisfactorily and the limit switches and position indicators checked for correct setting.
 - All electrical equipment shall be checked for correct connection and installation, electric motors and control gear checked for insulation resistance between the circuits and to earth, and for overheating.
 - All valves shall be opened and closed to show that they operate satisfactorily under all specified conditions and the indicators, and the limit switches are correctly set, etc.

- All miscellaneous equipment shall be tested for correct alignment and installation, efficient and smooth running, and satisfactory operation.
- Site welds shall be tested as specified.

7.2 Pre-Commissioning Tests

The pre-commissioning tests shall include, but not be limited to, the following:

- Inspection of the embedded parts,
- Radiographic or ultrasonic examination of site weld in load carrying members, other than seal welding seams,
- Inspection by feeler gauge measurement of satisfactory sealing seat of all seals,
- Insulation resistance tests on all site installed wiring and electrical connections,
- Setting of limit switches, indicators, and controls,
- Inspection of satisfactory installation of all components.

7.3 Commissioning Tests

The commissioning tests shall include, but not be limited to, the following:

- Measurement of operation speeds,
- Check of accuracy of indication, limit setting and alarm signals etc.,
- Check of water leakage from closed gates (a remarkable leakage to be repaired at once),
- Check of limits of travel,
- Check of power consumption of motors,
- Temperature raise of motors, bearings etc.,
- Check of general satisfactory operation.

8 MANDATORY SPARE PARTS AND TOOLS

(a) Sluice Isolation Valves

- One (1) set of seals and gasket used for each valve including 20% of the bolts and other fixation material with all necessary components.
- One (1) set of limit switches, contractor, fuses, relays, etc used of each type used for each valve.
- Two (2) nos. of motors used

- Two (2) nos. of gearbox used
- One (1) set of Rubber bushes for flexible couplings (if applicable)

Any other general spare parts as stipulated in the Standard Technical Requirements.

All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

(b) Gravel Trap Flushing Valves

- One (1) set of seals and gasket used for each valve including 20% of the bolts and other fixation material with all necessary components.
- One (1) set of limit switches, contractor, fuses, relays, etc used of each type used for each valve.
- Two (2) nos. of motors used
- Two (2) nos. of gearbox used
- One (1) set of Rubber bushes for flexible couplings (if applicable)

Any other general spare parts as stipulated in the Standard Technical Requirements.

All special tools and installation materials which are required for handling during shipment to site and installation, operation and maintenance of the equipment included in the supply.

9 TECHNICAL SCHEDULES

- (a) The Technical Schedules are a technical questionnaire to be furnished in filled-up form with the Bid. They are to be considered as an integral part of the Bid.
- (b) The Bidder is, therefore, requested to read these Technical Schedules with care and to complete them most conscientiously and with every necessary detail.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION III
STANDARD TECHNICAL REQUIREMENTS
FOR HYDROMECHANICAL WORKS**

**CHAPTER 13
ELECTRICAL EQUIPMENT**

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1 SCOPE OF SUPPLY

- (a) The supply shall include the electrical appliances necessary to feed the equipment for the hydro-mechanical works:
- One (1) 11 kV metal enclosed switchboard;
 - One (1) 500 kVA 11/0.4 kV cast resin insulated transformer;
 - One (1) 400 V main distribution board;
 - One (1) 110 V DC system;
 - One (1) set of cables, cabling systems and accessories;
 - One (1) set lighting and socket outlet system;
 - One (1) set of grounding system;
 - Mandatory spare parts for the aforesaid equipment;
 - All the equipment not explicitly mentioned but necessary for the installation and operation of the whole headwork system.

2 DESIGN CRITERIA

- (a) Correct rating including current transformer ratios and instrument scales is to be selected by the Contractor for Employer's approval.

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1. INTRODUCTION

- a. The permanent structures of the Civil Works shall be designed and constructed for completion of the Works by the Contractor in accordance with the Contract. The Contractor shall submit to the Employer detailed design and drawings for review in timely manner.
- b. Without prejudice to and without limiting or reducing the scope of or the requirements for the Works set forth in Part I, Part II, Part III and Part IV of the Employer's Requirements or Volume 3: Conditions of Contract and Contract Forms, the items in this section state the minimum requirements for the Contractor to conduct the Civil Works.
- c. Design basis criteria shall be submitted to Employer and get approval before commencement of detail design work,
- d. The Contractor shall design and implement works to achieve equal or better than the intent and performance of the Employer's concept design.
- e. Where the Standard Technical Requirements conflict with these Particular Requirements, the Particular Requirements shall apply.

2. HYDRAULIC GRADIENT

- a. The whole water conveyance system from the intake to the powerhouse shall be designed such that the hydraulic head loss shall not exceed 11.26m i.e., 2.6% of the gross head and 77.5 MW of rated capacity are guaranteed for the powerhouse (Considering the turbine efficiency of 90.5% and Generator Efficiency of 97.5% at design discharge of 21.28 m³/s). The Contractor shall submit, , hydraulic calculations to demonstrate the Contractor's preliminary design satisfies this requirement.
- b. For the purpose of compliance, the headloss shall be calculated for steady state flow conditions at the design discharge of 21.28 m³/s (hereinafter referred as the "design discharge").
- c. The turbine centreline is at EL. 1515.00 m.
- d. All headlosses shall be accounted for including, without limiting the following:
 - Flow through the trashracks.
 - Entry losses through gates, valves and openings.
 - Friction losses in open channels, canals, culverts, tunnels and/or low-pressure pipes and penstocks.
 - Flow through connecting tunnels and settling basin
 - Form losses in the conduit system due to bends, transitions (expansion and reduction) changes in diameter and branches.
 - Flow over water level or flow control weirs, etc.

3. DESIGN BASIS

3.1 Seismic Design

The Works shall be designed to resist seismic loads corresponds to earthquake return periods of DBE with probability of exceedance (T=475 years).

S. N.	Project Structure	For site		Design Earthquake
		α_h	α_v	
1	Weir	0.25	0.167	DBE of T = 475 year
2	Slopes	0.25	0.167	DBE of T = 475 year
3	Other surface structures	0.25	0.167	DBE of T = 475 year

- For underground structures and foundations, the design seismic coefficients value shall be taken as per the Indian Standard Code IS 1893 (Part 1): 2016.

3.2 Excavation Slopes Stability Verification Design Criteria

3.2.1 Criteria for slopes excavated within highly fractured or heavily altered rock masses

- The stability verification approach shall be, at least, the Limit Equilibrium Approach whereas the computational method to be applied shall be the Slices Method, according to different authors.
- For the colluvium/alluvium or in general soil like materials, the materials strength characteristics to be implemented in the analysis, in the frame of the long-term stability verification, shall be those "consolidated-drained"; the verification analysis will be carried out adopting a Strength Criterion expressed in terms of effective stresses.
- Upon specific geological slopes features, involving a cohesive material zone, in the frame of a short-term analysis, the consideration of cohesive zone undrained behavior and the relevant assumptions in terms of strength parameters, shall be required.
- Particular care shall be paid to the existing groundwater conditions in the slopes, especially after cutting and re-shaping, with relevant gradients patterns, affecting directly the stability conditions.
- For the seismic stability verification, the critical acceleration will be determined for each slip surface, through the conventional method, as the constant (uniform) horizontal acceleration $K_c \cdot g$ which is required to take the portion of the slope, limited by the surface, to a state of limiting equilibrium, i.e. leading to the condition $FS = 1$. Such critical acceleration will be compared with the Peak Ground Acceleration or any fraction of the same to be considered of reference for the pseudo-static analysis approach, in order to check the actual Safety Factor and possibly adjust the design slope. The PGA applicable for the case shall be determined in accordance with the principles and concepts presented in the paragraph "Seismic Design".
- Drainage system will be designed in order to ensure its effectiveness and according to long-term serviceability principles.

3.2.2 Criteria for slopes excavated within jointed rock masses

- For rock slopes stabilization design the utmost care shall be paid to the evaluation of the joints sets characterizing the rock structure.
- Each set will be characterized by its actual setting, continuity, frequency, alteration, roughness, filling and water circulation conditions.
- The strength along each joint set shall be defined in accordance with the Barton-Bandis Strength Model.
- The Limit Equilibrium wedge analysis shall be exhaustively developed leading to the determination of the optimized pattern of strengthening devices like rock-bolts/cables, characterized as permanent (long-term) measures.
- Particular care shall be paid to the existing or potential groundwater conditions in the slopes, with relevant gradients patterns, determined by reasonable pressure distributions along the joint planes, affecting directly the stability conditions.

- f. For the seismic stability verification, the seismic inertial force will be determined for each sliding wedge, on the basis of the Peak Ground Acceleration or any fraction of the same to be considered of reference for the pseudo-static analysis approach. The PGA applicable for the case shall be determined in accordance with the principles and concepts presented in the paragraph "Seismic Design".
- g. Drainage system will be designed in order to ensure its effectiveness and according to long-term serviceability principles. However, the assumptions made in the stability verifications concerning the drainage effectiveness shall be conservative, i.e. the least residual water filling ratio of the tension cracks supplying the joints with water shall not be less than 0.5.
- h. In general, the stability factors of safety will comply with the Standards and Regulations reported on Volume 2, Part II – General Requirements.

3.3 Underground Works Design Criteria

3.3.1 Primary Supports and Final Lining – Design Approach for the Determination of the basic loads for design

- a. As far as the Underground Works and in particular the Headrace Tunnel and caverns, the Contractor shall demonstrate, through complete report, that the criteria followed for the design and stability verifications inherent to the excavations, preliminary supports (rock-bolts, shotcrete & steel ribs) and final linings (structural reinforced shotcrete or reinforced concrete liner) are consistent with the Rock Mass - Supporting Structure interactional approach.
- b. The systematic application of any oversimplified "Rock – Load" type, or any other empirical approaches, as unique design method, shall not be allowed.

3.3.2 Design Parameters and Design Methodology

- a. The parameters needed to characterize strength and deformability of the rock mass shall be calculated, from those determined for the intact rock type through laboratory tests, by means of the Geological Strength Index (GSI) and directly from in-situ tests, evaluated preferably from direct appraisal in the field at location and elevations compatible with the underground structure to be designed.
- b. During the EPC Contractor's design activity, GSI determination can be done within the service adits foreseen for underground works construction and investigation scope. GSI correlation tables, specifically suited for the rock type, will have to be selected.
- c. As a general approach for underground works design and before any detailed numerical modelling activity, the Contractor shall demonstrate the application of the Rock Support Interaction Analysis Design, through the Ground-Support Characteristic Lines, assuming a perfectly circular tunnel shape. This method shall be implemented for designing the primary support system and decision on its mode of activation with respect to the excavation progress.
- d. With this approach, the Contractor shall model the progressive mobilization of the rock strength while controlling the rock plastic zone extent and the rock elastic-plastic deformations, providing also support for the loosened rock stabilization when such condition may apply. The scope is to control the interaction pressure by limiting it through the readjustment of the stress field in the rock surrounding the excavation, optimizing consistency and timing of the supports.

3.3.3 *Design Criteria of the Primary Support System*

- a. The primary supports system, consisting of a combined system of rock bolting with provision of grouting for long-term maintenance, reinforced shotcrete and steel ribs if necessary, shall be dimensioned in order to safely bear the interaction pressure (radial load) developing during the excavation progress carried out beyond the position of the front face corresponding to the support installation. In addition to this radial load, the dead weight of the potentially forming loosened rock mass, coinciding partly or totally with the plastic zone developed above the roof at the equilibrium stage, may have to be considered depending on the post-failure fracturing behaviour expected within the plastic zone, according to the Hoek's approach to tunnelling design.
- b. Through the construction of the Ground Characteristic Lines and the LDP (Longitudinal Deformation Profile) Lines, according to Hoek, the Contractor shall decide, optimize and show, at the final design stage and well detailed in the drawings, the distance of application of the supports from the advancing front face. This distance shall be optimized and defined in function of each rock class, as it is directly associated to the level of ground stress release, before supports installation, allowed on Site and assumed in the design and described by the combined Ground – Supports Characteristic Line diagrams. This design aspect is of the utmost importance in order to govern the final state of stress in the primary supports (and permanent lining) as well as the final deformation of the rock-support system and to establish the field procedure of excavation and support with reference to:
 - Strokes of excavation, as a function of the rock classification
 - Sequence of supports application
 - Distribution of monitoring devices, when and where foreseen

3.3.4 *Permanent Lining Design Criteria – Detailed numerical analyses to be performed*

- a. The subsequent underground works design stage shall be the numerical model analysis in terms of elastic-plastic stress strain analysis, through the application of the Finite Element Method or other suitable approach.
- b. Besides the final set of relevant geotechnical design parameters in terms of strength criterion, elastic-plastic constitutive law and initial state of in situ stress, it will be verified, when dealing with a 2D representative model, that a clear assumption has been made on the percentage of original stress release to be considered when modelling the preliminary supports activation.
- c. Such assumption must have been already outlined through the preliminary analyses carried out through the combination of Characteristic Lines Method and the LDP (Longitudinal Deformation Profile).
- d. In the modelled sequence, the permanent lining, whatever is the lining type (structural permanent reinforced shotcrete or reinforced cast in place concrete), shall be also simulated, for its verification and design.
- e. Through the numerical analysis of the Ground-Structure interaction the Contractor shall evaluate any axial load, shear and bending moment arisen along the lining axis development, due to non-uniform initial state of stress and due to the actual shape of the tunnel section, and the actual capability of the designed lining to withstand such loads. Moreover, the Contractor shall demonstrate that the following additional load cases, when applicable, have been taken into account and the lining structure is verified:
 - Extrados loading pressure build-up developing as consequence of groundwater.
 - Intrados loading pressure distribution due to internal pressurized water flowing in permanent or transient conditions, evaluating with a suitable design

- procedure the mode to govern the pattern of concrete or structural shotcrete cracks and the following leakage process.
- Since the permanent lining capability to withstand and transfer loads will require a tight contact of the lining with the surrounding rock, to be achieved through injection of suitable material in the contact gap between lining extrados and actual rock profile, the lining shall be designed to bear also grouting pressures, distributed according to the actual grouting procedure followed.
 - Loading effect on the structure obtained through the imposed suitable strain field equivalent to the seismic action due to a representative shear wave propagating normally to the tunnel axis.
- f. The possible modes of combination of the above reported load cases shall be duly verified. The following specifications must also be observed:
- In the case that a structural reinforced shotcrete is adopted as permanent lining, the Contractor shall demonstrate that its effective structural section and the actual shape of its axis alignment along the excavation profile are such to actually withstand the interaction loads without undergoing local overstress and anyway satisfying the structural verifications with the safety factors foreseen by the Standards and Regulations.
 - In the case that a structural reinforced shotcrete is adopted as permanent lining, the Contractor shall demonstrate that such lining is designed and constructed in such a way that the durability of the involved materials is ensured as well as the long-term serviceability, with full performance, of the lining system.

3.3.5 *Additional Stability verifications to be carried out*

- a. The Contractor shall demonstrate that, as an alternative verification, especially in cases in which the excavated rock mass instability may be governed by structurally controlled failure mechanisms, rather than by stress induced interaction loads, the load induced on supports by the unbalanced portion of the weight of rock wedges insisting on the supports, has been considered and the supports (anchor bolts, grouted dowels, shotcrete) have been verified accordingly.

3.3.6 *Specific Design Criteria*

- a. The subsequent underground works design stage shall be the numerical model analysis in terms of elastic–plastic stress strain analysis, through the application of the Finite Element Method or other suitable approach.
- b. The stability verification approach shall be the Limit Equilibrium Approach for defect-controlled kinematic failures.
- c. For such rock wedge stabilization design the utmost care shall be paid to the evaluation of the joint sets characterizing the rock structure.
- d. Each set will be characterized by its actual setting, alteration, roughness, filling and water circulation conditions.
- e. The strength along each joint set shall be defined in accordance with the Barton-Bandis Strength Model.
- f. The Limit Equilibrium wedge analysis shall be exhaustively developed leading to the determination of the optimized pattern of strengthening devices like rock-bolts/cables, characterized as permanent (long-term) measures, assuming the “joint ubiquitous conditions” to apply to identify the most critical wedges among those possible to develop.

- g. In performing the wedge limit equilibrium analyses no confining stabilizing stress distributions acting on the wedge limiting sides will be taken into account.
- h. The possible presence of groundwater pressures distributions destabilizing the wedges shall be carefully investigated.
- i. The Contractor shall perform all necessary investigations, material characterizations and analyses to validate compliance with both the minimum prescriptive seismic coefficients and the performance-based verification requirements stated herein.

4. RIVER DIVERSION WORKS

4.1 Function

- a. The purpose of the river diversion is to temporarily divert water flow from the natural river channel and site of the headworks to enable the headworks structures, namely the weir, undersluice, intake structure, stilling basin and floodwalls, to be constructed in dry foundation condition within and adjacent to the natural river channel.

4.2 Employer's Concept

- a. The river diversion works comprises of:
 - A D-shaped diversion tunnel on the right bank with finished dimensions of 6.1 m width and 6.7 m height. The length of the tunnel is approximately 290 m. The tunnel is lined with 300 mm thick concrete along its invert and on its wall up to the spring level.
 - An 11 m high rockfill cofferdam located about 102 m upstream of the weir axis with the crest level at EL.1958.00 m. A 13 m deep grout curtain row is provided along the cofferdam axis. No downstream cofferdam is provided.
- b. The construction flood for the diversion is taken as 1 in 5-year monsoon period flood equal to 501 m³/s.

4.3 Contractor's Design

- a. Under this Contract, the Contractor has the responsibility for selecting the flood against which the design of reasonable protection from overtopping shall be done and also for providing appropriate diversion works to accommodate it.
- b. As a minimum, the river diversion works shall be designed for minimum of 1 in 5-year monsoon period flood discharge with a minimum freeboard of 1 m for the cofferdam. The design of cofferdam shall incorporate a suitable cut-off to control under seepage and coffer dam safety. Cofferdam design and seepage control arrangement shall be designed considering construction works all year round including during the wet season.

Whatever diversion arrangements and construction design flood are proposed, the responsibility for protection of the construction of the headworks structure and associated works from the effects of flooding and any costs and schedule mitigation associated with an overtopping of the cofferdams rests solely with the Contractor.

- c. Detailed design of the river diversion works to facilitate the construction of the headworks shall be prepared by the Contractor for approval of the Employer. The Drawings and schedule for the River Diversion Works shall be submitted to the Employer at least sixty (60) days before the commencement of river diversion works. Contractor can start the work only after Employer's approval.
- d. The Contractor shall execute the maintenance of all the river diversion structures such as cofferdam, during the period that all the headworks structures such as weir, intake, undersluice and appurtenant works are under construction and shall

be responsible for, and shall repair, any damage to the headworks structures built by the Contractor caused by floods, rain or other reasons as necessary or as instructed by the Employer.

- e. The contractor shall remove the coffer dam after completion of Works in weir, undersluice, stilling basin, intake, and floodwalls.

5. DIVERSION WEIR (UNGATED SPILLWAY WEIR AND UNDERSLUICE)

5.1 Function

- a. The function of the concrete ungated spillway weir is to raise the water level in the river upstream of the diversion structure such that the required discharge can be diverted for generation to the intake structure. It also functions as a structure that can pass part of the design flood discharge.
- b. The function of the undersluice is to control sediment intrusion into the intake and power conduit by facilitating flushing of sediments deposited in front of the adjoining river intake and also to pass part of the design flood discharge.

5.2 Employer's Concept

- a. The spillway weir is a 32 m wide ungated concrete gravity structure with crest level fixed at EL. 1947 m. A concrete apron and rock protection in the riverbed is provided in the immediate downstream side of the weir and undersluice. A 52.5 m long horizontal stilling basin is provided in the downstream side. An upstream, intermediate and downstream concrete cut-off is provided along the length of the weir.
- b. The undersluice consists of two 3.5 m wide x 4.5 m high radial gated bays. A maintenance gate is provided upstream of the radial gates. A reinforced concrete apron is provided in the upstream side. A 58.14 m long horizontal stilling basin is provided in the downstream side.
- c. The surface of the spillway weir, undersluice, stilling basin and their walls are provided with a 500 mm thick layer of high-performance abrasion resistance concrete of Grade M60.
- d. Plain cement concrete (PCC) blocks are provided on the downstream of the stilling basin for both structures.

5.3 Contractor's Design

- a. Without prejudice to and without limiting or reducing the scope of or the requirements for the Works set forth in Part III and Part V of the Employer's Requirements of Volume 2: Conditions of Contract and Contract forms, the following conditions shall be taken into account for the diversion weir (Ungated Spillway Weir and Undersluice);
 - Undersluice and ungated spillway weir shall be concrete gravity type founded on the naturally consolidated river bed (permeable) material with provision for deep cut-off at upstream and downstream ends to minimize under seepage and limit uplift pressure of the structure.
 - The crest level of the Ungated Spillway Weir shall be EL. 1947.00 m.
 - The hydraulic design shall conform to recommendations of physical hydraulic model test study report.
 - The glacis profile of the ungated spillway and undersluice way and plan dimensions as shown in layout drawings are based on a physical hydraulic model test and shall be followed in the final design.
 - The divide wall shall be provided as shown in the layout drawings to minimize the cross-flow on upstream of the weir towards intake during a flood as recommended in physical modeling.

- A suitable arrangement shall be designed and provided for the release of minimum specified ecological flow to downstream.
- b. The Contractor shall undertake adequate additional sub-surface investigations to determine the actual foundation condition so that the Diversion Weir and Undersluices can be designed accordingly. The design of the diversion weir and under sluices shall incorporate suitable cut-off to control under seepage and limit uplift pressures on the undersluices.
- c. The design flood for the project shall be defined as a flood event with a return period of 100 years, with a flood discharge of 880 m³/s at the intake.
- d. The maximum flood for the project shall be defined as a flood event with a return period of 10000 years, with a flood discharge of 1442 m³/s at the intake. The diversion dam shall be able to pass the maximum flood with the spillway and undersluice in operation and a minimum freeboard of 0.5 m maintained at the abutments and working platforms of the associated structures.
- e. Minimum grade M25 concrete shall be provided for concrete facing except for abrasion-prone areas where high-performance concrete or hard stone lining or steel lining shall be provided.
- f. The concrete protection wall on the left and right banks on the upstream side of the weir axis shall be provided to ensure the stability of both banks as per the requirement during the detailed design/construction stage. These protection works shall be of sufficient height including adequate freeboard allowance, to contain the highly turbulent aerated flow of design discharge.
- g. A spillway access bridge of minimum load carrying capacity of 40R as per IRC class 6 or as sufficient load carrying capacity required during construction and operation and maintenance period shall be provided at a suitable location. The deck shall be not less than 4.5 m wide and sized to enable vehicles to be positioned where they can be loaded and unloaded by the gantry crane. All areas of the deck shall be designed to support vehicles of at least 40 tons capacity. Trailing cable gutter, if any shall be set flush with the gate deck. An access road shall lead to and be level with the gate deck. Removable load-bearing hatch covers shall be provided as required for crane access below the deck.
- h. Adequate permanent slope protection works shall be provided at all excavated areas of undersluice, ungated spillway, stilling basin, diversion tunnel inlet, and outlet.
- i. To protect the excavated riverbed and adjacent area of diversion weir from erosion caused by river flow, appropriate protection work shall be provided for bank slopes and river bed, as required.
- j. Control room building for installation of SCADA system for hydro-mechanical works shall be constructed in the head works area.

6. INTAKE

6.1 Function

The function of the intake is to withdraw steadily and safely the design discharge and additional discharge for flushing and continuous overloading flow (total intake discharge shall be 140% of the design discharge) from the river, steadily and safely to the desilting chambers for power generation. The intake structure shall be of concrete structure.

6.2 Employer's Concept

- a. Two river intakes (side intake) are provided on the right bank, one each for desilting chamber. The river intake axis shall be fixed at an angle as mandated by the Final Recommended Hydraulic Design in the Physical Model Report with the axis of the river flow and the crest level is fixed at EL. 1943.1 m.

- b. Full supply level at intake is 1947.5 masl
- c. The intake shall have adequate clearance from the undersluice invert level to ensure less entrance of suspended sediments through the intake.
- d. The design discharge for the intake is 27.7 m³/s which includes the rated design flow of 21.28 m³/s and 30% continuous flushing discharge (10% for gravel trap and 20% for desilting chamber). It is also checked for 10% additional continuous overloading (COL) with some additional loss.
- e. Each intake is provided with two trashrack openings each 3.5 m wide and 5 m high, separated by intermediate piers.
- f. Each intake is provided with a gate openings of 3.10 m x 3.10 m and is operated from a level of EL. 1955.0 m.
- g. Four bed load sluices, two under each intake are provided. The two sluices on the upstream part of the intake are provided with 1.0 m x 1.0 m openings. The two sluices on the downstream part of the intake are provided with 0.8 m x 0.8 m openings. The crest level of the sluices is at EL. 1941.50 m.
- h. Four hopper type gravel traps, two on each intake, are provided within the intake floor, immediately after the trash rack. The size of the gravel trap is of 0.8 m width x 0.5 m height at the start and 0.8 m x 0.8 m at the end. The crest level of the gravel trap is at EL. 1941.00 m.
- i. A trash passage of 2 m wide x 2 m high is provided as an opening in the wall between the intake and the undersluice structures.

6.3 Contractor's Design

- a. The Intake shall be designed for the design discharge of 21.28 m³/s for power generation plus 40% extra flow to allow for gravel trap, silt flushing and continuous overloading (COL).
- b. The hydraulic design shall conform to recommendations of physical hydraulic model test study report.
- c. Each desilting chamber shall be provided with its own intake.
- d. During drawing water through the intake, undesirable hydraulic phenomenon such as formation of vortex and harmful vibration at the trashrack(s) shall not be allowed.
- e. The maximum flow velocity through trash rack (net area after deduction for steel bars) shall be less than 1 m/s. The form and arrangement of the intake structure shall be designed to satisfy this requirement and shall incorporate gradual efficient transitions to minimize headloss.
- f. Inundation of intake gate hoist and flowing of water into the air-hole due to flood shall be avoided. The deck level of the intake structure shall provide adequate access and working area for cleaning and maintaining the trashracks.
- g. Bottom bed load sluices shall be provided under each intake opening with controlled sediment flushing arrangement to avoid accumulation of bed loads in front of intake.
- h. A hopper type gravel trap shall be provided within the intake floor immediately after trash rack opening to ensure that water entering the connecting tunnel and desilting chamber is free from suspended sediment particles larger than 0.2 mm. The gravel trap hooper shall be provided with controlled sediment flushing arrangement.
- i. The trashracks shall be cleaned by a Trashrack Cleaning Machine (TRCM) as specified in Section IV of the Employers Requirements.

- j. To protect the excavated riverbed and adjacent area for the intake from erosion caused by river flow, adequate and appropriate protection work for the bank slopes and riverbed is required.
- k. Suitable permanent slope protection works shall be provided along the excavated area in the vicinity of the intake in order to control any landslide or falling of rock/boulders.

7. UNDERGROUND WORKS

7.1 General

- a. The main underground works necessary for the construction of the project consist of:
 - Connecting Tunnels
 - Desilting Chamber & Flushing Tunnels
 - Link Tunnels
 - Headrace Tunnel
 - Adits Tunnels
 - Rock Trap
 - Surge Shaft
 - Valve Chamber
 - Pressure Shaft
 - Powerhouse and Transformer Caverns
 - Bus Duct Tunnels
 - Cable-Cum Ventilation Tunnel
 - Main Access Tunnel
 - Tailrace Tunnel
- b. For the proper design of the underground works the Contractor shall comply with the following general design requirements, verifying the most critical conditions to ensure a safe and functional operations of the works.
- c. Taking into account the location (horizontal and vertical) of the underground works with respect to the topography/ excavation surfaces, the Contractor shall evaluate the rock mass in-situ stress conditions (with specific geotechnical investigations) the position of the water table to adequately design the lining to be adopted.
- d. In designing the waterways tunnel lining, the Contractor shall verify that for the operation pressures the leakage from the tunnel are such not to damage permanent structures. The safety factor against the hydro-fracturing of the rock mass around the pressure tunnel shall be assessed. In particular, a steel liner may be provided where the minimum in situ principal stress is lower than the internal maximum water pressure. In addition, the hydraulic gradient around the pressure tunnel and underground excavations shall be evaluated by checking that it is lower than the maximum values indicated in reputable literature.
- e. In case of limited rock covers, the presence of excess pore pressures in the rock mass around the underground works shall be verified to evaluate the degree of stability of the natural soil slopes.
- f. The Contractor shall design the tunnel liner by verifying the safety factors against the collapse of the liner. In these analyses, particular importance will be given to the evaluation of the thickness of the “distressed zone” and “fissured zone” around the excavating tunnel periphery due to the conventional drill and blast techniques in jointed rock. The moduli of rock deformation shall reflect the effects of overlying rock

mass at the tunnel depth. Investigations shall be carried out accordingly. Geophysical measurement shall be made in the tunnels to determine the depth of fissured rock and its relative modulus of deformation with respect to the undisturbed, non distressed parent rock. The following loading conditions shall be verified:

- Stability analysis at the end of the excavation, to verify the suitability of the tunnel rock supports (rock bolts, shotcrete, etc.).
- Stability analysis at the end of construction with the presence of the tunnel liner and a null internal pressure.
- Stability analysis with the tunnel in operation and, consequently, the maximum internal pressure.
- Stability analysis of the tunnel for the drawdown of the reservoir with a null internal pressure and an external pressure head. This external design pressure for dewatered power waterways should take into account the potential external pressure head that can develop on the liner from various sources such as water table, unless drained.
- Analysis of the liner for temperature changes and hydraulic actions due to water flow along the tunnel and higher internal pressure for hydraulic operation.

7.2 Rock Mass Geotechnical Investigations

- a. In order to properly assess the geotechnical parameters of the underground works, the Contractor shall carry out detailed geological and geotechnical investigations of the rock mass.
- b. The Contractor shall assess in details the following:
 - Geological and geotechnical investigations with in-situ rock tests to evaluate the strength and modulus of deformability of the rock mass, both in the undisturbed and disturbed state (if necessary, in specific areas), due to the excavation with the traditional drill and blast method, as well as the in-situ minimum principal stress in the critical sections of the power waterways (in particular at the base of the surge shaft).
 - Hydro-fracturing and other standard geotechnical investigations tests to properly assess the actual confinement conditions for designing the the powerhouse cavern.
 - Geotechnical investigations to assess the permeability of the rock mass with Lugeon permeability test results. In some boreholes, grouting tests shall be performed to evaluate:
 - The groutability of the rock mass, with reference to the degree of fracturing and the characteristic of the joints.
 - The factors affecting grouting effectiveness, and
 - The most appropriate grouting materials, cement, fine or ultrafine cement, chemical grouts etc.
 - These tests will be necessary to define the consolidation grouting around the tunnel excavations for the purpose of increasing the stiffness and decreasing the permeability in the distressed zone, where poor rock may be found and to reduce the tendency for axial flow toward the portal in the distressed zone outside the tunnel liner.

7.3 Lining

7.3.1 Steel Lining

- a. Steel lining shall be provided for the following works:
 - Power tunnels (HRT) sections near the surge shafts and throttled sections of the surge shafts.
 - The entire length of the pressure shafts.
 - The entire length of the manifolds and individual penstocks
- b. As a general concept, a watertight lining, usually of a steel type, shall be required in the vicinity of any free surface where the in-situ stresses are below the internal tunnel pressure and the possibility of large amount of leakage may strongly affect the stability of the involved slopes as well as of any other permanent facility.
- c. Steel linings shall be designed using the most critical combination of the loading conditions as mentioned below. It shall be self-resistant without considering the contribution of the surrounding concrete.
 - Internal water pressure corresponding to the maximum water level in the reservoir;
 - Water hammer overpressure linearly varying along the penstock and lining axis;
 - Dead load (according to the erection procedure);
 - Temperature variation of ± 10 degree Celsius;
 - Stresses induced by external stiffeners (anchoring shapes or reinforcing beams);
 - Longitudinal hydraulic thrust;
 - Earthquake load as induced by the peak ground acceleration of MDE in any direction (only for the parts not embedded in concrete);
 - External pressure due to cement grouting.

7.3.2 Reinforced Concrete Lining

- a. The reinforced concrete lining shall be designed in order to withstand the acting loads and to yield, under the maximum internal hydraulic load, a crack width that limits the resulting permeability of the lining and controls the magnitude of the lining-rock interface hydraulic pressure, in order to avoid the possibility of hydro-fracturing or hydro-splitting in the surrounding rock mass.
- b. The design shall prevent the development of unacceptable leakages due to the uncontrolled increase in the resulting lining permeability.

8. CONNECTING TUNNEL

8.1 Function

- a. The function of the connecting tunnel is to convey water from the river intake to the underground desilting chambers.

8.2 Employer's Concept

- a. Two numbers of connecting tunnels, one from each river intake, are provided.
- b. The tunnels are designed for pressurized flow with an average velocity of flow of 1.5 m/s.
- c. The tunnels are D-shaped with a finished size of 3.9 m x 3.9 m and are provided with 300 mm thick concrete lining throughout their lengths.

8.3 Contractor's Design

- a. Each river intake shall have its own connecting tunnels connecting the intake to the individual desilting chamber.
- b. The connecting tunnels shall be designed for the design discharge of 21.28 m³/s for power generation plus 30% extra flow to allow for silt flushing and continuous overloading (COL). The connecting tunnels provided shall carry equal discharge.

9. UNDERGROUND DESILTING CHAMBERS

9.1 Function

- a. The desilting chambers are provided to settle and remove the suspended sediment particles of an average diameter 0.2 mm and larger (with 90% efficiency) to ensure that water entering the conveyance system is free of sediments than can damage the penstock and turbines runners due to abrasion.

9.2 Employer's Concept

- a. Two underground desilting chambers with a continuous sediment flushing arrangement during monsoon are provided to remove suspended sediment size of 0.2 mm and above. The flow on the desilting chambers is pressurized.
- b. The desilting chambers is designed for a total maximum discharge of 27.66 m³/s including 30% additional silt flushing and continuous overloading discharge (COL). The desilting chambers is designed to trap at least 90% of a particle size of 0.2 mm diameter.
- c. Each chambers have an effective size of 63 m x 11.5 m x 14.65 m (L x W x H) with 25 m additional length of transition sections at the inlets.
- d. A D-shaped silt flushing tunnel of size 3.9 m x 3.9 m (W x H) is provided from each desilting chamber. Each flushing duct is provided with a bonneted gate near its end for controlling flushing operation. Downstream of the gate chamber a common D-shaped silt flushing tunnel, 4.5 m wide and 4.5 m high is provided to convey the flushed sediments from the flushing duct to the river.
- e. The gate cum ventilation tunnel is provided for operation of each desilting basin outlet gates located at gate chambers.
- f. Silt flushing access tunnel is provided for operation of the silt flushing gate located at silt flushing chamber.

9.3 Contractor's Design

- a. A minimum of two desilting chamber shall be provided, so that uninterrupted power generation can be maintained in the event that one basin need to be decommissioned for maintenance. Each desilting chamber shall have its own flushing system.
- b. The Contractor shall be responsible for the design of an efficient and effective desilting chamber and flushing system. The desilting chambers shall be designed for a total maximum discharge of 27.66 m³/s, including 20% additional for silt flushing and 10% for continuous overloading discharge (COL).
- c. The desilting chambers shall be designed to enable for 90% removal of sediments of size 0.2 mm or larger sediment particles. Desilting chambers shall enable easy removal of deposited sediments by flushing the sediments back into the river.
- d. The outlet of the silt flushing tunnel shall be kept above the design flood level (1 in 50-year flood) in the river.
- e. Gates provided at flushing arrangements and associated hydromechanical equipment shall be installed, the specification of which are specified in Part III and Part IV of the Employer's Requirements.

- f. The access tunnel for designing basin outlet gates and silt flushing gates shall be provided in order to provide access during installation and operation and maintenance purpose. The access tunnel shall be lined in the invert with PCC concrete.
- g. Proper lighting system shall be provided in the access tunnel and gate operation area.

10. LINK TUNNELS

10.1 Function

- a. The link tunnel convey water from the power intake immediately after desilting chambers to the headrace tunnel.

10.2 Employer's Concept

- a. Two link tunnels, each with an excavated D shaped profile 4.5 m wide and 4.5 m high, start after the power intake and merge into the headrace tunnel. The tunnels are excavated as D shaped but are finished in a horse-shoe shape with a 300 mm concrete lining.
- b. Each set of power intake and link tunnels is designed to steadily and safely convey water for power generation and capable to carrying a discharge of 10.64 m³/s. It shall also be able to carry 10% overloading discharge with some higher friction losses.

10.3 Contractor's Design

The contractor shall implement the following design criteria:

- a. Each desilting basin shall have its own link tunnel connecting it to the headrace tunnel.
- b. Each link tunnels shall be designed to convey water for power generation and capable to carrying a discharge of 10.64 m³/s. It shall also be able to carry 10% more discharge for continuous overloading (COL) with some higher friction losses. The acceptable higher friction losses for the COL case shall be approved by the Employer.
- c. Each set of gates and associated hydromechanical equipment shall be installed, the specification of which are specified in Part III and Part IV of the Employer's Requirements.

11. HEADRACE TUNNEL

11.1 Function

- a. The headrace tunnel has the function to steadily and safely flow the design discharge (plus 10% additional discharge for COL with some higher frictional losses) for power generation from the link tunnel to the surge shaft and penstocks.

11.2 Employer's Concept

- a. The headrace tunnel is aligned through the right bank of Ghunsa Khola.
- b. The headrace tunnel is excavated as D-shaped tunnel with excavated dimensions varying between 4.6 m to 5m in width and 4.55 to 4.75 m in height. The shotcrete lined tunnel has finished dimensions of 3.6 m width and 3.6 m height. The reinforced concrete lined section has a 300 mm thick concrete lining finished to a 3.2 m D-shaped.
- c. A rock trap is provided in the headrace tunnel just upstream of the surge shaft.
- d. The headrace tunnel is designed with the downward slope towards the surge shaft.

11.3 Contractor's Design

The contractor shall implement the following design criteria:

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- a. The headrace tunnel shall be designed to safely withstand extremes of internal and external pressure at all points. Permanent drainage arrangements shall be provided for the purposes of tunnel dewatering for maintenance.
 - b. The headrace tunnel shall be designed to convey water for power generation and capable to carrying a discharge of 21.28 m³/s plus 10% more discharge for continuous overloading (COL).
 - c. The maximum flow velocity in concrete lined headrace tunnel sections shall be less than 3.0 m/s.
 - d. The maximum flow velocity in unlined (shotcrete and specified support only) sections of headrace tunnel shall be 2.00 m/s.
 - e. Tunnel support measures shall be provided to ensure long-term stability of the headrace tunnel and surrounding rock mass. Permanent rock support measures shall be determined on the basis of physical rock parameters at unlined section.
 - f. The rock support and lining shall be provided according to the rock mass quality "Q- Value" as per the following table as a minimum:

Rock Class		Rock Support				Lining
Support class	Rock class	SFRS (mm)	Rock bolt (25Ø)		Steel ribs/ RRS	Shotcrete/ Concrete lining
			Length (m)	Spacing, c/c staggered (m)		
R1	I to III (Q >4)	50	2.5	2.00 × 2.00	-	Shotcrete lining + Invert PCC lining
R3	IV (1.0<Q<4)	60	2.5	1.75 × 1.75	-	Concrete lining
R5	V (0.1<Q<1)	120	2.5	1.50 × 1.50	-	Concrete lining
R7	VI (Q<0.1)	50	2.5	1.00 × 1.00	ISWB-150 @ 1 m c/c RRS-I in 200 mm SFRS	Concrete lining

Note: Refer Tender Drawing (GK-WC-C-04)

- g. Subject to compliance to Clause 1.2 (a) of this Particular Technical Requirements, in tunnel sections where the encountered rock quality allows, the Contractor may propose sections of the headrace tunnel with either a concrete or shotcrete lining for the permanent support.
- h. Notwithstanding (f) above, concrete (M 25) of a least 30 cm thickness shall be placed at the invert of the headrace tunnel. The arch or side wall of the headrace tunnel shall be covered with shotcrete with wire netting/fiber shotcrete or concrete. Wire netting shall be spread between the primary shotcrete and secondary shotcrete. The minimum final thickness of the shotcrete lining or the reinforced concrete lining along the arch or side wall of the headrace tunnel shall as indicated on the Employer's Concept Drawings for construction of the Works and as determined by the rock quality class.
- i. A minimum 25 m length of headrace tunnel immediately upstream of the surge shaft shall be steel lined.
- j. Any cracks, cave-ins and over-breaks inside the headrace tunnel shall be adequately filled by concrete or any other suitable materials in order to avoid any water leakage from the tunnel.
- k. All instrumentation required during tunnel excavation and rock support shall be provided and regular data collection and analysis shall be done and rock support and lining design shall be revised accordingly.
- l. The ADIT at the beginning and end of Headrace Tunnel shall be equipped with the Bulk Head gate, specification of which are specified in Part III and Part IV of the Employer's Requirements.
- m. Whereas other intermediate ADIT shall be plugged with Concrete with suitable drain pipes.
- n. All adits shall be provided with a lockable metal gate at their inlet location to prevent unauthorized entry into the tunnel.
- o. All niches provided in headrace tunnel for facilitating excavation shall be fully backfilled with concrete of grade M15.
- p. The ADITs equipped with Bulkhead gates shall be lined with concrete in the invert with suitable drainage arrangement.
- q. Concrete lining in headrace tunnel shall be provided in a minimum length of 100 m on either side of the Adit-Headrace tunnel junction except for the adit 3-headrace tunnel junction

12. ROCK TRAP

12.1 Function

- a. The function of the rock trap is to trap loose rock and concrete fragments produced due to various reasons to protect hydromechanical and equipment from huge impact.

12.2 Employer's Concept

- a. A rock trap of size 39 m x 3.9 m x 2.25 m (L x W x H) is designed immediately upstream of surge shaft. The entire section along the rock trap is D-shaped and has a 300 mm thick concrete lining.

12.3 Contractor's Design

- a) The rock trap shall be located immediately upstream of the surge shaft as indicated in the Employer's Concept Drawing.
- b) The rock trap shall collect small fragments of rock, aggregates so that they do not travel downstream of surge shaft. Provisions shall be providing such that the collected rock and concrete fragments can be removed during the maintenance work of headrace tunnel.

13. SURGE SHAFT

13.1 Function

- a. A surge shaft main function is to cater to the upsurge and downsurge requirements in the conveyance system due to sudden closure or opening of the hydraulic governor for turbine operation and protect the pressure tunnel and pressure shaft from the effects of water hammer. Particularly, the surge shaft:
 - Provides a free water surface close to the discharge regulation mechanism;
 - Supplies the additional water required by the turbine during load demand until the conduit velocity has accelerated to the new steady state condition;
 - Stores water during load rejection until the conduit velocity has been retarded to the new steady state; and
 - Protects the pressure shaft itself against detrimental effects of water hammer.
 - contributes to pressure regulation, enhances transient stability of the system, ensures operational safety by preventing excessive pressure rise or vacuum conditions and dissipates part of the transient energy, thereby improving the overall reliability and efficiency of during operation.

13.2 Employer's Concept

- a. A restricted orifice type surge shaft with reinforced concrete lined cylindrical shaped is provided at the end of the headrace tunnel in a ridge near Japantar.
- b. The surge shaft is designed as a 56.4 m high underground reinforced concrete lined cylindrical structure of internal diameter 6 m, open to sky, with the top located at a platform formed at EL. 1972.00 m. The orifice of 1.5 m diameter is provided at the bottom.
- c. The surge shaft is designed to respond and perform satisfactorily under the anticipated transient pressure envelope. The maximum upsurge and minimum downsurge levels are EL. 1969.58 m (Dwg. 1970.71) and EL. 1928.46 m. (Dwg. 1927.64) respectively.

- d. The Surge Shaft shall ensure operational safety by preventing excessive pressure rise or vacuum conditions and shall dissipate part of the transient energy, thereby improving the overall reliability and efficiency of during operation
- e. A permanent access road is provided to the top of the surge shaft.

13.3 Contractor's Design

- a. Surge shaft shall be provided upstream of penstock pipe to allow stable governing system in the turbine and to keep pressure rise within acceptable limit. For efficient dampening of mass oscillation, a circular type surge tank shall be designed. It shall be designed as an underground type with the top open to sky.
- b. The required diameter shall be determined using comprehensive transient analysis (elastic water column), satisfying Thoma's stability criterion and additional stability/damping requirements under full load rejection/acceptance and their worst combinations considering the topographical conditions. The height of the surge shaft shall be fixed considering the possible surges due to various loading conditions such as full load rejection, full load acceptance and their worst possible combinations. The physical limits in the surge shaft should allow for minimum of 2 m tolerance for the up and down surge.
- c. The surge shaft shall be a restricted orifice type and the freeboard of the maximum downsurge level in the surge shaft above the restricted orifice shall be at least 1.5 times the internal diameter of the orifice and shall ensure that no air is sucked into the headrace/penstock during downsurge events.
- d. The surge shaft shall be provided with reinforced concrete lining over its entire height. Steel Lining shall be provided in the orifice. The surge shaft and orifice shall perform satisfactorily under all anticipated transient conditions.
- e. Access road shall be provided to the top of the surge shaft.
- f. The surge shaft shall be covered by thick metal sheets with adequate support structures. The top of the surge shaft shall be fenced with chain linked fencing with barbed wire and concertina barbed tape with lockable metal gate at the entrance.
- g. Adequate slope stability and drainage facilities shall be provided surrounding to the top of the Surge shaft.
- h. The Contractor shall also provide an overflow/relief arrangement to a safe discharge path to manage extreme upsurge beyond design.

14. VALVE CHAMBER

14.1 Function

- a. A valve chamber is provided to house a valve that isolates the headrace tunnel and surge shaft from the pressure shaft at times when the pressure shaft and the water passages within the powerhouse need to be emptied for repair and maintenance.

14.2 Employer's Concept

- a. A valve chamber of size 10 m long, 13 m wide and 17 m high is provided to house a butterfly valve of 3 m diameter, at a distance of 21 m from the surge shaft.
- b. A permanent access is provided to the valve chamber from the Adit 3 portal.

14.3 Contractor's Design

- a. An underground valve chamber of suitable size to house a penstock protection valve (PPV) shall be provided between the base of the surge shaft and the top of the pressure shaft. The equipment housed in the chamber is specified in Part V of the

Employers Requirements. The valve chamber shall be equipped with EOT crane for maintenance of the PPV.

- b. The valve chamber structure shall be designed for the hydraulic forces from PPV and load from the overhead crane for handling the valve.
- c. A permanent access tunnel shall be provided to the valve chamber for operational and maintenance purposes. The sizing of the access tunnel is to be sufficient to allow removal of the largest PPV part, in the event of replacement.
- d. The access tunnel shall be lined in the invert with suitable drainage facilities.
- e. The Access tunnel shall be provided with a lockable metal gate at their inlet location to prevent unauthorized entry into the tunnel.
- f. The permanent access road shall be provided to the inlet of the access tunnel.
- g. The valve chamber shall be equipped with proper lightning arrangements for operation and maintenance purpose.
- h. A suitable drain pipe shall be provided in the valve house for draining seepage water and emptying the headrace tunnel.

15. PRESSURE SHAFT

15.1 Function

- a. The function of the pressure shaft is to convey water from the headrace tunnel to the underground powerhouse via the valve chamber.

15.2 Employer's Concept

- a. The pressure shaft is designed as a steel lined underground structure encased in concrete consisting of upper horizontal pressure shaft, upper vertical pressure shaft, middle horizontal pressure shaft, lower vertical pressure shaft and lower horizontal pressure shaft.
- b. The pressure shaft has a constant finished diameter of 2.5 m with varying steel thickness and concrete backfill over its entire length.
- c. At the end of the lower horizontal pressure shaft part and just upstream of the powerhouse, the pressure shaft bifurcates through a **wye branching arrangement**. The penstocks are provided with steel liners and concrete backfill.

15.3 Contractor's Design

- a. The Contractor shall perform a detailed Computational Fluid Dynamics (CFD) analysis to optimize the design of bifurcation or trifurcation sections, ensuring minimal flow disturbance and structural integrity of the penstock. The design of the branching section must be based on this CFD study, considering potential flow irregularities due to internal stiffeners and ensuring compliance with all relevant hydraulic and structural performance criteria.
- b. All the sections of the pressure shaft shall be designed to comply with calculated pressure head and headloss in order to meet the required performance. The diameter of the pressure shafts sections shall not be less than 2.5 m. The pressure shaft sections and the penstock sections after bifurcation or trifurcation shall be fully steel lined with backfill concrete.
- c. The steel lining of the pressure shaft with horizontal sections, vertical sections and individual penstock pipe after bifurcation or trifurcation shall be designed to safely withstand extremes of internal and external pressure at all points. The specification of the steel lined pressure shaft and the inner steel liner are specified in Section IV of the Employer's Requirements.

- d. The pressure shaft shall be provided with permanent drainage arrangements for the purposes of dewatering.
- e. Manhole shall be provided at appropriate location for access to the pressure shaft during operation and maintenance.

16. POWERHOUSE COMPLEX (POWERHOUSE CAVERN, BUSDUCT TUNNEL AND TRANSFORMER CAVERN)

16.1 Function

- a. The powerhouse complex function as an underground cavern that provides a space to house all the mechanical and electrical plant and equipment required for the production of hydroelectric power.

16.2 Employer's Concept

- a. The powerhouse complex is planned as an underground type inside the hillock near Japantar on the right bank of Ghunsa Khola.
- b. The powerhouse is designed to house three units of vertical axis Pelton turbine-Generators and associated auxiliaries. The size of the powerhouse is estimated as 84 m long, 16 m wide and 36 m high.
- c. Service bay is provided at the end of the Main access tunnel. The tunnel from the service bay connects the Transformer Cavern with rails for transportation of the transformer.
- d. An underground transformer cavern is designed to house three sets of one-phase main transformers along with a spare transformer (total $9+1=10$) arranged in separate transformer cells and the double circuit Gas Insulated Switchgear (GIS). The size of the transformer cavern is estimated as 80 m long, 13 m wide and 25 m high. GIS shall be in the same floor.
- e. Three bus duct tunnels, each D-shaped with a 4 m width and 4 m height is provided to connect the powerhouse and transformer cavern at the machine floor level.
- f. The centreline of the turbine is fixed at an EL. 1515.00 m and the machine hall floor is at an EL. 1524.40 m.
- g. A control room inside the powerhouse complex
- h. A switchgear room, battery room, HVAC system area, workshop, stores are adequately provided.

16.3 Contractor's Design

- a. As a minimum, the powerhouse complex shall comprise of:
 - A main access tunnel, a machine hall for housing turbine, generator, and their auxiliary equipment;
 - An erection bay and a service cum control room.
 - Transformer cum GIS Cavern;
 - Interconnection bus duct tunnels;
 - Cable cum ventilation tunnel and interconnection tunnel;

The contractors design shall incorporate the load of the Plant and Equipment from the

- b. All required geo-mechanical tests shall be conducted by the Contractor for the design of rock support of powerhouse complex.
- c. The powerhouse shall be suitably sized to accommodate the generating units, facilities and equipment normally associated with an underground powerhouse of this type and size. Access to the powerhouse shall be on a permanent main access tunnel

- of not smaller than 7 m width and 7 m height to allow fully loaded transport truck to load and off load equipment at the loading area on the machine floor level of the powerhouse.
- d. The powerhouse shall accommodate three (3) vertical axis Pelton/generation units, and all associated equipment, loading gantry crane, powerhouse overhead travelling crane, one elevator at end of the powerhouse suitable of moving a minimum of (10) persons and small equipment between all floors (minimum capacity 1 ton), erection bay, storage areas, a control room, washrooms, offices, first aid room, facilities areas and workshops area. The Contractor's design shall incorporate adequate stair access between each of the floors of the powerhouse.
 - e. The underground powerhouse complex shall also include and accommodate all auxiliary systems and services including earthing, HVAC, station power system, potable water supply, and sewerage systems suitable for the underground complex, control room, workshop, and offices. Wastewater shall be collected and discharged to a suitable septic tank system.
 - f. The powerhouse complex design shall incorporate adequate clearances for electrical and mechanical equipment, staircases, lift, and illumination systems.
 - g. Rock support for the underground power-house complex shall be as indicated in the Employer's concept drawings and as determined by rock quality and results of geo-mechanical tests in the machine hall cavern.
 - h. Fireproof gates and doors and staircase design shall be provided as per the requirement of the underground powerhouse in line with international safety standards.
 - i. The powerhouse shall be suitably designed to house the generation equipment and to carry out all operational and maintenance related activities. The powerhouse erection bay shall be adequately sized for heavy maintenance work on one generation unit.
 - j. The powerhouse complex shall be designed to control the effects if groundwater and tailwater inflows into the powerhouse. Groundwater and tailwater inflows and seepage shall be directed to the drainage sump. The drainage circuit shall be equipped with sufficient oil/water separators, and shall be connected to the automatic sump dewatering system.
 - k. Foundation treatment shall be carried out to achieve the objection of preparation of foundation surface to receive concrete.
 - l. All interior concrete floors and walls shall be painted with a heavy-duty industrial epoxy paint. Floor paint shall be of highly non-slip variety, following an Owner approved design. All safety equipment, handrails, bridge crane and special tools, etc. shall be painted suitable grade of corrosion resistant paint and shall be "Safety Yellow" in colour.
 - m. The mechanical and electrical plant and equipment, including the ancillary and control equipment, shall be designed, procured, supplied, installed and commissioned under the Contract for LOT 2: Electro-mechanical Works. Layout, sizes, planning, design, and engineering of all components of the powerhouse complex shall be done in coordination with requirements of electro-mechanical works by LOT 2. The contractor shall not be entitled for any claims for the changes in size of powerhouse, including erection bay, switchgear Transformer Cavern etc in complying the requirements of the Lot 2 Contractor.
 - n. Suitable sized (as required by the Lot 2 Contractor) busduct tunnel shall be provided connecting the powerhouse to the transformer cavern.
 - o. Hatch covers meeting the load and fire-proof requirements shall be provided around the opening of MIV and runner removal.
 - p. The transformer cavern/hall is an underground structure and shall be designed to house three sets of one-phase main transformers along with a spare transformer and

associated plant and equipment. The transformer hall shall also have adequate space for the installation of Gas Insulated Switchgear (GIS).

- q. The control room and office shall be provided with ventilation and air-conditioning, constructed with sound-proofing insulation and protected from excessive vibration.
- r. Adequate size permanent main access tunnel shall be provided to the transformer cavern/hall from the Service Bay. An adequately sized emergency exit tunnel shall be provided connecting the transformer hall to the machine floor level of the powerhouse on the opposite end of the main access tunnel.
- s. Each single-phase transformer shall be housed in a separately enclosed cell with reinforced concrete walls between transformers, and provision should be made for easy installation and removal of transformer from the cell. The transformers shall be on a concrete pedestal within an oil spill containment bund. Slot covers shall close off the top of each slot when not in use. The transformer cavern shall be dimensioned to meet all the requirements of housing all transformers including station transformers and GIS to be designed and supplied by the Lot 2 Contractor.
- t. The powerhouse cavern and the transformer cavern shall be roofed with waterproof suspended ceiling and lined as required, with gutters and drains to divert any seepage flow. The deking material shall be pre-painted galvanized corrugated sheets.
- u. Stainless steel railings shall be provided to meet all safety requirements.
- v. The main access tunnel shall be Concrete lined in the invert with suitable side drains and adequate lightning facilities.
- w. Permanent instrumentation for powerhouse cavern and transformer cavern shall be provided.
- x. The powerhouse shall contain the following minimum services:
 - Water supply system used for the powerhouse shall be filtered and treated. The filtered and treated stored water shall be available for industrial uses, firefighting and shall produce all of the powerhouse potable water requirements.
 - Sewage treatment and disposal system
 - Firefighting system
 - Multi-telephone line installation
 - Single side-band radio system of VHF radio system utilizing an existing VHF radio system operated by the Employer
 - Electrical lighting and power points
 - Emergency lighting
 - Mechanical ventilation supply and exhaust systems. The supply of air fans and plenums shall distribute a steady supply of fresh air to the powerhouse and transformer hall in order to drive heat and stale air out of the access tunnel. During fire detection this supply system shall be automatically switch off. Separately the exhaust air system shall extract air from potentially contaminated areas, battery rooms, welding bays, kitchens, toilets and drainage pits via duct to outside of the underground powerhouse. Fans shall be selected for low noise emission and maximum operating efficiency.

17. TAILRACE TUNNEL

17.1 Function

- a. The tailrace tunnel is provided to steadily and safely convey the design discharge for power generation from the turbine pit to the river.

17.2 Employer's Concept

- a. A D-shaped tailrace tunnel with 4.5 m width and 4.5 m height to convey the turbine discharge safely back into Ghunsa Khola near its confluence with Tamor River. The invert and side walls are up to the maximum flow depth is concrete lined.
- b. The tunnel has an invert slope of 1 in 680 from the turbine collecting chamber to towards the outlet. The dimensions adopted for the tunnel result in a velocity of 2.62 m/s at maximum discharge.
- c. From the tailrace tunnel outlet portal, a box-culvert structure with internal dimension of 3.9 m wide and 4.2 m height is provided. Adequate protection structure is provided for the culvert structure.
- d. The tailrace invert level and outlet gate sill are fixed at EL. 1507.25 m. The invert level outlet is fixed at the Q_{100} water level in the river.

17.3 Contractor's Design

- a. The tailrace tunnel shall be sized adequately to carry a free-flow channel for a design discharge of 21.28 m³/s plus 10% additional discharge for COL.
- b. The tunnel shall be concrete lined at the invert and the side walls up to the maximum flow depth or as per the support requirements as defined by the Rock Class.
- c. The tailrace outlet invert level shall be above EL. 1507.25 m which corresponds to Q_{100} water level in the river.
- d. The tailrace outlet shall have a gate, the specification of which are specified in the Part V Employer's Requirements, and other facilities to completely discharge water from the tailrace tunnel. The tailrace outlet gate shall be designed to automatically close when the river water level rises above EL 1507.0 m and shall be well equipped with the SCADA system and can be operated from the Powerhouse control room.
- e. The tailrace outlet shall be designed and constructed not to cause collapse or erosion of natural ground and or/slopes and also not to score the foundations of other permanent structures due to water discharged from the tailrace. The Contractor shall make adequate protection measures against possible flooding condition at the tailrace outlet and also include protection works at the tailrace outlet to prevent erosion of the river banks. Outfall structure at the end of tailrace outlet shall be provided to match the actual site condition.
- f. One stretch of the tailrace Culvert near the end shall be designed so as to withstand the maximum loading of the moving vehicles (with heaviest part of the electromechanical equipment) in the road above it in addition to the other loading conditions.

18. ADITS

18.1 Function

- a. Adits are provided at intervals in the water conveyance to provide work fronts for the construction works of the headrace tunnel, pressure shaft and caverns, to complete it in the stipulated time frame and aid in operation and maintenance when deemed necessary.

18.2 Employer's Concept

- a. Six construction adits are proposed to open up multiple working faces on the tunnels to reduce the overall construction programme. The construction adits and its location are as follows:

- Adit 1: Proposed at Ch. 0+110 m of the headrace tunnel. After the construction of the headrace tunnel this adit is provided with inside openable hinged bulkhead doors of opening size 2.5 m x 2.5 m.
 - Adit 2: Proposed at Ch. 1+513.66 m of the headrace tunnel. After the construction of the headrace tunnel this adit is plugged with concrete and fenced at the portal.
 - Adit 3: Proposed at Ch. 4+320 m of the headrace tunnel. After the construction of the headrace tunnel this adit is provided with inside openable hinged bulkhead doors of opening size 2.5 m x 2.5 m.
 - Adit 4: Proposed adit connects with the middle horizontal segment of the pressure shaft near its mid-length to provide multiple fronts for excavation and erection of the pressure shaft steel liner. An access manhole is provided for inspection of the pressure shaft during operation and maintenance.
 - Adit 5: Proposed adit branches off the main access tunnel and joins the lower horizontal segment just upstream of the bifurcation or trifurcation of the steel pressure shaft.
 - Adit 5A: Proposed adit leads to Service Bay, and also provided to access heat exchanger placed in branch/unit tailrace tunnels.
- b.
- c. Suitable drain pipes with two valves for each drain pipe shall be provided in all adit plugs to facilitate drainage of the headrace tunnel.
- d. Seepage and leakage water in any adit and access tunnel after installation of Bulk head gates/concreting and grouting shall not exceed 10 liters per second.
- e. Suitable provision for seepage and leakage flow measurement (V notch or rectangular notch) shall be installed in all adits and access tunnels.
- f. All adits are D shaped tunnel with excavated size of 4.5 m width and 4.5 m height except Adit 5A. Adit 5A is D shaped tunnel with excavated size of 7.6 m width and 8.0 m height.

18.3 Contractor's Design

- a. In order to satisfy the time for completion, the Contractor shall establish construction adits to facilitate access to the headrace tunnel/pressure shaft and facilitate concurrent work in multiple faces. The Contractor shall determine the number of construction adits required. However, ADIT 1 ADIT 2, ADIT 3, ADIT 4 Adit 5 are mandatory ADITS to be constructed by the Contractor.
- b. On completion of the headrace tunnel and pressure shaft, the adits that are not used for inspection and maintenance shall be plugged with concrete and the portal fenced with gate. The Contractor shall submit the design of the concrete plugs for the Employers approval.
- c. On completion of the headrace tunnel, the adit that needs to be converted into access for the headrace tunnel and rock trap (ADIT 1 and ADIT 3) shall be equipped and sealed by a bulkhead door to facilitate entry to the for inspection and maintenance. The bulkhead gate shall be as specified in Section IV of the Employers Requirements.

19. CIVIL WORKS OF TAKE OFF CABLE YARD

19.1 Function

- a. Power Cables from the GIS connect to the outgoing power transmission lines at the Take-Off-Yard; the civil works provide the necessary foundations and associated drainage to accommodate the Take-Off-Yard equipment and structures.

19.2 Employer's Concept

- a. An outdoor Takeoff yard for interconnection of the power cables from the GIS to the transmission line shall be constructed in Japanatar (near the outlet portal of CVT.)
- b. The civil structures of Takeoff yard consists of river protection works, foundation for takeoff equipment, gantry structures.
- c. The level of takeoff yard has been designed above the correspond to 1 in 100 years return period flood, which has been achieved by constructing river protecton structures and compacted backfilling.

19.3 Contractor's Design

- d. An area nominally required shall be prepared for the electrical equipment to be installed under the Contract of Lot 2: Electro-mechanical Works.
- e. The site area allocated to the cable yard shall have sufficient space and shall be stable and free from landslide, collapse and erosion due to heavy rain. To avoid such landslide, collapse and erosion, a drainage system with enough discharge capacity shall be provided in the Site area allocated to the cable yard.
- f. Design and construction of the surface drainage system and underground drainage system, if any, shall comply with Nepalese or International Standards.
- g. The Contractor shall design and construct the river protection works at Takeoff Yard. The takeoff yard shall be above the elevation corresponding to 1 in 100 years flood level.

20. ACCESS ROAD AND BRIDGES

20.1 Function

- a. The access roads will facilitate all-weather vehicular access to the permanent structures of the project during construction and for operational and maintenance purposes.

20.2 Contractor's Design

20.2.1 Road layout

- b. The route shall be as indicated in the Employer's Concept Drawings or better as proposed by the Contractor and reviewed by the Employer so as to minimize adverse impacts to the existing facilities, landscape and daily life of the surrounding local people due to widening and/or construction of new roads.
- c. The route up to each permanent structure such as Headworks, Adits, Powerhouse, Takeoff Yard, Tailrace, Main Access Tunnel Portal etc and other roads required for operation and maintenance shall shall be constructed by the Contractor.
- d. The Contractor shall construct the road to the temporary facilities such as batching plant, storage yards, crushing plant, camp facilities, workshop, etc as required for smooth construction of the Works.

20.2.2 Design and Specifications

- a. The road type for the permanent access roads shall be of an all-weathered gravel road of which the access roads shall be trafficable throughout a year during construction and after taking over.
- b. A proper drainage system of the access roads shall be provided. Design and construction of the surface and underground drainage system, if any, shall comply with the Nepalese Standards. If such Nepalese standards do not exist, applicable international standards shall be used.
- c. The design and construction works for the access roads shall include facilities for safe driving such as traffic boards, distance boards, guide boards, sign posts, guard rails/wire/facility and ancillary facilities such as bridge and culverts.
- d. Without prejudice to and without limiting or reducing the scope of or the requirements for the Works set forth in Part III of the Employer's Requirement or Volume 3: Conditions of Contract and Contract Forms, the following are the minimum requirements of the access road:
 - Access roads shall be designed for taking account of size and weight transportation required for the Works during construction and for operation and maintenance of the Powerhouse after taking-over;
 - The formation width of the road shall not be less than 5.5 m. However, for difficult terrains requiring blasting, the road formation width can be reduced to 4.0 m. A wide lay-byes of minimum 2.5 m shall be provided at every 400 to 500 m intervals.
 - The longitudinal grades of the permanent access roads shall not be greater than 12%.

20.2.3 Access Roads & Requirements

- a. The access roads, including bridges crossing the river, shall be , designed and constructed by the Contactor, as the Permanent Works which, shall be available for operation and maintenance of the Project by the Employer after taking-over of the Works under the Contract. The following permanent access roads and bridges shall be provided:
 - Road from Entry Point at (Existing Handrung Bailey Bridge location) to Inlet Portal of Main Access Tunnel (all weathered gravel road by upgrading the existing road).
 - Road from Main Access Tunnel portal to Cable-Cum-Ventilation Tunnel portal, Ghunsa right Bank (gravelled road)
 - Road from Cable cum ventilation tunnel to Adit 3 (at surge shaft location) (all weather gravel road)
 - Road from Adit 3 to top of Surge shaft (all weather gravel road)
 - Road to Adit 4 (all weather gravel road)
 - Cable cum ventilation tunnel to Headworks (all weather gravel road)
 - Road to Adit 1 and Adit 2 (all weater gravel road)
 - Road to Gate cum ventilation tunnel portal (all weather gravel road).
- b. The Contractor shall design, construct and maintain all roads, bridges and related works access and to the site that may be necessary for completion of the Civil and Hydromechanical Works. In case that the access roads are used as construction roads, the Contractor shall repair such access roads, if necessary, and transfer the access roads to the Employer in good condition after taking-over as permanent roads specified in the Contract.

- c. The Contractor shall carryout the rolling (with vibratory roller) of the access road in every 2 months.
- d. If the Contractor thinks an existing road is necessary to be repaired, the Contractor shall repair the road at his own expense. In case the Contractor causes any damage to the existing road, the Contractor shall repair and keep it as its basis.
- e. Land for the access road will be provided by the Employer to the extent required for permanent Works.
- f. The Contractor shall construct temporary river crossing at headworks site, powerhouse site and other locations it deems necessary and maintain them to allow construction activities all year around during construction period.

20.2.4 Maintenance of Access Road

- a. The Contractor shall maintain the access roads built or improved by him (from Handrung to the all the project component's location) for the whole of the Contract period prior to the Employer taking over the Works.
- b. The maintenance obligation includes, but not limited to, the following Works:
 - Repair of irregularities produced by the traffic;
 - Repair of related works damaged by weather;
 - Periodical shaping of the roadway in order to maintain it in optimum conditions for traffic at all times and for drainage;
 - Interior cleaning of culverts, including headwall ditched and drainage trenches;
 - Cleaning and shaping of earth ditches and dispose of material away from the road;
 - Providing the necessary signs; and
 - Providing an effective dust control. Dust control shall consist in applying either water or dust palliative, or both, for the alleviation or prevention of dust nuisance.
 - The Contractor shall carryout the rolling of the gravel road in every 2 months.

20.2.5 Bridges

- a. The Contractor shall design and construct the Permanent Steel truss Bridge as indicated in the Employer's Concept drawing crossing Ghunsa Khola.
- b. The bridges shall be designed for Class A loading as defined in the Indian Road Congress. Other equivalent standard codes loading can also be used with the approval from the Employer.
- c. The selection of bridge site shall be as indicated in the Employer's Concept Drawings or better as proposed by the Contractor and approved by the Employer. The bridge axis shall be aligned along a straight reach of the river and perpendicular to the direction of flow, if possible. The abutments shall be sited on firm riverbanks.
- d. The bridges shall be designed as a single span structure, with no intermediate pier and shall be a single lane structure with carriageway not less than 4.5 m. The vertical clearance between the deck level to the bottom of top member, in case of truss bridge, shall not be less than 4.75 m or adequate for crossing the tallest single equipment likely to use the bridge.
- e. The bridges shall be designed for 1 in 100-year flood discharges with sufficient freeboard. The bridge abutments and foundations shall be protected as necessary against scour.

- f. Adequate river training works shall be designed and provided by the Contractor as the site condition requirement.

21. DISPOSAL AREA

21.1 Contractor's Design

- a. The disposal area shall be used for the disposal of excavated materials not to be utilized for fills, backfills, and aggregates. The disposal area shall be cleared of all downed and standing vegetation and grubbed, and topsoil shall be removed prior to placing waste excavated materials thereon. And the drainage layers and/or drainage trenches shall be provided.
- b. Retaining walls shall also be provided as necessary to maintain slope stability and protection against flood if the area is near the river or natural drains.
- c. The Contractor shall design, construct and maintain the disposal area so as to keep the area from collapsing during and after the construction. The Contractor shall utilize the areas as indicated in the Employer's Concept Drawings for disposal area or as propose the detail of the additional spoil area if not sufficient for the Employer's Review.
- d. All fill and backfill for the disposal area shall be protected and maintained in a satisfactory condition during and after the completion of the Works. In the event of slip-outs in any part of the fill, the material shall be removed from the slip area, and such portion of the fill shall be rebuilt.
- e. The disposal area shall be vegetated after completion of the works.

22. LIGHTING

- a. The proper lighting shall be installed at the below-mentioned locations and/or sections as per Employer's Requirements, in order to enable safe and sound maintenance and operation work at night.
 - i. Access roads, as necessary.
 - ii. Bridge Locations
 - iii. Entire Headworks Area
 - iv. Gate operation chambers at desilting basin.
 - v. Adits used for operation and maintenance purposes including the portal area.
 - vi. Top of Surge Shaft
 - vii. Valve chamber
 - viii. Bulk head door locations
 - ix. Cable cum ventilation tunnel,
 - x. Tailrace outlet structure.
 - xi. Main Access Tunnel
- b. The lighting shall be connected to the station service distribution system.

23. APPROACH WAYS

- a. Appropriate working space and approach ways including ladders and stairs shall be designed to safely carry out the operation and maintenance of each structure. Such working space and approach ways shall have enough width and safety measures such as handrails or a drainage system with enough discharge capacity for safe operation and maintenance.

24. WARNING SYSTEM

- a. A sudden discharge from the Headworks and/or powerhouse may cause harm to people living downstream due to fluctuation of river water. For this reason, if required, warning system shall be established by the Contractor to warn the downstream people whenever the water level soars rapidly by sudden water release. The warning systems

shall be established around the Headworks tailrace and the riverside where local residents may utilize water. The warning system will contain motor sirens, loudspeakers, warning boards and other facilities for warning. The warning enables to be given from the control room at the headworks.

25. SUPPLEMENTARY CIVIL WORKS

- a. Supplementary Works shall include:
 - i. Headworks operation Center includes:
 - Maintenance area with 5 m ceiling.
 - Workshop and welding bay.
 - Tools and equipment store.
 - Parts and materials store.
 - Control room and communications center.
 - Back-up battery room.
 - Offices.
 - First aid station.
 - Kitchen and eating/restrooms.
 - Washrooms and ablution amenities.
 - Stand-by diesel generator and fuel store.
 - Car parking hardstand areas.
 - ii. Workshop tools to comprise: Workshop furniture, hand tools, powered hand tools, band saw, cut-off saw, radial drilling machine, lathe, pedestal grinder, drill press, hydraulic press, AC welders, electrode ovens, oxy-acetylene welder/cutter, electronic workshop tools and instruments, oil centrifuges, sump pumps, air compressors, motorized trolleys and fork-lifts, jib cranes, chain blocks, jacks, portable ventilation fans and ducts, portable lighting equipment, HP washer.
 - iii. Construction type and building materials: single or two-storey, concrete slab floor with footings, masonry double skin cavity external walls, tiled roof, roof, and wall insulation, double glazed windows, roller door to the workshop and welding bay, and other access doors.
 - iv. Sewage from the headworks and pot head yard operations center is drained into a septic tank with seepage trench overflow. The tank and trench are not less than 300 m from any water course. The tank and trench are designed for the normal accommodation level to be 10 persons and the peak accommodation level to be 25 persons.
 - v. Particular metalwork in headworks, surge shaft, valve house, and powerhouse complex include staircase and landing platforms required for the crane access, hatches in headworks, valve house, power station, surge shaft protection cover, and tailrace outfall gate structure.
 - vi. Operators Residence Building including followings:
 - Minimum 1700 sqft with appropriate partitions, toilet/bathroom, kitchen/dining area.
 - The building shall be concrete structural building.
 - vii. Undersluice stoplog storage facilities at headworks area.
 - viii. Guard post at Headworks, Takeoff Yard and Powerhouse Main Access Tunnel Portal.
 - ix. Gate Operation Centre for undersluice gates.
 - x. Chain linked fencing with barbed wire and concertina barbed tape with lockable metal gate at the entrance at Powerhouse Main Access Tunnel Porta, Takeoff Yard, Headworks Area.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION IV
PARTICULAR TECHNICAL REQUIREMENT FOR
HYDROMECHANICAL WORKS**

**CHAPTER 1
HYDROMECHANICAL EQUIPMENT**

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1 SCOPE OF WORKS

Scope of HM works:

- The HM works shall include any other related works not otherwise defined that is required as a consequence of the Contractor's design including for efficient and effective operation and maintenance.
- All the HM works shall be in accordance with the relevant specified Standard Technical Requirements, unless otherwise approved.
- Where the Standard Technical Requirements conflict with these Particular Requirements, the Particular Requirements shall apply
- The Contractor shall design and implement works to achieve eSqual or better than the intent and performance of the Employers concept design.
- Except where specifically stated the Contractor is entirely responsible for all of the requirements for achieving fully functioning HM works; including automatic control where this is the Employers concept.

2 GATES

2.1.1 Under 7.6 m width and 8.0 m height. Sluice Gate

Two (2) sets of radial gates, hydraulic hoist with its guide frame, sealing arrangement, steel support, embedded parts, dogging device with handling tools and all appurtenant parts complete with necessary accessories.

2.1.2 Trash Removal Gate

One (1) set of vertical lift slide type bonneted gate with its guide frame, electrically operated screw hoisting with its guide frame, lifting beam, metallic sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

2.1.3 Intake Service Gates

Two (2) sets of vertical fixed wheel gate with its guide frame, electrically operated rope drum hoisting with its guide frame, lifting beam, sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

2.1.4 Bottom Sluice Isolation Gate Valves

Four (4) sets of gate valves, steel supports, motor with gear box, and appurtenant parts all complete with necessary accessories. Two (2) nos. for operating service and other two (2) nos. for emergency service.

2.1.5 Gravel Trap Gate Valves

Four (4) Nos. of gate valves, steel supports, motor with gear box, and appurtenant parts all complete with necessary accessories. Two (2) nos. for operating service and other two (2) nos. for emergency service.

2.1.6 Desilting Chamber Outlet Gate / Headrace Tunnel Inlet Gate

Two (2) sets of vertical fixed wheel gate with its guide frame, electrically operated rope drum hoisting with its guide frame, lifting beam, sealing arrangement, steel support, embedded parts, dogging device with handling tools and appurtenant parts complete with necessary accessories.

2.1.7 Silt Flushing Gates

Four (4) sets of vertical lift slide type bonneted gate with hydraulic hoist, handling tools and appurtenant parts complete with necessary accessories. Two (2) sets for operating service and Two (2) sets for emergency service.

2.1.8 Adit Tunnel Gate

One (1) set of bulkhead gate, manually operated door handle with the possibility of using power tools such as power jack, excavator arm, etc., with its frame, sealing arrangements, steel supports, embedded parts, handling tools and appurtenant parts complete with necessary accessories.

2.1.9 Tailrace Gate

Two (2) sets of vertical fixed wheel type gate, electrically operated rope drum hoist with provision of manual operation and interlocking hoisting with its guide frame, sealing arrangement, steel supports, embedded parts, dogging device with handling tools and appurtenant parts all complete with necessary accessories.

2.2 MAINTENANCE GATES

2.2.1 Undersluice Maintenance Gate

One (1) set of vertical lift slide type gate with filler valve assembly, electric driven monorail crane operated hoisting with its guide frame, lifting beam, sealing arrangement, steel supports, embedded parts, dogging device with handling tools and appurtenant parts all complete with necessary accessories.

2.2.2 Intake Maintenance Gate

Oner (1) set of vertical lift slide type gate with filler valve, electric driven monorail crane operated hoisting, with its guide frame, lifting beam, sealing arrangement, steel supports, embedded parts, dogging device with handling tools and appurtenant parts all complete with necessary accessories.

2.3 TRASHRACKS

2.3.1 Intake Trashrack

Four (4) complete sets of intake trashrack with one set of trashrack cleaning machine with required supporting beams, and all the necessary accessories.

2.4 STEEL PENSTOCK PIPE AND ACCESSORIES

2.4.1 Steel Lining

- One (1) complete headrace tunnel steel liner commences from 25 m upstream of the surge-tank center line including 4 m long inlet transition from D-shape to circular
- One (1) complete steel lining for penstock shafts upper curve
- One (1) complete steel lining for upper penstock vertical shaft
- One (1) complete steel lining for upstream penstock shaft middle curve
- One (1) complete steel lining for middle horizontal high-pressure penstock
- One (1) complete steel lining for downstream penstock middle curve
- One (1) complete steel lining for lower penstock vertical shaft
- One (1) complete steel lining for the penstock shafts bottom curve
- One (1) complete steel lining for the lower horizontal high-pressure penstock

2.4.2 Trifurcation

- One (1) complete trifurcation from penstock inlet diameter to the manifold inlet diameter
- Three (3) manifolds to the unit inlet valves diameters

2.5 AUXILIARY ELECTRICAL SYSTEM

- One (1) complete set of electrical appliances necessary to feed the equipment for the hydro-mechanical works

2.6 FITTING ACCESSORIES, SPARE PARTS AND SPECIAL TOOLS

- Complete set of fittings, accessories, spare parts and special tools as prescribed in particular technical specification

Note:

- Actual number of supply and dimensions of different gates, stoplogs, trash racks, steel linings, emergency closing valve and hoisting system shall be as per the particular technical requirements for the equipment described hereunder.
- The Contractor shall provide any access ladder and platform, handrail, cover plate, curbing etc., around the equipment to be supplied under this contract.

- Mandatory spare parts are listed in the following chapters; all spare parts shall be packed and protected for an in-door storage time of at least 10 years.

3 DESIGN AND CONSTRUCTION REQUIREMENTS

- (a) The hydromechanical equipment shall be designed, manufactured, arranged and installed to provide functional design and neat appearance. All parts of the equipment shall be arranged to facilitate surveillance, maintenance and operation. All control sequences shall be simple and rational.
- (b) The design calculation for the hydromechanical equipment shall be based on latest DIN 19704, Basis for Calculation of Hydraulic Steel Structures. The other steel structural works shall be based on DIN 18800 or Euro Code 3 (EN 1993).
- (c) The hoisting appliances such as cranes shall be designed as per "Rules for the Design of Hoisting Appliances"-Issued by FEM. The tunnel steel lining and appliances shall be designed as per CECT.
- (d) The parts of the equipment shall be designed and arranged so that they can be easily inspected, cleaned, erected and dismantled without involving large scale dismantling of other parts of the works. They shall be designed, and manufactured in accordance with the latest recognized rules of workmanship and modern engineering practice.
- (e) The regulations, standards and guidelines listed in these specifications shall be observed in the design, calculation and manufacture of the equipment. All parts of the equipment shall be suitable in every respect for continuous operation at maximum output under the climatic conditions and operating conditions prevailing at the site.
- (f) Special attention shall be given to parts of the equipment which are delivered by other manufacturers/suppliers. Problems arising in this conjunction shall be solved by the Contractor and be defined in writing.
- (g) For individual items of the equipment, the materials and the design are to be selected which are best suited for the operating conditions to which the parts in question will be subjected. Only designs and types shall be offered which have proved their reliability in long-term continuous operation.
- (h) All live, moving and rotating parts shall be adequately secured in order to avoid danger to the operating staff. All electrical components shall be grounded.
- (i) Manufacturers shall take appropriate measures to prevent the ingress of dust into any equipment (such as bearings, relays, control and measuring equipment etc.), which may thereby be endangered.
- (j) Suitable lifting eyes and backing-out bolts shall be provided where required or where they will be useful for erection and dismantling. Pockets and depressions likely to hold water shall be avoided, and if not avoidable they shall be properly drained.
- (k) Parts of the equipment principally intended for standby purposes shall be protected from corrosion by careful choice of material and, if necessary, by additional means; these should not reduce their continuous standby readiness.

- (l) All design details and layout matters shall be discussed in periodic meetings with the Employer. The first design meeting between the Contractor and the Employer shall take place within Twenty-eight 28 days after the date of commencement of the Contract. Further design meetings shall take place as agreed between the participants until the design work is completed.
- (m) Tolerances shall be checked at every stage and the final survey/inspection shall meet the defined tolerances. The final survey/inspection shall be on complete chapters and on the completed structure, after post weld heat treatment if applicable, and shall be carried out by the Contractor.
- (n) All setting out and fit-up shall be subject to an appropriate tolerance. Where no appropriate tolerance is stated below, then the tolerance shall be obtained from the Employer.
- (o) The Employer shall reserve the right to employ independent dimensional control sources as cross checks whenever considered necessary throughout the fabrication program.
- (p) No forcing or constraining of components shall be undertaken to obtain the required tolerance without the approval of the Employer.
- (q) Local tolerance shall be as specified in the design code and shall include straightness, flatness, curvature and alignment.
- (r) The finish product shall comply with the overall tolerance as specified in the latest DIN 19704 and CECT.

4 EQUIPMENT OPERATION DURING COMMISSIONING OF GENERAL UNITS

- (a) The Contractor i.e. hydromechanical specialists shall fully cooperate with other specialists and with the Employer during commissioning of generating units.
- (b) During the commissioning, the hydromechanical specialists shall be responsible for the operation of the hydromechanical equipment and the implementation of all necessary safety measures.
- (c) In case, at the time of commissioning of generating units, the permanent power supply for the operation of various hydromechanical equipment will not be available, the hydromechanical equipment shall be fed with provisional power supply (Diesel sets or provisional lines) until the permanent power supply is available. All costs for the above are deemed to be included in the contract price.

**REMIT HYDRO LIMITED
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(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION IV
PARTICULAR TECHNICAL REQUIREMENT FOR
HYDROMECHANICAL WORKS**

**CHAPTER 2
TRASHRACKS**

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1 FUNCTION

- a. The trashrack is installed at the intake of the conveyance system to prevent the ingress of debris or large-size trash that could compromise turbine performance and operational safety.
- b. It is specifically designed to exclude:
 - i. Waterborne material that is not effectively removed by desilting chambers.
 - ii. Any material that could adversely affect the Lot 2 Contractor's turbines.

1 EMPLOYER'S CONCEPT

- a. The fine trashrack shall be positioned at the intake entrance, ensuring optimal hydraulic performance across the full turbine operating range.
- b. The trashrack bars shall be spaced no greater than 1/5th of the jet diameter at maximum needle opening. The exact spacing shall be determined during detailed engineering in coordination with the turbine manufacturer.
- c. The maximum allowable head loss across a clean trashrack is limited to 100 mm, with the size and orientation of the bars optimized accordingly.
- d. The trashrack design shall prevent vibrations under all operational conditions.
- e. **The arrangement, including approach angle and vertical inclination, shall facilitate efficient raking and debris removal.**
- f. Technical Data for Trashrack

1. No. of bays	: 4 Nos.
2. Clear width of opening	: 3.50 m
3. Clear height of opening	: 5.00 m
4. Inclination	: 80° (with horizontal)
5. EL. at top of pier	: EL 1955.00 m
6. MWL	: EL 1953.80 m
7. Sill level	: EL 1943.10 m
8. No. of trash racks	: 4 Sets
9. Type of trash rack	: Removable and inclined
10. Clear spacing between trash bars	: 40 mm and should not be larger than 1/5 of the jet diameter at maximum needle opening of Lot 2 Contractor's turbine.
11. Differential head for design	: 7.0 m for trash bars and 6.0 m for horizontal girders and end girders
12. Operating equipment	: Manual and automatic hydraulic Trash Rack Cleaning Machine with Grappler arrangement.

13.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc.	:	General Technical Specifications, Particular Technical Requirements and IS: 11388/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN
14.	Minimum thickness of the trash rack bars	:	12 mm
15.	Max. flow throughout the trash racks opening	:	5.32 m ³ /s
16.	Maximum water velocity in the trash rack net area	:	1.0 m/s
17.	Corrosion allowance	:	2 mm
- g. All the information concerning elevations, dimensions, operating conditions is approximate only and shall be confirmed by the Employer prior to manufacture.
- h. All the welds shall be checked by non-destructive tests (dye penetration or ultrasonic).
- i. Provision shall be made for the installation of head-differential measurement equipment.
- j. The head losses of the trash racks shall be minimized and guaranteed.
- k. The drawings shall be based on structural calculation under consideration of the relevant dimensions and operation requirements of the equipment described in the specification.

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CHAPTER 3
TRASHRACK CLEANING MACHINE

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2	EMPLOYER'S CONCEPT	1

1 FUNCTION

- a. A traveling gantry-type automatic Trash Rack Cleaning Machine (TRCM) with a hydraulic grappler arrangement is installed at the power intake to remove debris and floating trash from vertical trash racks.
- b. TRCM effectively clears tree trunks, logs, bulky materials, branches, drowned animals, and other floating debris accumulated in front of the trash rack.

2 EMPLOYER'S CONCEPT

- a. One (1) complete set of the trashrack cleaning machine (TRCM) shall be supplied for the intake fine trashrack.
- b. The intake TRCM shall travel on rails along the top of the intake block. The TRCM will be parked in a bay above the construction joint. Means of securing the TRCM at an extreme water level shall be provided.
- c. The machine shall have the option of being operable both manually by an operator or automatically without an operator. The rake traverses the trash-rack structure to allow cleaning of the entire structure of one bay at a time. For fully automatic operation, the machine is guided by the head loss measuring device supplied under the contract and the TRCM starts when the pressure differential is sufficient, operating automatically when the pressure differential reaches a preset threshold. Manual override capability shall also be provided.

d. Technical Data for TRCM:

Type	: Traveling gantry type (Hydraulically and Automatically)
Quantity	: One (1) set.
Operation	: Manual and automatic
Center to center of rail travel	: 4.5 m (approx.).
Length of track	: 20.0 m (approx.). (to be determined by bidder)
Trashrack clear opening (W x H)	: 3.50 m x 5.00 m
Inclination of trashracks (horizontal)	: 80°
Minimum net trash handling capacity (at maximum depth)	: 2000 kg
Minimum raking width of the trash bucket	: To suit the guide arrangement
Rake bucket minimum opening	: 1.4 m
Raking bucket lifting speed	: 10 ± 10% m/ min
Raking bucket lowering speed	: 10 ± 10% m/ min
Long travel speed (High)	: 20 ± 10% m/ min
Long travel speed (Low)	: 5 ± 10% m/ min
Inching facility	: Yes
Remote control operation facility	: No
Max. Hydraulic operating pressure	: 20 MPa

Number of hydraulic boom	: 1 No.
Minimum operating radius	: 12.5 m (approx.)
Minimum operating angle	: 270° (approx.)
Lifting capacity of grappler (Excluding the weight of grappler)	: 2000 kg
Clear lifting height up to deck	: 12 m (approx.)
Hoisting/ Lowering speed	: 5 m/ min
No. of grapples (hydraulically operated with easy replaceability)	: 2, One Multi-prong grapple matching human finger arrangement and one with two pairs of tongs parallel to each other suitable for grabbing of logs.
Prime mover operated self-unloading (Vol.)	: 3.5 m ³ (minimum)
Trash disposal vehicle (Tipper Capacity)	: 5 MT (minimum)
Maximum water level	: 1953.80 m asl
Elevation of Lowest rack position	: 1943.10 m asl
Elevation of operating platform	: 1955.00 m asl

- e. The machine shall be sourced from a globally recognized manufacturer specializing in heavy-duty trash rack cleaning machines.
- f. The TRCM shall be designed, supplied, and installed with all necessary components, including:
 - Rake assembly (bucket, arm cylinders, lifting device)
 - Hydraulic grappler device
 - Guide frame with rollers
 - Trash disposal vehicle
 - Gantry rails, end stoppers, buffers and all necessary accessories
- g. The rake bucket shall be engineered to match the embedded guiding arrangement of the trashrack, as indicated in the Employer's concept drawings.
- h. The cleaning shall be guaranteed during full flow through the intake and even with a cross water velocity up to 4 m/ s on the u/ s of trash rack.
- i. The machine shall be structurally and functionally compatible with the intake trashrack block, corresponding trashracks and the trashrack support structure.
- j. All dimensional, elevation and operating condition data provided in the specifications are approximate and shall be verified with the Employer prior to manufacturing.
- k. The TRCM system shall include any other related components that is not otherwise defined as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- l. Following type of trash is likely to be encountered: - Tree stumps, Root stocks, Grass Weeds Plastic bags, Animal Carcass, etc.
- m. The trash rake shall be suitable for the type of trash rack provided and shall be designed to clean the full width and full depth (as far as possible) of all trash racks. The trash so collected after each cleaning cycle shall be arranged to be discharged into a suitable trash disposal vehicle. The trash disposal vehicle shall be provided with suitable prime mover and hydraulically operated tipping arrangement to dump the trash automatically at a suitable

location. The trash rake shall fit and operate within the dimensions shown on the drawings, with adequate clearance around all structures, equipment and devices. The manufacturer shall ensure that the raking machine rake teeth shall fit between the trash rack bars with sufficient clearance to ensure free movement. All components, devices and assemblies shall be weatherproof, for outdoor use and designed for the Site climatic condition. Exposed equipment's shall be provided with covers wherever required. All members, devices, etc. which could otherwise trap water shall be provided with drain holes. All structural tubing and piping shall be seal welded to prevent entrapment of moisture. All motions including gantry and rake hoist shall be controlled by hydraulic motors/ Thyristorised controlled squirrel cage motors. The supply to the equipment will be by cable reeling drum.

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CHAPTER 4
MAINTENANCE GATES

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1 FUNCTION

1.1 Undersluice Maintenance Gate

- a. The undersluice maintenance gate is a temporary isolation barrier designed to facilitate repair and maintenance of the radial gates by preventing water ingress into the maintenance zone.
- b. The gate is intended for deployment only under balanced hydrostatic conditions to ensure controlled installation and removal without inducing excessive differential pressure.
- c. The maintenance gate is designed to seal against embedded guide-slot frames using a combination of rubber seals and mechanical positioning features to achieve watertight isolation.
- d. The system includes filler valves to equalize pressure across the gate before removal, ensuring safe handling and operation.

1.2 Intake Maintenance Gate

- a. The intake maintenance gate provides a temporary isolation barrier to facilitate inspection, repair and maintenance of the intake service gates by preventing water ingress into the maintenance zone.
- b. The gate is designed for installation and removal exclusively under balanced hydrostatic conditions to prevent differential pressure buildup and ensure safe operation.
- c. It incorporates sealing mechanisms to establish a watertight interface against the embedded guide-slot frames, ensuring effective isolation during maintenance activities.

2 EMPLOYER'S CONCEPT

2.1 Undersluice Maintenance Gate

- (a) The maintenance gate assembly consists of:
 - Two sets of embedded gate guide-slot frames, incorporating bottom, side and top-edge sealing surfaces.
 - One downstream-sealing maintenance gate, complete with rubber seals, slides and a lifting beam.
 - Leaf springs at each upstream-side corner to facilitate precise positioning for optimal sealing.
- (b) The gate shall be installed and removed using an electric monorail hoist, with the gate and lifting beam normally stored at deck level using a latching device installed at the top of the gate guide groove.
- (c) Filler valves (minimum size 150 mm × 150 mm) at the top of the maintenance gate shall enable controlled filling of the inter-gate space before removal. These valves shall be actuated via the lifting beam and electric monorail hoist.

- (d) A dogging device shall be provided for securing the gate panels in position within the gate slot. The Contractor shall design, supply, install, and test the manual dogging mechanism, incorporating considerations for:
- Long-term loading and impact loading
 - Manual operation with position indicators for open/closed and loaded/unloaded conditions
- (e) The maintenance gate shall be structurally designed to withstand all operational and hydrostatic loads associated with the power plant's requirements.
- (f) All dimensions, elevations, and operating conditions provided are approximate and must be verified with the Employer before fabrication.
- (g) Non-destructive testing (NDT), including dye penetration or ultrasonic testing, shall be conducted on all welds to ensure structural integrity.
- (h) Final drawings shall be developed based on structural calculations, considering the relevant dimensions and operational constraints of the maintenance gate system.
- (i) The undersluice maintenance gate system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- (j) Technical Data for Undersluice Stoplogs

1.	No. of openings	:	2 Nos.
2.	No. of gates	:	1 No.
3.	EL. at top of pier	:	EL 1955.00 m
4.	MWL	:	EL 1953.80 m
5.	Sill level	:	EL 1939.45 m
6.	Clear width of opening	:	3.50 m
7.	Clear height of opening	:	4.50 m
8.	Center to center of side seals	:	3.60 m
9.	Center to center of tracks	:	4.10 m
10.	Type of gate	:	Vertical lift slide type equipped with filler valve assembly.
11.	Location of skin plate	:	Downstream
12.	Location of seals	:	Downstream
13.	Design head	:	14.35 m
14.	Type of hoist	:	Electrically operated monorail hoist equipped with automatic engaging/disengaging type lifting beam
15.	Hoisting speed	:	0.5 m/ min

16.	Long travel speed	:	4.0 m/ min
17.	Height of lift required	:	16.00 m
18.	Permissible stress:		
	i. Gate	:	Dry and accessible
	ii. Embedded parts	:	Wet and inaccessible
19.	Permissible deflection	:	Span/ 800 (span = center to center of tracks)
20.	Operating criteria	:	Fully open/ Fully close
21.	Maximum permissible leakage through a closed gate per m length of the seal	:	5 L/ min
22.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and hoist	:	General Technical Specifications, Particular Technical Requirements and IS: 5620, IS: 3938 and IS: 13591/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.2 Intake Maintenance Gate

- (a) The intake maintenance gate system comprises:
- Two embedded gate guide-slot frames, each featuring integrated bottom, side and top-edge sealing surfaces to support the maintenance gate.
 - One downstream-sealing maintenance gate, complete with rubber seals, sliding components and a lifting frame for secure engagement with the guide-slot frames.
 - Leaf springs positioned at each upstream-side corner of the gate to ensure precise alignment and effective sealing upon deployment.
- (b) To enable controlled installation and removal, the maintenance gate incorporates two filler valves (minimum size: 150 mm × 150 mm) at the top of the structure. These valves allow for gradual equalization of water pressure between the maintenance gate and the intake service gate before removal. Actuation of the filler valves is facilitated by the lifting beam and an electric monorail hoist.
- (c) The storage and deployment mechanism includes:
- A latching device positioned at the top of the gate guide groove to secure the maintenance gate and lifting beam at deck level when not in use.
- An electric monorail hoist for precise lifting, installation and removal of the gate assembly in accordance with operational requirements.

Intake Maintenance gate

1.	No. of openings	:	2 Nos.
2.	No. of gates	:	1 No.
3.	EL. at top of pier	:	EL 1955.00 m
4.	MWL	:	EL 1953.80 m
5.	Sill level	:	EL 1941.00 m
6.	Clear width of opening	:	3.10 m
7.	Clear height of opening	:	3.10 m
8.	Center to center of side seals	:	3.20 m
9.	Center to center of tracks	:	3.50 m
10.	Type of gate	:	Vertical Lift Slide Type equipped with filler valves
11.	Location of skin plate	:	Upstream
12.	Location of seals	:	Upstream
13.	Design head	:	12.80 m
14.	Type of hoist	:	Electrically Operated Monorail Hoist equipped with automatic engaging/disengaging type lifting beam
15.	Hoisting speed	:	0.5 m/ min
16.	Long travel speed	:	4.0 m/ min
17.	Lift required	:	14.50 m
18.	Permissible stress:	:	
	i. Gate	:	Dry and accessible
	ii. Embedded parts	:	Wet and inaccessible
19.	Permissible deflection	:	Span/ 800 (span = center to center of tracks)
20.	Operating criteria	:	Fully open/ Fully close
21.	Maximum permissible leakage through a closed gate per m length of the seal	:	5 L/ min
22.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and Hoist	:	General Technical Specifications, Particular Technical Requirements and IS: 5620, IS: 3938 and IS: 13591/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

- b. All the information concerning elevations, dimensions, operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.
- c. All the welds shall be checked by non-destructive tests (dye penetration or ultrasonic).
- d. The drawings shall be based on structural calculation under consideration of the relevant dimensions and operation requirements of the equipment described in the specification
- e. The maintenance gates shall be designed in every respect to meet safely all the requirements of the power plant.
- f. The intake maintenance gate system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.

Note: The leakage of the inserted stoplog for both undersluice and intake shall not exceed 0.1 l/s per meter of active sealing length and not more than 1.0 l/s for one complete stoplog. This value shall be guaranteed in new and clean conditions at a full supply water level indicated above.

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CHAPTER 5
GATES AND VALVES

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1 FUNCTION

For the closure of different structures, following gates and valves are provided:

1.1 Undersluice Gate

- (a) The undersluice shall be adjacent to the HEP intakes. The radial gates shall be for sluicing away any build-up of sand, rock, gravel or debris that is trapped in the intake area.
- (b)
- (b) The radial gates shall be designed to operate during the following river flow conditions:

Maximum operating water level	EL 1953.8 m
Minimum operating water level	EL 1947.0 m
- (c) The profile and arrangement of the water passages at the gate shall be designed to ensure that, to the maximum extent possible, rocks shall be carried through the gateway and shall not come to rest in the gateway where they would impede closure of gates.

1.2 Trash Removal Gate

- (a) The trash removal gate shall be provided for regular flushing of the floating trash/ debris accumulated at intake area.
- (b) The gates shall open reliably under maximum differential head and close reliably into maximum flow conditions.
- (c) Gates shall be operated either fully open or fully closed.

1.3 Intake Service Gates

- (a) The intake gates shall be closed when flushing or maintaining the desilting chambers.
- (b) The intake gates shall be capable of closing into flow of up to 50% of the rated power station flow including flushing flow.
- (c) The gates shall be fully open or fully closed and regulating type and shall be left partially open whenever required.

1.4 Bottom Sluice Isolation Gate Valves

- (a) The bottom sluice isolation gate valves shall be provided for flushing of the debris that is accumulated downstream of the intake trash racks.
- (b) The valves/ gates shall be required to open reliably under maximum differential head and close reliably into maximum flow conditions.
- (c) Valves/ gates shall be operated either fully open or fully closed.

1.5 Gravel Trap Gate Valves

- (a) The gravel trap valves/ gates shall be provided for flushing of a gravel trap that is accumulated downstream of the intake trash racks.
- (b) The valves/ gates are required to open reliably under maximum differential head and close reliably into maximum flow conditions.
- (c) Valves/ gates are operated either fully open or fully closed.

1.6 Desilting Chamber Outlet Gates / Headrace Tunnel Inlet Gates

- (a) The desilting chamber outlet gate shall be for isolating each desilting chamber against back-flow from the head race tunnel during drainage and maintenance.
- (b) The gate shall be installed and removed only under balanced hydrostatic conditions.

1.7 Silt Flushing Gate

- (a) The silt flushing gates shall be provided for regular flushing of the desilting chambers.
- (b) The gates shall be required to open reliably under maximum differential head and close reliably into maximum flow conditions.
- (c) Gates shall be operated either fully open or fully closed.
- (d) The gate shall be designed for a normal static head corresponding to FSL in addition to vacuum head.
- (e) Each gate shall be operated by independent hydraulic hoist. Each hydraulic hoist shall be designed for operation of the gate for lowering, raising and holding the gate at any intermediate position during its travel under unbalanced head of water. The gate hoisting system shall comprising of double acting hydraulic cylinder, shall have sufficient hoist/ thrust capacity to open and close the gate against design head. The hoist capacity computations shall conservatively consider the weight of the disc, rod and piston, the frictional forces of the gate seats, rod stuffing box and the hydrodynamic uplift/ down-pull forces during operation. An allowance of 20% as reserve capacity shall be provided.
- (f) The gate structure and gate leaf shall be strong and rigid and shall be designed to withstand an overloading condition and the combined forces of a normal water level and a seismic acceleration of appropriate value (depending on seismic zone of location). The effects of increased pressure head shall be considered in the seismic computations.

1.8 Adit Bulkhead Gate

- (a) The Adit bulkhead doors shall be provided to enable maintenance access to an equipment like Bobcat, shotcrete machine, concrete pump, small transit mixer to be used during the maintenance/ repair of headrace tunnel (headrace tunnel).

1.9 Tailrace Gate

- (a) The purpose of the tailrace gate shall be to prevent silt, rocks and debris being washed into the tailrace by extreme river floods.
- (b) The tail race gates shall be used to isolate the powerhouse during flood condition.

2 EMPLOYER'S CONCEPT

- (a) All the gates and valves will be installed and operated only under balanced and unbalanced hydrostatic conditions.
- (b) All the gates and valves including its hoisting system shall be designed in every respect of safe operation for all the requirements of the power plant.
- (c) The Employers Concept for functional requirement for various gates and valves is listed here under for relevant components:

2.1 Undersluice Gate

- i. Two submerged radial gates, including top-edge sealing are provided. Each gate assembly consists of trunnion anchors, side guide rollers, embedded seal plates, hydraulic actuators and integrated local and remote-control systems.
- ii. The gates remain in a normally closed position. Opening is achieved through hydraulic oil pressure, while closure is facilitated by gravitational force. When not in a fully closed or transitional state, hydraulic pressure supports the gates. A leakage control mechanism is incorporated to prevent gate drift exceeding 20 mm within a 24-hour period.
- iii. The profile and arrangement of the water passages at the gates are designed to maximize hydraulic efficiency and sediment transport. The system ensures that rocks and debris are effectively discharged through the sluiceway, preventing sediment accumulation that could obstruct gate closure and disrupt operations.
- iv. The radial gates are provided for reliable operation under variable river flow conditions. The maximum operating water level is set at EL 1953.80 m, while the minimum operating water level is EL 1947.0 m. Structural and hydraulic design shall ensure operational efficiency across this range or other range that is demanded because of Contractors' design.
- v. The undersluice system is positioned adjacent to the intakes. The radial gates are designed to sluice out accumulated sediments, including sand, gravel, rocks, and debris, from the intake area to ensure unobstructed water flow.
- vi. Independent mechanical locking devices are installed to secure the gates in the fully open position during maintenance. When fully raised, the design ensures accessibility and replaceability of all sealing components without requiring structural modifications or dismantling.
- vii. Each radial gate is manually and independently operated, either locally from the gatehouse or remotely from the Headworks Operations Centre/Control Room. The control system incorporates three modes: LOCAL, REMOTE, and OFF. In OFF mode, all powered operations are disabled, but manual operation via hand-operated pumps and

valves remains functional. In LOCAL mode, the gate responds to on-site raise/stop/lower push button commands. In REMOTE mode, commands are executed from the Headworks Operations Centre/Control Room. The gate opening sequence is designed with an adjustable time limit per actuation, requiring multiple successive commands for full gate opening.

viii. Technical Data for Undersluice Radial Gate

1.	No. of openings	: 2 Nos.
2.	No. of gates	: 2 Nos.
3.	EL. at top of pier	: EL 1955.00 m
4.	MWL	: EL 1953.80 m
5.	Sill level	: EL 1939.25 m
6.	Trunnion axis	: EL 1945.00 m
7.	Clear width of opening	: 3.50 m
8.	Clear height of opening	: 4.50 m
9.	Outer radius of skin plate	: 7.50 m (may change slightly during DDE)
10.	Side seal span	: 3.50 m
11.	Type of gate	: Radial (sluice) gates
12.	Location of skin plate	: Upstream
13.	Location of seals	: Upstream
14.	Design head	: 14.55 m
15.	Type of hoist	: Hydraulic hoist (single acting)
16.	Hoisting speed	: 0.7 m/ min
17.	Lift required	: 6.0 m
18.	Permissible stress:	: As per IS: 4623
i.	Gate (skin plate)	: Wet and accessible
ii.	Embedded parts	: Wet and inaccessible
19.	Permissible deflection	: 80% of the initial compression of top seal for the top girder and span/ 800 for other girders.
20.	Operating criteria	: Fully open/ Fully close, lowering and raising under unbalanced head condition
21.	Maximum permissible leakage through a closed gate per m length of the seal	: 5 L/ min
22.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and hoist	: General Technical Specifications, Particular Technical Requirements and IS: 4623 and IS: 10210/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.2 Trash Removal Gate

- i. The trash removal gate is designed for regular flushing of floating trash and debris accumulated at the intake area, ensuring unobstructed water flow and operational efficiency.
- ii. The gate shall be capable of opening reliably under the maximum differential head and closing securely under maximum flow conditions, ensuring continuous functionality in all hydraulic scenarios.
- iii. The gate operates in two discrete positions: fully open or fully closed, with no intermediate positioning to maintain system simplicity and reliability.
- iv. The trash removal gate shall be manually operated from the gate operating floor level, ensuring ease of access and control during operation.
- v. The gate control system includes two operational modes: LOCAL and OFF. In LOCAL mode, the gate responds to local raise/stop/lower push button commands, enabling precise control over gate movements. In OFF mode, all electrical controls are disabled. However, a manual hand-operated mechanism shall be available to allow gate operation in the absence of electrical power.
- vi. The system is designed with redundancy to ensure gate functionality under all conditions, including power failure scenarios, by providing an alternative manual operation mechanism.
- vii. The operational condition of the Trash Removal Gate is under unbalanced head.
- viii. Technical Data for Trash Removal Gates:

1.	No. of openings	:	1 No.
2.	No. of gates	:	1 No.
3.	El. at top of pier	:	EL 1955.00 m
4.	MWL	:	EL 1953.80 m
5.	Sill level	:	EL 1946.50 m
6.	Clear width of opening	:	2.00 m
7.	Clear height of opening	:	2.00 m
8.	Center to center of side seals	:	2.10 m
9.	Center to center of tracks	:	2.45 m
10.	Type of gate	:	Vertical lift slide type
11.	Location of skin plate	:	Upstream
12.	Location of seals	:	Downstream
13.	Design head	:	7.30 m
14.	Type of hoist	:	Electrically operated screw hoist
15.	Hoisting speed	:	0.5 m/ min
16.	Lift required	:	9.00 m
17.	Permissible stress:		
i.	Gate	:	Dry and accessible
ii.	Embedded parts	:	Wet and inaccessible
18.	Permissible deflection	:	Span/ 800 (span = center to center of tracks)

19. Operating criteria	:	Fully open/ fully close
20. Maximum permissible leakage through a closed gate per m length of the seal	:	5 L/ min
21. Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and hoist	:	General Technical Specifications, Particular Technical Requirements and IS: 5620 and IS: 11228/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.3 Intake Service Gate

- i. The intake service gates are closed during flushing or maintenance of the desilting chambers to prevent sediment accumulation and ensure efficient system operation. The gates shall be capable of closing against a flow of up to 50% of the rated power station discharge, including flushing flow. They are designed for both fully open and fully closed positions but also allow partial opening when required for flow regulation under balanced head.
- ii. The system consists of two upstream-sealing, submerged fixed-wheel gates, each equipped with embedded frames, an electric rope drum hoist and integrated local and remote control facilities. These components ensure reliable operation under submerged conditions.
- iii. The intake service gates are normally maintained in a fully open position. The gates are self-closing by gravity and operated using an electric rope drum hoist, ensuring controlled closure without reliance on external power sources during emergency conditions.
- iv. The electric rope drum hoist is installed on steel trestles and bridge structures, providing a stable and robust mounting arrangement for lifting and lowering operations.
- v. All power and control cables shall be routed through separate underground conduits, with free draining pulling pits to prevent water accumulation and ensure long-term reliability of the electrical and control systems.
- vi. The intake service gates may be operated either locally from the gatehouse or remotely from the Headworks Operations Center (HOC)/control room. The control system offers three operational modes: LOCAL, REMOTE and OFF. In OFF mode, all powered operations are disabled. It is envisaged that in LOCAL mode, the gates respond to on-site raise/lower push button commands. In REMOTE mode, gate operations are controlled from the HOC, allowing centralized monitoring and operation of the intake system.
- vii. Technical Data for Intake Service Gate:

- Type of gate	Vertical lift fixed wheel gate
- Number of gates	Two (2) sets
- Clear span of opening	3.10 m

- Clear height of opening	3.10 m
- EL. at top of pier	1955.00 masl
- Design water level	1953.80 masl
- Sill level	1941.00 masl
- Design head on sill	12.80 m
- Water tightness	4-way downstream sealing
- Type of seal	Side and top: J type, bottom: flat seal
- Hoist type	Rope drum hoist
- Number of hoists	Two (2) sets

2.4 Bottom Sluice Isolation Gate/Valves

- i. The valves/gates are designed to reliably open under the maximum differential head and securely close against the maximum flow conditions, ensuring effective debris removal and system integrity. They operate in two discrete positions: fully open or fully closed.
- ii. The system consists of a tandem valve arrangement, where the downstream valve functions as the operating/service valve, while the upstream valve serves as the emergency/maintenance valve, providing redundancy and system reliability.
- iii. The valves are installed at the base of a 14 m deep access shaft. Access is provided via a caged ladder with intermediate landings. The motor with gearbox mechanism is mounted on an intermediate steel structure floor, ensuring stability and ease of maintenance.
- iv. All wetted surfaces of the valves that are susceptible to scouring or erosion shall be constructed from austenitic stainless steel or other corrosion-resistant materials, ensuring long-term durability and resistance to hydraulic wear.
- v. The valves/gates can be operated locally from the intermediate steel structure floor or remotely from the Headworks Operations Center (HOC)/Control Room. Three control modes are available: LOCAL, REMOTE, and OFF. In OFF mode, all electrical operations are disabled but manual operation via a hand-operated wheel/lever remains functional. In LOCAL mode, the valve/gate responds to on-site raise/stop/lower push button commands. In REMOTE mode, the HOC operators control valve movements through remote raise/stop/lower commands. Opening is time-limited per activation, requiring multiple sequential commands for full valve/gate opening.
- vi. Technical Data for Bottom Sluice Isolation Valves/Gates:
 1. No. of openings : 2 Nos. for service valves and 2 Nos. for emergency valves
 2. No. of valves : 2 Nos. service and 2 Nos. emergency
 3. EL. at top of pier : EL 1955.00 m

4.	MWL	:	EL 1953.80 m
5.	Sill level	:	EL 1941.12 m
6.	Valve diameter	:	0.80 m
7.	Type	:	Gate valve
8.	Pressure rating	:	PN 2.0
9.	Operating criteria	:	Fully open/ Fully close
10.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of valves	:	General Technical Specifications, Particular Technical Requirements and AWWA C-509 or BS: 5150/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.5 Gravel Trap Gate/Valves

- i. The valves/gates must reliably open under maximum differential head and securely close under maximum flow conditions. Operation is strictly limited to two positions i.e. fully open or fully closed.
- ii. The system consists of a tandem valve configuration with the downstream valve serving as the operating/service valve and the upstream valve functioning as the emergency/maintenance valve, providing system redundancy and operational flexibility.
- iii. The valves are installed at the base of a 14 m deep access shaft with access facilitated via a caged ladder and intermediate landings. The motor with gearbox mechanism is mounted on an intermediate steel structure floor to ensure structural integrity and ease of maintenance.
- iv. All wetted surfaces of the valves that are susceptible to scouring or erosion shall be constructed from austenitic stainless steel or other corrosion-resistant materials, ensuring longevity and hydraulic wear resistance.
- v. The valves/gates can be operated either locally from the intermediate steel structure floor or remotely from the Headworks Operations Center (HOC)/Control Room. Three control modes are available: LOCAL, REMOTE, and OFF. In OFF mode, all electrical operations are disabled but manual operation via a hand-operated wheel/lever remains functional.
- vi. In LOCAL mode, the valve/gate responds to on-site raise/stop/lower push button commands. In REMOTE mode, operators at the HOC control valve movements through remote raise/stop/lower commands. The raise function operates for a preset limited time per activation, requiring multiple sequential commands for full valve/gate opening.
- vii. Technical Data for Gravel Trap Gate/Valves:
 1. No. of openings : 2 Nos. for service valves and 2 Nos for emergency valves
 2. No. of valves : 2 Nos. service and 2 Nos. emergency

3.	El. at top of pier	:	El 1955.00 m
4.	MWL	:	El 1953.80 m
5.	Sill level	:	El 1941.12 m
6.	Valve diameter	:	0.50 m
7.	Type	:	Gate valve
8.	Pressure rating	:	PN 2.0
9.	Operating criteria	:	Fully open/ fully close
10.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of valves	:	General Technical Specifications, Particular Technical Requirements and AWWA C-509 or BS: 5150/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.6 Desilting Chamber Outlet Gate / Headrace Tunnel Inlet Gate

- i. The gates are installed and removed exclusively under balanced hydrostatic conditions ensuring safe and controlled operation without exposing structural components to differential pressure loads.
- ii. The system consists of two sets of embedded guide-slot frames and two vertical lift fixed wheel gates. Each gate is equipped with downstream seals and a roller track to ensure proper alignment and sealing.
- iii. The gates are normally stored above the gate guide-slot frame and secured in place using latching devices. This configuration prevents unnecessary exposure to water flow and reduces wear on sealing components.
- iv. Each gate is operated using an independent electric rope drum hoist providing controlled lifting and lowering functions with precise positioning capabilities.
- v. The guide slot frames are embedded within the structure and feature a side seal, bottom sill and top edge sealing surfaces. These surfaces ensure effective sealing when the gate is in a closed position.
- vi. The gates are equipped with rubber seals designed to interface with the guide slot frame sealing surfaces ensuring a watertight closure and preventing leakage when isolation is required.
- vii. Technical Data for Desilting Chamber Outlet Gate/ HRT Inlet Gate:

1.	No. of openings	:	2 Nos.
2.	No. of gates	:	2 Nos.
3.	EL. at top of pier	:	EL 1955.00 m
4.	MWL	:	EL 1953.80 m
5.	Sill level	:	EL 1939.90 m
6.	Clear width of opening	:	3.90 m
7.	Clear height of opening	:	3.90 m

8.	Center to center of side seals	:	4.00 m
9.	Center to center of tracks	:	4.40 m
10.	Type of gate	:	Vertical lift roller type
11.	Location of skin plate	:	Downstream
12.	Location of seals	:	Downstream
13.	Design head	:	13.90
14.	Type of hoist	:	Electrically operated rope drum hoist
15.	Hoisting speed	:	0.7 m/ min
16.	Lift required	:	15.60 m
17.	Permissible stress:	:	
i.	Gate	:	Dry and accessible
ii.	Embedded parts	:	Wet and inaccessible
18.	Permissible deflection	:	Span/ 800 (span = center to center of tracks)
19.	Operating criteria	:	Fully open/ Fully close
20.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and hoist	:	General Technical Specifications, Particular Technical Requirements and IS: 4622 and IS: 6938/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.7 Silt Flushing Gate

- i. The gates shall operate reliably under maximum differential head conditions ensuring smooth opening and secure closure even under full-flow conditions. The operation is strictly either fully open or fully closed.
- ii. The gates shall be designed to withstand a normal static head corresponding to the Full Supply Level (FSL) and additional vacuum head conditions. Each gate is operated by an independent hydraulic hoist system capable of controlled lowering, raising and intermediate positioning under unbalanced hydraulic conditions.
- iii. The gate hoisting mechanism consists of a double-acting hydraulic cylinder with sufficient thrust capacity to overcome design head resistance. The capacity calculations account for the weight of the disc, rod and piston as well as frictional forces in the gate seats, rod stuffing box and hydrodynamic uplift/down-pull effects. An additional 20% reserve capacity is included to ensure operational reliability.
- iv. The gate structure and gate leaf shall be designed to withstand combined loading conditions, including normal water pressure and seismic accelerations based on the project's seismic zone classification. Seismic design calculations consider increased pressure head effects during dynamic loading.
- v. Each desilting chamber is equipped with one set of emergency and service gates. The silt flushing gates are arranged in tandem, with the downstream gate serving as the

service/operating gate and the upstream gate functioning as the emergency/maintenance gate. These gates are housed within a lower gate chamber, positioned beneath the desilting outlet and headrace inlet waterways.

- vi. The silt flushing gates can be operated locally from the lower gate chamber or remotely from the Headworks Operations Center (HOC)/ Control Room. The operating mode selection includes LOCAL, REMOTE, and OFF. In OFF mode, no powered operation is available, but manual operation via a hand-operated pump and valves remains possible. In LOCAL mode, the gate responds to raise/stop/lower push buttons, while in REMOTE mode, the gate is controlled from the HOC, responding to operator-issued raise/lower commands.
- vii. Technical Data for Silt Flushing Gate:

1.	No. of openings	: 2 Nos. for service gate and 2 Nos. for emergency gate
2.	No. of gates	: 2 Nos. for service gate and 2 Nos. for emergency gate
3.	EL. of operating chamber	: EL 1930.50 m
4.	MWL	: EL 1953.80 m
5.	Sill level	: EL 1927.58 m
6.	Clear width of opening	: 1.0 m
7.	Clear height of opening	: 1.0 m
8.	Center to center of side seals	: ~ 1.40 m
9.	Center to center of tracks	: ~ 1.30 m
10.	Sill to top seal center	: ~ 1.150 m
11.	Type of gate	: Vertical lift slide type bonneted gate
12.	Location of skin plate	: Upstream
13.	Location of seals	: Downstream
14.	Design head	: 26.22
15.	Type of hoist	: Hydraulic hoist (double acting)
16.	Hoisting speed	: 0.5 m/ min
17.	Stroke required	: 1.40 m
18.	Permissible stress:	:
i.	Gate	: Wet and inaccessible
ii.	Embedded parts	: Wet and inaccessible
19.	Permissible deflection	: Span/ 2000 (span = center to center of tracks)
20.	Operating criteria	: Fully open/ Fully close
21.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field	: General Technical Specifications, Particular Technical Requirements and IS: 9349 and IS:10210/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

erections and tests etc. of gate
and hoist

2.8 Adit Tunnel Bulkhead Gate

- i. The headrace tunnel can be accessed through Adit 1 and Adit 4 (Now Adit 3). These adits serve as entry points for maintenance and repair activities, ensuring operational efficiency.
- ii. The tunnel invert elevation at Adit 1 is EL 1931.81 m and at Adit 4, it is EL 1912.27 m. The design head for the bulkhead doors is 29.96 m at Adit 1 (adopted 31.0 m) and 55.96 m at Adit 4 (adopted 56.0 m), ensuring structural integrity under hydraulic loading conditions.
- iii. The bulkhead doors shall be fabricated from steel, ensuring durability and watertightness. The doors provide a clear opening of no less than 2.5 m in both height and width to accommodate maintenance equipment.
- iv. The doors shall be sealed using a bolted flange mechanism onto an embedded steel frame, preventing water ingress. High quality rubber seals ensure a watertight closure, maintaining the structural integrity of the tunnel.
- v. The doors shall be designed as side double hinged units, allowing for smooth operation. They shall be supported by flanged wheels that run on single or dual circular tracks embedded into the floor ensuring stability and ease of movement.
- vi. The design shall ensure that the bulkhead doors can withstand the designated hydraulic pressure while allowing efficient access for maintenance. The track and hinge mechanisms shall be designed for long-term durability with minimal operational resistance.
- vii. Technical Data:

1. No. of openings	:	1 No. at Adit 1 and 1 No. at Adit 3
2. No. of doors	:	1 No. at Adit 1 and 1 No. at Adit 3
3. MWL	:	EL 1947.00 m
4. Bottom level of door	:	EL. 1939.81 m at Adit 1 EL. 1921.02 m at Adit 3
5. Clear width of opening	:	2.50 m
6. Clear height of opening	:	2.50 m
7. Type of door	:	Inside openable side hinged door
8. Location of skin plate	:	Downstream
9. Location of seals	:	Downstream
10. Design head	:	31.0 m at Adit 1 56.0 m at Adit 4
11. Permissible stress:	:	
i. Gate	:	Wet and accessible

ii. Embedded parts	Wet and inaccessible
12. Permissible deflection	: Span/ 800 (span = center to center of tracks)
13. Operating criteria	: Fully open/ Fully close
14. Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of bulkhead door	: General Technical Specifications, Particular Technical Requirements and IS: 5620 and IS: 9349 / relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

2.9 Tailrace Gate

- i. The gate shall be a fixed wheel gate assembly, featuring rubber sealing elements towards the powerhouse structure, although precise sealing is not considered critical due to the operational nature of the gate.
- ii. The gate shall be driven by an individual electric rope drum hoist, with the mechanism designed for reliable operation under the expected differential head. When the gate is not in use, it shall be stored in its respective guide slots, secured by latching devices designed to maintain positional integrity under operational conditions.
- iii. The tailrace outlet gate shall be operable through manual control, either from a local control panel situated at the gate or remotely from the powerhouse's control room. The gate mechanism shall include limit switches to precisely indicate when the gate is in a fully opened or fully closed position, ensuring operational safety and integrity.
- iv. The gate's operating mode shall be selected locally and can be set to one of three configurations: LOCAL, REMOTE or OFF. In OFF mode, no powered operation is available and option of manual operation via a hand-wheel mechanism shall be provided allowing for gate actuation in the event of power loss or emergency operation. In LOCAL mode, the gate responds to push buttons for raising and lowering, providing a local means of operation with immediate responsiveness. In REMOTE mode, the gate's operation is fully monitored and controlled from the powerhouse control room, allowing centralized coordination with the overall plant operation.
- v. The design of the tailrace gate ensures compliance with the required operational parameters, considering maximum differential head, flood conditions, and operational reliability. The entire gate assembly, hoisting mechanism, and control system are engineered to ensure seamless functionality and optimal performance across all operational scenarios, with robust safety and redundancy mechanisms incorporated throughout.
- vi. Technical Data for Tailrace Gate:

1. No. of openings	: 2 Nos.
2. No. of gates	: 2 Nos.
3. EL. at top of pier	: EL 1511.95 m
4. MTWL	: EL 1511.00 m

5.	Sill level	:	EL 1507.25 m
6.	Clear width of opening	:	2.25 m
7.	Clear height of opening	:	4.20 m
8.	Center to center of side seals	:	2.35 m
9.	Center to center of tracks	:	2.70 m
10.	Type of gate	:	Vertical lift roller type
11.	Location of skin plate	:	Towards Power house
12.	Location of seals	:	Towards Power house
13.	Design head	:	3.75
14.	Type of hoist	:	Electrically operated rope drum hoist
15.	Hoisting speed	:	0.7 m/ min
16.	Lift required	:	5.20 m
17.	Permissible stress:		
i.	Gate	:	Dry and accessible
ii.	Embedded parts	:	Wet and inaccessible
18.	Permissible deflection	:	Span/ 800 (span = center to center of tracks)
19.	Operating criteria	:	Fully open/ Fully close
20.	Applicable specifications for design standards, Materials, fabrication, quality control, painting, shop assembly, field erections and tests etc. of gate and hoist	:	General Technical Specifications, Particular Technical Requirements and IS: 4622 and IS: 6938/ relevant ASTM, ASME, DIN, JIS, BS, IEC or EN

(d) All the information concerning elevations, dimensions, operating conditions is approximate only and must be confirmed by the Employer prior to manufacture

(e) All the welds shall be checked by non-destructive tests (dye penetration or ultrasonic).

(f) The drawings shall be based on structural calculation under consideration of the relevant dimensions and operation requirements of the equipment described in the specification.

(g) All the gates and valves shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.

Note: Leakage of the gate shall not exceed 0.1 l/s per meter of active sealing length, but not more than 1.5 l/sec for each complete gate. This value shall be guaranteed in new and clean conditions, at a maximum water level indicated above.

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME 2
EMPLOYER'S REQUIREMENTS

SECTION IV
PARTICULAR TECHNICAL REQUIREMENT FOR
HYDROMECHANICAL WORKS

CHAPTER 6
STEEL LINING AND PENSTOCK

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1 GENERAL DESCRIPTION

- a. Unless otherwise approved the headrace tunnel and Pressure shaft steel liner Work shall include:
 - i. headrace tunnel steel liner 25 m upstream of surge shaft.
 - ii. Pressure shaft including surge shaft orifice.
 - iii. Unit Pressure Shafts.
 - iv. Manholes at Adit 4 and Adit 5.
 - v. Bends.
 - vi. Trifurcations or two Bifurcations/ Manifolds.
- b. The Contractor shall design and implement Works to achieve equal or better than the intent and performance of the Employers concept design.
- c. Layout of pressure shaft shall comprise of horizontal tunnels and vertical shafts as shown in Employer Concept drawings or as per the Contractor's design subject to approval by Employer to minimize geological risks during construction.
- d. The purpose of the headrace tunnel and Pressure shaft is to:
 - i. Convey water from the of the surge tank to each of the three power station turbines.
 - ii. Withstand nominal transient pressure of 125% of the maximum static pressure; that is up to 5.3 MPa at the lowest part and 0.42 MPa at the highest part.
 - iii. Form a protective lining of the surge tank off-take and orifice.
 - iv. Include all provisions required for installation and removal of pressure shaft isolating valve that is located immediately downstream of the surge tank.
 - v. Withstand external ground water pressure.

2 Employers Concept

- a. The LOT 1 Contractor shall design, fabricate, deliver and install the steel liner for headrace tunnel, Pressure shaft.
- b. The design and manufacture shall be in accordance with equivalent or higher Indian Standards for the design and manufacture of pressure vessels and without reliance on the embedding concrete for strength/ support.
- c. The headrace tunnel steel liner commences from 25 m upstream of the surge-tank center line including 4 m long inlet transition from D-shape to circular.
- d. The pressure shaft steel liner commences from 6 m downstream of the surge-tank center line.
- e. The pressure shaft bends are lobster-backs with effective center-line radius 4.0 – 5.0 times the nominal diameter. The location of the upper bend shall be sufficiently distant from pressure shaft isolating valve to avoid any flow induced pressure differentials on the open valve. This arrangement shall be certified by the valve designer as consistent with operation and performance guarantees.
- f. Rock participation shall not be allowed in design of thickness for steel liner of headrace tunnel and pressure shaft.
- g. Steel liners have a system of longitudinal and circumferential weld joints. Longitudinal joint of each shell will be shop weld joint. Circumferential weld between two shells forming a ferrule for transportation purpose will also be shop weld joint. Circumferential weld between two ferrules will be field weld joint. All longitudinal and circumferential welds will be full penetration butt joints. All

longitudinal and circumferential shop welds will be checked by 100% radiographic method. Each ferrule weld joints will be checked for hydro static pressure test in shop. For such joints, code IS 2825 – 1969 (Table 1.1) recommends a joint efficiency of 1.0. However, it is expected that, it may not be possible to verify all field weld with ultrasonic testing or radiographic testing. For such joints, code IS 2825 – 1969 (Table 1.1) recommends a joint efficiency of 0.85. However, the steel liner of Pressure Shaft is designed for a joint efficiency of 95% for stringent testing procedures as given in the Technical Specifications.

- h. All steel liners will be painted with anti-corrosive epoxy paint. However, the steel liner of Pressure Shaft is designed for a corrosion allowance (additional thickness) of 1.5 mm.
- i. Provision for manholes of minimum diameter 500 mm for pressure shaft inspection shall be provided as per following:
 - vi. 1 No. near upper vertical bend at Adit 4.
 - vii. 1 at Adit 5.
- j. A trifurcation or two bifurcations/ manifolds shall be provided for branching of main pressure shaft to unit pressure shafts.
- k. Steel Liner design shall be verified for internal and external pressure. Use of external stiffener rings for resisting external pressure is not allowed.
- l. The steel liner shall be designed to withstand the internal water pressure (including pressure rise due to water hammer effect) when full as well as external water pressures when empty during grouting operations or when the pressure shaft is dewatered.
- m. The steel liner of pressure shaft shall be designed for maximum internal water pressure, due to maximum water level in Reservoir or in Surge Shaft (E.L 1953.80) plus the anticipated increase in pressure due to water hammer effect.
- n. Pressure rise due to water hammer effect shall be calculated above static water level in Reservoir or maximum upsurge level in surge shaft. It varies uniformly along pressure shaft, from maximum 108.75 m at turbine end (being 25% of static head of 435.00 m from El.1947.00 to El. 1512.00) to 58.71 m between max operating water level in surge shaft and c/l of headrace tunnel below surge shaft (i.e., max surge water level El.1970.71 and headrace tunnel c/l El. 1912.0). At intermediate locations, pressure rise shall be calculated by linear interpolation.
- o. The steel liner of headrace tunnel and Pressure Shaft when empty shall be designed for maximum external water pressure head, which shall be either the difference between the ground level vertically above the pressure shaft or the maximum level from which water is likely to find its way around steel liner, whichever is less. Accordingly, the external pressure should be checked with critical external buckling pressure obtained from Amstutz's equation with a factor of safety of 1.50. In case no data on ground water table is available, headrace tunnel and pressure shaft steel liners shall be designed for minimum of 50.0 m of external water pressure.
- p. The grade of steel for headrace steel liner shall be Welten 680 or better and the grade of steel for penstock shall be Welten 710 grade or better.
- q. Technical data:

Headrace tunnel steel liner

Length of steel liner	:	25m upstream of surge shaft
FRL	:	EL 1947.0
Max upsurge level	:	EL 1970.71
Liner c/l level	:	EL 1914.15
C/l of machine	:	EL 1515.0
Grade of steel	:	TMCP steel plates conforming to BS EN 10025: Part 2 having Yield Strength $\geq$ 450 MPa, Ultimate Tensile Strength $\geq$ 610 MPa

Main pressure shaft and unit penstock steel liner

Length of main steel liner including trifurcation	:	795 m long
Length of unit penstock steel liner	:	90 m long
FRL	:	EL 1947.0 m
Max upsurge level	:	EL 1970.71 m
Pressure shaft steel liner c/l level	:	EL 1914.15 m to EL 1515.0 m
C/l of machine	:	EL 1515.0 m
Grade of steel	:	TMCP steel plates conforming to BS EN 10025: Part 2 having Yield Strength $\geq$ 450 MPa, Ultimate Tensile Strength $\geq$ 610 MPa (EL 1914.15 m to EL 1778.0 m) and Yield Strength $\geq$ 575 MPa, Ultimate Tensile Strength $\geq$ 780 MPa (from EL 1778.0 m to EL 1515.0 m)

2.1 Manhole

2.1.1 Function

- The manholes shall be provided to enable maintenance access into the headrace tunnel and Pressure Shaft for general inspections.

2.1.2 Employer's Concept

- The pressure shaft steel liner access through manhole shall be at Adit 5.
- The manhole cover shall be of structural steel and rigid enough to sustain the water pressure and shall be leakage proof. The manhole cover shall have flanged bolted connection with the headrace tunnel steel pipe.

2.2 Trifurcation or Bifurcations/ Manifolds

- a. The trifurcation or two bifurcations/ manifolds shall be designed for internal water pressure of 1.5 times the (static head + Transient pressure head) at the location of trifurcation or two bifurcations/ manifolds.

2.3 Hydrostatic Testing

- a. The fabricated sections for underground pressure conduit downstream of valve house including straight shells, wye and manholes etc., shall be subjected to hydrostatic testing in shop in accordance with paragraph 8.4 of IS: 2825-1969. Hydrostatic arrangement along with all apparatus, testing equipment, rigs, bulk heads and accessories required for the Hydrostatic Test shall be clearly detailed out by the bidder at the time of furnishing his Tender and shall be duly arranged by the Contractor at his own Cost. During testing, each piece shall be subjected to a test pressure as indicated on the drawings prepared by bidder and approved by Employer. If required, suitable vent(s) shall be provided at a high point to vent out possible air pockets while the penstock shell, bend, wye etc., are being filled. The test pressure shall not be applied until the penstock section and its contents reach the same temperature which shall, preferably, be not less than 15 °C. After testing the penstock shall and before applying the pressure, the equipment shall be inspected to ensure that all joints are leak proof and all low-pressure filling lines and other appurtenances that should not be subjected to that test pressure, are removed/ disconnected.
- b. After being completely filled with water, the pressure in penstock assembly, to be tested, shall be increased slowly and uniformly until the specified test pressure is reached. The test pressure shall be applied three times successively increasing and decreasing at uniform rate and shall then be held at the specified test pressure for such a time as is considered sufficient for inspection of plates and all welded joints; but the period shall in no case be less than ten minutes. All defective welded seams and all defects in steel plates discovered during the hydrostatic pressure test shall be marked and after draining out the water they shall be repaired to the satisfaction of Employer. After repair and radiographic/ ultrasonic examination, as the case may be, all sections shall again be subjected to a hydrostatic pressure test. This procedure shall be repeated till satisfactory results are obtained throughout.
- c. No hydrostatic testing shall be required for underground steel liner in headrace tunnel steel liner.

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CHAPTER 7
MONORAIL CRANE

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2.2	Monorail hoist for intake maintenance gate	2

1 FUNCTION

- (a) One (1) set of monorail hoist shall be supplied at upstream of undersluice structure for the operation of undersluice maintenance gate.
- (b) One (1) set of monorail hoist shall be supplied at upstream of intake structure for the operation of intake maintenance gate.

2 EMPLOYER'S CONCEPT

- (a) The lifting capacity of a monorail hoist shall not be lower than those indicated here, but, if necessary, a higher capacity shall be considered if required by the heaviest part to be lifted.
- (b) The lifting capacity of the monorail hoist as well as the elevation of rail shown in drawings are indicative; the hoisting capacity shall not be lower than that indicated above but, if necessary, higher capacity shall be considered if required by the weight to be lifted, while the rail elevation shall be fixed by the contractor to allow to lift the maintenance gates above the operating floor and to easily handle the maintenance gates during operation and maintenance of the maintenance gates.
- (c) The contractor shall be free to install two hoists, working in parallel, or a single hoist with double capacity of the two single ones, under the condition that the selected arrangement will guarantee a correct operation of the maintenance gates.
- (d) The hoist shall be pendent control. Monorail hoist will include an automatic mechanically operated lifting beam to handle the maintenance gates.
- (e) The monorail hoists shall be designed in every respect to meet safely all the requirements of the power plant, project and relevant standards.
- (f) The monorail hoisting system shall be compatible with the other components not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- (g) Technical Data:

2.1 Monorail hoist for under-sluice maintenance gate

- Type of hoist	Electrically operated monorail hoist
- Number of monorail hoist	1
- Capacity of hoist	70 kN
- Length of runway	to be determined by Bidder
- Elevation of operating floor	as shown in drawing
- Clearance height of hooks to floor	to be determined by the Bidder
- Elevation of the stoplogs sill	as shown in drawing
- Total lift of hook	to be determined by the Bidder
- Hoist speed	0-4m/min.
- Travelling speed	6 m/min

2.2 Monorail hoist for intake maintenance gate

- Type of hoist	Electrically operated monorail hoist
- Number of monorail hoist	1
- Capacity of hoist	1 x 60 kN
- Length of runway	to be determined by Bidder
- Elevation of operating floor	as shown in drawing
- Clearance height of hooks to floor	to be determined by the Bidder
- Elevation of the stoplogs sill	as shown in drawing
- Total lift of hook	to be determined by the Bidder
- Hoist speed	0-4m/min.
- Travelling speed	6 m/min
- (h) All the information concerning elevations, dimensions, and operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.
- (i) The electrical supply of the hoists shall be carried out by insulated flexible cables of festoon type.
- (j) The electrical supply of the hoists shall be carried out by insulated flexible cables of festoon type.

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CHAPTER 8
ROPE DRUM HOIST

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2.2	Rope drum hoists for desilting chamber outlet gate / tunnel inlet gates.....	1
2.3	Rope drum hoists for tailrace gates	2

1 FUNCTION

- (a) Two (2) sets of rope drum hoist shall be supplied at intake for installation, operation, maintenance and removal of intake service gates.
- (b) Two (2) sets of rope drum hoist shall be supplied at Desilting Chamber Outlet Gate / tunnel inlet for installation, operation, maintenance, and removal of tunnel inlet gates.
- (c) Two (2) sets of electric rope drum hoist shall be supplied at tailrace for installation, operation, maintenance, and removal of tailrace gates.

2 EMPLOYER'S CONCEPT

- (a) The lifting capacity of a rope drum hoist shall not be lower than those indicated hereinafter but, if necessary, a higher capacity shall be considered if required by the heaviest part to be lifted.
- (b) A rope drum hoist shall be designed in every respect for safe operation, ease of repair and maintenance and for all the requirements of the power plant.
- (c) The rope drum hoisting system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- (d) Technical Details

2.1 Rope drum hoists for intake gates

- Type of hoist	Electrically operated rope drum hoist
- Number of hoists	2
- Capacity of a hoist	70 kN
- Elevation of operating floor	as shown in drawing
- Clearance height from the feet to main hook	to be determined by the Bidder
- Total lift of hook	to be determined by the Bidder
- Speed of main hoist (variable)	0-4 m/min

2.2 Rope drum hoists for desilting chamber outlet gate / tunnel inlet gates

- Type of hoist	Electrically operated rope drum hoist
- Number of hoists	2
- Capacity of a hoist	220 kN
- Elevation of operating floor	as shown in drawing
- Clearance height from the feet to main hook	to be determined by the Bidder
- Total lift of hook	to be determined by the Bidder

-
- Speed of main hoist (variable)	0-4 m/min

2.3 Rope drum hoists for tailrace gates

- Type of hoist	Electrically operated rope drum hoist
- Number of hoists	2
- Capacity of a hoist	30 kN
- Elevation of operating floor	as shown in drawing
- Clearance height from the feet to main hook	to be determined by the Bidder
- Total lift of hook	to be determined by the Bidder
- Speed of main hoist (variable)	0-4 m/min

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CHAPTER 9
HYDRAULIC HOIST

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2	EMPLOYER'S CONCEPT	1
2.1	Hydraulic hoist for undersluice gate	1
2.2	Hydraulic hoist for silt flushing gates	1

1 FUNCTION

2 EMPLOYER'S CONCEPT

- (a) Two (2) sets of hydraulic hoists with double acting double cylinders shall be supplied for the under-sluice gates.
- (b) Four (4) sets of hydraulic hoists with double acting single cylinder shall be supplied for the Silt flushing gates.
- (c) Power for Hydraulic hoist is fed from the Motor Control Centers for the respective areas. Power shall be fed to the corresponding Electrohydraulic control panel mounted on the high oil pressure unit (HPU). All Control devices shall be constructed and tested as per the applicable IEC standards.
- (d) A hydraulic hoist shall be designed in every respect for safe operation, ease of repair and maintenance and for all the requirements of the power plant.
- (e) Technical Data

2.1 Hydraulic hoist for undersluice gate

- Type of hoist Hydraulic hoist
- Number of hoists 2
- Number of cylinders per gate 2
- Type of cylinder Double acting
- Capacity of a hoist 2 x 75 kN
- Maximum/minimum system pressure to be determined by the Bidder
- Mounting of the hydraulic hoists should be done as:
 - Trunnion of hoist on under-sluice piers or side walls for end gates
 - HPU room for hoist on under-sluice piers

2.2 Hydraulic hoist for silt flushing gates

- Type of hoist Hydraulic hoist
- Number of hoists 4
- Number of cylinders per gate 1
- Type of cylinder Double acting
- Capacity of a hoist 20 kN
- Maximum/minimum system pressure to be determined by the Bidder

-
- Mounting of the hydraulic hoists should be done on the sit flushing chamber
 - (f) All the information concerning elevations, dimensions, and operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.
 - (g) The capacity of the hydraulic hoist as well as the elevation of platform shown in drawings are indicative; the hoisting capacity shall not be lower than that indicated above but, if necessary, higher capacity shall be considered if required by the weight to be lifted.
 - (h) The hydraulic hoisting system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.

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CHAPTER 10
SCREW SPINDLE HOIST

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2	EMPLOYER'S CONCEPT	1
2.1	Motorized screw spindle hoist for trash removal gate	1

1 FUNCTION

- (a) One (1) set of motorized single screw spindle hoist shall be supplied at intake area (adjacent to under-sluice) for the operation of the trash removal gate.

2 EMPLOYER'S CONCEPT

- (a) One (1) set of motorized single screw spindle hoist shall be supplied at intake area (adjacent to under-sluice) for the operation of the trash removal gate.
- (b) The lifting capacity of a screw spindle hoist shall not be lower than those indicated here, but, if necessary, a higher capacity shall be considered if required by the heaviest part to be lifted.
- (c) A motorized screw spindle hoist shall be designed in every respect for safe operation, ease of repair and maintenance and for all the requirements of the power plant.
- (d) The spindle hoisting system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- (e) Technical Data:

2.1 Motorized screw spindle hoist for trash removal gate

- Type of hoist	Motorized single screw spindle
- Number of hoists	1
- Capacity of a hoist	35 kN
- Elevation of operating platform	to be determined by the Bidder
- Sill to platform height	to be determined by the Bidder
- (f) All the information concerning elevations, dimensions, and operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.

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CHAPTER 11
EOT CRANE FOR SILT FLUSHING CHAMBER

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1	FUNCTION.....	1
2	EMPLOYER'S CONCEPT	1

1 FUNCTION

The EOT crane for silt flushing chamber crane is designed for lifting, lowering and moving heavy loads within an operational setting. Equipped with high-capacity squirrel cage motors, it ensures smooth hoisting, traversing and braking operations for efficient load handling. Limit switches prevent over-travel and slack rope conditions, ensuring safe and controlled movement of the hoist and trolley.

2 EMPLOYER'S CONCEPT

- (a) One (1) complete set of EOT crane shall be supplied at silt flushing gate chamber.
- (b) The crane shall be electrically driven, pendant control operated, indoor, single trolley, single girder overhead travelling type of at least 5 Tonne capacity. The crane shall be able to operate under full load without abnormal noise and undue vibration. All movements shall be continuous and smooth. Slipping of the load shall not occur at any time.
- (c) Structural design of the crane shall be done in accordance with IS 807 - 2006 or relevant International Standards. The crane shall be designed as per latest IS: 3177 - 1999 or relevant International Standards except as otherwise specified in these specifications.
- (d) Without in any way detracting from their performance, the crane shall have an aesthetic appearance with clean lines, and a neat and tidy arrangement of cables and mechanisms.
- (e) Crane shall be designed keeping in mind the transportation limits to the project Site.
- (f) The EOT Crane system shall include any other related components that is not otherwise defined that is required as a consequence of Contractor's design including for efficient and effective operation and maintenance.
- (g) All the information concerning elevations, dimensions and operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.
- (h) Technical Details

Basic Parameters:

SN	Items	Description
1	Capacity of the crane-safe working load	5 tons
2	Type of crane	Single girder electrically operated overhead travelling (EOT) crane
3	Span (center to center of rails), m	8.8 m (approx.)
4	Longitudinal travel, m	10.5 m (approx.)
5	Altitude of the place	EL 1947.10 m (floor)
6	Class of crane as per IS: 3177(1999)	M2

7	Standards to which crane conforms	As per IS: 3177 (1999) or equivalent International Standard		
8	Operational speeds (loaded)	MH	CT	LT
a)	Speed in m/ min (main motion)	1.5	10	15
b)	Micro motion in m/ min	10% of main speed		
9	Acceleration values in cm/ sec ²	CT		LT
		7		8
10	Lift of crane	MH		
a)	Maximum lift of hook above floor level	5.50 m		
b)	Maximum drop of hook below floor level	16.50 m		
c)	Total lift	22.00 m		
11	Terminal position (CT)	Upstream (U/ s)		Downstream (D/ s)
a)	Of main hook from center of rails	1200 mm		900 mm
12	Maximum travel (LT)	Entry/ service bay		Other end
a)	Of the main hook from the inner edge of walls	1000 mm (approx.)		1000 mm (approx.)
13	Working clearances required	Upstream		Downstream
a)	Between center of rail and the nearest side obstruction in the (mm):	300 mm (approx.)		300 mm (approx.)
b)	Between the top of crane beam and the lowest overhead obstruction(mm):	900 mm		
c)	LT rail size	50 mm sq. Bar		
d)	Distance between center line of MH hook to top of LT rails (mm)	1200 mm (maximum)		
14	Controls	Pendant control		
15	Tolerance to be confirmed			

a)	Minimum possible travel (mm), with all brakes adjusted and hook carrying rated load shall be:	MH	CT	LT
		1.5 mm	5 mm	5 mm
b)	The motor speed not to exceed 105% of synchronous speed while lowering a rated load	Yes		
c)	The vertical deflection of the crane girders caused by the rated load plus all dead loads not to exceed 1/900 of the crane span	Yes		
d)	Camber provided (mm)	Yes		
B)	Mechanical details			
1	Crane bridge			
a)	Platform	Full platform on drive side of bridge and a short platform at each corner of idle side.		
b)	Provision of clamping while in motion during earthquake	Yes		
c)	Provision of "holding clamps" when crane is not in operation	Yes		
2	Wheels			
a)	Material/ chemical composition	C55Mn75 (forged steel)		
b)	Hardness of wheels	300 – 350 BHN		
c)	Depth of hardness	10 mm		
3	Gears box details			
a)	Hardness (gear/ pinion)	Gears 220-250 BHN/ Pinions 260-280 BHN		
b)	Materials (gears/ pinion)	Gears EN8/ EN9 : pinion EN19/ EN24		
4	Type of lifting hook	C-shank		
C)	Electrical details			
1	Motor particulars	Rating (20% higher than computed kW)		
a)	Degree of protection	IP55		

b)	Class of insulation/ max. Temperature limit	F/B		
c)	Rating in minutes of continuous operation	60 min		
2	Brake particulars	MH	CT	LT
a)	Type of brake used	Disc -DCEM	Disc -DCEM	Disc -DCEM
b)	Material of brake lining	Asbestos free		
3	Down shop leads (DSL)	Shrouded copper bus bar		
D)	Other details:			
1	Details of safety device	MH		
	Load cells with load limit switch	Only load limit switch		
2	Painting on equipment			
a)	Type of paint	Primer and finish coats of epoxy based.		
b)	Extent	All steel surfaces exposed to weather		
c)	Total dry film thickness (microns)	180 – 200 DFT		

- (i) Inching operation for all motions shall be feasible for achieving slow operation of the crane for purpose of erection, lowering centering, alignment etc.
- (j) The winding drums shall have machined grooves and there shall not be more than one layer of rope on the drum when the rope is in fully wound position and its length shall be such that each lead of rope has minimum of two full turns when the hook is in its lowest position and one spare groove for each rope lead off the drum when the hook is at its highest position. The drums shall be made of seamless pipe as per ASTM A106 GR A/ B, Cast steel (ASTM A27) IS 2062 Grade E, rolled steel of welded construction (ASTM A36) and in case of welded drum this should be stress relieved.
- (k) The hook shall be designed to prevent any couple moment on the pulley block. A locking device shall be fitted to prevent rotation of hook. The hooks shall be equipped with a safety device to prevent disengagement of the slings.
- (l) The hoisting ropes shall be 6 x 36 construction, flexible plough steel wire type with fiber core and internal lubricant. The factor of safety of the hoisting ropes shall not be less than six (6). The hoist ropes shall be provided with slack detectors.
- The lifting tackle shall consist of a safety lower block and hook, necessary sheaves, flexible steel wire rope etc.

- Sheaves shall be made of cast steel/ forged steel/ rolled steel and shall be machine grooved to a depth of not less than one and a half (1.5) times the diameter of rope.
 - All gears shall be constructed of cast steel/ forged steel (with low/ medium carbon alloy steel and suitably heat treated) of adequate strength and durability to meet the requirements for the intended class of service, and manufactured to AGMA quality class 5 or better.
 - The gear trains shall be in totally enclosed oil tight gear cases with welded seams. The Material of gear casing shall be cast iron (ASTM grade A48)/ cast steel (ASTM A27). All gears not enclosed in gear case shall be properly guarded.
 - Shafts of Material of construction confirming to AISI 1045/ AISI 1055 shall be supported by anti-friction bearings.
 - Drive couplings shall be of the sealed, grease lubricated, flexible type.
- (m) The trucks shall be designed to distribute the load evenly to each wheel. The carriage (trucks) shall be of cast steel/ structural steel/ sections or plates (ASTM A36), welded, riveted or bolted together and shall be of box type with openings at each end for receiving the truck wheels.
- (n) Safety lugs shall be provided which shall extend below the top of rail on both sides to prevent the trucks from leaving the rails. Lugs shall be provided on the truck frames to permit a drop of not more than 25 mm in case of broken axle.
- (o) The Bridge shall consist of single girder supported by two (2) end trucks, for bridge movement. The girders shall be of the box type construction. The Material of construction shall confirm to ASTM A36. The box section girders shall be reinforced by stiffening ribs etc. Steel stops shall be welded near the end of each girder to engage bumpers on the trolley to prevent it from leaving the bridge.
- (p) The bridge shall be carried on sufficient number of wheels on each side. All wheels shall be double flanged machined or ground to size.
- The crane wheels shall be made of Material C55Mn75 steel or cast or wrought Iron.
 - All axles shall be forced fit into the wheel and the driving wheels shall be keyed to the axles in addition to the forced fit.
 - Wheel assembly shall be arranged such that replacement of a wheel can be achieved from the side without undue difficulties.
 - The journal boxes of all the truck wheels shall be drip proof and shall be provided with roller bearing with high pressure grease lubrication.
- (q) Runway Rails
- Two runway rails along with fixing clamps etc. for bridge travel shall extend to the full length of the silt flushing gate chamber and the service bay. The rails shall be laid and fixed to the crane runway beam by means of anchor bolts, etc. In case the rails are fixed on the RCC beam, the necessary insert plates and sole plates also shall be part of the supplier's scope.
- (r) Operation
- The following minimum functions of EOT crane shall be provided through Pendant:
- i. Forward and reverse speed control of the bridge travel motion.
 - ii. Right and left speed control of trolley travel motion.
 - iii. Up and down speed control of the hoist motion.

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- iv. On and off control of the crane's master contactor.
 - v. On and off control of the lights on the underside of the crane bridge.
 - vi. On and off control for the crane's alarm gong.
- (s) Walkways and Ladders
- Ladders, platforms, walkways, hand holds etc., necessary to give safe access to bridge drive and trolley drive mechanisms and all other components of the crane needing inspection, maintenance and repair shall be provided.
- (t) Controls
- The crane mechanism namely, main hoist, long travel and cross travel shall be provided with resistance control. Each control shall give the smooth and un-interrupted control of operation.
- (u) Brakes
- The brakes shall be able to stop the crane at rated load and speed within a maximum distance of 5 mm. Braking during travel shall be gradual and permit precise positioning. Each brake shall have a capacity one and a half (1.5) times the full load torque of the bridge travel motors and shall be designed to be secured in position.
 - An automatic electromechanical brake capable of bringing the motion of fully loaded trolley safely to rest shall be provided.
 - The hoist brakes shall have the following features:
 - i. Braking torque shall equal 150% of the full load torque of the motor.
 - ii. The brakes shall be spring operated shoe type with solenoid release.
 - All the electro mechanical brakes shall have 60-minute rated coils. The electrical operating parts shall consist of AC or DC solenoids, which shall release the brake on energization (in case of DC solenoids, suitable rectifier unit shall be supplied by the Contractor). Interruption or failure of electric power supply shall apply all brakes immediately.
- (v) Lubrication
- Provision shall be made for lubricating all bearings including ball and roller bearings by a pressure gun system and all lubrication nipples shall be readily accessible. High-pressure grease guns shall be supplied with the crane and the crane shall be handed over completely lubricated with approved oils and grease.
- (w) Bumpers
- Spring/ Rubber bumpers shall be attached to the bridge trucks and the trolley. They shall be capable of bringing the crane and the trolley to a gradual stop when traveling at rated speed in either direction/ when the power supply is off and thus eliminate excessive stresses and damage to any part of the crane.
- (x) Wrenches and Tools
- All wrenches and special tools necessary for the proper operation and maintenance as required for assembling, dismantling and for the efficient maintenance, operation and repair of the crane shall be supplied by the Contractor. These maintenance tools and instruments shall not be used by the

Contractor during construction, erection and assembly, without the consent of the Employer. Any breakages shall be replaced without any additional Cost to the Employer within the warranty period.

(y) Electrical Equipment and Controls

- All electrical equipment associated with the crane, including Down Shop Lead (DSL), runway conductors, cables, motors, push buttons, switches, control panels, starters, relays, lighting, control transformers, wiring conduits, etc., shall be provided and installed by the Contractor.
- The Down Shop Lead arrangement shall consist of Copper Shrouded Bus Bar mounted on the brackets. A suitable current collector shall be provided with the DSL.
- The trolley shall receive the electric supply with the use of rubber insulated copper flexible cables of adequate size.

(z) Motors

- All motors shall be. The motors shall be suitable for frequent reversing, frequent acceleration and braking.
- The crane shall be equipped with three phase squirrel cage motors of ample capacity for perform the duties specified without exceeding the rated full load torque. All motors shall be TEFC type, 400 V, 3 ϕ , 50 Hz, 60 minutes rating, crane duty with pullout torque at rated voltage and frequency not less than 225% of full load torque. The motors shall be selected based on 20% higher rating than the computed kW rating. All motors shall at least be of 60 minutes (40% CDF) rating.
- The motor shall have a class F insulation and be operated at a maximum temperature rise limited to Class B.

(aa) Crane Protective Panels

- The power supply from the main collectors shall be protected by a three pole main line contactor and totally enclosed circuit breakers with a minimum interrupting capacity of 18 kA at 400 V to switch off power supply to the crane with provision to lock in open position. The protective panel shall include 1 ϕ control circuit transformers 110 V, 50 Hz of sufficient capacity for all magnetic control on the crane, if required. Thermal overload relays with under voltage protection for each motor shall be provided. A double pole fuse switch or 3-phase fuse switch shall be provided for each motor and all control circuits. The panels shall meet the enclosure protection of IP55.

(bb) Limit Switches

- Necessary limit switches shall be provided for all cranes to prevent over winding, over traversing and over travelling. At least the following limit switches shall be provided for crane.
 - i. Hoist driven limit switches for the upper and lower hook position.
 - ii. A back-up fail safe over travel limit switch for the extreme upper position of hoist.
 - iii. Lever-operated limit switches for both end positions of all travel motions.

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- iv. Limit switches for slack rope, mechanisms to stop the motor when a sudden slack in the tension or a breaking of the hoist cables occurs. In this case the brake shall immediately be applied.
- Limit switches shall be so arranged that they can be readily tested.
- (cc) Lighting and Convenience Outlets
- The permanent lighting system on the crane shall consist of two no's. 400 W metal halide lighting units to illuminate uniformly the area under the crane, with a convenient outlet at each end of the bridge. A light under the crane indicating 'in service' shall be provided.
- (dd) Maintenance - Padlocking
- Whenever an intervention is required on any apparatus, it shall be possible to isolate the apparatus from its power supply and the power cut off devices shall be padlocked.
- (ee) Safety Requirements
- In the design of crane, all safety regulations as applicable with factory acts, electricity rules etc., as prevailing in the Employer's Country and at the Site of installation shall be taken into consideration and should be provided.
 - The crane shall be designed to withstand seismic forces and as a safeguard against movement of the crane off the rail during an earthquake, suitable provision to contain the movement of crane shall be made. Clamping necessary to contain the movement of the crane during earthquake shall be provided. Also, "Holding Clamps" to keep the crane in a locked condition while not in operation shall be supplied and arranged.

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CHAPTER 12
GEARED MOTOR

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2.2	Geared motor for gravel trap gates/valves	2

1 FUNCTION

- (a) Four (4) sets of geared motor shall be supplied for the operation of bottom sluice isolation valves/gates. Two (2) for service valves and two (2) for emergency valves.
- (b) Four (4) sets of geared motor shall be supplied for the operation of gravel trap valves/gates. Two (2) for service valves and two (2) for emergency valves.

2 EMPLOYER'S CONCEPT

- (a) The elevation shown in drawings are indicative. The torque, motor speed and gear ratio are approximate and shall be finalized during construction.
- (b) All the information concerning elevations, dimensions, and operating conditions is approximate only and must be confirmed by the Employer prior to manufacture.
- (c) Details

2.1 Geared motor for bottom sluice isolation gates/valves

- Type of operation	Electrically operated
- Number of geared motors	4
- Capacity of a motor	3 kW
- Required torque	starting 2500 Nm Running 1500 Nm
- Motor speed	1400 RPM
- Gear ratio	2800:1
- Gear type	Helical or bevel helical
- Backlash	≤ 10 arcminutes
- Output Shaft	Solid
- Shaft diameter	To be decided by the contractor
- Power Supply	415 V ± 10%
- Motor Type	Squirrel cage induction motor
- Protection class	IP70
- Cooling	Self-cooled
- Manual Override	Handwheel operation with declutching Mechanism
- Limit Switches	Adjustable mechanical limit switches for Open/Close positions
- Elevation of operating floor Contractor)	as shown in drawing (to be confirmed by

-
- Corrosion Protection	Treated with anti-corrosive paint

2.2 Geared motor for gravel trap gates/valves

- Type of operation	Electrically operated
- Number of geared motors	4
- Capacity of a motor	3 kW
- Required torque	starting 2500 Nm Running 1500 Nm
- Motor speed	1400 RPM
- Gear ratio	2800:1
- Gear type	Helical or bevel helical
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- Manual Override	Handwheel operation with declutching Mechanism
- Limit Switches	Adjustable mechanical limit switches for Open/Close positions
- Elevation of operating floor	as shown in drawing
- Corrosion Protection	Treated with anti-corrosive paint

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)**

**BIDDING DCOUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

**SECTION IV
PARTICULAR TECHNICAL REQUIREMENT FOR
HYDROMECHANICAL WORKS**

**CHAPTER 13
ELECTRICAL EQUIPMENT**

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1 11 kV METAL ENCLOSED SWITCHBOARD

1.1 Composition

- (a) The switchboard shall consist of one cubicle equipped with circuit breaker, earthing switch, measuring devices (CT, VT, Ammeter and Voltmeter) and electrical protections.
- (b) The supply shall be inclusive of metallic frame for installation on the floor.

1.2 Construction Characteristics

1.2.1 Switchboard

- (a) The switchboards shall be of the single bus bar, floor mounted metal enclosed, air tight and air insulated type with circuit breaker as appropriate and operated by motor charged spring means.
- (b) The degree of protection shall be IP 41.
- (c) The metal enclosed switchboard shall be self-supporting, free standing, floor mounted cubicle type of steel construction. The thickness of steel shall not be less than 2 mm. The ventilated apertures shall be vermin proof, fitted with screens suitable for geothermal environment.
- (d) Doors and openings shall be fully sealed and provision shall be made for ensuring that the cubicles will remain airtight if components have been removed for service. Contractor must provide full details of the arrangements made for maintaining the controlled air increment inside the switchboard giving particular attention to facilities provided for maintenance.
- (e) Each switchgear cubicle shall have a thermo-statically controlled heater unit, fitted of adequate size to prevent condensation in the very humid site conditions and suitable for operation on AC 230 V supply.
- (f) All materials used shall be flame-retardant.
- (g) Access to the switchgear components shall be from the front of the panels. The contractor shall provide all necessary cable gland plates and terminals for the switchboard. The interior of each cubicle shall be finished in gloss white.
- (h) The bus bars shall be of copper conductor, rigidly supported and fully insulated throughout their lengths including tee-off connections and joints between adjacent bus bar chambers. The bus bars are to be fully rated throughout.
- (i) The bus bars are to be completely enclosed in an earthed metal chamber. If removable panels are fitted to give access to the bus bar chamber, the removal of these panels must not give access to any circuits that may be electrically energized from their remote ends. No small wiring or other equipment shall be mounted in the bus bar chamber.
- (j) Bus bar joints and connections shall be made utilizing high-tensile bolts, nuts and washers. Provision shall be made for access so that maintenance of the joints is possible.
- (k) All spare switches are to be wired out to the terminal board in the panel. Auxiliary relays in place of auxiliary switches will not be accepted unless specifically approved by the

employer. Auxiliary switches shall be rated in accordance with their duty. Spare switches shall be rated not less than 10 A, 110 V DC.

- (l) Earthing switches interlocked with the load break switch shall be provided on line arrival.

1.2.2 Cabling Compartment

- (a) Adequate spaced shall be allowed for terminating the multicore cables.
- (b) The control and instrumentation cabling terminations shall be arranged in such a manner that access can be obtained without removing any cover that would permit access to high voltage main connections.

1.2.3 Switchboard Circuit Controls

- (a) Each auxiliary plant circuit shall have a local-off-remote selector switch mounted on the appropriate switchboard. In the local position the circuit shall be controlled from the switchboard. In the remote position the circuit shall be controlled from the DCS.
- (b) The circuit control information provided in this specification is intended for bidding purposes only. The contractor shall finalize the logic diagram and submit it to the employer for approval.

1.2.4 Earthing Bar

- (a) A suitably sized metallic earth bar rated for maximum earth fault current shall be installed on the full length of the board with provision for earth cable connections at each end. All metallic non-current carrying parts of the switchboard shall be effectively connected to it. Where frame leakage protection is specified, a separate insulated bus bar is required.

2 MV/LV TRANSFORMER

2.1 Design Data

- (a) The transformer shall be of cast resin insulated type and conform to the requirements below.
- (b) The transformers shall be suitable for service under current ambient conditions. The transformers shall be designed for direct bus duct connection at high voltage side and cable connection at low voltage side.

- Rated Power 500 kVA
- Rated Voltages
 - HV 11 kV
 - LV 400 kV
- Max. System Voltage
 - HV 12 kV
 - LV 440 kV
- Rated Frequency 50 Hz
- Cooling System AN

• Vector Group	Dyn11
• Rated Impedance Voltage	< 4.5%
• Power Frequency Dry Test Voltage	
- HV	28 kV
- LV	2.5 kV
• No Load Tap Changer	±2.5%, ±5%
• Voltage Taps on HV side	
• Insulation Temperature Class	F
• Degree of Protection	IP 00
• Environmental Class	E0
• Climatic Class	C1
• Fire Behaviour Class	F1
- (c) In case of transformers mounted in enclosures, the transformer/enclosure combination shall be designed and provided by the transformer manufacturer.

2.2 Temperature Rise

- (a) The transformer shall be capable of withstanding continuous operation at rated power and at voltage 10% higher than the rated voltage, without causing dangerously high temperatures or abnormal vibration.
- (b) Unless otherwise stated in the Technical Schedules, the temperature rise during rated conditions shall not exceed 75 °K (over 45 °C ambient temperature).

2.3 Accessories

- (a) The transformer shall be provided with the following, but not limited, accessories:
- Connection terminals for HV- and LV-side,
 - Terminal blocks for connection of external cables to the transformer accessories,
 - Temperature detector elements (i.e. RTD) of the Pt-100 type in all phases,
 - Temperature monitoring unit for remote alarm,
 - Lifting devices, such as eyes or hooks, for lifting of the complete transformer,
 - Set of plain rollers designed for the weight of the transformer and for longitudinal and lateral travel. Arrangement to lock the rollers in the final position to be made,
 - Earthing terminals,
 - Rating plate with information as listed in IEC 60076-11.

3 400 V Main Distribution Board

3.1 Construction Characteristics

3.1.1 Switchboard

- (a) The structure of the board shall consist of a modular, metal enclosed draw out type, self-supporting steel frame suitable for floor installation.
- (b) The thickness of steel shall not be less than 2 mm. The ventilated apertures shall be vermin proof, fitted with screens suitable for geothermal environment.
- (c) The protection class shall be IP 41, with doors opened or breakers removed IP 20.
- (d) The board will be divided in vertical sections. Each vertical section shall consist of individual cubicles or cells for circuit breakers and auxiliary equipment. Each cell shall be provided with hinged door. All equipment and relays necessary to reproduce the approved schematic diagram of auto-manual change-over shall be located in an individual steel cubicle.
- (e) The cells shall house individually incoming air circuit breaker and, depending of the size, one to three feeder molded circuit breakers.
- (f) The boards shall be of compact and uniform arrangement, respectively of the frame size of the circuit breakers and of the rated current of the busses.
- (g) The design shall be such as to ease maintenance and changes in the circuit, providing at the same time full safety to the operation personnel.
- (h) The vertical sections shall be bolted together to form a rigid free-standing structure. Extensions shall be possible by bolting at either extremity new vertical sections, reducing the shut-down time to a minimum.
- (i) All materials used shall be flame-retardant.
- (j) Removable screwed covers, or hinged doors, shall be provided for access to the cubicle terminals. Power and auxiliary terminals shall be separated from each other and suitably shielded to avoid accidental contacts.
- (k) The busbars shall be housed in segregated steel sheet compartment.
- (l) All doors and covers shall be suitably gasketed to make the compartments dust-tight. The doors shall also be fitted with key lock.
- (m) The alignment of all breaker draw out rails shall be identical with respect to the floor.
- (n) Cable entry shall be provided from the bottom and access to the board can be only from the front.
- (o) Each switchgear cubicle shall have a thermostatically controlled heater unit, fitted of adequate size to prevent condensation in the very humid site conditions and suitable for operation on AC 230 V supply
- (p) Each switchboard is to be equipped with 3 phase bus bars and a neutral bus bar. The neutral busbar shall have a current rating not less than half that of the phase bus bars
- (q) The bus bars shall be of copper conductor, rigidly supported and fully insulated throughout their lengths, including tee-off connections and joints between adjacent busbar chambers. The busbars are to be fully rated throughout.

- (r) The bus bars are to be completely enclosed in an earthed metal chamber. If removable panels are fitted to give access to the bus bar chamber, the removal of these panels must not give access to any circuits that may be electrically energized from their remote ends. No small wiring or other equipment shall be mounted in the bus bar chamber.
- (s) Bus bar joints and connections shall be made utilizing high-tensile bolts, nuts and washers. Provision shall be made for access so that maintenance of the joints is possible.

3.1.2 Cable Compartments

- (a) Each motor starter, or other distinct circuit shall form an individual compartment in which the main and control circuit cables are terminated.
- (b) Access to these terminations shall be arranged so that it is independent of access to any other circuit compartment. In the case of draw-out or other types of withdrawable units, terminations shall be on the fixed portion of the unit.
- (c) It shall be possible to remove or install main and control cable without requiring access to live equipment on any adjacent unit.
- (d) Cable ways and access to terminals shall be generously proportioned to allow for ease in installing main and control cables.

3.1.3 Miscellaneous

- (a) The 400 V switchboards shall be provided complete with:
 - Current transformers mounted on the stationary portion of the switchboard.
 - Incoming ammeter
 - Incoming voltmeter
 - Remote fault signalizations

4 110 V DC SYSTEM

4.1 Supply

- (a) The scope of work shall comprise the following:
 - one (1) lead acid batteries 110 V, minimum 150 Ah approx.;
 - two (2) battery chargers 400 V AC/110 V DC, 75 A DC approx.;
 - one (1) 110 V DC main switchboards;
 - one (1) lot of 110 V DC sub-distribution boards.

4.2 Batteries

- (a) The storage batteries shall be of the high performance, low maintenance lead-acid type, suitable to operate satisfactorily at all prevailing conditions. Each cell shall be enclosed in a high strength, translucent, heat and impact resistant plastic container. The top cover shall be provided with removable labyrinth plugs which enable the measurement of the electrolyte density and the venting of gas, but preventing the emission of acid sprays and minimising the evaporation. A completely sealed type of battery will be preferred if a service life of 15 years can be guaranteed.

- (b) The number of cells shall be selected so that the voltage of the battery does not exceed 110% of the rated voltage during float charging.
- (c) The batteries shall be of the lead acid type and cells with positive tubular plates.
- (d) Each cell shall have an individual container of clear plastic so that the acid level, the plates and the bottom of the container are clearly visible. The container shall be completely closed and be provided with an acid spray preventing vent plug. Each group of four containers shall stand in a plastic basin with sufficient volume for collecting all acid from one of the four cells in case of a leakage. The polarity of the cells, and of the complete battery, shall be engraved and easily legible.
- (e) Each battery assembly shall be complete with bases resistant to sulphuric acid. Bolted or welded interconnections between the cells shall be included.
- (f) The capacity of each battery shall be selected to permit service without A.C. power under the following load situations:
- (g) Supply of the emergency lighting for 10 hours
- (h) Supply of the station control system for 10 hours
- (i) At the end of this period, the voltage of the D.C. networks (measured on the busbars of the main distributions) shall be at least 90% of the rated voltage with the batteries being loaded as specified.
- (j) The individual cells shall be arranged in single rows of single or double tiers mounted on impregnated, painted wooden step type racks or on steel racks specially coated for the purpose. The clearance to ground shall be approx. 250 mm and the upper tier shall be at convenient working height.
- (k) The main characteristics of the storage batteries shall be the following:
- | | |
|---|----------------------------|
| • Type | Maintenance Free Lead acid |
| • Rated voltage | 110 V DC |
| • Rated capacity 10 h discharge (min) | 150 Ah |
| • Nominal voltage | 2.0 V/Cell |
| • Trickle charging voltage (floating) | 2.2 V/Cell |
| • End voltage after 10 h discharge at rated current | 1.8 V/Cell |
| • Maximum self discharge rate at 40°C | %/month < 5 |
| • DC system | Isolated, L+/L-/PE |

4.3 Battery Fuse Cabinets

- (a) For each battery, a fuse cabinet is required. The cabinet shall be particularly designed for battery fuses and have physically separated partitions for each polarity. The front cover shall be transparent for easy observation of the fuses. Each fuse cabinet shall contain fuse-holders, clamps, etc, and:
- one charger fuse,
 - one battery fuse,

- one auxiliary fuse.
- (b) The battery fuses shall be high capacity cartridge type, specially designed for D.C. application.
- (c) The cabinet shall have provision for connection of a load resistor for occasional determination of battery capacity.

4.3.1 Chargers

- (a) Heavy duty, natural or forced air-cooled charging rectifiers with fully controlled, 6-pulse thyristor bridges shall be provided to supply the initial charging, boost charging, float charging and the total power demand of all connected electrical consumers and any other full rate charging that may be required for the specified lead acid batteries.
- (b) The input voltage range of the chargers shall comply with the requirements stated in the General Technical Specifications. The output voltage range shall be compatible with the operating voltage of the batteries and the D.C./A.C. power converters supplied.
- (c) The rated current of the battery chargers shall be selected to allow for recharging a fully discharged battery in 5 hours, in addition to simultaneously supplying the D.C. load.
- (d) In addition, the chargers shall comply with the following technical data and requirements:
- | | | |
|--|--|--|
| • Power supply | 400 V A.C. three phase or 230 V A.C. single phase | |
| • Output voltage adjustable between | 110 V $\pm$ 15% | |
| • Stability of the output voltage | Less than $\pm$ 1% for the maximum input voltage and frequency variations, and from 1% to 95% of rated output current. | |
| • Maximum deviation of the current limitation | $\pm$ 2% of rated current | |
| • Ripple of output voltage | Without the battery connected: | Less than 4% peak of the rated output voltage |
| | With battery connected: | Less than 1% peak-peak of the rated output voltage |
| • RFI-emission measured selectively with 3 kHz filter: | 4 kHz - 4 MHz, max. 15 mV | |
| | 4 MHz and above, max 13 mV | |
- (e) Dry type transformers and solid state (thyristor or transistor) rectifiers shall be used throughout. Each charger shall be supplied with reactor to reduce ripples.
- (f) The chargers shall be completely equipped for a fully automatically controlled charging included floating charging of the batteries, and shall be of a constant voltage type with

- current limiting device. By means of a change-over switch a change from normal charging and float-charging to boost charging of the battery shall be possible. After the boost charging, the charger shall switch back to float charging.
- (g) Each of the chargers for the 110 V batteries shall be rated to maintain normal charging and float-charging of both batteries. Each charger shall be complete with instruments, breakers and protection, including but not limited to:
- Breakers and protection on A.C. and D.C. side, with alarm contacts
 - One Voltmeter for the D.C. voltage
 - One Ammeter for the D.C. current
 - Alarms for "high volts", "low volts", "earth fault" and "fail"
 - Switch for charger "ON"/"OFF", including indicating lamp for charger "ON"
- (h) The supervisory functions may be integrated with the charger or supplied as separate units. Alarm signals shall in addition to local indication, also generate a contact closure signal for reporting to the station control system, and shall as minimum indicate the following battery system faults:
- low voltage
 - earth fault
- (i) Surge protection devices shall be provided to protect the charger from damage due to voltage transients in the AC or DC system. Rapid charging after restoring an AC supply failure shall be initiated manually or automatically with a full-rate current of adjustable duration.
- (j) The main characteristics of the battery chargers shall be the following:
- | | |
|--|-----------------------------|
| • Charging mode | I/U constant characteristic |
| • Nominal input voltage | 400/230 V AC |
| • Rated output voltage | 110 V DC approx |
| • Rated output current | 75 A DC |
| • Initial and boost charging, adjustable | 2.4 V/cell |
| • Float charging operation | 2.23 V/cell |
| • Recharging from 1.8 V/cell to rated capacity | 12 h max. |
| • Protection class | IP 41 |

REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)

BIDDING DCOUMENT
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CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)

VOLUME III
EMPLOYER'S REQUIREMENTS

PART 4
PARTICULAR TECHNICAL REQUIREMENTS
HYDROMECHANICAL WORKS

CHAPTER 14
SPARE PARTS AND TOOLS

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1 SPARE PARTS AND TOOLS

- a. All spare parts supplied shall be absolutely interchangeable with each other and with the parts for which they are intended to be replaced. If the Employer's Representative observes that such interchangeability is not met to the extent required, he reserves the right to return all such parts which do not fit to the Contractor within the period of 2 years after handing over, who in turn is to supply immediately new spare parts free of charge.
- b. The spare parts shall be treated and packed for long term storage under the climatic conditions prevailing at Site. Each spare part shall be clearly marked or labelled on the outside of its packing with its description and tag number. Packing shall be such that it can be broken and removed for checking during handing over but reused to the maximum possible extent.
- c. The Contractor shall guarantee the long-term availability of spares for ten years after Taking-Over. Prior to stopping the production of spare parts for the equipment under this Contract the Contractor shall give at least twelve (12) months advance Notice so that the Employer will have the opportunity to order the required quantity of spare parts.
- d. The Contractor shall check and/ or test at Site, in the presence of the Employer's Representative, the spare parts, tools and appliances. Acceptance of any of these items will not take place until the Contractor has submitted the final lists.
- e. The Contractor to furnish spare parts and tools along with item wise price for 5 years normal operation. The list of mandatory Spare Parts is detailed in Particular Technical Specifications.

1.1 List of Mandatory Spare Parts

A	Radial gates and hydraulic hoist	Unit	Quantity
	At undersluice		
1	Side seal, top seal, anti-jet seal and bottom seal (all seals undrilled) for the gate including 20% of the fasteners and other fixation Material.	Set	1
2	Side guide roller assembly of radial gate with their fasteners	Set	1
3	Self-lubricating bush and washer for trunnion assembly of radial gate	No.	1
4	Hydraulic cylinder seals and gaskets of radial gate hoist.	Set	1
5	Hydraulic cylinder limit switch of radial gate hoist.	Set	1
6	Bearing for power pack motor of radial gate hoist.	Set	1
7	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, switch and indication lamp of power pack.	Set	1
8	Filter, control valve, pressure gauge, pressure switch of radial gate hoist power pack.	Set	1
9	Lifting attachment bearing at piston rod end and cyl. head end of hydraulic cyl. of radial gate hoist.	Set	1

B	Spare parts for maintenance gate and electric monorail hoist		
	At undersluice		
1	Side seals, top seals & bottom seals (undrilled) for the gate including 20% of the fasteners.	Set	1
2	Guide shoes, leaf springs, slide pads (al. Bronze) etc.	Set	1
3	Side guide assembly of lifting beam for maintenance gate with fasteners		
4	Main spring, rubber seal, washer and nut etc. For filler valve assembly	Set	2
5	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of mono rail hoist	Set	1
6	Brake shoes with lining and brake coil for brakes of monorail hoist	Set	1
7	Grease nipple of lifting beam and monorail hoist	Set	1
8	Rubber bushes for flexible couplings (if applicable)	Set	1
9	Bearings of lifting pulley and lifting hook of lifting beam	Set	1
	At intake		
1	Side seals, top seals and bottom seals (undrilled) for the gate including 20% of the fasteners	Set	1
2	Guide shoes, leaf springs, slide pads (al. Bronze) etc.	Set	1
3	Side guide assembly of lifting beam for maintenance gate with fasteners		
4	Main spring, rubber seal, washer and nut etc. for filler valve assembly	Set	2
5	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of mono rail hoist	Set	1
6	Brake shoes with lining and brake coil for brakes of monorail hoist	Set	1
7	Grease nipple of lifting beam and monorail hoist	Set	1
8	Rubber bushes for flexible couplings (if applicable)	Set	1

9	Bearings of lifting pulley and lifting hook of lifting beam	Set	1
C	Spare parts for vertical lift roller type gate and electric rope drum hoist		
	At intake		
1	Side seal, top seal and bottom seal (all seals undrilled) with 20% fastener	Set	1
2	Side guide shoe with fastener	Set	1
3	Wheel bearing for wheel assembly of gate	Set	1
4	Rubber seal, "O" ring for wheel assembly	Set	1
5	Grease nipple of wheel assembly	Set	1
6	Grease nipple of rope drum hoist	Set	1
7	Bearing for motor and gear box of rope drum hoist.	Set	1
8	Bush bearing for rope drum axle of rope drum hoist.	Set	1
9	Bush bearing of lifting attachment of rope drum hoist	Set	1
10	Brake shoes with lining and brake coil for brakes of rope drum hoist	Set	1
11	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of rope drum hoist	Set	1
	At desilting basin outlet		
1	Side seal, top seal & bottom seal (all seals undrilled) with 20% fastener	Set	1
2	Side guide shoe with fastener	Set	1
3	Wheel bearing for wheel assembly of gate	Set	1
4	Rubber seal, "O" ring for wheel assembly	Set	1
5	Grease nipple of wheel assembly	Set	1
6	Grease nipple of rope drum hoist	Set	1
7	Bearing for motor and gear box of rope drum hoist	Set	1
8	Bush bearing for rope drum axle of rope drum hoist	Set	1
9	Bush bearing of lifting attachment of rope drum hoist	Set	1

10	Brake shoes with lining and brake coil for brakes of rope drum hoist	Set	1
11	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of rope drum hoist.	Set	1
	At tail race		
1	Side seal, top seal and bottom seal (all seals undrilled) with 20% fastener	Set	1
2	Side guide shoe with fastener	Set	1
3	Wheel bearing for wheel assembly of gate	Set	1
4	Rubber seal, "O" ring for wheel assembly	Set	1
5	Grease nipple of wheel assembly	Set	1
6	Grease nipple of rope drum hoist	Set	1
7	Bearing for motor and gear box of rope drum hoist.	Set	1
8	Bush bearing for rope drum axle of rope drum hoist	Set	1
9	Bush bearing of lifting attachment of rope drum hoist	Set	1
10	Brake shoes with lining and brake coil for brakes of rope drum hoist	Set	1
11	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, indication lamp, carbon brushes and limit switch of rope drum hoist	Set	1
D	Spare parts for trash removal gate and electric screw hoist		
1	Rubber seals (undrilled) for the gate including 20% of the bolts and other fixation Material	Set	1
2	Guide shoes and slide pads (Al. Bronze)	Set	1
3	Various fuses (Kit kat) and fusewire (5 A to 100 A) one coil each	Set	1
4	Electrical moving and fixed contacts for starter, limit switch etc.	Set	1
5	Brake shoe liners	Set	1
6	Brake coil	No.	1

7	Flexible coupling for hoist motor	Set	1
8	Rubber bushes (for couplings)	Set	1
9	Starter assembly	No.	1
E	Hydraulic trash rack cleaning machine with grappler arrangement		
1	Detachable stainless steel/ high strength polypropylene sheet combing rake teeth strip with stainless steel fasteners	Set	1
2	Bushes/ bearings for motor of hydraulic unit	Set	2
3	Gaskets (O-rings) for each hydraulic unit	Set	2
5	Control relays, terminal switches, limit switches, push buttons	Set	1
6	Brake linings for each type of brakes	Set	1
7	Motor carbon brushes	Set	1
8	Fuse elements	Set	2
9	Two sets of 10% of all nuts, bolts and washers	Set	2
10	All types of grease nipples	Set	1
11	Solenoid, valves, pressure gauge, and pressure switch of each type	Set	1
12	Oil filters	Set	2
F	Silt flushing service/ emergency gate and hydraulic hoist		
1	Side seal, top seal and bottom seal (all seals unholed) of silt flushing gate with 20% fastener	Set	1
2	Gasket/ "O" ring for bonnet cover of silt flushing gate	Set	2
3	Gasket/ "O" ring for lifting attachment of silt flushing gate	Set	1
5	Hydraulic cylinder seals and gaskets of silt flushing gate hoist	Set	1
6	Hydraulic cylinder limit switch of silt flushing gate hoist	Set	1
7	Bearing for power pack motor of silt flushing gate hoist	Set	1
8	Fuse/ fuse wire coil (of applicable ratings), auxiliary contactor, control relay, push button, switch and indication lamp of power pack	Set	1
9	Filter, control valve, pressure gauge, pressure switch of silt flushing gate hoist power pack	Set	1

10	Gasket/ "O" ring for man hole cover of silt flushing gate chamber	Set	1
G	EOT crane at silt flushing gate chamber		
A)	Thruster, brake shoe with lining, brake solenoid coils complete to serve hoist brake	No.	1
B)	Fixed and moving contacts and accessories for the controller, for trolley drive	Set	1
C)	Fixed and moving contacts for the controller, brake shoe with lining, brake solenoid coils complete for long travel drive	Set	1
D)	Coils of each model for the starters and control switches	Set	1
E)	Each type of rectifiers for solenoid-operated brakes, circuit breakers, indicating lamps and indicating light assemblies	Set	1
F)	Springs, O-rings, oil seals, gaskets, packing etc. for complete crane (each type and size)	Sets	2
G)	Couplings complete with coupling bolts, rubber sleeves etc. (each type and size)	Set	1
H)	Each type of push button, control switch, disconnecting switch, terminal block, fuse block, plug connector, plug module (each type)	Set	1
I)	Each type of limit switches	Set	1
H)	Current collection assembly (each type)	Sets	4

Note: other necessary spare parts recommended by the manufacturer to be detailed in separate data sheets.

1.2 List of Tools and Tackles for HM Equipment (S) Maintenance

SN	Description	Quantity
1.	Chain Pulley Block-2 T Capacity (Heavy Duty)	2 sets
2.	Chain Pulley Block-5 T Capacity (Heavy Duty)	2 sets
3.	Tripod - 20' height (Heavy Duty)	2 sets
4.	Rope Fitted with thimble - 16 mm diameter x 10 m long	2 sets
5.	Chain - 3 T Capacity x 10 m Long (Heavy duty)	2 sets
6.	"D" Block - 3 T Capacity (Heavy Duty)	2 sets
7.	Manual Hydraulic Jack - 5 T Capacity (Heavy Duty)	2 sets

8.	Spanner Kit	2 sets
9.	Pipe Wrench - (Heavy Duty)	2 sets
10.	Screw Driver Set- (Size: Small, Medium, Large)	2 sets
11.	Hand Plier	2 sets
12.	Allen Key Set (Size: 5 mm to 10 mm)	2 sets
13.	Grease Gun	2 sets
14.	D' Clamps: (Size: Small, Medium, Large) (Heavy Duty)	2 sets
15.	Lifting Hook - eye end type- 5 T Capacity (Heavy Duty)	2 Nos.
16.	Wire Brush, Hand Gloves, Welder's Glass	2 Sets
17.	Welding Machine	2 No's.
18.	Hammer - 5 kg	1 No.
19.	Hammer - 7 kg	1 No.
20.	Rope Cutter Blade	2 Nos.
21.	Portable Grinder (W)	1 No.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT(GKHEP)
(77.5 MW)**

**BIDDING DOCUMENTS
FOR
CONSTRUCTION
OF**

**LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 2
EMPLOYER'S REQUIREMENTS**

SECTION V – ACTIVITY SCHEDULE

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1 SECTION V – ACTIVITY SCHEDULE

1.1 Preamble

The Activity Schedule or Bid Price Schedule has been prepared in conjunction with Conditions of Contract together with the Employer's Requirements and the Employer's Concept Drawings.

The Bidder shall quote the Lumpsum price for execution of all Works under Lumpsum price on EPC basis. The total quoted price will be divided to each Milestones as per the percentage weightage of each Milestones as defined in **Table 3**. The prices shall be quoted for the complete scope of Work as described or implied from this Bidding Documents. The Milestones stated in Sub-Clause 1.6 relate to the design and construction progress of the Works under this Contract, and shall be used to regulate the payments and the Delay Damages under this Contract.

The Schedules do not generally give a full description of the plant to be supplied and the services to be performed under each item. Bidders shall be deemed to have read the Employer's Requirements and other sections of the Bidding Document and review the Drawings to ascertain the full scope of the requirements included in each item prior to Quoting the bid price. The quoted bid prices shall be deemed to cover the full scope as aforesaid, including overheads and profit. No additional payments shall be made for parts of the Works which are necessary for completion of the project in accordance to the tender documents but which have not been listed in the Activity Schedules.

The Bidder shall complete the table under Sub-Clause 1.6 and include the Bid Price in US Dollars (USD) and Nepalese Rupees (NRs.) for the completion of each Milestone (Except MS 17 to MS 34, which shall be quoted in USD only). The US Dollar portion of the total price of the Bid Price shall not exceed 60% of the total Bid Price. In addition, the Bidder shall complete the selected milestones within the period specified in Bid Price Schedule.

If Bidders are unclear or uncertain as to the scope of any item, they shall seek clarification in accordance with ITB 7 prior to submitting their Bid.

Prices shall be filled in by indelible ink, and any alterations necessary due to errors, etc., shall be initialed by the Bidder.

As specified in the Bid Data Sheet and Special Conditions of Contract, prices shall be fixed and firm for the duration of the Contract.

Bids which contain unbalanced prices may be determined to be nonresponsive and may be rejected by the Employer. It may arise that the Employer shall ask Bidders to correct Bids which contain unbalanced prices during the contract negotiations. The Time for Completion of the whole of the Works shall not be more than **1,460 days** after the Commencement Date. The Contractor can offer a shorter period for the completion of the Works.

Payments shall be made to the Contractor in US dollar and Nepalese Rupees as indicated under each respective item. The US dollar payment portion shall be paid as per the exchange rate on the day of payment to the Contractor so that the currency exchange rate shall not be borne by the Contractor. Generally, payments will be made after completion of each milestone. However, partial payment is also allowed for certain milestones as specified in conditions of contract. Project design submitted by the Contractor and approved by the Employer shall be the basis for calculating the percent progress of each milestone for making the payments. When requested by the Employer for the purposes of making payments or part payments or valuing variations, or evaluating claims, or for such other purposes as the Employer may reasonably require, the Contractor shall provide the Employer with a breakdown of any composite or lump sum items included in the Schedules. The cost for this Provisional Sum shall be NRs. 7,50,00,000.00 which has been estimated by the Employer.

1.2 Project Milestone/Activity Schedule

The total volume of work is divided into number of milestones as specified in table under Sub-Clause 1.6. Based on the Employer's Concept Design and Concept Drawings, the percentage weightage has been calculated by the Employer based on the quantities of works calculated from the Employers Concept drawings and indicated in the **Table 3**. The Contractor shall be paid according to the terms of the Contract and according to the prices included in the table under Sub-Clause 1.6. Delay Damages shall apply for any delays beyond the Completion Date for the Milestones MS-14, MS-75, MS-98, MS-130 and MS-131

1.3 Value Added Tax (VAT)

The Statements sent to the Employer on a regular basis shall include the prices quoted in the table under Sub-Clause 1.6 by the Contractor and provisional sum items, and the VAT that shall be charged according to the regulations in force in Nepal.

VAT at the rate of 13% is applicable on Milestones MS-1 to MS-16, MS-35 to MS-133. No VAT shall be applicable for Milestones MS-17 to MS-34 as these items are subjected to 1% custom duty when imported from outside the country. Amount allocated for provisional sum is inclusive of VAT.

1.4 Project Pay Items and Mode of Payment

The Contractor shall be paid according to the terms of the Contract and according to the prices quoted in Sub-Clause 1.6 (Bid Price Schedule) The sums entered by the Contractor in Sub-Clause 1.6 shall be due for payment to the Contractor when the corresponding Milestones have been completed in full or partial as defined in the corresponding milestones.

Milestones reflect the different sections of works that constitute the Scope of Works, each section of works is divided into different pay items.

The Bidder shall estimate the quantity of each item at his own judgement, referring if needed to the Employer's Concept Design and Concept Drawings, which are provided for information only in Volume 4 and Volume 5 of the Bidding Document. The Bidder shall offer a total price to complete each milestone in Nepalese Rupees and US Dollar.

The Contractor shall issue monthly Interim Statements for payment that reflect the works actually carried out as determined by the rates and percent completion of each item shown in the Milestone pursuant to Clause 55.4 of the Conditions of Contract.

The Payment Modality of each Milestones shall be as follows and in accordance to the Conditions of the Contract.

No.	Description of Activity (Milestone (MS))	Payment procedure
A.	General and Preliminary Works (Contractor's Infrastructures, Construction Facilities, Access Road, Bridge and Others)	
MS-1	Establishment of Contractor's site offices, accommodations labour camp, including medical facilities, water supply and sanitation facilities	50% after completion of works at Powerhouse area and remaining 50% after completion at Headworks area.
MS-2	Establishment of Contractor's material testing laboratory, material and fuel storage facilities, site workshops and explosive storage facilities including Army bunker.	25% after establishment of material testing laboratory, 25% after establishment of material and fuel storage facilities, 25% after establishment of Workshop and 25% after explosive storage facilities
MS-3	Contractor's Key personnel and construction plant and equipment mobilized to the Site.	After Completion
MS-4	Establishment of Concrete aggregate crushing and sorting plant and Batching Plant at Powerhouse and Headworks area and ready to operate.	50 % after establishment in Powerhouse area and 50% after establishment in Headworks Area.
MS-5	Establishment of Construction power supply system (including construction power line from Powerhouse to Headworks, Surge shaft and other project structures and facilities location),	After Completion
MS-6	Effecting and maintaining the Insurance as per the Contract	75% Payment shall be made after submission of evidence of effecting of the CAR and PLI Insurance coverage. 25% shall be made after submission of EAR policy and GPA insurances
MS-7	Construction of permanent access road (Roadway Excavation) from the Road Head at Powerhouse location to surge shaft, adit tunnels, Headworks and others project structures location as required.	Payment shall be made on after completion of each 10% of Roadway excavation length based on the road length progress in comparison to the total road length required for the project which shall be based on the detailed design report.
MS-8	Construction of permanent access road (Side Drain construction, protection works and Graveling Works) from the Road Head at Powerhouse location to surge shaft, adit tunnels, Headworks and others project structures location as required.	Payment shall be made after completion of each 10% of Side Drain construction, Protection works (length) and graveling works based on the road length progress in comparison to the total road length required for the project which shall be based on the detailed design report

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-9	Foundation Construction including superstructures for Permanent steel truss Bridge all complete that allows installation of steel structures at Ghunsa Khola Crossing all complete	After Completion
MS-10	Metal Works (including design, procurement, delivery, fabrication, erection testing and commissioning) for permanent steel truss Bridge at Ghunsa Khola Crossing all complete	After Completion
MS-11	Ghunsa Khola Steel Truss Bridge Foundation protection and river training works all complete	After Completion
MS-12	Regular service and maintenance of the Access Road and Bridges (from Handrung Bridge to Project structures location)	Payment shall be made on yearly basis in equal installments after completion of MS-8 and MS-9.
B.	Survey, Investigation, Design and As-Built Documentation	
MS-13	Completion of additional geological investigations. The Contractor shall decide where it is necessary to carry out these investigations in order to provide sufficient information for the contractor's design and construction of the works.	50 % after completion of geological and geotechnical investigations works and other tests as necessary (other than hydro fracture test) and 50% after completion of Hydrofracturing test and other associated tests in powerhouse
MS-14	Survey and Preliminary design of Civil and Hydromechanical Works	After Completion
MS-15	Detailed design of Civil and Hydromechanical Works	50% after submission and approval of Access Road, Bridges, Headworks and water conveyance system. Remaining 50 % after submission and approval of all detailed design works
MS-16	As-built documentation/Drawings and Operation & Maintenance Manual	After Completion
C.	Importation price of Hydromechanical Equipment (CIF port of Entry (Nepal Boarder) Price)	

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-17	All metal material and metal parts of the equipment for the undersluice radial gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic operated hoist, hoist support structures, gate control and protection structures and necessary tools and equipment including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-18	All metal material and metal parts of the equipment for the trash removal gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, Motorized single screw spindle hoist, hoist support structures and necessary tools and equipment including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-19	All metal material and metal parts of the equipment for the Intake Gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic operated hoist, gate control and protection structures and necessary tools and equipment including all accessories and Intake Gate Stoplog including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-20	All metal material and metal parts of the equipment for the desilting chamber outlet/ HRT inlet gates including gate body, roller guide assemblies, sealing accessories, gate embedded parts, electric rope drum hoist, hoist supporting structures and all accessory tools and equipment and mandatory	Upon Shipment as per the Conditions of Contract

No.	Description of Activity (Milestone (MS))	Payment procedure
	spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	
MS-21	All metal material and metal parts of the equipment for the silt flushing gates (desilting chamber) including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-22	All metal material and metal parts of the equipment for the Adit-1 side hinged door (Bulk Head Door) including gate body, sealing accessories, and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-23	All metal material and metal parts of the equipment for the Adit-3 side hinged door (Bulk Head Door) including gate body, sealing accessories, and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-24	All metal material and metal parts of the equipment for the tailrace outlet gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, electric rope drum hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-25	All metal material and metal parts of the equipment for undersluice Stoplog including stoplog body, guide frames, embedded parts and all accessory tools and equipment and mandatory spare parts (hydromechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-26	All metal material and metal parts of the equipment for Intake Stoplog including stoplog body, guide frames, embedded parts, Electric Monorail Houst, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (hydromechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-27	All metal material and metal parts of the equipment for the silt flushing stoplog (desilting chamber) including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-28	All metal material and metal parts of the equipment for the intake trashrack including trashrack panels, supporting beam, guide frames, embedded parts, anchors and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-29	All metal material and metal parts of the equipment for the and Trashrack cleaning machine Hydraulic grapple with rotator, rake carriage, guided chute, guide rails, trash transportation trolley, embedded parts, guide rails and necessary all tools and equipment all complete and mandatory spare parts (Hydromechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-30	All metal material and metal parts of the equipment for motorized gravel trap flushing valves (Service and Maintenance) with upstream, intermediate and downstream pipe and flange connection including all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-31	All metal material and metal parts of the equipment for the motorized bottom sluice isolation valves (Service and Maintenance) including upstream, intermediate and downstream pipes and flanges with all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-32	All metal material and metal parts of the equipment for Monorail hoist for undersluice stoplog including rails, hoisting equipment, embedded parts, control and protection structure and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-33	All metal material and metal parts of the equipment for the steel penstock pipe (Lining in upstream of the Surge shaft location) including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Upon Shipment as per the Conditions of Contract
MS-34	All metal material and metal parts of the equipment for the Steel penstock pipe from surge shaft to powerhouse including Bifurcation and branching pipes including supports, stiffeners/thrust rings, seepage rings, and necessary all tools and equipment all complete all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	Partial payment shall be made upon shipment for each 10% of weight of materials as per the Conditions of Contract.
D.	Civil Works	
D.1	River Diversion and Headwork Structures (Diversion Weir/Spillway, Undersluice, Stilling Basin, River Intake and Flood Walls)	
MS-35	Construction of Inlet Portal and Outlet Portal of Diversion Tunnel all complete.	50% Payment shall be made after completion of each portal

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-36	Excavation and primary support of Diversion Tunnel all complete	Payment shall be made on progress of each 25% of excavation and primary support of diversion tunnel measured on linear basis with respect to the total length of diversion tunnel.
MS-37	Completion of final support and grouting in diversion tunnel all complete.	Payment shall be made on progress of each 50% of final support and grouting of diversion tunnel measured on linear basis with respect to the total length of diversion tunnel.
MS-38	Construction of Cofferdams and all temporary measures for the river diversion at under sluice/intake site completed and the river has started flowing through the Diversion Tunnel.	After Completion
MS-39	Excavation and support of Weir, Undersluice, Stilling basin, upstream launching apron area all complete	20% after excavation of weir and undersluice up to weir platform level (EL 1955 masl) 20% after excavation of weir and undersluice up to upstream cutoff invert (1934.66 masl) 20% after excavation of weir and undersluice up to deepest point of cutoff invert (1929.75 masl) 20% after excavation of Stilling basin area 20% after excavation of upstream launching apron area and remaining all excavation works in weir, undersluice, stilling basin, floodwalls area
MS-40	Foundation treatment to control seepage in weir and undersluice area all complete	After Completion

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-41	Concrete works in weir and undersluice all complete	10% after completion of concrete works up to top of downstream cutoff (currently at 1935.25 masl) 10% after completion of concrete works up to weir base (currently at 1938.25 masl) 10% after completion of concrete works up to 1.4 m above the weir base (currently at 1939.65 masl) 10% after completion of concrete works up to 2.9 m above the weir base (currently at 1941.15 masl) 10% after completion of concrete works up to 4.4 m above the weir base (currently at 1942.65 masl) 10% after completion of concrete works up to spillway gate top level (currently at 1943.95 masl) 10% after completion of concrete works up to top of spillway part (currently at 1946.50 masl) 10% after completion of concrete works up to radial gate hydraulic hoist support level (currently at 1955.00 masl) 10% after completion of concrete works of spillway bridge
MS-42	Concrete works in Stilling Basin all complete	payment shall be made after completion of each 10% of concrete works in stilling basin measured based on the poured volume of concrete.
MS-43	Concrete works in Upstream flood wall all complete	After Completion
MS-44	Concrete works in Downstream floodwall all complete	50% payment shall be made after completion up to EL 1940 and remaining 50% after completion
MS-45	Concrete works in Launching apron all complete	After Completion
MS-46	Abrasion resistant concrete or hard stone pitching or steel lining in weir and undersluice all complete	50% after completion of works in undersluice and spillway part and remaining 50% after completion of all works
MS-47	Installation of Steel truss bridge structure in spillway portion with procurement, transportation, fabrication, installation testing and commissioning of the bridge all complete	After Completion
MS-48	Backfilling, Levelling, Boulder Rip Rap and gabion works all complete	After Completion
MS-49	Opencut excavation and support in Intake, gravel trap, gravel trap flushing, bottom sluice, Headworks Operation Centre and trash removal gate all complete	After Completion

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-50	Concrete works in Intake, gravel trap, gravel trap flushing, bottom sluice, and trash removal gate all complete	25% after completion of concrete works in Intake, gravel trap, gravel trap flushing, bottom sluice up to intake invert level (currently at 1941.00 masl) 25% after completion of concrete works in Intake, gravel trap, gravel trap flushing and bottom sluice up to top of trashrack (currently at 1947.50 masl) 25% after completion of concrete works in Intake, gravel trap, gravel trap flushing, bottom sluice and up to intake platform level (currently up to 1955.00 masl) 25% after completion of concrete works in trash removal channel all complete
MS-51	Excavation and support of tunnel to gate operation chamber and Gate operation chamber all complete	After Completion
MS-52	Construction of Headworks Operation Centre and Operator's Quarter room at Headworks	After Completion
MS-53	Completion of all works associated with the weir, undersluice, stilling basin, floodwalls, intake structures including headworks operation centre building, guardhouse, fencing, river protection works, backfilling and landscaping, gate operation chambers, gate operation room and spillway bridge.	After Completion
MS-54	Removal of Cofferdam	After Completion
D.2	Connecting Tunnels, Desilting Chambers and Power Intake (Desilting Basin Outlet)	
MS-55	Excavation and primary support of Connection tunnels	Payment shall be made on progress of each 50% of excavation and primary support of connecting tunnels (both) measured on linear basis with respect to the total length (both) of diversion tunnel.
MS-56	Final support including lining and grouting of Connection tunnels	Payment shall be made on progress of each 50% of Final Support and grouting of connecting tunnels (both) measured on linear basis with respect to the total length (both) of diversion tunnel.
MS-57	Construction of Inlet Portal for gate cum ventilation tunnel all complete	After Completion

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-58	Excavation and primary support on Gate cum ventilation tunnel including tunnel to silt flushing gate chamber	Payment shall be made on progress of each 25% of excavation and primary support of gate cum ventilation tunnel measured on linear basis with respect to the total length of Gate cum ventilation tunnel including silt flushing gate chamber tunnel
MS-59	Final Support of gate cum ventilation tunnel including silt flushing gate chamber	Payment shall be made on progress of each 25% of final support of gate cum ventilation tunnel measured on linear basis with respect to the total length of Gate cum ventilation tunnel including silt flushing gate chamber tunnel
MS-60	Excavation and support of desilting outlet gate operation chambers (both) all complete	50% for excavation and primary support and 50% after final support and lining, grouting all complete
MS-61	Inlet Portal preparation of Silt Flushing tunnel	After Completion
MS-62	Excavation and primary support of Silt flushing tunnel	Payment shall be made on progress of each 25% of excavation and primary support of silt flushing tunnel measured on linear basis with respect to the total length of silt flushing tunnel (including tunnels to both desilting chambers)
MS-63	Final Support of silt flushing tunnel all complete	Payment shall be made on progress of each 20% of final support of silt flushing tunnel measured on linear basis with respect to the total length of silt flushing tunnel (including tunnels to both desilting chambers)
MS-64	Excavation and support of silt flushing gate chamber all complete	After Completion
MS-65	Excavation and primary support of desilting basin chamber 1	Payment shall be made as follows: 25% after excavation and support of crown part 25% after excavation and support up to top of hoppers level 25% after excavation and support up to top of flushing conduit, 25% after completion of excavation and primary support
MS-66	Final Support, lining and grouting (as necessary) of desilting chamber 1 all complete	Payment shall be made as follows: 25% after final support up to top of flushing conduit, 25% after final support up to top of hoppers level 25% after final support of wall top 25% after completion of final support

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-67	Excavation and primary support of desilting basin chamber 2	Payment shall be made as follows: 25% after excavation and support of crown part 25% after excavation and support up to top of hoppers level 25% after excavation and support up to top of flushing conduit, 25% after completion of excavation and primary support
MS-68	Final Support, lining and grouting (as necessary) of desilting chamber 2 all complete	Payment shall be made as follows: 25% after final support up to top of flushing conduit, 25% after final support up to top of hoppers level 25% after final support of wall top 25% after completion of final support
MS-69	Completion of all works associated with the Desilting Chambers, Ventilation Tunnel and Flushing Tunnel including fencing and protection works all complete.	After Completion
D.3	Adit Tunnels	
MS-70	Construction of Inlet Portal for Adit tunnels (Currently Adit 2, Adit 3, and Adit 4)	33.33% for construction of each Adit tunnel inlet portal
MS-71	Excavation and primary rock support of Adit tunnels (Currently Adit 1 from junction of Silt flushing tunnel to HRT Adit 2, Adit 3 including access to valve house chamber, Adit 4 at middle of pressure shaft and Adit 5 to lower pressure shaft near bifurcation)	Payment shall be made based on the progress of each 20% of excavation and primary support works in Adit tunnels based on the progress measured in linear to that of total length in meter as per the final design
MS-72	Final Support of Adit Tunnels (Currently Adit 1 from junction of Silt flushing tunnel to HRT, Adit 2, Adit 3 including access to valve house chamber and Adit 4) all complete	Payment shall be made based on the progress of each 20% of final rock support/concrete lining/grouting works in Adit tunnels based on the progress measured in linear to that of total length in meter as per the final design
MS-73	Concrete Plug in Adit 2 and Manhole works in Adit 4 all complete	After Completion
D.4	Headrace Tunnel including Link Tunnels, Rock Trap	
MS-74	Construction of Link tunnels all complete	50% after excavation and primary support of link tunnels (both and 50% after final support and concrete lining of link tunnels (both)

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-75	Completion of the excavation and primary support to headrace tunnel including length of rock trap (that includes the excavation and primary support of headrace tunnel from all faces)	Payment shall be made based on the progress of each 5% of Headrace tunnel excavation and primary support (cumulative from all excavation fronts) based on linear meter with respect to the final design.
MS-76	Completion of all final support (except concrete lining) to headrace tunnel including length of rock trap	Payment shall be made based on the progress of each 20% of Headrace tunnel final support (except concrete lining) (cumulative from all excavation fronts) based on linear meter with respect to the final design.
MS-77	Completion of overt concrete lining in Headrace tunnel all complete	Payment shall be made based on the progress of each 10% of Headrace overt concrete lining (cumulative from all excavation fronts) based on linear meter with respect to the final design.
MS-78	Completion of Invert Concrete lining in Headrace tunnel all complete	Payment shall be made based on the progress of each 20% of headrace tunnel invert concrete lining (cumulative from all excavation fronts) based on linear meter with respect to the final design.
MS-79	Completion of grouting in headrace tunnel all complete	Payment shall be made based on the progress of each 10% of Headrace tunnel grouting works (cumulative from all excavation fronts) based on linear meter with respect to the final design.
MS-80	Completion of Backfill concrete and grouting after steel lining in penstock (steel lining) upstream of the surge shaft in Headrace tunnel	After Completion
MS-81	Completion of all works associated with the headrace tunnel, rock trap and adits, fencing, doors installation, lighting works and protection works all complete.	After Completion
D.5	Surge Shaft, Valve Chamber and Pressure Shaft	
MS-82	Construction of valve chamber	50% after excavation and primary support and 50% after final support and concrete works including structures for EOT crane
MS-83	Excavation and slope stabilization of Surge shaft top all complete	After Completion
MS-84	Excavation and primary rock support on surge shaft all complete	After Completion
MS-85	Final Support and concrete lining with grouting and steel lining in orifice in Surge shaft all complete	Payment shall be made as per progress of each 50% final support works measured

No.	Description of Activity (Milestone (MS))	Payment procedure
		based on linear meter progress of height of surge shaft
MS-86	Excavation of Pilot tunnels in both vertical pressure shafts	50% after breakthrough of pilot tunnel in each vertical pressure shaft
MS-87	Excavation and primary support of pressure shaft both horizontal and vertical portions including bifurcation and branch pipe tunnels (which includes total length from every front)	Payment shall be made as per progress of each 10% of excavation and primary support measured based on the linear meter progress with respect to the total length of penstock including bifurcation and branching pipes as per the final design
MS-88	Completion of backfill concreting and grouting after steel lining to penstock shaft (which includes total length from every front) all complete	Payment shall be made as per progress of each 20% measured based on the linear meter progress with respect to the total length of penstock (excluding bifurcation and branching pipes) as per final design
MS-89	Completion of all works associated with the surge shaft, valve chamber, steel lined penstock shaft, bifurcation and branch pipes, fencing, doors, lighting, surge shaft cover, and protection works.	After Completion
D.6	Powerhouse Cavern, Transformer cum GIS Cavern, Tailrace tunnel, Escape tunnel, Busduct and Access tunnel to Transformer cum GIS, Cable cum ventilation tunnel, and Takeoff Structures	
MS-90	Construction of Inlet portal for Main Access tunnel all complete	After Completion
MS-91	Excavation and primary support of Main Access Tunnel	Payment shall be made as per progress of each 20% of excavation and primary support measured based on the linear meter progress with respect to the total length Main access tunnel as per the final design
MS-92	Final Support of Main access tunnel including lining in overt (as necessary) and Invert lining all complete	Payment shall be made as per progress of each 50% of Final support measured based on the linear meter progress with respect to the total length Main access tunnel as per the final design
MS-93	Construction of Inlet Portal for Cable cum Ventilation Tunnel all complete	After Completion
MS-94	Excavation and primary Support of cable cum ventilation tunnel including tunnel to powerhouse crown and transformer cavern	Payment shall be made as per progress of each 50% of excavation and primary support measured based on the linear meter progress with respect to the total length Cable cum Ventilation tunnel as per the final design

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-95	Final support including lining (as necessary), grouting of Cable cum ventilation tunnel including tunnel to transformer cavern all complete	After Completion
MS-96	Excavation and support of Powerhouse Cavern all complete	Payment shall be made based on the progress measured based on the Excavation and support with respect to different level splitting the total height of powerhouse into 10 equal parts.
MS-97	First stage mass concrete works (below machine hall level) in Powerhouse cavern	Payment shall be made based on the progress measured based on the first stage concrete works with respect to different level splitting the total height from Machine hall level to powerhouse bottom into 10 equal parts.
MS-98	Powerhouse concrete works above Machine hall level and concrete works of office, control room, switchgear and battery room	25% after completion of works of Office, control room, switchgear room, battery room up to Machine hall level 25% after completion of concrete works of Office, control room, switchgear room, battery room all complete 25% after completion of powerhouse superstructure works (above machine hall level) up to top of intermediate beam 25% after completion of all concrete works in powerhouse superstructure works
MS-99	Partition and finishing works of Office, Control Room, Switchgear, battery room area all complete	After Completion
MS-100	Powerhouse suspended ceiling, wall works all complete	After Completion
MS-101	Completion of second stage concrete works and all concrete works in Powerhouse cavern all complete	After Completion
MS-102	Construction of, Escape tunnel, Bus duct tunnels and access tunnel to Transformer cum GIS Cavern all complete	50% after excavation and primary support and remaining 50% after final completion
MS-103	Excavation and support of Transformer cum GIS cavern all complete	25% after completion of works of crown part, remaining 75% shall be paid on equal 3 installments based on the progress measured with respect to level (by dividing the height by 3)
MS-104	Concrete works in transformer cum GIS cavern all complete	50% after completion of concrete works in invert and foundations, 50% after completion of concrete works in superstructure
MS-105	Finishing works in transformer cum GIS cavern including walls, ceiling all complete	After Completion

No.	Description of Activity (Milestone (MS))	Payment procedure
MS-106	Preparation of Inlet portal for Tailrace Tunnel all complete	After Completion
MS-107	Excavation and primary Support of Tailrace tunnel	Payment shall be made based on the progress of each 25% of excavation and primary support of Tailrace tunnel measured based on linear meter with respect to the final design.
MS-108	Final support of tailrace tunnel all complete	Payment shall be made based on the progress of each 50% of Final Support of Tailrace tunnel measured based on linear meter with respect to the final design.
MS-109	Construction of cut and cover tailrace box culvert, tailrace outlet gate structure, river protection works and all associated works of Tailrace tunnel all complete	After Completion
MS-110	Construction of Takeoff Structures all complete	After Completion
MS-111	Completion of all works associated with the Powerhouse and transformer cum GIS cavern, Tailrace Tunnel, Escape Tunnel, Busduct Tunnel, Access tunnel to Transformer cum GIS cavern, Cable cum ventilation tunnel, takeoff structures including finishing, painting, lighting, sewerage, water supply all complete	After Completion
E.	Hydro-Mechanical Works (Delivery to the Site, fabrication, Installation, Testing and Commissioning)	
MS - 112	Delivery to the Site, fabrication, Installation of Undersluice radial gates, hoisting system, embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 113	Delivery to the Site, fabrication, Installation of Trash removal gate, hoisting system, embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 114	Delivery to the Site, fabrication, Installation of Intake gate, hoisting system, embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)

No.	Description of Activity (Milestone (MS))	Payment procedure
MS - 115	Delivery to the Site, fabrication, Installation of desilting chamber outlet gates/HRT inlet gates, hoisting system, embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 116	Delivery to the Site, fabrication, Installation of silt flushing gates, hoisting system, embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 117	Delivery to the Site, fabrication, Installation of Adit 1 side hinged door (Bulk Head Door) embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 118	Delivery to the Site, fabrication, Installation of Adit 3 side hinged door (Bulk Head Door) embedded parts including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 119	Delivery to the Site, fabrication, Installation of Tailrace outlet gate, hoisting system, embedded parts including all accessories erection and testing all complete.	20% after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 120	Delivery to the Site, fabrication, Installation of undersluice stoplog including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 121	Delivery to the Site, fabrication, Installation of Intake stoplog, hoisting system including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 122	Delivery to the Site, fabrication, Installation of silt flushing stoplog, hoisting system including all accessories all complete	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 123	Delivery to the Site, fabrication, Installation of intake trashrack including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 124	Delivery to the Site, fabrication, Installation of Trash cleaning machine including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 125	Delivery to the Site, fabrication, Installation of Gravel flushing valve, hoisting system, including all	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)

No.	Description of Activity (Milestone (MS))	Payment procedure
	accessories erection and testing all complete.	
MS - 126	Delivery to the Site, fabrication, Installation of bottom sluice isolation valve, hoisting system, including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 127	Delivery to the Site, fabrication, Installation of monorail hoist for undersluice stoplog including all accessories erection and testing all complete.	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 128	Delivery to the Site, fabrication, Installation of steel penstock pipe (upstream of Surge Shaft location) including all accessories all complete	20 % after Delivery to the Site and 80% After Completion (erection and testing all complete)
MS - 129	Delivery to the Site, fabrication, Installation of steel penstock pipe and bifurcation and branching pipes including all accessories	20% after Delivery to the Site and remaining 80% shall be paid in equal 10 installments after installation of each 10% length of penstock pipe measured based on the total length of penstock pipe including bifurcation and branching pipes of as per the design.
MS - 130	Pressure testing of entire water conveyance system successfully completed.	After Completion
F.	Completion of Works	
MS - 131	Testing of all hydraulic structures including hydromechanical and electromechanical equipment successfully completed and commissioned all complete.	After Completion
MS - 132	Demobilization of all construction plant & equipment, temporary facilities and reinstatement of disturbed areas all completed.	After Completion
MS - 133	Completion of all remaining works and issuance of the Taking-Over certificate by the Employer.	After Completion

1.5 Assignment of Bid Price

The bid price for the Contract is USD (in figures) (in words) and NRs.
. (in figures) (in words)

[To be fulfilled by the bidder as Lumpsum]

The total Bid Price in NRs as per the USD selling exchange rate prevailing on the 30 days prior to the last date of submission of Bid is NRS.

. (in figures) (in words) (sum of Foreign currency and Local Currency) including Provisional Sum. Custom Duty and VAT.

[It is assigned for different activities as follows.]

In order to have balanced bid offer, the activity wise bid price in total bid price shall be the figures in percentages specified as in the **Table 1**.

Table 1 Assignment of Bid Price

S.N.	Description	Activity wise Bid Price in Total Bid Price, % (excluding VAT & Taxes)	Remarks
A	General and Preliminary Works (Contractor's Infrastructures, Construction Facilities, Access Road, Bridge and Others)	12.73%	
B	Survey, Investigation, Design and As-Built Documentation	2.45%	
C	Importation price of Hydromechanical Equipment (CIF port of Entry (Nepal Boarder) Price)	7.68%	
D	Civil Works	73.18%	
E	Hydro-Mechanical Works (Delivery to the Site, fabrication, Installation, Testing and Commissioning)	3.29%	
F	Completion of Works	0.67%	
Total Bid Price		100.00%	

Table 2 Summary of Activity Schedules

(To be submitted with the Price Bid)

Activity Summary No	Description	Bid Price (Foreign Currency)		Bid Price (Local Currency)	
		USD (In Figures)	USD (In Words)	NRs (In Figures)	NRs (in Words)
A	General and Preliminary Works (Contractor's Infrastructures, Construction Facilities, Access Road, Bridge and Others)				
B	Survey, Investigation, Design and As-Built Documentation				
C	Importation price of Hydromechanical Equipment {CIF Port of Entry (Nepal Boarder)}			NA	NA
D	Civil Works				
E	Hydro-Mechanical Works (Delivery to the Site, Fabrication, Erection/Installation, Testing and Commissioning)				
F	Completion of Works				
Total Bid Price (NRs)					
% of Foreign Currency with respect to Total Bid Price (as per the selling rate of US\$ prevailing on 30 days prior to the last date of bid submission)					
Provisional Sum (As directed by the Employer)				75,000,000.00	Seventy -five Million Only

Activity Summary No	Description	Bid Price (Foreign Currency)		Bid Price (Local Currency)	
		USD (In Figures)	USD (In Words)	NRs (In Figures)	NRs (in Words)
	Custom Duty @ 1% on Imported Hydromechanical Equipment (on Activity summary No "C" above)				
	VAT @ 13% on Activity Summary no (A + B + D + E + F) above				
	Total Bid Amount including Provisional Sum, Custom duty and VAT (In Figures)				
	Total Bid Amount including Provisional Sum, Custom duty and VAT (In Words)				
					

Note:

The above table shall be prepared taking sum of the Milestones under each Headings.

The Foreign Currency portion shall not exceed 60% with respect to total Bid price (excluding Provisional Sum)

The Exchange rate shall be the selling rate of US\$ prevailing on 30 days prior to the last date of bid submission published by Nepal Rastra Bank.

Financial Evaluation shall be done based on the information obtained from the above table. If information obtained from System generated (online filled -Activity Schedule) Activity Schedule differs from the above table, then the information from above sheets shall prevail.

The Custom duty under MS 17 to MS 34 shall be reimbursed by the Employer to the Contractor.

1.6 Bid Price Schedule

The total lump sum price offered by the bidder shall be divided between the One Hundred thirty three (133) milestones specified hereunder as per the percentage weightage of each milestones defined in the Table 3.

Table 3 Breakdown of Activity Schedules for Bid and Payment purpose.

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
A.	General and Preliminary Works (Contractor's Infrastructures, Construction Facilities, Access Road, Bridge and Others)	12.73%								
MS-1	Establishment of Contractor's site offices, accommodations labour camp, including medical facilities, water supply and sanitation facilities	0.85%					2	50%	PARTIAL	
MS-2	Establishment of Contractor's material testing laboratory, material and fuel storage facilities, site workshops and explosive storage facilities including Army bunker.	0.68%					4	25%	PARTIAL	
MS-3	Contractor's Key personnel and construction plant and equipment mobilized to the Site.	0.84%					1	100%	FULL	
MS-4	Establishment of Concrete aggregate crushing and sorting plant and Batching Plant at Powerhouse and Headworks area and ready to operate.	0.09%					2	50%	PARTIAL	
MS-5	Establishment of Construction power supply system (including construction power line from Powerhouse to Headworks, Surge shaft and other project structures and facilities location),	0.37%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-6	Effecting and maintaining the Insurance as per the Contract	1.85%					2	75% & 25%	PARTIAL	
MS-7	Construction of permanent access road (Roadway Excavation) from the Road Head at Powerhouse location to surge shaft, adit tunnels, Headworks and others project structures location as required.	2.89%					10	10%	PARTIAL	
MS-8	Construction of permanent access road (Side Drain construction, protection works and Graveling Works) from the Road Head at Powerhouse location to surge shaft, adit tunnels, Headworks and others project structures location as required.	3.31%					10	10%	PARTIAL	
MS-9	Foundation Construction including superstructures for Permanent steel truss Bridge all complete that allows installation of steel structures at Ghunsa Khola Crossing all complete	0.56%					1	100%	FULL	
MS-10	Metal Works (including design, procurement, delivery, fabrication, erection testing and commissioning) for permanent steel truss Bridge at Ghunsa Khola Crossing all complete	0.17%					1	100%	FULL	
MS-11	Ghunsa Khola Steel Truss Bridge Foundation protection and river training works all complete	0.02%					1	100%	FULL	
MS-12	Regular service and maintenance of the Access Road and Bridges (from Handrung Bridge to Project structures location)	1.09%					4	25%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
B.	Survey, Investigation, Design and As-Built Documentation	2.45%								
MS-13	Completion of additional geological investigations. The Contractor shall decide where it is necessary to carry out these investigations in order to provide sufficient information for the contractor's design and construction of the works.	0.61%					2	50%	PARTIAL	
MS-14	Survey and Preliminary design of Civil and Hydromechanical Works	0.85%					1	100%	FULL	180
MS-15	Detailed design of Civil and Hydromechanical Works	0.97%					2	50%	PARTIAL	
MS-16	As-built documentation/Drawings and Operation & Maintenance Manual	0.02%					1	100%	FULL	
C.	Importation price of Hydromechanical Equipment (CIF port of Entry (Nepal Border) Price)	7.68%								
MS-17	All metal material and metal parts of the equipment for the undersluice radial gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic operated hoist, hoist support structures, gate control and protection structures and necessary tools and equipment including all accessories and mandatory spare	0.32%			NA	NA	1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
	parts (Hydro-mechanical equipment) CIF Nepal Boarder									
MS-18	All metal material and metal parts of the equipment for the trash removal gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, Motorized single screw spindle hoist, hoist support structures and necessary tools and equipment including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.04%			NA	NA	1	100%	FULL	
MS-19	All metal material and metal parts of the equipment for the Intake Gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic operated hoist, gate control and protection structures and necessary tools and equipment including all accessories and Intake Gate Stoplog including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.18%			NA	NA	1	100%	FULL	
MS-20	All metal material and metal parts of the equipment for the desilting chamber outlet/ HRT inlet gates including gate body, roller guide assemblies, sealing accessories, gate embedded parts, electric rope drum hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.22%			NA	NA	1	100%	FULL	
MS-21	All metal material and metal parts of the equipment for the silt flushing gates (desilting chamber) including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.17%			NA	NA	1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-22	All metal material and metal parts of the equipment for the Adit-1 side hinged door (Bulk Head Door) including gate body, sealing accessories, and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.04%			NA	NA	1	100%	FULL	
MS-23	All metal material and metal parts of the equipment for the Adit-3 side hinged door (Bulk Head Door) including gate body, sealing accessories, and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.05%			NA	NA	1	100%	FULL	
MS-24	All metal material and metal parts of the equipment for the tailrace outlet gate including gate body, roller guide assemblies, sealing accessories, gate embedded parts, electric rope drum hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.08%			NA	NA	1	100%	FULL	
MS-25	All metal material and metal parts of the equipment for undersluice Stoplog including stoplog body, guide frames, embedded parts and all accessory tools and equipment and mandatory spare parts (hydromechanical equipment) CIF Nepal Boarder	0.05%			NA	NA	1	100%	FULL	
MS-26	All metal material and metal parts of the equipment for Intake Stoplog including stoplog body, guide frames, embedded parts, Electric Monorail Houst, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (hydromechanical equipment) CIF Nepal Boarder	0.05%			NA	NA	1	100%	FULL	
MS-27	All metal material and metal parts of the equipment for the silt flushing stoplog (desilting chamber) including gate body, roller guide assemblies, sealing accessories, gate embedded parts, hydraulic hoist, hoist supporting structures and all accessory tools and equipment and mandatory spare parts (Hydro-	0.17%			NA	NA	1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
	mechanical equipment) CIF Nepal Boarder									
MS-28	All metal material and metal parts of the equipment for the intake trashrack including trashrack panels, supporting beam, guide frames, embedded parts, anchors and all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.15%			NA	NA	1	100%	FULL	
MS-29	All metal material and metal parts of the equipment for the and Trashrack cleaning machine Hydraulic grapple with rotator, rake carriage, guided chute, guide rails, trash transportation trolley, embedded parts, guide rails and necessary all tools and equipment all complete and mandatory spare parts (Hydromechanical equipment) CIF Nepal Boarder	0.52%			NA	NA	1	100%	FULL	
MS-30	All metal material and metal parts of the equipment for motorized gravel trap flushing valves (Service and Maintenance) with upstream, intermediate and downstream pipe and flange connection including all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.12%			NA	NA	1	100%	FULL	
MS-31	All metal material and metal parts of the equipment for the motorized bottom sluice isolation valves (Service and Maintenance) including upstream, intermediate and downstream pipes and flanges with all accessory tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.17%			NA	NA	1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-32	All metal material and metal parts of the equipment for Monorail hoist for undersluice stoplog including rails, hoisting equipment, embedded parts, control and protection structure and all accessories tools and equipment and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.05%			NA	NA	1	100%	FULL	
MS-33	All metal material and metal parts of the equipment for the steel penstock pipe (Lining in upstream of the Surge shaft location) including all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	0.17%			NA	NA	1	100%	FULL	
MS-34	All metal material and metal parts of the equipment for the Steel penstock pipe from surge shaft to powerhouse including Bifurcation and branching pipes including supports, stiffeners/thrust rings, seepage rings, and necessary all tools and equipment all complete all accessories and mandatory spare parts (Hydro-mechanical equipment) CIF Nepal Boarder	5.13%			NA	NA	10	10%	PARTIAL	
D.	Civil Works	73.18%								
D.1	River Diversion and Headwork Structures (Diversion Weir/Spillway, Undersluice, Stilling Basin, River Intake and Flood Walls)	19.84%								
MS-35	Construction of Inlet Portal and Outlet Portal of Diversion Tunnel all complete.	0.45%					2	50%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-36	Excavation and primary support of Diversion Tunnel all complete	1.82%					5	20%	PARTIAL	
MS-37	Completion of final support and grouting in diversion tunnel all complete.	1.19%					4	25%	PARTIAL	
MS-38	Construction of Cofferdams and all temporary measures for the river diversion at under sluice/intake site completed and the river has started flowing through the Diversion Tunnel.	0.23%					1	100%	FULL	
MS-39	Excavation and support of Weir, undersluice, Stilling basin, upstream launching apron area all complete	1.24%					5	20%	PARTIAL	
MS-40	Foundation treatment to control seepage in weir and undersluice area all complete	0.21%					1	100%	FULL	
MS-41	Concrete works in weir and undersluice all complete	4.40%					10	10%	PARTIAL	
MS-42	Concrete works in Stilling Basin all complete	3.32%					10	10%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-43	Concrete works in Upstream flood wall all complete	0.49%					1	100%	FULL	
MS-44	Concrete works in Downstream floodwall all complete	0.88%					2	50%	PARTIAL	
MS-45	Concrete works in Launching apron all complete	0.68%					1	100%	FULL	
MS-46	Abrasion resistant concrete or hard stone pitching or steel lining in weir and undersluice all complete	1.26%					2	50%	PARTIAL	
MS-47	Installation of Steel truss bridge structure in spillway portion with procurement, transportation, fabrication, installation testing and commissioning of the bridge all complete	0.16%					1	100%	FULL	
MS-48	Backfilling, Levelling, Boulder Rip Rap and gabion works all complete	0.69%					1	100%	FULL	
MS-49	Opencut excavation and support in Intake, gravel trap, gravel trap flushing, bottom sluice, Headworks Operation Centre and trash removal gate all complete	0.28%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-50	Concrete works in Intake, gravel trap, gravel trap flushing, bottom sluice, and trash removal gate all complete	1.42%					4	25%	PARTIAL	
MS-51	Excavation and support of tunnel to gate operation chamber and Gate operation chamber all complete	0.49%					1	100%	FULL	
MS-52	Construction of Headworks Operation Centre and Operator's Quarter room at Headworks	0.18%					1	100%	FULL	
MS-53	Completion of all works associated with the weir, undersluice, stilling basin, floodwalls, intake structures including headworks operation center building, guardhouse, fencing, river protection works, backfilling and landscaping, gate operation chambers, gate operation room and spillway bridge.	0.39%					1	100%	FULL	
MS-54	Removal of Cofferdam	0.06%					1	100%	FULL	
D.2	Connecting Tunnels, Desilting Chambers and Power Intake (Desilting Basin Outlet)	9.55%								
MS-55	Excavation and primary support of Connection tunnels	0.63%					2	50%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-56	Final support including lining and grouting of Connection tunnels	0.61%					2	50%	PARTIAL	
MS-57	Construction of Inlet Portal for gate cum ventilation tunnel all complete	0.14%					1	100%	FULL	
MS-58	Excavation and primary support on Gate cum ventilation tunnel including tunnel to silt flushing gate chamber	0.53%					4	25%	PARTIAL	
MS-59	Final Support of Gate cum ventilation tunnel including silt flushing gate chamber	0.38%					4	25%	PARTIAL	
MS-60	Excavation and support of desilting outlet gate operation chambers (both) all complete	0.52%					2	50%	PARTIAL	
MS-61	Inlet Portal preparation of Silt Flushing tunnel	0.23%					1	100%	FULL	
MS-62	Excavation and primary support of Silt flushing tunnel	0.68%					4	25%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-63	Final Support of silt flushing tunnel all complete	1.18%					5	20%	PARTIAL	
MS-64	Excavation and support of silt flushing gate chamber all complete	0.36%					1	100%	FULL	
MS-65	Excavation and primary support of desilting basin chamber 1	1.12%					4	25%	PARTIAL	
MS-66	Final support, lining and grouting (as necessary) of desilting chamber 1 all complete	0.98%					4	25%	PARTIAL	
MS-67	Excavation and primary support of desilting basin chamber 2	1.12%					4	25%	PARTIAL	
MS-68	Final support, lining and grouting (as necessary) of desilting chamber 2 all complete	0.98%					4	25%	PARTIAL	
MS-69	Completion of all works associated with the Desilting Chambers, Ventilation Tunnel and Flushing Tunnel including fencing and protection works all complete.	0.09%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
D.3	Adit Tunnels	3.79%								
MS-70	Construction of Inlet Portal for Adit tunnels (Currently Adit 2, Adit 3, and Adit 4)	0.31%					3	33.33%	PARTIAL	
MS-71	Excavation and primary rock support of Adit tunnels (Currently Adit 1 from junction of Silt flushing tunnel to HRT Adit 2, Adit 3 including access to valve house chamber, Adit 4 at middle of pressure shaft and Adit 5 to lower pressure shaft near bifurcation)	3.00%					5	20%	PARTIAL	
MS-72	Final Support of Adit Tunnels (Currently Adit 1 from junction of Silt flushing tunnel to HRT, Adit 2, Adit 3 including access to valve house chamber and Adit 4) all complete	0.38%					5	20%	PARTIAL	
MS-73	Concrete Plug in Adit 2 and Manhole works in Adit 4 all complete	0.10%					1	100%	FULL	
D.4	Headrace Tunnel including Link Tunnels, Rock Trap	13.93%								
MS-74	Construction of Link tunnels all complete	0.86%					2	50%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-75	Completion of the excavation and primary support to headrace tunnel including length of rock trap (that includes the excavation and primary support of headrace tunnel from all faces)	7.41%					20	5%	PARTIAL	730
MS-76	Completion of all final support (except concrete lining) to headrace tunnel including length of rock trap	0.80%					5	20%	PARTIAL	
MS-77	Completion of overt concrete lining in Headrace tunnel all complete	3.24%					10	10%	PARTIAL	
MS-78	Completion of Invert Concrete lining in Headrace tunnel all complete	0.32%					5	20%	PARTIAL	
MS-79	Completion of grouting in headrace tunnel all complete	0.75%					10	10%	PARTIAL	
MS-80	Completion of Backfill concrete and grouting after steel lining in penstock (steel lining) upstream of the surge shaft in Headrace tunnel	0.04%					1	100%	FULL	
MS-81	Completion of all works associated with the headrace tunnel, rock trap and adits, fencing, doors installation, lighting works and protection works all complete.	0.51%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
D.5	Surge Shaft, Valve Chamber and Pressure Shaft	5.40%								
MS-82	Construction of valve chamber	0.53%					2	50%	PARTIAL	
MS-83	Excavation and slope stabilization of Surge shaft top all complete	0.45%					1	100%	FULL	
MS-84	Excavation and primary rock support on surge shaft all complete	0.38%					1	100%	FULL	
MS-85	Final Support and concrete lining with grouting and steel lining in orifice in Surge shaft all complete	0.58%					2	50%	PARTIAL	
MS-86	Excavation of Pilot tunnels in both vertical pressure shafts	0.17%					2	50%	PARTIAL	
MS-87	Excavation and primary support of pressure shaft both horizontal and vertical portions including bifurcation and branch pipe tunnels (which includes total length from every front)	1.55%					10	10%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-88	Completion of backfill concreting and grouting after steel lining to penstock shaft (which includes total length from every front) all complete	1.55%					10	10%	PARTIAL	
MS-89	Completion of all works associated with the surge shaft, valve chamber, steel lined penstock shaft, bifurcation and branch pipes, fencing, doors, lighting, surge shaft cover, and protection works.	0.17%					1	100%	FULL	
D.6	Powerhouse Cavern, Transformer cum GIS Cavern, Tailrace tunnel, Escape tunnel, Busduct and Access tunnel to Transformer cum GIS, Cable cum ventilation tunnel, and Takeoff Structures	20.67%								
MS-90	Construction of Inlet portal for Main Access tunnel all complete	0.28%					1		FULL	
MS-91	Excavation and primary support of Main Access Tunnel	2.02%					5	20%	PARTIAL	
MS-92	Final Support of Main access tunnel including lining in overt (as necessary) and Inert lining all complete	0.67%					2	50%	PARTIAL	
MS-93	Construction of Inlet Portal for Cable cum Ventilation Tunnel all complete	0.15%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-94	Excavation and primary Support of cable cum ventilation tunnel including tunnel to powerhouse crown and transformer cavern	0.71%					2	50%	PARTIAL	
MS-95	Final support including lining (as necessary), grouting of Cable cum ventilation tunnel including tunnel to transformer cavern all complete	0.27%					1	100%	FULL	
MS-96	Excavation and support of Powerhouse Cavern all complete	3.48%					10	10%	PARTIAL	
MS-97	First stage mass concrete works (below machine hall level) in Powerhouse cavern	3.13%					10	10%	PARTIAL	690
MS-98	Powerhouse concrete works above Machine hall level and concrete works of office, control room, switchgear and battery room	1.00%					4	25%	PARTIAL	690
MS-99	Partition and finishing works of Office, Control Room, Switchgear, battery room area all complete	0.48%					1	100%	FULL	
MS-100	Powerhouse suspended ceiling, wall works all complete	0.11%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-101	Completion of second stage concrete works and all concrete works in Powerhouse cavern all complete	0.24%					1	100%	FULL	
MS-102	Construction of, Escape tunnel, Bus duct tunnels and access tunnel to Transformer cum GIS Cavern all complete	1.17%					2	50%	PARTIAL	
MS-103	Excavation and support of Transformer cum GIS cavern all complete	1.39%					4	25%	PARTIAL	
MS-104	Concrete works in transformer cum GIS cavern all complete	1.09%					2	50%	PARTIAL	
MS-105	Finishing works in transformer cum GIS cavern including walls, ceiling all complete	0.35%					1	100%	FULL	
MS-106	Preparation of Inlet portal for Tailrace Tunnel all complete	0.05%					1	100%	FULL	
MS-107	Excavation and primary Support of Tailrace tunnel	2.35%					4	25%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS-108	Final support of tailrace tunnel all complete	0.87%					2	50%	PARTIAL	
MS-109	Construction of cut and cover tailrace box culvert, tailrace outlet gate structure, river protection works and all associated works of Tailrace tunnel all complete	0.29%					1	100%	FULL	
MS-110	Construction of Takeoff Structures all complete	0.18%					1	100%	FULL	
MS-111	Completion of all works associated with the Powerhouse and transformer cum GIS cavern, Tailrace Tunnel, Escape Tunnel, Busduct Tunnel, Access tunnel to Transformer cum GIS cavern, Cable cum ventilation tunnel, takeoff structures including finishing, painting, lighting, sewerage, water supply all complete	0.38%					1	100%	FULL	
E.	Hydro-Mechanical Works (Delivery to the Site, fabrication, Installation, Testing and Commissioning)	3.29%								
MS - 112	Delivery to the Site, fabrication, Installation of Undersluice radial gates, hoisting system, embedded parts including all accessories erection and testing all complete.	0.14%					2	20% & 80%	PARTIAL	
MS - 113	Delivery to the Site, fabrication, Installation of Trash removal gate, hoisting system, embedded parts including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS - 114	Delivery to the Site, fabrication, Installation of Intake gate, hoisting system, embedded parts including all accessories erection and testing all complete.	0.08%					2	20% & 80%	PARTIAL	
MS - 115	Delivery to the Site, fabrication, Installation of desilting chamber outlet gates/HRT inlet gates, hoisting system, embedded parts including all accessories erection and testing all complete.	0.09%					2	20% & 80%	PARTIAL	
MS - 116	Delivery to the Site, fabrication, Installation of silt flushing gates, hoisting system, embedded parts including all accessories erection and testing all complete.	0.07%					2	20% & 80%	PARTIAL	
MS - 117	Delivery to the Site, fabrication, Installation of Adit 1 side hinged door (Bulk Head Door) embedded parts including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	
MS - 118	Delivery to the Site, fabrication, Installation of Adit 3 side hinged door (Bulk Head Door) embedded parts including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	
MS - 119	Delivery to the Site, fabrication, Installation of Tailrace outlet gate, hoisting system, embedded parts including all accessories erection and testing all complete.	0.04%					2	20% & 80%	PARTIAL	
MS - 120	Delivery to the Site, fabrication, Installation of Undersluice stoplog including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS - 121	Delivery to the Site, fabrication, Installation of Intake stoplog, hoisting system including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	
MS - 122	Delivery to the Site, fabrication, Installation of silt flushing stoplog, hoisting system including all accessories all complete	0.07%					2	20% & 80%	PARTIAL	
MS - 123	Delivery to the Site, fabrication, Installation of intake trashrack including all accessories erection and testing all complete.	0.07%					2	20% & 80%	PARTIAL	
MS - 124	Delivery to the Site, fabrication, Installation of Trash cleaning machine including all accessories erection and testing all complete.	0.22%					2	20% & 80%	PARTIAL	
MS - 125	Delivery to the Site, fabrication, Installation of Gravel flushing valve, hoisting system, including all accessories erection and testing all complete.	0.05%					2	20% & 80%	PARTIAL	
MS - 126	Delivery to the Site, fabrication, Installation of bottom sluice isolation valve, hoisting system, including all accessories erection and testing all complete.	0.07%					2	20% & 80%	PARTIAL	
MS - 127	Delivery to the Site, fabrication, Installation of monorail hoist for undersluice stoplog including all accessories erection and testing all complete.	0.02%					2	20% & 80%	PARTIAL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
MS - 128	Delivery to the Site, fabrication, Installation of steel penstock pipe (upstream of Surge Shaft location) including all accessories all complete	0.07%					2	20% & 80%	PARTIAL	
MS - 129	Delivery to the Site, fabrication, Installation of steel penstock pipe and bifurcation and branching pipes including all accessories	2.02%					11	20% & 8%	PARTIAL	
MS - 130	Pressure testing of entire water conveyance system successfully completed.	0.18%					1	100%	FULL	1350
F.	Completion of Works	0.67%								
MS - 131	Testing of all hydraulic structures including hydromechanical and electromechanical equipment successfully completed and commissioned all complete.	0.31%					1	100%	FULL	1460
MS - 132	Demobilization of all construction plant & equipment, temporary facilities and reinstatement of disturbed areas all completed.	0.18%					1	100%	FULL	
MS - 133	Completion of all remaining works and issuance of the Taking-Over certificate by the Employer.	0.17%					1	100%	FULL	

No.	Description of Activity (Milestone (MS))	Weightage in percentage to the Bid Price (Excluding VAT and Provisional Sum)	USD (In Figures)	USD (In Words)	NRS (In Figures)	NRS (In Words)	Stage for Payment (Number of partial Payments)	Percentage Weightage (Percentage of the partial Payment weightage)	Payment Procedure	Days to Completion after the Commencement Date
	Total of All Milestones	100.00%								
	Custom Duty @ 1% on Imported Hydromechanical Equipment (MS -17 to MS -34)									
	VAT @ 13 % (On MS -1 to MS -16 and MS -35 to MS -133)									
	Total Amount									

A special customs duty rate of **1%** of the CIF border price shall apply to above Milestones **MS - 17 to MS – 34** and VAT will not be applicable on these items. The Contractor shall pay the Custom duty as applicable which shall be reimbursed by the Employer. Milestones except MS-17 to MS-34 are subjected to 13% VAT, which shall be added to those Milestones.

1.7 Preamble to Dayworks Schedule

1.7.1 General

Work shall not be executed on a Dayworks basis except by written order of the Employer. Bidders shall enter basic rates for Dayworks items in the Schedules, which rates shall apply to any quantity of Dayworks ordered by the Employer. Nominal quantities have been indicated against each item of Dayworks, and the extended total for Dayworks shall be carried forward as a Provisional Sum to the Summary Total Bid Amount. Unless otherwise adjusted, payments for Dayworks shall be subject to price adjustment in accordance with the provisions in the Conditions of Contract.

1.7.2 Dayworks Labor

In calculating payments due to the Contractor for the execution of daywork, the hours for labor will be reckoned from the time of arrival of the labor at the job site to execute the particular item of daywork to the time of return to the original place of departure, but excluding meal breaks and rest periods. Only the time of classes of labor directly doing work ordered by the Employer and for which they are competent to perform will be measured. The time of gangers (charge hands) actually doing work with the gangs will also be measured but not the time of foremen or other supervisory personnel.

The Contractor shall be entitled to payment in respect of the total time that labor is employed on daywork, calculated at the basic rates entered by him in the Schedule of Daywork Rates: 1. Labor. The rates for labor shall be deemed to cover all costs to the Contractor including the amount of wages paid to such labor, transportation time, overtime, subsistence allowances, and any sums paid to or on behalf of such labor for social benefits in accordance with (Country of Borrower) law, as well as Contractor's profit, overheads, superintendence, liabilities and insurance and allowance to labor, timekeeping and clerical and office work, the use of consumable stores water, lighting and power; the use and repair of staging, scaffolding workshops and stores portable power tools, manual plant and tools; supervision by the Contractor's staff, foremen and other supervisory personnel; and charges incidental to the foregoing. The rates shall be stated in the local currency and the payments shall be made in Local currency (NPR).

1.7.3 Daywork Materials

The Contractor shall be entitled to payment in respect of materials used for daywork (except for materials for which the cost is included in the percentage addition to labor costs as detailed heretofore), at the rates entered by him in the Schedule of Daywork Rates: 2. Materials and shall be deemed to include overhead charges and profit as follows:

- a) The rates for materials shall be calculated on the basis of the invoiced price, freight, insurance, handling expenses, damage, losses, etc., and shall provide for delivery to store for stockpiling at the Site. The rates shall be stated in the local currency and the payments shall be made in Local currency (NPR).
- b) The cost of hauling materials for use on work ordered to be carried out as daywork from the store or stockpile on the Site to the place where it is to be used will be paid in accordance with the terms for Labor and Constructional Plant in this Schedule.

1.7.4 Daywork Contractor's Equipment

The Contractor shall be entitled to payment in respect of Contractor's Equipment already on Site and employed on daywork at the basic rental rates entered by him in the Schedule of Daywork Rates: 3. Contractor's Equipment. The said rates shall be deemed to include due and complete allowance for depreciation, interest, indemnity and insurance, repairs, maintenance, supplies, fuel, lubricants, and other consumable, and all overhead profit and administrative costs related to the use of such equipment. The cost of drivers, operators and assistants will be paid for separately as described under the section on Daywork Labor.

In calculating the payment due to the Contractor's Equipment employed on daywork, only the actual number of working hours will be eligible for payment, except that where applicable and agreed with the Employer, the traveling time from the part of the Site where the Construction Plant was located when ordered by the Employer to be employed on daywork and the time for return journey thereto shall be included for payment.

The basic rental rates for Contractor's Equipment employed on daywork shall be stated in local currency and the payments to the Contractor shall be made in Local currency (NRs).

Schedule of Daywork Rates: 1. Labour

Item No.	Description	Unit	Nominal quantity	Rate (NRs)		Amount (NRs)
				In figures	In words	
D100	Foreman	hour	600			
D101	Laborer	hour	7200			
D102	Mason	hour	1000			
D103	Bricklayer	hour	800			
D104	Carpenter	hour	140			
D105	Steelwork Erector/Welder	hour	500			
D106	Bar bender	hour	600			
D107	Driver for vehicle up to 10 tons	hour	500			
D108	Operator for crane, excavator, dozer, loader, roller, grader	hour	1400			
D109	Operator for batching plant, crushing plant	hour	300			
D110	Operator for DG set, shotcrete machine, drilling machine, pumping machine, compressor	hour	1000			
D111	Mechanical/electrical installers/pipe fitters	hour	400			

Item No.	Description	Unit	Nominal quantity	Rate (NRs)		Amount (NRs)
				In figures	In words	
Total Amount in Figures (carried forward to Summary, p.____)						
Total Amount in words						

Bidder or his Authorized Representative: Name:.....

Signature:.....

Date:.....

Seal:.....

Schedule of Daywork Rates: 2. Materials

Item No.	Description	Unit	Nominal quantity	Rate (NRs)		Amount (NRs)
				In figures	In words	
D200	Cement, ordinary Portland, or equivalent in bags	ton	1000			
D201	Mild steel reinforcing bar up to 16 mm diameter to BS 4449 or equivalent	ton	20			
D202	Fine aggregate for concrete as specified in the Specification	m ³	150			
D203	Coarse aggregate for concrete as specified in the specification	m ³	300			
D204	Gelignite (Nobel Special Gelatine 60 %, or equivalent) including caps, fuse, wire and requisite accessories	ton	30			
D205	Wood	ft ³	5			
D206	Formwork/scaffolding	m ²	150			
Total Amount in Figures (carried forward to Summary, p.____)						
Total Amount in words:						

Bidder or his Authorized Representative:

Name:.....

Signature:.....

Date:.....

Seal:.....

Schedule of Daywork Rates: 3. Contractor's Equipment

Item No.	Description	Unit	Nominal quantity	Rate (NRs)		Amount (NRs)
				In figures	In words	
Excavator , loader, dumper, etc.						
D300	Excavator (min 0.75 m ³)	hour	300			
D301	Bulldozer (15/25 ton)	hour	20			
D302	Wheel Loader (2 m ³)	hour	150			
D303	Dump Truck (10 ton)	hour	500			
D304	Concrete Mixing Truck (5m ³)	hour	160			
D305	Crane (25 ton)	hour	30			
D306	Vibrating Roller (12 ton)	hour	100			
D307	Grader	hour	100			
Other Plants/Equipment						
D308	Batching Plant	hour	50			
D310	Diesel Generator (100 KVA)	hour	100			
D311	Water Pump (20 l/s)	hour	100			
D312	Air Compressor (13m ³ /s)	hour	100			
D313	Concrete Pump (10 m ³ /h)	hour	100			
D314	Wet Shotcrete Machine (5 m ³ /h)	hour	40			
D315	Vertical Drilling Machine	hour	100			
Total Amount in Figures (carried forward to Summary, p.____)						
Total Amount in words:						

Bidder or his Authorized Representative:

Name:.....

Signature:.....

Date:.....

Seal:.....

Daywork Summary

Item No.	Description	Amount (NRs)	% Foreign Cost
1	Total for Daywork: Labour		
2	Total for Daywork: Materials		
3	Total for Daywork: Contractor's Equipment		
Total Amount in Figures (carried forward to Summary, p.____)			
Total Amount in words:			

Bidder or his Authorized Representative:

Name.....

Signature:.....

Date:.....

Seal:

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (GKHEP)
(77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT NO. 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**INTERNATIONAL COMPETITIVE BIDDING (ICB)
[Single Stage Two Envelope Bidding Procedure]**

**VOLUME 3 of 5
Conditions of Contract**

January 2026

Invitation for Bids No.: GKHEP/ICB-082/83/EPC-1
Employer: Remit Hydro Limited
Country: Nepal

Remit Hydro Limited
Ghunsa Khola Hydroelectric Project
Citizen Investment Trust Building, New Baneshwor
Kathmandu
NEPAL

Tel.: +977-1- 4581780
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PREFACE

This volume is part of the Tender Documents for Lot 1 – Civil and Hydro-mechanical Works of Ghunsa Khola Hydroelectric Project under EPC contract. The complete set of Tender Documents consists of the following volumes.

Volume 1	Bidding Procedures Section I - Instructions to Bidders (ITB) Section II - Bid Data Sheet (BDS) Section III - Evaluation and Qualification Criteria (EQC) Section IV - Bidding Forms (BDF) Section V - Eligible Countries
Volume 2	EMPLOYER'S REQUIREMENTS Section I – Scope of Works Section II – General Technical Requirements Section III – Standard Technical Requirements Section IV – Particular Technical Requirements Section V – Activity Schedule (ACS)
Volume 3	Conditions of Contract Section I - General Conditions of Contract (GCC) Section II - Special Conditions of Contract (SCC) Section III - Annexures Section IV - Contract Forms (COF)
Volume 4	Basic Project Report Part A: General Information 1 – Introduction 2 – Key Features of the project 3 – Power and Energy Studies 4 – Salient Features of Employer's Concept Design Part B: Project Description 5 – Topographic Survey and mapping 6 – Hydrology and Meteorology 7 – Sedimentology 8 – Geology and Geotechnics 9 – Seismicity
Volume 5	Employer's Concept Drawings

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77 MW)**

**BIDDING DOCUMENTS
FOR
CONSTRUCTION
OF**

**LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 3
CONDITIONS OF CONTRACT**

**SECTION I
GENERAL CONDITIONS OF CONTRACT**

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GENERAL CONDITIONS OF CONTRACT	
CLAUSE	DETAILS
A. GENERAL	
1. Definitions	1.1 Boldface type is used to identify defined terms. a) Accepted Contract Amount means the amount accepted in the Letter of Acceptance for the execution and completion of the Works and the remedying of any defects. b) Activity Schedule is a schedule of the activities comprising the construction, installation, testing, and commissioning of the Works in a lump sum contract. It includes a lump sum price for each activity, which is used for valuations and for assessing the effects of Variations and Compensation Events. c) Base Date means the date Thirty (30) days prior to the latest date for submission of the Tender. d) Compensation Events are those defined in GCC 35.4 hereunder. e) Completion Date is the date of completion of the Works as certified by the Employer. f) Contract is the Contract between the Employer and the Contractor to design, execute, complete, and maintain the Works. It consists of the documents listed in GCC 2.3 below. g) Contractor is the party whose Bid to carry out the Works has been accepted by the Employer. h) Contractor's Representative means the person named by the Contractor in the Contract or appointed from time to time by the Contractor under Clause 12. [Contractor's Representative], who acts on behalf of the Contractor. i) Contractor's Personnel means the Contractor's Representative and all personnel whom the Contractor utilizes on Site, who may include the staff, labour and other employees of the Contractor and of each Subcontractor; and any other personnel assisting the Contractor in the execution of the Works. j) Contractor's Documents means the calculations, computer programs and other software, drawings, manuals, models and other documents of a technical nature supplied by the Contractor under the Contract; k) Contractor's Bid is the completed bidding document submitted by the Contractor to the Employer. l) Contract Price is the Accepted Contract Amount stated in the Letter of Acceptance and thereafter as adjusted in accordance with the Contract. m) Commencement Date is given in the SCC. It is the latest

	date when the Contractor shall commence execution of the Design and Works. It does not necessarily coincide with any of the Site Possession Dates. n) Days are calendar days; months are calendar-months. o) Dayworks are varied work inputs subject to payment on a time basis for the Contractor's employees and Equipment, in addition to payments for associated Materials and Plant. p) Defect is any part of the Works not completed in accordance with the Contract. q) Defects Liability Certificate is the certificate issued by Employer upon correction of defects by the Contractor. r) Defects Liability Period is the period calculated from the Completion Date where the Contractor remains responsible for remedying defects. s) Drawings include calculations and other information provided or approved by the Employer for the execution of the Contract. t) Employer is the party who employs the Contractor to carry out the Works, as specified in the SCC. u) Employer's Representative means the person named by the Employer in the Contract or appointed from time to time by the Employer under Clause 13. [The Employer's Representative], who acts on behalf of the Employer. v) Employer's Personnel means the Employer's Representative, the assistants referred to in Clause 13.5 and all other staff, labour and other employees of the Employer's Representative, and any other personnel notified to the Contractor, by the Employer or the Employer's Representative, as Employer's Personnel w) Equipment is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works. x) Force Majeure means an exceptional event or circumstance: which is beyond a Party's control; which such Party could not reasonably have provided against before entering into the Contract; which, having arisen, such Party could not reasonably have avoided or overcome; and, which is not substantially attributable to the other Party. y) Initial Contract Price is the Contract Price listed in the Employer's Letter of Acceptance. z) Intended Completion Date is the date on which it is intended that the Contractor shall complete the Works. The Intended Completion Date is specified in the SCC. The Intended Completion Date may be revised only by the Employer by issuing an extension of time or an acceleration order. aa) Letter of Acceptance means the formal acceptance by the Employer of the Bid and denotes the formation of the contract at the date of acceptance. bb) Materials are all supplies, including consumables, used by

	the Contractor for incorporation in the Works. cc) Party means the Employer or the Contractor, as the context requires. dd) SCC means Special Conditions of Contract. ee) Plant is any integral part of the Works that shall have a mechanical, electrical, chemical, or biological function. ff) Employer is the person named in the SCC (or any other competent person appointed by the Employer and notified to the Contractor, to act in replacement of the Employer) who is responsible for supervising the execution of the Works and administering the Contract. gg) Retention Money means the aggregate of all monies retained by the Employer pursuant to GCC 60.1 hh) Schedules means the document(s) entitled schedules, completed by the Contractor and submitted with the Letter of Bids, as included in the Contract. Such document may include the Bill of Quantities, data, lists, and schedules of rates and/or prices. ii) Site means the places specified in the SCC where the Permanent Works are to be executed and to which Plant and Materials are to be delivered, and any other places as may be specified in the Contract as forming part of the Site. jj) Site Investigation Reports are those that were included in the bidding documents and are factual and interpretative reports about the surface and subsurface conditions at the Site. kk) Specification means the Specification of the Works included in the Contract and any modification or addition made or approved by the Employer. ll) Subcontractor is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract, which includes work on the Site. mm) Temporary Works are works designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the Works. nn) Tests on Completion means the tests which are specified in the Contract or agreed by both Parties or instructed as a Variation, and which are carried out before the Works are taken over by the Employer. oo) Tests after Completion means the tests (if any) which are specified in the Contract which are carried out after the Works are taken over by the Employer. pp) Variation is an instruction given by the Employer which varies the Works qq) Works are what the Contract requires the Contractor to plan, conduct engineering study, design, construct, install, operate and maintain and finally turn over to the Employer, as defined in the SCC. rr) Operation and Maintenance Period is the period from the

	end of Defect Liability Period where the contractors remain responsible for operation and performance-based maintenance of the works.
2. Interpretation	2.1 In the Contract, except where the context requires otherwise: (a) words indicating one gender include all genders; (b) words indicating the singular also include the plural and words indicating the plural also include the singular; (c) provisions including the word “agree”, “agreed” or “agreement” require the agreement to be recorded in writing, and (d) “written” or “in writing” means hand-written, type-written, printed or electronically made, and resulting in a permanent record. The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions 2.2 If sectional completion, referred as milestone is specified in the SCC, references in the GCC to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion Date for the whole of the Works). 2.3 The documents forming the Contract shall be interpreted in the following order of priority: (a) Contract Agreement, (b) Letter of Acceptance, (c) Letters of Technical Bid and Price Bid, (d) Special Conditions of Contract, (e) General Conditions of Contract, (f) Employer’s Requirements, (g) Activity Schedules, and (i) Any other document listed in the SCC as forming part of the Contract. 2.4 If an ambiguity or discrepancy in the contract document is found, the priority shall be such as may be accorded by the governing law.

3. Law and Language	3.1 The law governing the Contract is stated in the SCC. 3.2 Throughout the execution of the Contract, the Contractor shall comply with the import of goods and services prohibitions in the Employer's country when by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's Country prohibits any import of goods from, or any payments to, a particular country, person, or entity. Where the borrower's country prohibits payments to a particular firm or for particular goods by such an act of compliance, that firm may be excluded. 3.3. As between the Parties, the Employer shall retain the copyright and other Employer's intellectual property rights in the Employer's Requirements and other documents made by (or on behalf of) the Employer. The Contractor may, at his cost, copy, use, and obtain communication of these documents for the purposes of the Contract. They shall not, without the Employer's consent, be copied, used or communicated to a third party by the Contractor, except as necessary for the purposes of the Contract. Party 3.4. The language for communications shall be that stated in the SCC. If no language is stated there, the language for communications shall be the language in which the Contract (or most of it) is written. If there are versions of any part of the Contract which are written in more than one language, the version which is in the ruling language stated in the SCC shall prevail.
4. Contract Agreement	4.1 The Contract shall come into full force and effect on the date stated in the Contract Agreement. 4.2 Without altering the basic nature or scope of work, the agreement may be revised upon mutual written consent as per prevailing Public Procurement Law. 4.3 The Contractor shall design, execute and complete the Works in accordance with the Contract, and shall remedy any defects in the Works. When completed, the Works shall be fit for the purposes for which the Works are intended as defined in the Contract. 4.4 The Contractor shall provide the Plant and Contractor's Documents specified in the Contract, and all Contractor's Personnel, Goods, consumables and other things and services, whether of a temporary or permanent nature, required in and for this design, execution, completion and remedying of defects. 4.5 The Works shall include any work which is necessary to satisfy the Employer's Requirements, or is implied by the Contract, and all works which (although not mentioned in the Contract) are necessary for stability or for the completion, or safe and proper operation, of the Works. 4.6 Throughout the design and execution of the Works, and as long thereafter as is necessary to fulfil the Contractor's obligations, the Contractor shall provide all necessary superintendence to

	plan, arrange, direct, manage, inspect and test the work. Superintendence shall be given by a sufficient number of persons having adequate knowledge of the language for communications (defined in Clause 3. [Law and Language])) and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Works. 4.7 The Contractor shall be responsible for the adequacy, stability and safety of all Site operations, of all methods of construction and of all the Works. 4.8 The Contractor shall, whenever required by the Employer, submit details of the arrangements and methods which the Contractor proposes to adopt for the execution of the Works. No significant alteration to these arrangements and methods shall be made without this having previously been notified to the Employer. 4.9 Except as otherwise stated in the Contract: (a) the Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Works; (b) by signing the Contract, the Contractor accepts total responsibility for having foreseen all difficulties and costs of successfully completing the Works; and (c) the Contract Price shall not be adjusted to take account of any unforeseen difficulties or costs. 4.10 For the purposes of Clause 4.9, unforeseeable difficulties include physical conditions like man-made or natural physical conditions including sub-surface and hydrological conditions which the Contractor encounters at the Site during execution of the Works. 4.11 Subject to any mandatory requirements under the governing law of the Contract, termination of the Contract under any Clause of these Conditions shall require no action of whatsoever kind by either Party other than as stated in the Clause.
5. Use of Contractor's Documents	5.1 The Contractor shall retain the copyright and other intellectual Contractor's Documents property rights in the Contractor's Documents and other design documents made by (or on behalf of) the Contractor. The Contractor shall be deemed (by signing the Contract) to give to the Employer a non-terminable transferable non-exclusive royalty-free license to copy, use and communicate the Contractor's Documents, including making and using modifications of them. This license shall: (a) apply throughout the actual or intended working life (whichever is longer) of the relevant parts of the Works, (b) entitle any person in proper possession of the relevant part of the Works to copy, use and communicate the Contractor's Documents for the purposes of completing, operating, maintaining, altering, adjusting, repairing and

	demolishing the Works, and (c) in the case of Contractor's Documents which are in the form of computer programs and other software, permit their use on any computer on the Site and other places as envisaged by the Contract, including replacements of any computers supplied by the Contractor. 5.2 The Contractor's Documents and other design documents made by (or on behalf of) the Contractor, shall not, without the Contractor's consent, be used, copied or communicated to a third party by (or on behalf of) the Employer for purposes other than those permitted under this Clause.
6. Contractor's Use of Employer's Documents	6.1 The Employer shall retain the copyright and other Employer's intellectual property rights in the Employer's Requirements and other documents made by (or on behalf of) the Employer. The Contractor may, at his cost, copy, use, and obtain communication of these documents for the purposes of the Contract. They shall not, without the Employer's consent, be copied, used or communicated to a third party by the Contractor, except as necessary for the purposes of the Contract.
7. Assignment	7.1 Neither Party shall assign the whole or any part of the Contract or any benefit or interest in or under the Contract. However, either Party; (a) may assign the whole or any part with the prior agreement of the other Party, at the sole discretion of such other Party; and (b) may, as security in favor of a commercial bank or financial institution, assign its right to any moneys due, or to become due, under the Contract.
8. Care and Supply of Documents	8.1 Each of the Contractor's Documents shall be in the custody and care of the Contractor, unless and until taken over by the Employer. Unless otherwise stated in the Contract, the Contractor shall supply to the Employer's Representative six copies of each of the Contractor's Documents. 8.2 The Contractor shall keep, on the Site, a copy of the Contract, publications named in the Specification, the Contractor's Documents (if any), the Drawings and Variations and other communications given under the Contract. The Employer's Personnel shall have the right of access to all these documents at all reasonable times. 8.3 If a Party becomes aware of an error or defect in a document which was prepared for use in executing the Works, the Party shall promptly give notice to the other Party of such error or defect.
9. Confidential Details	9.1 The Contractor's and the Employer's Personnel shall disclose all such confidential and other information as may be reasonably required in order to verify the Contractor's compliance with the Contract and allow its proper implementation.

	9.2 Each of them shall treat the details of the Contract as private and confidential, except to the extent necessary to carry out their respective obligations under the Contract or to comply with applicable Laws. Each of them shall not publish or disclose any particulars of the Works prepared by the other Party without the previous agreement of the other Party. However, the Contractor shall be permitted to disclose any publicly available information, or information otherwise required to establish his qualifications to compete for other projects. 9.3 Notwithstanding the above, the Contractor may furnish to its Subcontractor(s) such documents, data and other information it receives from the Employer to the extent required for the Subcontractor(s) to perform its work under the Contract, in which event the Contractor shall obtain from such Subcontractor(s) an undertaking of confidentiality similar to that imposed on the Contractor under this Clause.
10. Compliance with Laws	10.1 The Contractor shall, in performing the Contract, comply with applicable Laws. Unless otherwise stated in the SCC: (a) the Employer shall have obtained (or shall obtain) the planning, zoning or similar permission for the Permanent Works, and any other permissions described in the Employer's Requirements as having been (or being) obtained by the Employer; and the Employer shall indemnify and hold the Contractor harmless against and from the consequences of any failure to do so; and (b) the Contractor shall give all notices, pay all taxes, duties and fees, and obtain all permits, licenses and approvals, as required by the Laws in relation to the design, execution and completion of the Works and the remedying of any defects; and the Contractor shall indemnify and hold the Employer harmless against and from the consequences of any failure to do so. 10.2 The Employer shall (where he is in a position to do so) provide reasonable assistance to the Contractor at the request of the Contractor: (a) by obtaining copies of the Laws of Nepal which are relevant to the Contract but are not readily available, and (b) for the Contractor's applications for any permits, licenses or approvals required by the Laws of Nepal: (i) which the Contractor is required to obtain under Clause 10.1, (ii) for the delivery of Goods, including clearance through customs, and (iii) for the export of Contractor's Equipment when it is removed from the Site.
11. Joint and Several Liability	11.1 If the Contractor is a joint venture of two or more entities, all such entities shall be jointly and severally liable to the Employer for the fulfillment of the provisions of the Contract, and shall designate one of such persons to act as a leader

	with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered.
12. Contractor's Representative	12.1 The Contractor shall appoint the Contractor's Representative and shall give him all authority necessary to act on the Contractor's behalf under the Contract. 12.2 Unless the Contractor's Representative is named in the Contract, the Contractor shall, prior to the Commencement Date, submit to the Employer for consent the name and particulars of the person the Contractor proposes to appoint as Contractor's Representative. If consent is withheld or subsequently revoked, or if the appointed person fails to act as Contractor's Representative, the Contractor shall similarly submit the name and particulars of another suitable person for such appointment. 12.3 The Contractor shall not, without the prior consent of the Employer, revoke the appointment of the Contractor's Representative or appoint a replacement. The Contractor's Representative shall, on behalf of the Contractor, receive instructions under Clause 33. [Instructions, Inspection and Audits]. 12.4 The Contractor's Representative may delegate any powers, functions and authority to any competent person, and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Employer has received prior notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked. 12.5 The Contractor's Representative and all these persons shall be fluent in the language for communications defined in Clause 3 [Law and Language] .
13. The Employer's Representative	13.1 The Employer may appoint an Employer's Representative to act on his behalf under the Contract. In this event, he shall give notice to the contractor of the name, address, duties and authority of the Employer's Representative. 13.2 The Employer's Representative shall carry out the duties assigned to him, and shall exercise the authority delegated to him, by the Employer. Unless and until the Employer notifies the Contractor otherwise, the Employer's Representative shall be deemed to have the full authority of the Employer under the Contract, except in respect of Clause 79 [Termination by Employer], to amend the Contract and to relieve either Party of any duties, obligations or responsibilities under the Contract. 13.3 Any approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by the Employer or Employer's Representative (including absence of disapproval) shall not relieve the Contractor from any responsibility he has under the Contract, including responsibility for errors, omissions, discrepancies and non-compliances. 13.4 If the Employer wishes to replace any person appointed as

	Employer's Representative, the Employer shall give the Contractor not less than Fifteen (15) days' notice of the replacement's name, address, duties and authority, and of the date of appointment. 13.5 The Employer or the Employer's Representative may from time to time assign duties and delegate authority to assistants, and may also revoke such assignment or delegation, by giving a Notice to the Contractor of the name, assigned duties and delegated authority of the assistant. The assignment, delegation or revocation shall not take effect until this Notice has been received by the Contractor. 13.6 Assistants shall be suitably qualified persons, who are competent to carry out these duties and exercise this authority, and who are fluent in the language for communications defined in Clause 3. [Law and Language]
14. Delegation	14.1 All these persons, including the Employer's Representative and assistants, to whom duties have been assigned or authority has been delegated, shall only be authorized to issue instructions to the Contractor to the extent defined by the delegation. Any approval, check, certificate, consent, examination, Inspection, instruction, notice, proposal, request, test, or similar act by a delegated person, in accordance with the delegation, shall have the same effect as though the act had been an act of the Employer. However: (a) unless otherwise stated in the delegated person's communication relating to such act, it shall not relieve the Contractor from any responsibility he has under the Contract, including responsibility for errors, omissions, discrepancies and non-compliances; (b) any failure to disapprove any work, Plant or Materials shall not constitute approval, and shall therefore not prejudice the right of the Employer to reject the work, Plant or Materials; and (c) if the Contractor questions any determination or instruction of a delegated person, the Contractor may refer the matter to the Employer, who shall promptly confirm, reverse or vary the determination or instruction.
15. Communications	15.1 Communications between parties that are referred to in the Conditions shall be effective only when in writing. Wherever these Conditions provide for the giving or issuing of approvals, certificates, consents, determinations, notices and requests, these communications shall be: (a) in writing and delivered by hand (against receipt), sent by mail or courier, or transmitted using any of the agreed systems of electronic transmission as stated in the SCC; and (b) delivered, sent or transmitted to the address for the recipient's communications as stated in the Contract. However: (i) if the recipient gives notice of another address,

	communications shall thereafter be delivered accordingly; and (ii) if the recipient has not stated otherwise when requesting an approval or consent, it may be sent to the address from which the request was issued.
16. Subcontracting	16.1 The Contractor shall not subcontract the maximum % value of whole Works, as stated in the SCC. The Contractor shall be responsible for the acts or defaults of any Subcontractor, his agents or employees, as if they were the acts or defaults of the Contractor. The Sub contractor shall meet the qualification requirement as specified in SCC. Where specified in the SCC, the Contractor shall give the Employer not less than Thirty (30) days' notice of: (a) the intended appointment of the Subcontractor, with detailed particulars which shall include his relevant experience, (b) the intended commencement of the Subcontractor's work, and (c) the intended commencement of the Subcontractor's work on the Site. 16.2 In the event of approved subcontracting the Contractor shall ensure that Subcontractors do not further sub-let their contract. 16.3 The Contractor shall not terminate the engagement of a subcontractor without the prior written consent of the Employer. 16.4 The Contractor shall keep a log showing the following information on the Sub-contractors, suppliers and transporters engaged in the contract works: • Name and Address • Copy of Subcontracting Agreement • Works and value contract • Commencement and completion dates • Copy of payment certificates
17. Other Contractors	17.1 The Contractor shall cooperate and share the Site with Other Contractors, public authorities, utilities, and the Employer between the dates given in the Schedule of Other Contractors, as stated in the SCC. The Contractor shall also provide facilities and services for them as described in the Schedule. The Employer may modify the Schedule of Other Contractors, and shall notify the Contractor of any such modification
18. Personnel and Equipment	18.1 The Contractor shall employ the key personnel and use the equipment identified in its Bid to carry out the Works, or other personnel and equipment approved by the Employer. The Employer shall approve any proposed replacement of key personnel and equipment only if their relevant qualifications or characteristics are substantially equal to or better than those proposed in the Bid.

	18.2 The Employer may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representative if applicable, who: (a) persists in any misconduct or lack of care, (b) carries out duties incompetently or negligently, (c) fails to conform with any provisions of the Contract, or (d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment. If appropriate, the Contractor shall then appoint (or cause to be appointed) a suitable replacement person. 18.3 The Contractor shall be responsible for all Contractor's Equipment. When brought on to the Site, Contractor's Equipment shall be deemed to be exclusively intended for the execution of the Works. 18.4 The Contractor shall submit, to the Employer, details showing the number of each class of Contractor's Personnel and of each type of Contractor's Equipment on the Site. 18.5 Details shall be submitted each calendar month, in a form approved by the Employer, until the Contractor has completed all work. 18.6 The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Contractor's Personnel, and to preserve peace and protection of persons and property on and near the Site. 18.7 Each item of Plant and Materials shall, to the extent consistent with the Laws of Nepal, become the property of the Employer at whichever is the earlier of the following times, free from liens and other encumbrances: (a) when it is delivered to the Site; (b) when the Contractor is entitled to payment of the value of the Plant and Materials under Clause 44. [Delays Ordered by the Employer].
19. Indemnities	19.1 The Contractor shall indemnify and hold harmless the Employer, the Employer's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of: (a) bodily injury, sickness, disease or death, of any person whatsoever arising out of or in the course of or by reason of the design, execution and completion of the Works and the remedying of any defects, unless attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents, and (b) damage to or loss of any property, real or personal (other than the Works), to the extent that such damage or loss; arises out of or in the course of or by reason of the Contractor's design (if any) , execution and completion of the Works and the remedying of any defects, and is

	not attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, their respective agents, or anyone directly or indirectly employed by any of them. 19.2 The Employer shall indemnify and hold harmless the Contractor, the Contractor's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of (a) bodily injury, sickness, disease or death, which is attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents, and (b) the matters for which liability may be excluded from insurance cover, as the Employer's right to have the Permanent Works executed on, over, under, in or through any land, and to occupy this land for the Permanent Works, damage which is an unavoidable result of the Contractor's obligations to execute the Works and remedy any defects, and causes under Employer's Risks, except to the extent that cover is available at commercially reasonable terms. 19.3 Neither Party shall be liable to the other Party for loss of use of any Works, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract, other than under Clause 83 [Payment upon Termination] and Clause 19.1. This Clause shall not limit liability in any case of fraud, deliberate default or reckless misconduct by the defaulting Party. 19.4 The Contractor shall take full responsibility for the care of the items listed in the SCC (if any), from the respective dates of use or occupation by the Contractor, up to the respective dates of hand-over or cessation of occupation (where hand-over or cessation of occupation may take place after the date stated in the Taking-Over Certificate for the Works). If any loss or damage happens to any of the above items while the Contractor is responsible for their care, arising from any cause whatsoever other than those for which the Employer is liable, the Contractor shall, at his own cost, rectify the loss or damage to the satisfaction of the Employer
20. Intellectual and Industrial Property Rights	20.1 In this Clause, "infringement" means an infringement (or alleged infringement) of any patent, registered design, copyright, trademark, trade name, trade secret or other Rights intellectual or industrial property right relating to the Works; and "claim" means a claim (or proceedings pursuing a claim) alleging an infringement. 20.2 Whenever a Party does not give notice to the other Party of any claim within Thirty (30) days of receiving the claim, the first Party shall be deemed to have waived any right to indemnity under this Clause. 20.3 The Employer shall indemnify and hold the Contractor harmless against and from any claim alleging an

	infringement which is or was: (a) an unavoidable result of the Contractor's compliance with the Employer's Requirements, or (b) a result of any Works being used by the Employer: (i) for a purpose other than that indicated by, or reasonably to be inferred from, the Contract, or (ii) in conjunction with anything not supplied by the Contractor, unless such use was disclosed to the Contractor prior to the Base Date or is stated in the Contract. 20.4 The Contractor shall indemnify and hold the Employer harmless against and from any other claim which arises out of or in relation to (i) the Contractor's design, manufacture, construction or execution of the Works, (ii) the use of Contractor's Equipment, or (iii) the proper use of the Works. 20.5 If a Party is entitled to be indemnified under this Clause, the indemnifying Party may (at its cost) conduct negotiations for the settlement of the claim, and any litigation or arbitration which may arise from it. The other Party shall, at the request and cost of the indemnifying Party, assist in contesting the claim. This other Party (and its Personnel) shall not make any admission which might be prejudicial to the indemnifying Party, unless the indemnifying Party failed to take over the conduct of any negotiations, litigation or arbitration upon being requested to do so by such other Party.
21. Employer's Risks	21.1 From the Commencement Date until the Defects Liability Certificate has been issued, the followings are Employer's risks: Occurrence of natural disaster such as earthquake, fire, Excessive rainfall (atibrishti), flood and landslide in such a way that affects the component of the project adversely or the Contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic. 21.3 If and to the extent that any of the risks listed in Clause 21.1 above results in loss or damage to the Works, Goods or Contractor's Documents, the Contractor shall promptly give notice to the Employer and shall rectify this loss or damage to the extent required by the Employer. 21.4 If the Contractor suffers delay and/or incurs Cost from rectifying this loss or damage, the Contractor shall give a further notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42 [Extension of Intended Completion Date], and (b) payment of any such Cost, which shall be added to the Contract Price. 21.5 After receiving this further notice, the Employer shall

	proceed in accordance with Clause 32 [Determinations] to agree or determine these matters.
22. Contractor's Risks	22.1 From the Commencement Date until the Defects Liability Certificate has been issued, the risks of personal injury, death, and loss of or damage to property (including, without limitation, the Design, Works, Plant, Materials, and Equipment) and other contractor's obligations mentioned in the Contract, which are not Employer's risks are Contractor's risks. 22.2 If any loss or damage happens to the Design, Works, Goods or Contractor's Documents during the period when the Contractor is responsible for their care, from any cause not listed in Clause 21.1, the Contractor shall rectify the loss or damage at the Contractor's risk and cost, so that the Design, Works, Goods and Contractor's Documents conform with the Contract. 22.3 The Contractor shall bear the risk for changes in the cost of materials, fuel or other prices due to variation in the currency exchange rate. 22.4 The Contractor shall bear the risk of increases in the cost of labour and materials (the inflation risk). In case of those outside the specified time period (contract period or extended contract period where the time extension has been granted to the Contractor by the Employer), the Contractor may act as per Clause 35 [Contractor's Claims]. 22.5 The Contractor shall bear all the risk including geological, professional and technical risk during execution of the project in design, procurement, construction and operation and maintenance stage.
23. Insurance	23.1 The Contractor shall be responsible for effecting and maintaining the insurance specified in the relevant Clause. Each insurance shall be effected with insurers and in terms approved by the Employer. These terms shall be consistent with any terms agreed by both Parties before they signed the Contract Agreement. 23.2 The Contractor shall provide insurance in the joint names of the Employer and the Contractor from the Commencement Date to the end of the Defects Liability Period, in the amounts and deductibles per occurrence of not more than the amount stated in the SCC for the following events which are due to the Contractor's risks: (a) loss of or damage to the Works, Plant, and Materials; (b) loss of or damage to Equipment; (c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and (d) Personal injury or death. (e) Liability for breach of professional duty Liability for breach of professional duty: To the extent that the

	Contractor is responsible for the design of part of the Permanent Works under the Contract, and consistent with the indemnities specified in Clause 19 [Indemnities]: (a) the Contractor shall effect and maintain professional indemnity insurance against liability arising out of any act, error or omission by the Contractor in carrying out the Contractor's design obligations in an amount not less than that stated in the SCC (if not stated, the amount agreed with the Employer); and (b) if stated in the SCC, such professional indemnity insurance shall also indemnify the Contractor against liability arising out of any act, error or omission by the Contractor in carrying out the Contractor's design obligations under the Contract that results in the Works (or Section or Part or major item of Plant, if any), when completed, not being fit for the purpose(s) for which they are intended under the Contract. The Contractor shall maintain this insurance for the period specified in the SCC. 23.3 The Contractor shall insure the Works, Plant, Materials and Contractor's Documents for not less than the full reinstatement cost including the costs of demolition, removal of debris and professional fees and profit. 23.4 The Contractor shall insure the Contractor's Equipment for not less than the full replacement value, including delivery to Site. For each item of Contractor's Equipment, the insurance shall be effective while it is being transported to the Site and until it is no longer required as Contractor's Equipment. 23.5 The Contractor shall insure against each Party's liability for any loss, damage, death or bodily injury which may occur to any physical property (except for Works and Contractor's Equipment) or to any person (except Contractor's Personnel), which may arise out of the Contractor's performance of the Contract and occurring before end of Defect Liability Period. 23.6 The Contractor shall effect and maintain insurance against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel. The Employer shall also be indemnified under the policy of insurance, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Employer or of the Employer's Personnel. The insurance shall be maintained in full force and effect during the whole time that these personnel are assisting in the execution of the Works. For a Subcontractor's employees, the insurance may be effected by the Subcontractor, but the Contractor shall be responsible for compliance with this Clause. 23.7 The contractor shall insure the engineering stage work such as survey, design and drawing in the form of professional liability insurance for not less than the cost assigned for the engineering stage, as a liability for breach

	of professional duty. 23.8 Policies, certificates and evidence of premium payment for insurance shall be delivered by the Contractor to the Employer for the Employer's approval before the Commencement Date. All such insurance shall provide for compensation to be payable in the proportions of Nepali Rupees required to rectify the loss or damage incurred. 23.9 If the Contractor does not provide any of the policies and certificates required, the Employer may affect the insurance which the Contractor should have provided and recover the premiums the Employer has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due. 23.10 The Contractor shall keep the insurers informed of any relevant changes to the execution of the Works and ensure that insurance is maintained in accordance with this Clause. 23.11 Nothing in this Clause limits the obligations, liabilities or responsibilities of the Contractor, under the other terms of the Contract or otherwise. Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with these obligations, liabilities or responsibilities. However, if the Contractor fails to effect and keep in force an insurance which is available and which it is required to effect and maintain under the Contract, and the Employer neither approves the omission nor effects insurance for the coverage relevant to this default, any moneys which should have been recoverable under this insurance shall be paid by the Contractor. 23.12 Alterations to the terms of insurance shall not be made without the approval of the Employer. 23.13 Both parties shall comply with any conditions of the insurance policies.
24. Site Data and Reports	24.1 The Contractor, in preparing the Bid, shall rely on conceptual design report or any such report referred to in the SCC, made available by the Employer, supplemented by any information available to the Contractor. The Contractor shall be responsible for verifying and interpreting all such data. The employer shall not bear the risk of the accuracy or discrepancy of the study report provided to the contractor. 24.2 To the extent which was practicable (taking account of cost and time), the Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Tender or Works. To the same extent, the Contractor shall be deemed to have inspected and examined the Site, its surroundings, the above data and other available information, and to have been satisfied before submitting the Tender as to all relevant matters, including (without limitation):

	(a) the form and nature of the Site, including sub-surface conditions, (b) the hydrological and climatic conditions, (c) the extent and nature of the work and Goods necessary for the execution and completion of the Works and the remedying of any defects, (d) the Laws, procedures and labour practices of Nepal, and (e) the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services
25. Contractor to Construct the Works	25.1 The Contractor shall construct and install the Works in accordance with the Employer's Requirements. 25.2 The Contractor shall set out the Works in relation to original points, lines and levels of reference specified in the Contract or notified by the Employer or Employer Representative. The Contractor shall be responsible for the correct positioning of all parts of the Works, and shall rectify any error in the positions, levels, dimensions or alignment of the Works. 25.3 The Employer shall not be responsible for the accuracy, sufficiency or completeness of the data provided.
26. Works to Be Completed within intended Completion Date	26.1 The Contractor may commence execution of the Works on the Commencement Date and shall carry out the Works in accordance with the Program submitted by the Contractor, as updated with the approval of the Employer, and complete them within the intended Completion Date abiding the fulfillment of the completion of the milestone of the project. 26.2 The Contractor shall confine his operations to the Site, and to any additional areas which may be obtained by the Contractor and agreed by the Employer as working areas. The Contractor shall take all necessary precautions to keep Contractor's Equipment and Contractor's Personnel within the Site and these additional areas, and to keep them off adjacent land. 26.3 During the execution of the Works, the Contractor shall keep the Site free from all unnecessary obstruction, and shall store or dispose of any Contractor's Equipment or surplus materials. The Contractor shall clear away and remove from the Site any wreckage, rubbish and Temporary Works which are no longer required. 26.4 Upon the issue of the Taking-Over Certificate for the Works, the Contractor shall clear away and remove all Contractors' Equipment, surplus material, wreckage, rubbish and Temporary Works. The Contractor shall leave the Site and the Works in a clean and safe condition. However, the Contractor may retain on Site, during the Defects Liability Period, such Goods as are required for the Contractor to fulfil obligations under the Contract.

27. Design by Contractor	27.1 The Contractor shall be deemed to have scrutinized, prior to bid submission, the Obligations the Employer's Requirements (including design criteria and calculations, if any). The Contractor shall carry out, and be responsible for the design of the Works and for the accuracy of such Employer's Requirements (including design criteria and calculations), except as stated in Clause 27.3. Design shall be prepared by qualified designers who (a) are engineers or other professionals, qualified, experienced and competent in the disciplines of the design for which they are responsible; (b) comply with the criteria (if any) stated in the Employer's Requirements; and (c) are qualified and entitled under applicable Laws to design the Works. 27.2 The Contractor's Documents shall comprise the technical documents specified in the Employer's Requirements, documents required to satisfy all regulatory approvals, and the documents described in the Clause 78. [Operating and Maintenance Manuals]. Unless otherwise stated in the Employer's Requirements, the Contractor's Documents shall be written in the language for communications defined in Clause 3. [Law and Language]]. 27.3 The Contractor shall prepare all Contractor's Documents, and shall also prepare any other documents necessary to instruct the Contractor's Personnel. 27.4 If the Employer's Requirements describe the Contractor's Documents which are to be submitted to the Employer for review, they shall be submitted accordingly, together with a notice as described below. In the following provisions of this Clause, (i) "review period" means the period required by the Employer for review, and (ii) "Contractor's Documents" exclude any documents which are not specified as being required to be submitted for review. 27.5 Unless otherwise stated in the Employer's Requirements, each review period shall not exceed Forty-five (45) days, calculated from the date on which the Employer receives a Contractor's Document and the Contractor's notice. This notice shall state that the Contractor's Document is considered ready, both for review in accordance with this Clause and for use. The notice shall also state that the Contractor's Document complies with the Contract, or the extent to which it does not comply. 27.6 The Employer may, within the review period, give notice to the Contractor of approval or that a Contractor's Document fails (to the extent stated) to comply with the Contract. If a Contractor's Document so fails to comply, it shall be rectified, resubmitted and reviewed in accordance with this Clause, at the Contractor's cost. During underground work, if site condition differs the condition considered in design, the Contractor shall revise the design as per new condition, submit to employer and shall get approval letter and shall start the work. 27.7 For each part of the Works, and except to the extent that the

	Parties otherwise agree: (a) execution of such part of the Works shall not commence prior to the expiry of the review periods for all the Contractor's Documents which are relevant to its design and execution; (b) execution of such part of the Works shall be in accordance with these Contractor's Documents, as submitted for review; and (c) if the Contractor wishes to modify any design or document which has previously been submitted for review, the Contractor shall immediately give notice to the Employer. Thereafter, the Contractor shall submit revised documents to the Employer in accordance with the above procedure. 27.8 No examination or lack of examination of whatsoever nature by the Employer, or Employer's Representatives or Employer Personnel of the Contractor's drawings, documents, calculations or details relating to the execution of the Works or otherwise nor any certification, comment, rejection or approval expressed by such persons in regard thereto, either with or without modification, shall in any respect relieve or absolve the Contractor from any obligations or liability under or in connection with the Contract. 27.9 The design, the Contractor's Documents, the execution and the completed Works shall comply with Nepal's technical standards, building, construction and environmental Laws, Laws applicable to the product being produced from the Works, and other standards specified in the Employer's Requirements, applicable to the Works, or defined by the applicable Laws. 27.10 All these Laws shall, in respect of the Works and each Section, be those prevailing when the Works are taken over by the Employer under Clause 76 [Taking Over of the Works]. References in the Contract to published standards shall be understood to be references to the edition applicable on the Base Date, unless stated otherwise. 27.11 If changed or new applicable standards come into force in Nepal after the Base Date, the Contractor shall give notice to the Employer and (if appropriate) submit proposals for compliance. In the event that: (a) the Employer determines that compliance is required, and (b) the proposals for compliance constitute a variation, then the Employer shall initiate a Variation in accordance with Clause 53 [Variations]. 27.12 The Contractor shall carry out the training of Employer's Personnel in the operation and maintenance of the Works to the extent specified in the Employer's Requirements. If the Contract specifies training which is to be carried out before taking-over, the Works shall not be considered to be completed for the purposes of taking-over under Clause 76.

	[Taking Over of the Works] until this training has been completed. 27.13 If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the Contractor's Documents, they and the Works shall be corrected at the Contractor's cost, notwithstanding any consent or approval under this Clause.
28. Safety, Security and Protection of the Environment	28.1 The Contractor shall: (a) comply with all applicable safety regulations, (b) take care for the safety of all persons entitled to be on the Site, (c) use reasonable efforts to keep the Site and Works clear of unnecessary obstruction so as to avoid danger to these persons, (d) provide fencing, lighting, guarding and watching of the Works until completion and taking over under Clause 76. [Taking Over of the Works], and (e) provide any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land 28.2 The Contractor shall not interfere unnecessarily or improperly with: (a) the convenience of the public, or (b) the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Employer or of others. 28.3 The Contractor shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from any such unnecessary or improper interference. 28.4 Unless otherwise stated in the contract: (a) The Contractor shall be responsible for keeping unauthorized persons off the Site, and (b) authorized persons shall be limited to the Contractor's Personnel and the Employer's Personnel; and to any other personnel notified to the Contractor, by (or on behalf of) the Employer, as authorized personnel of the Employer's other contractors on the Site. 28.5 The Contractor shall take all reasonable steps to protect the environment (both on and off the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations. The Contractor shall ensure that any cut or fill slopes are planted in grass or other plant cover as soon as possible to protect them from erosion. Any spoil or material removed from drains shall be disposed of to designated stable tipping areas as directed by the Employer. 28.6 The Contractor shall ensure that emissions, surface

	discharges and effluent from the Contractor's activities shall not exceed the values indicated in the Employer's Requirements, and shall not exceed the values prescribed by applicable Laws. 28.7 The Employer shall have the power to disallow any working practice or activity of the Contractor or direct that such practices or activities be modified should the Employer consider, on the advice of the relevant Government Departments, that the practices or activities will be harmful to wildlife. 28.8 The Contractor shall provide on the Site such lifesaving apparatus as may be appropriate and an adequate and easily accessible first aid outfit or such outfits as may be required by any government ordinance, factory act, etc., subsequently published and amended from time to time.
29. Discoveries	29.1 Anything of historical or fossils, coins, articles of value or antiquity, and structures or other interest or of significant value unexpectedly discovered on the Site, shall be the property of the Employer. The Contractor shall notify the Employer of such discoveries and carry out the Employer's instructions for dealing with them. 29.2 The Contractor shall take reasonable precautions to prevent Contractor's Personnel or other persons from removing or damaging any of these findings. 29.3 If the Contractor suffers delay and/or incurs Cost from complying with the instructions, the Contractor shall give a further notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42. [Extension of Intended Completion Date] , and (b) payment of any such Cost, which shall be added to the Contract Price. 29.4 After receiving this further notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine these matters.
30. Possession of the Site and it's Access	30.1 The Employer shall give the Contractor right of access to, and possession of, all the Site parts of the Site within the time (or times) stated in the SCC. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give (to the Contractor) possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner stated in the Employer's Requirements. However, the Employer may withhold any such right or possession until the Performance Security has been received. If no such time is stated in the SCC, the Employer shall give the Contractor right of access to, and possession of, the Site with effect from the Commencement Date. 30.2 Until the Performance Certificate has been issued, the

	Contractor shall have the right of access to all parts of the Works and to records of the operation and performance of the Works, except as may be inconsistent with the Employer's reasonable security restrictions. 30.3 If right of access to, and possession of a part is not given by the date stated in the SCC, the Employer shall be deemed to have delayed the start of the relevant activities, and this shall be a Compensation Event. 30.4 The Contractor shall allow the Employer and any person authorized by the Employer access to the Site and to any place where work in connection with the Contract is being carried out or is intended to be carried out.
31. Access Route and Transport of Goods	31.1 The Contractor shall be deemed to have been satisfied as to the suitability and availability of access routes to the Site. The Contractor shall use reasonable efforts to prevent any road or bridge from being damaged by the Contractor's traffic or by the Contractor's Personnel. These efforts shall include the proper use of appropriate vehicles and routes. 31.2 Except as otherwise stated in these Conditions: (a) the Contractor shall (as between the Parties) be responsible for any maintenance which may be required for his use of access routes; (b) the Contractor shall provide all necessary signs or directions along access routes, and shall obtain any permission which may be required from the relevant authorities for his use of routes, signs and directions; (c) the Employer shall not be responsible for any claims which may arise from the use or otherwise of any access route, (d) the Employer does not guarantee the suitability or availability of particular access routes, and (e) Costs due to non-suitability or non-availability, for the use required by the Contractor, of access routes shall be borne by the Contractor. 31.3 Unless otherwise stated in the SCC: (a) the Contractor shall give the Employer not less than Twenty-one (21) days' notice of the date on which any Plant or a major item of other Goods will be delivered to the Site; (b) the Contractor shall be responsible for packing, loading, transporting, receiving, unloading, storing and protecting all Goods and other things required for the Works; and (c) the Contractor shall indemnify and hold the Employer harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from the transport of Goods, and shall negotiate and pay all claims arising from their transport.

32. Determinations	32.1 When carrying out his/her duties under this Clause, the Employer's Representative shall not be deemed to act for the Employer. Whenever these Conditions provide that the Employer shall proceed in accordance with this Clause 32 [Determination] to agree or determine any matter, the Employer shall consult with the Contractor in an endeavor to reach agreement. If agreement is not achieved, the Employer shall make a fair determination in accordance with the Contract, taking due regard of all relevant circumstances. 32.2 The Employer shall give notice to the Contractor of each agreement or determination, with supporting particulars. Each Party shall give effect to each agreement or determination, unless the Contractor gives notice, to the Employer, of his dissatisfaction with a determination within Fifteen (15) days of receiving it. After then, parties shall proceed as per Clause 36. [Dispute Settlement] or Clause 37 [Dispute Settlement by Arbitration].
33. Instructions, Inspections and Audits	33.1 The Employer may issue to the Contractor instructions which may be necessary for the Contractor to perform his obligations under the Contract. The Contractor shall carry out all instructions of the Employer, or from the Employer's Representative or an assistant to whom the appropriate authority which comply with the applicable laws where the Site is located. 33.2 Each instruction shall be given in writing and shall state the obligations to which relates and the Clause (or other term of the Contract) in which the obligations are specified. If any such instruction constitutes a Variation, Clause 53 [Variations] shall apply. 33.3 The Contractor shall keep, and shall make all reasonable efforts to cause its Subcontractors and consultant [if any] to keep accurate and systematic accounts and records in respect of the Works in such form and details as will clearly identify relevant time changes and costs. 33.4 The Contractor shall permit the GoN/DP and/or persons appointed by the GoN/DP to inspect the Site and/or the accounts and records of the Contractor and its sub-contractors relating to the performance of the Contract, and to have such accounts and records audited by auditors appointed by the GoN/DP if required by the GoN/DP. The Contractor's attention is drawn to Clause 84.2 which provides, inter alia, that acts intended to materially impede the exercise of the GoN's/DP's inspection and audit rights provided for under this Clause constitute an obstructive practice subject to contract termination.
34. Employer's Claims	34.1 If the Employer considers himself to be entitled to any payment under any Clause of these Conditions or otherwise in connection with the Contract, and/or to any extension of the Defects Liability Period, he shall give notice and particulars to the Contractor. 34.2 The notice shall be given as soon as practicable after the

	Employer became aware of the event including the condition of non-compliance with the milestone or circumstances giving rise to the claim. A notice relating to any extension of the Defects Liability Period shall be given before the expiry of such period. 34.3 The particulars shall specify the Clause or other basis of the claim, and shall include substantiation of the amount and/or extension to which the Employer considers himself to be entitled in connection with the Contract. The Employer shall then proceed in accordance with Clause 32 [Determinations] to agree or determine (i) the amount (if any) which the Employer is entitled to be paid by the Contractor, and/or (ii) the extension (if any) of the Defects Liability Period in accordance with Clause 49.2. 34.4 The Employer may deduct this amount from any moneys due, or to become due, to the Contractor. The Employer shall only be entitled to set off against or make any deduction from an amount due to the Contractor, or to otherwise claim against the Contractor, in accordance with this Clause or with sub-paragraph (a) and/or (b) of Clause 55.6.
35. Contractor's Claims	35.1 If the Contractor considers himself to be entitled to any extension of the Time for Completion and/or any additional payment, under any Clause of these Conditions or otherwise in connection with the Contract, the Contractor shall give notice to the Employer of such Compensation Events or cause of additional payments, describing the event or circumstance giving rise to the claim. The notice shall be given as soon as practicable, and not later than Twenty-one (21) days after the Contractor became aware, or should have become aware, of the event or circumstance. 35.2 If the Contractor fails to give notice of a claim within such period of Twenty-one (21) days, the Time for Completion shall not be extended, the Contractor shall not be entitled to additional payment, and the Employer shall be discharged from all liability in connection with the claim. 35.3 The Contractor shall also submit any other notices which are required by the Contract, and supporting particulars for the claim, all as relevant to such event or circumstance. 35.4 The following shall be Compensation Events: (a) The Employer does not give access to a part of the Site by the Site Possession Date pursuant to GCC 30.1. (b) The Employer modifies the Schedule of Other Contractors in a way that affects the work of the Contractor under the Contract. (c) The Employer instructs the Contractor to uncover or to carry out additional tests upon work, which is then found to have no defects. (d) The Employer unreasonably does not approve a subcontract to be let. (e) The Employer gives an instruction for dealing with an

	unforeseen condition, caused by the Employer, or additional work required for safety or other reasons. (f) Other contractors, public authorities, utilities, or the Employer does not work within the dates and other constraints stated in the Contract, and they cause delay or extra cost to the Contractor. (g) The advance payment is delayed. (h) The effects on the Contractor of any of the Employer's Risks. (i) The Employer unreasonably delays issuing a Certificate of Completion. 35.5 The Contractor shall not be entitled to compensation to the extent that the Employer's interests are adversely affected by the Contractor's not having given early warning or not having cooperated with the Employer. Also, all events (like monsoon rain, festivals, government holidays etc.), what shall sure to be occurred during the Contract Period; shall not be Compensation Event. If the contractor has not completed any activity as per the milestone, without having any compensation event, such activities shall be subjected to liquidated damages. 35.6 The Contractor shall keep such contemporary records as may be necessary to substantiate any claim, either on the Site or at another location acceptable to the Employer. Without admitting liability, the Employer may, after receiving any notice under this Clause, monitor the record-keeping and/or instruct the Contractor to keep further contemporary records. The Contractor shall permit the Employer to inspect all these records, and shall (if instructed) submit copies to the Employer. 35.7 Within Twenty-one (21) days after the Contractor became aware (or should have become aware) of the event or circumstance giving rise to the claim, or within such other period as may be proposed by the Contractor and approved by the Employer, the Contractor shall send to the Employer a fully detailed claim which includes full supporting particulars of the basis of the claim and of the extension of time and/or additional payment claimed. If the event or circumstance giving rise to the claim has a continuing effect: (a) this fully detailed claim shall be considered as interim; (b) the Contractor shall send further interim claims at monthly intervals, giving the accumulated delay and/or amount claimed, and such further particulars as the Employer may reasonably require; and (c) the Contractor shall send a final claim within Thirty (30) days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the Contractor and approved by the Employer. 35.8 Within Twenty-one (21) days after receiving a claim or any

	further particulars supporting a previous claim, or within such other period as may be proposed by the Employer and approved by the Contractor, the Employer shall respond with approval, or with disapproval and detailed comments. He may also request any necessary further particulars, but shall nevertheless give his response on the principles of the claim within such time. 35.9 Each interim payment shall include such amounts for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claim as he has been able to substantiate. 35.10 The Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine (i) the extension (if any) of the Time for Completion (before or after its expiry) in accordance with Clause 42 [Extension of Intended Completion Date], and/or (ii) the additional payment (if any) to which the Contractor is entitled under the Contract. 35.11 The requirements of this Clause are in addition to those of any other Clause which may apply to a claim. If the Contractor fails to comply with this or another Clause in relation to any claim, any extension of time and/or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded the Clause 35.2.
36. Dispute Settlement	36.1 The Employer and the Contractor shall attempt to settle amicably by direct negotiation any disagreement or dispute arising between them under or in connection with the Contract. 36.2 Any dispute between the Parties as to matters arising pursuant to this Contract which cannot be settled amicably within Thirty (30) days after receipt by one Party of the other Party's request for such amicable settlement may be referred to Arbitration within Thirty (30) days after the expiration of amicable settlement period.
37. Dispute Settlement by Arbitration	37.1 Unless settled amicably, any dispute shall be finally settled by arbitration. The arbitration shall be conducted in accordance with the arbitration procedures at the place given in the SCC. The Arbitration Act, 2055 (1999) shall be the governing law for arbitration process. 37.2 The arbitrator(s) shall have full power to open up, review and revise any certificate, determination, instruction, and opinion or valuation of (or on behalf of) the Employer, relevant to the dispute.
B. STAFF AND LABOR	

38. Staff, Labour and their facilities	38.1 The Contractor shall make arrangements for the engagement of all staff and labour, local or otherwise, and for their payment, housing, feeding and transport. 38.2 The Contractor shall pay rates of wages, and observe conditions of labour, which are not lower than those established for the trade or industry where the work is carried out. 38.3 The Contractor shall not employ forced labor, which consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty. This covers any kind of involuntary or compulsory labor, such as indentured labor, bonded labor, or similar labor-contracting arrangements. 38.4 The Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Employer's Personnel. 38.5 The Contractor shall comply with all the relevant labour Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights. 38.6 The Contractor shall require his employees to obey all applicable Laws, including those concerning safety at work. 38.7 The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the Permanent Works. 38.8 The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with local health authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay and ambulance service are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. 38.9 The Contractor shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility, and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the execution of the Works, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority. 38.10 The Contractor shall send, to the Employer, details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety and welfare of persons, and damage to property, as the Employer may reasonably require. 38.11 Except as otherwise stated in the Employer's

	Requirements, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel. The Contractor shall also provide facilities for the Employer's Personnel as stated in the Employer's Requirements. 38.12 Key Personnel: If no Key Personnel are specified in the Employer's Requirements this Clause shall not apply. The Contractor shall appoint the natural persons named in the Bid to the positions of Key Personnel. If not so named, or if an appointed person fails to act in the relevant position of Key Personnel, the Contractor shall submit to the Employer for consent the name and particulars of another person the Contractor proposes to appoint to such position. If consent is withheld or subsequently revoked, the Contractor shall similarly submit the name and particulars of a suitable replacement for such position. If the Employer does not respond within Fifteen (15) days after receiving any such submission, by giving a Notice stating an objection to the appointment of such person (or replacement) with reasons, the Employer shall be deemed to have given the Employer's consent. The Contractor shall not, without the Employer's prior consent, revoke the appointment of any of the Key Personnel or appoint a replacement (unless the person is unable to act as a result of death, illness, disability or resignation, in which case the appointment shall be deemed to have been revoked with immediate effect and the appointment of a replacement shall be treated as a temporary appointment until the Employer gives his/her consent to this replacement, or another replacement is appointed, under this Clause). All Key Personnel shall be based at the Site (or, where Works are being executed off the Site, at the location of the Works) for the whole time that the Works are being executed. If any of the Key Personnel is to be temporarily absent during execution of the Works, a suitable replacement shall be temporarily appointed, subject to the Employer's prior consent. All Key Personnel shall be fluent in the language for communications defined in Clause 3. [Law and Language]
39. Child Labor	39.1 The Contractor shall not employ any child to perform any work including work, that is economically exploitative, or is likely to be hazardous to, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. 'Child' means a child below the statutory minimum age specified under applicable national law. Where national laws have provisions for employment of minors, the Contractor shall follow those laws applicable to the Contractor. Children below the age of 18 years shall not be employed in dangerous work.

40. Non-discrimination and Equal Opportunity	40.1 The Contractor shall not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment relationship on the principle of equal opportunity and fair treatment, and shall not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline. In countries where national law provides for non-discrimination in employment, the Contractor shall comply with national law. When national laws are silent on nondiscrimination in employment, the Contractor shall meet this Sub-Clause's requirement. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination.
C. TIME CONTROL	
41. Program and Progress	41.1 Within the time stated in the SCC, after the date of the Letter of Acceptance, the Contractor shall submit to the Employer for approval a Program showing the general methods, arrangements, order, and timing for all the activities consistent with those in the Activity Schedule. 41.2 Unless otherwise stated in the Contract, each program shall include: (a) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each major stage of the Works, (b) the periods for reviews for Contractor's Documents, (c) the sequence and timing of inspections and tests specified in the Contract, and (d) a supporting report which includes: (i) a general description of the methods which the Contractor intends to adopt for the execution of each major stage of the Works, and; (ii) the approximate number of each class of Contractor's Personnel and of each type of Contractor's Equipment for each major stage. 41.3 Whenever the previous program is inconsistent with actual progress or with the Contractor's obligations, an update of the Program shall be done by the Contractor showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities. 41.4 The Contractor shall submit an updated Activity Schedule within Fifteen (15) days of being instructed to by the Employer's Representative, for approval. 41.5 The Employer approval of the Program shall not alter the

	Contractor's obligations. The Contractor may revise the Program and submit it to the Employer again at any time. 41.6 The Contractor shall have to keep daily log of all the activities in a format approved by the Employer. The daily log shall not constitute nor take the place of any notice required to be given by Contractor to Employer pursuant to the Contract Documents. The daily log shall document all activities at the Project site including, but not limited to, the following: (i.) Weather conditions showing the high and low temperatures during work hours, the amount of precipitation received on the Project site, and any other weather conditions which adversely affect the Work; (ii.) Soil conditions which adversely affect the Work; (iii.) The hours of operation by Contractor and subcontractor's personnel; (iv.) The number of Contractor and subcontractor's personnel present and working at the Project site, by subcontract and trade; (v.) All equipment present at the Project site, description of equipment use and designation of time equipment was used (specifically indicating any down time); (vi.) Description of Work being performed at the Project site; (vii.) Any unusual or special occurrences at the Project site; (viii.) Materials received at the Project site; and (ix.) A list of all visitors to the Project site. 41.7 Unless otherwise stated in the SCC, monthly progress reports shall be prepared by the Contractor and submitted to the Employer in six copies or as stated in the SCC. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within Seven (7) days after the last day of the period to which it relates. Reporting shall continue until the Contractor has completed all work which is known to be outstanding at the completion date stated in the Taking-Over Certificate for the Works. Each report shall include: (a) charts and detailed descriptions of progress, including each stage of design, Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection, testing, commissioning and trial operation; (b) photographs showing the status of manufacture and of progress on the Site; (c) for the manufacture of each main item of Plant and Materials, the name of the manufacturer, manufacture

	location, percentage progress, and the actual or expected dates of: (i) commencement of manufacture, (ii) Contractor's inspections, (iii) tests, and (iv) shipment and arrival at the Site; (d) the details described in Clause 18.4,18.5; (e) copies of quality assurance documents, test results and certificates of Materials; (f) list of Variations, notices given under Clause 34. [Employer's Claims] and notices given under Clause 35. [Contractor's Claims] ; (g) safety statistics, including details of any hazardous' incidents and activities relating to environmental aspects and public relations; and (h) comparisons of actual and planned progress, with details of any events or circumstances which may jeopardize the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome delays.
42. Extension of the Intended Completion Date	42.1 The Contractor shall be entitled to an extension of the Time for Completion if natural disaster such as earthquake, fire, <i>Excessive rainfall (atibrishti)</i>, flood and landslide occurs and affects the component of the project adversely or the contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic.
43. Acceleration	43.1 When the Employer wants the Contractor to finish before the Intended Completion Date, the Employer shall obtain priced proposals for achieving the necessary acceleration from the Contractor. If the Employer accepts these proposals, the Intended Completion Date shall be adjusted accordingly and confirmed by both the Employer and the Contractor. 43.2 If the Contractor's priced proposals for acceleration are accepted by the Employer, they are incorporated in the Contract Price and treated as a Variation.
44. Delays Ordered by the Employer	44.1 The Employer may instruct the Contractor to delay or to suspend progress of part or all of the Works at any time instruct the Contractor. During such delay or suspension, the Contractor shall protect, store and secure such part or the Works against any deterioration, loss or damage.
45. Management Meetings	45.1 Either the Employer or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance

	with the early warning procedure. 45.2 The Employer shall record the business of management meetings and provide copies of the record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken shall be decided by the Employer either at the management meeting or after the management meeting and stated in writing to all who attended the meeting. 45.3 The Employer shall set pre-determined frequency of such meetings, as specified in the SCC
46. Early Warning	46.1 The Contractor shall warn the Employer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work, increase the Contract Price, or delay the execution of the Works. The Employer may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided by the Contractor as soon as reasonably possible. 46.2 The Contractor shall cooperate with the Employer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Employer.
D. QUALITY CONTROL	
47. Quality Assurance	47.1 The Contractor shall institute a quality assurance system to demonstrate compliance with the requirements of the Contract. The system shall be in accordance with the details stated in the Contract. The Employer shall be entitled to audit any aspect of the system. 47.2 Details of all procedures and compliance documents shall be submitted to the Employer for information before each design and execution stage is commenced. When any document of a technical nature is issued to the Employer, evidence of the prior approval by the Contractor himself shall be apparent on the document itself. 47.3 Compliance with the quality assurance system shall not relieve the Contractor of any of his duties, obligations or responsibilities under the Contract. 47.4 The Contractor shall carry out the manufacture of Plant, the production and manufacture of Materials, and all other execution of the Works: (a) in the manner (if any) specified in the Contract, (b) in a proper workmanlike and careful manner, in accordance with recognized good practice, and (c) with properly equipped facilities and non-hazardous Materials, except as otherwise specified in the Contract. 47.5 The Contractor shall submit samples to the Employer, for review

	in accordance with the procedures for Contractor's Documents, as specified in the Contract and at the Contractor's cost. Each sample shall be labelled as to origin and intended use in the Works. 47.6 The Employer's Personnel shall at all reasonable times: (a) have full access to all parts of the Site and to all places from which natural Materials are being obtained, and; (b) during production, manufacture and construction (at the Site and, to the extent specified in the Contract, elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of Materials. 47.7 The Contractor shall give the Employer's Personnel full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility. 47.8 In respect of the work which Employer's Personnel are entitled to examine, inspect, measure and/or test, the Contractor shall give notice to the Employer whenever any such work is ready and before it is covered up, put out of sight, or packaged for storage or transport. 47.9 The Employer shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or promptly give notice to the Contractor that the Employer does not require to do so. If the Contractor fails to give the notice, he shall, if and when required by the Employer, uncover the work and thereafter reinstate and make good, all at the Contractor's cost.
48. Tests	48.1 This Clause shall apply to all tests specified in the Contract, other than the Tests after Completion [as stated in SCC] 48.2 The Employer shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Employer may instruct the Contractor to search for a Defect and to uncover and test any work that the Employer considers may have a Defect. 48.3 If the Employer instructs the Contractor to carry out a test not specified in the Employer's Requirements to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect, the test shall be a Compensation Event. 48.4 The Contractor shall provide all apparatus, assistance, documents and other information, electricity, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. 48.5 The Contractor shall agree, with the Employer, the time and place for the specified testing of any Plant, Materials and other

	parts of the Works. 48.6 The Employer shall give the Contractor not less than 24 hours' notice of the Employer's intention to attend the tests. If the Employer does not attend at the time and place agreed, the Contractor may proceed with the tests, unless otherwise instructed by the Employer, and the tests shall then be deemed to have been made in the Employer's presence. 48.7 If the Contractor suffers delay and/or incurs Cost from complying with these instructions or as a result of a delay for which the Employer is responsible, the Contractor shall give notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42 [Extension of Intended Completion Date], and (b) payment of any such Cost, which shall be added to the Contract Price. After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine these matters. 48.8 The Contractor shall promptly forward to the Employer duly certified reports of the tests. When the specified tests have been passed, the Employer shall, endorse the Contractor's test certificate, or issue a certificate to him, to that effect. If the Employer has not attended the tests, he shall be deemed to have accepted the readings as accurate.
49. Correction of Defects	49.1 If, as a result of an examination, inspection, measurement or testing, any Plant, Materials, design or workmanship is found to be defective or otherwise not in accordance with the Contract, the Employer may reject the Plant, Materials, design or workmanship by giving notice to the Contractor, with reasons ; before the end of the Defects Liability Period, which begins at Completion, and is defined in the SCC. The Contractor shall then promptly make good the defect and ensure that the rejected item complies with the Contract. 49.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Employer's notice. Otherwise, The Defects Liability Period shall be extended for as long as Defects remain to be corrected. 49.3 If the Employer requires this Plant, Materials, design or workmanship to be retested, the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Employer to incur additional costs, the Contractor shall subject to Clause 34. [Employer's Claims] pay these costs to the Employer. 49.4 Notwithstanding any previous test or certification, the Employer may instruct the Contractor to:

	(a) remove from the Site and replace any Plant or Materials which is not in accordance with the Contract, (b) remove and re-execute any other work which is not in accordance with the Contract, and (c) execute any work which is urgently required for the safety of the Works, whether because of an accident, unforeseeable event or otherwise. 49.5 If the Contractor fails to comply with any such instruction, which complies with Clause 33 [Instructions, Inspection and Audits], the Employer shall be entitled to employ and pay other persons to carry out the work. Except to the extent that the Contractor would have been entitled to payment for the work, the Contractor shall subject to Clause 34. [Employer's Claims] pay to the Employer all costs arising from this failure. 49.6 If delivery and/or erection of Plant and/or Materials was suspended under Clause 44.2 or Clause 80 [Contractor's Entitlement to Suspend Work], the Contractor's obligations under this Clause shall not apply to any defects or damage occurring more than two years after the Defects Liability Period for the Plant and/or Materials would otherwise have expired. 49.7 If the work of remedying of any defect or damage may affect the performance of the Works, the Employer may require the repetition of any of the tests described in the Contract, including Tests on Completion and/or Tests after Completion [if applicable]. The requirement shall be made by notice within Thirty (30) days after the defect or damage is remedied. These tests shall be carried out in accordance with the terms applicable to the previous tests. 49.8 The Contractor shall, if required by the Employer, search for the cause of any defect, under the direction of the Employer. Unless the defect is to be remedied at the cost of the Contractor, the Cost of the search shall be agreed or determined in accordance with Clause 32. [Determinations] and shall be added to the Contract Price. 49.9 The contractor shall be liable to the project completed by him to the Latent Defect Liability period, if specified in the SCC.
50. Uncorrected Defects	50.1 If the Contractor has not corrected a Defect within the time specified in the Employer's notice, the Employer shall assess the cost of having the Defect corrected, and remedial work shall have to be executed at the risk and cost of the Contractor. The Employer may (at his option): (a) carry out the work himself or by others, in a reasonable manner and at the Contractor's risk and cost, and the Contractor shall subject to Clause 34 [Employer's Claims] pay to the Employer the costs reasonably incurred by the Employer in remedying the defect or damage; (b) agree or determine a reasonable reduction in the Contract Price in accordance with Clause 32 [Determinations]; or

	(c) if the defect or damage deprives the Employer of substantially the whole benefit of the Works or any major part of the Works, terminate the Contract as a whole, or in respect of such major part which cannot be put to the intended use. Without prejudice to any other rights, under the Contract or otherwise, the Employer shall then be entitled to recover all sums paid for the Works or for such part (as the case may be), plus financing costs and the cost of dismantling the same, clearing the Site and returning Plant and Materials to the Contractor. 50.2 If the defect or damage cannot be remedied expeditiously on the Site and the Employer gives consent, the Contractor may remove from the Site for the purposes of repair such items of Plant as are defective or damaged. This consent may require the Contractor to increase the amount of the Performance Security by the full replacement cost of these items, or to provide other appropriate security.
E. COST CONTROL	
51. Contract Price	51.1 The Contractor shall be deemed to have satisfied himself as to the Correctness and Sufficiency of the Contract Price. Unless otherwise stated in the Contract, the Contract Price covers all the Contractor's obligations under the Contract (including those under Provisional Sums, if any) and all things necessary for the proper design, execution and completion of the Works and the remedying of any defects. 51.2 The Contractor shall bear all costs and charges for special and/or temporary rights-of-way which he may require, including those for access to the Site. The Contractor shall also obtain, at his risk and cost, any additional facilities outside the Site which he may require for the purposes of the Works. 51.3 Each Provisional Sum shall only be used, in whole or in part, in accordance with the Employer's instructions, and the Contract Price shall be adjusted accordingly. The total sum paid to the Contractor shall include only such amounts, for the work, supplies or services to which the Provisional Sum relates, as the Employer shall have instructed. For each Provisional Sum, the Employer may instruct: (a) work to be executed (including Plant, Materials or services to be supplied) by the Contractor and valued under Clause 53. [Variations]; and/or (b) Plant, Materials or services to be purchased by the Contractor, for which there shall be added to the Contract Price less the original Provisional Sums: (i) the actual amounts paid (or due to be paid) by the Contractor, and (ii) a sum for overhead charges and profit, calculated as a percentage of these actual amounts by

	applying the relevant percentage rate (if any) stated in the Contract. 51.4 The Contractor shall, when required by the Employer, produce quotations, invoices, vouchers and accounts or receipts in substantiation. 51.5 In such lump sum contract, the Activity Schedule shall contain the priced activities for the Works to be performed by the Contractor. The Activity Schedule is used to monitor and control the performance of activities on which basis the Contractor will be paid. If payment for Materials on Site shall be made separately, the Contractor shall show delivery of Materials to the Site separately on the Activity Schedule. 51.6 Unless otherwise stated in the SCC: (a) payment for the Works shall be made on the basis of the lump sum Contract Price, subject to adjustments in accordance with the Contract; and (b) the Contractor shall pay all taxes, duties and fees required to be paid by him under the Contract, and the Contract Price shall not be adjusted for any of these costs, except otherwise as per the Clause 53.5
52. Changes in the Contract Price	52.1 The Activity Schedule shall be amended by the Contractor to accommodate changes of Program or method of working made at the Contractor's own discretion. Prices in the Activity Schedule shall not be altered when the Contractor makes such changes to the Activity Schedule.
53. Variations	53.1 No variation order shall be made unless and otherwise any addition or alteration to the work is made by the Employer. 53.2 Variations may be initiated by the Employer at any time, with or without request from the Contractor prior to issuing the Taking-Over Certificate for the Works. A Variation shall not comprise the omission of any work which is to be carried out by others. Each instruction to execute a Variation, with any requirements for the recording of Costs, shall be issued by the Employer to the Contractor, who shall acknowledge receipt. 53.3 The Contractor shall execute and be bound by each Variation, unless the Contractor promptly gives notice to the Employer stating (with supporting particulars) that (i) the Contractor cannot readily obtain the Goods required for the Variation, (ii) it will reduce the safety or suitability of the Works, or (iii) it will have an adverse impact on the achievement of the Performance Guarantees. Upon receiving this notice, the Employer shall cancel, confirm or vary the instruction 53.4 The Contractor may, at any time, submit to the Employer a written proposal which (in the Contractor's opinion) will, if adopted, (1) accelerate completion, (ii) reduce the cost to the Employer of executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the

	Employer. The proposal shall be prepared at the cost of the Contractor. The Employer shall, as soon as practicable after receiving such proposal, respond with approval, disapproval or comments. 53.5 Upon instructing or approving a Variation, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine adjustments to the Contract Price and the Schedule of Payments. These adjustments shall take account of the Contractor's submissions under Clause 53.3, if applicable. 53.6 Adjustments for Changes in Legislation: The Contract Price shall be adjusted to take account of any increase or decrease in Cost resulting from a change in the Laws of Nepal (including the introduction of new Laws and the repeal or modification of existing Laws) or in the judicial or official governmental interpretation of such Laws, made after the Base Date, which affect the Contractor in the performance of obligations under the Contract. If the Contractor suffers (or will suffer) delay and/or incurs (or will incur) additional Cost as a result of these changes in the Laws or in such interpretations, made after the Base Date, the Contractor shall give notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42. [Extension of Intended Completion Date], and (b) payment of any such Cost, which shall be added to the Contract Price. After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine these matters.
54. Cash Flow Forecasts	54.1 When the Program is updated, the Contractor shall provide the Employer with an updated cash flow forecast.
55. Interim Payment Certificate	55.1 The Contractor shall submit a Statement in six copies (or as stated in the SCC) to the Employer after the end of the period of payment stated in the SCC (if not stated, after the end of each month), in a form approved by the Employer, showing in detail the amounts to which the Contractor considers himself to be entitled, together with supporting documents which shall include the relevant report on progress in accordance with Clause 41 [Program and Progress]. 55.2 The Statement shall include the following items, as applicable, which shall be expressed in the various currencies in which the Contract Price is payable, in the sequence listed: (a) the estimated contract value of the Works executed and the Contractor's Documents produced up to the end of the month (including Variations but excluding items described in sub-paragraphs (b) to (f) below);

	(b) any amounts to be added and deducted for changes in legislation and changes in cost, in accordance with the Clause 53.5 and Clause 59. [Price Adjustments]; (c) any amount to be deducted for retention, calculated by applying the percentage of retention as per the Clause 60. [Retention] to the total of the above amounts, (d) any amounts to be added and deducted for the advance payment and repayments in accordance with Clause 63 [Advance Payment]; (e) any other additions or deductions which may have become due under the Contract or otherwise, including those under Clause 36 [Dispute Settlement], Clause 37 [Dispute Settlement by Arbitration]; and (f) the deduction of amounts included in previous Statements. 55.3 The estimated contract value of the Works executed shall comprise the value of completed activities in the Activity Schedule and/or as methodology stated in the SCC. 55.4 Schedule of Payments: If the Contract includes a Schedule of Payments specifying the installments in which the Contract Price will be paid, then unless otherwise stated in this Schedule: (a) the installments quoted in the Schedule of Payments shall be the estimated contract values for the purposes of subparagraph (a) of Clause 55.2, subject to Clause 55.5; and (b) if these installments are not defined by reference to the actual progress achieved in executing the Works, and if actual progress is found to be less than that on which the Schedule of Payments was based, then the Employer may proceed in accordance with Clause 32 [Determinations] to agree or determine revised installments, which shall take account of the extent to which progress is less than that on which the installments were previously based. If the Contract does not include a Schedule of Payments, the Contractor shall submit non-binding estimates of the payments which he expects to become due during each quarterly period. The first estimate shall be submitted within Forty-five (45) days after the Commencement Date. Revised estimates shall be submitted at quarterly intervals, until the Taking-Over Certificate has been issued for the Works. 55.5 If the Contractor is entitled, under the Contract, to an interim payment for Plant and Materials which are not yet on the Site, the Contractor shall nevertheless not be entitled to such payment unless: (a) the relevant Plant and Materials are in the Country and have been marked as the Employer's property in accordance with the Employer's instructions; or (b) the Contractor has delivered, to the Employer, evidence of insurance and a bank guarantee in a form and issued by an entity approved by the Employer in amounts and

	currencies equal to such payment. This guarantee may be in a similar form to the form referred to in Clause 63. [Advance Payment] and shall be valid until the Plant and Materials are properly stored on Site and protected against loss, damage or deterioration. 55.6 Payments due shall not be withheld, except that: (a) if anything supplied or work done by the Contractor is not in accordance with the Contract, the cost of rectification or replacement may be withheld until rectification or replacement has been completed; and/or (b) if the Contractor was or is failing to perform any work or obligation in accordance with the Contract, and had been so notified by the Employer, the value of this work or obligation may be withheld until the work or obligation has been performed. 55.7 The Employer may, by any payment, make any correction or modification that should properly be made to any amount previously considered due. Payment shall not be deemed to indicate the Employer's acceptance, approval, consent or satisfaction.
56. Payments	56.1 The Employer shall pay the Contractor the amounts certified by the Employer after assurance of the quality of the work as per the specification substantiated with the test report as enunciated in the Employers' requirement and in the activity schedule within Thirty (30) days of the date of each payment certificate. 56.2 If the Employer makes a late payment, the Contractor shall be paid interest as indicated in the SCC on the late payment in the next payment. Interest shall be calculated from the date by which the payment should have been made up to the date when the late payment is made. The Contractor shall be entitled to this payment without formal notice, and without prejudice to any other right or remedy. 56.3 If an amount certified is increased in a later certificate or as a result of an award by an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute. 56.3 Activities of the Works which are unpriced in the Activity Schedule, shall not be paid for by the Employer and shall be deemed covered by other activities prices in the Contract.
57. Tax	57.1 The Employer shall not adjust the Contract Price in case of change in taxes, duties, and other levies.
58. Currency	58.1 The currency of Contracts shall be Nepali Rupees.
59. Price Adjustment	59.1 The contract shall not be subjected to price adjustment in any case.

60. Retention	60.1 The Employer shall retain from each payment due to the Contractor the proportion stated in the SCC until the expiry of the Defect Liability Period. 60.2 Upon the issue of a Defects Liability Certificate by the Employer, in accordance with GCC 77.0, half the total amount retained shall be repaid to the Contractor and half when the Contractor has submitted the evidence of submission of tax return to the concerned Internal Revenue Office.
61. Liquidated Damages	61.1 If contractor fails to complete the section of work as per the milestone, the Employer shall charge liquidated damage as stated in the SCC, but if the contractor completes the whole project within the intended project completion date, the employer shall pay back the amount equivalent to the previously charged liquidated damage to the contractor. 61.2 If the Contractor fails to complete the works on or before the last date of intended completion date (initial or extended contract period where the time extension has been granted to the Contractor by the Employer period), the Contractor shall subject to Clause 34 [Employer's Claims] pay delay damages to the Employer for this default. These delay damages shall be the sum stated in the SCC, which shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate. 61.3 The total amount of liquidated damages shall not exceed the amount defined in the SCC. The Employer may deduct liquidated damages from payments due to the Contractor. However, in such case, the Employer shall extend the Intended Completion Date, which shall be subjected to the Liquidated Damage. 61.4 These delay damages shall be the only damages due from the Contractor for such default, other than in the event of termination under Clause 79 [Termination by Employer] prior to completion of the Works. These damages shall not relieve the Contractor from his obligation to complete the Works, or, from any other duties, obligations or responsibilities which he may have under the Contract.
62. Bonus	62.1 The Contractor shall be paid a Bonus calculated at the rate per calendar day stated in the SCC for each day (less any days for which the Contractor is paid for acceleration) that the Completion is earlier than the Initial Intended Completion Date. The Employer shall certify that the Works are complete, although they may not be due to be complete. 62.2 The total amount of Bonus shall not exceed the amount defined in the SCC.

63. Advance Payment	63.1 The Employer shall make an advance payment in two equal installments, as an interest-free loan for mobilization and design, when the Contractor submits an unconditional bank guarantee from 'A' class commercial Bank or Financial Institution in a form acceptable to the Employer in amounts equal to the advance payment, in accordance with this Clause including the details stated in the SCC. 63.2 The Contractor is to use the advance payment only to pay for Design, Equipment, Plant, Materials, and mobilization expenses required specifically for execution of the Contract. The Contractor shall demonstrate that advance payment has been used in this way by supplying copies of invoices or other documents to the Employer. 63.3 The guarantee shall remain effective until the advance payment has been repaid, but the amount of the guarantee shall be progressively reduced by the amounts repaid by the Contractor. 63.4 The advance payment shall be amortized at the rate for repayments as stated in SCC, and it shall be calculated by dividing the total amount of the advance payment by the Contract Price stated in the Contract Agreement Less Provisional Sums. 63.5 No account shall be taken of the advance payment or its repayment in assessing valuations of work done, Variations, price adjustments (if claimed under the contract), Compensation Events, Bonuses, or Liquidated Damages.
64. Securities	64.1 The Performance Security (including any additional performance securities {above 5% of contract price} required as per the Prevailing Public Procurement Act and Regulation) shall be provided to the Employer no later than the date specified in the Letter of Acceptance and shall be issued in an amount specified in the SCC, by a 'A' class commercial Bank or Financial Institution acceptable to the Employer, and denominated in Nepali Rupees. The Performance Security (other than additional performance securities) shall be valid until a date Thirty (30) days from the date of issue of the Defect Liability Certificate in the case of a bank guarantee. 64.2 Any additional performance securities {above 5% of contract price} as per Clause 64.1 shall be valid until a date Thirty (30) days from the date of Taking Over of the Works and shall be returned within Fifteen (15) days from the Taking Over of the Works. 64.3 The performance security issued by any foreign Bank outside Nepal must be counter guaranteed by an 'A' class commercial Bank or Financial Institution in Nepal. 64.4 The Employer shall not make a claim under the Performance Security, except for amounts to which the Employer is entitled under the Contract in the event of: (a) failure by the Contractor to extend the validity of the Performance Security as instructed by Employer, in

	which event the Employer may claim the full amount of the Performance Security, (b) failure by the Contractor to pay the Employer an amount due, as either agreed by the Contractor or determined under Clause 34 [Employer's Claims] or Clause 36 [Dispute Settlement] or Clause 37 [Dispute Settlement by Arbitration], within Forty-five (45) days after this agreement or determination, (c) failure by the Contractor to remedy a default within Forty-five (45) days after receiving the Employer's notice requiring the default to be remedied, or (d) circumstances which entitle the Employer to termination under Clause 79 [Termination by Employer], irrespective of whether notice of termination has been given. 64.5 The Employer shall indemnify and hold the Contractor harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from a claim under the Performance Security to the extent to which the Employer was not entitled to make the claim. 64.6 The Employer shall return the Performance Security (other than additional performance securities) to the Contractor within Twenty-one (21) days after the Contractor has become entitled to receive the Performance Certificate.
65. Day works	65.1 If applicable, the Day works rates in the Contractor's Bid shall be used for small additional amounts of work only when the Employer has given written instructions in advance for additional work to be paid for in that way. 65.2 For work of a minor or incidental nature, the Employer may instruct that a Variation shall be executed on a Dayworks basis. The work shall then be valued in accordance with the Dayworks schedule included in the Contract, and the following procedure shall apply. If a Dayworks schedule is not included in the Contract, this Clause shall not apply. 65.3 Before ordering Goods for the work, the Contractor shall submit quotations to the Employer. When applying for payment, the Contractor shall submit invoices, vouchers and accounts or receipts for any Goods. 65.4 Except for any items for which the Dayworks schedule specifies that payment is not due, the Contractor shall deliver each day to the Employer accurate statements in duplicate which shall include the following details of the resources used in executing the previous day's work: (a) the names, occupations and time of Contractor's Personnel, (b) the identification, type and time of Contractor's Equipment and Temporary Works, and (c) the quantities and types of Plant and Materials used. 65.5 One copy of each statement will, if correct, or when agreed,

	be signed by the Employer and returned to the Contractor. The Contractor shall then submit priced statements of these resources to the Employer, prior to their inclusion in the next Statement under Clause 55. [Interim Payment Certificates].
66. Cost of Repairs	66.1 Loss or damage to the Works or Materials to be incorporated in the Works between the Commencement Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.
F. FORCE MAJEURE	
67. Definition of Force Majeure	67.1 In this Clause, "Force Majeure" means an exceptional event or circumstance, natural disaster such as earthquake, fire, <i>Excessive rainfall (atibrishti)</i> , flood and landslide, if occurs and affects the component of the project adversely or the contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic.
68. Notice of Force Majeure	68.1 If a Party is or will be prevented from performing its substantial obligations under the Contract by Force Majeure, then it shall give notice to the other Party of the event or circumstances constituting the Force Majeure and shall specify the obligations, the performance of which is or will be prevented. The notice shall be given within Fifteen (15) days after the Party became aware, or should have become aware, of the relevant event or circumstance constituting Force Majeure. 68.2 The Party shall, having given notice, be excused performance of its obligations for so long as such Force Majeure prevents it from performing them. 68.3 Notwithstanding any other provision of this Clause, Force Majeure shall not apply to obligations of either Party to make payments to the other Party under the Contract.
69. Duty to Minimize Delay	69.1 Each Party shall at all times use all reasonable endeavors to minimize any delay in the performance of the Contract as a result of Force Majeure. 69.2 A Party shall give notice to the other Party when it ceases to be affected by the Force Majeure.
70. Consequences of Force Majeure	70.1 If the Contractor is prevented from performing its substantial obligations under the Contract by Force Majeure of which notice has been given under GCC 68, and suffers delay and/or incurs Cost by reason of such Force Majeure, the Contractor shall be entitled subject to GCC 37 to (a) an extension of time for any such delay, if completion is or will be delayed, under GCC42; and (b) if the event or circumstance is of the kind described in sub-paragraphs (a) to (d) of GCC 68.2 and, in the case of subparagraphs (b) to (d), occurs in Nepal, payment

	of any such Cost, including the costs of rectifying or replacing the Works and/or Goods damaged or destructed by Force Majeure, to the extent they are not indemnified through the insurance policy referred to in GCC 23. 70.2 After receiving this notice, the Employer shall proceed in accordance with GCC 32 [Determinations] to agree or determine these matters.
71. Force Majeure Affecting Subcontractor	71.1 If any Subcontractor is entitled under any contract or agreement relating to the Works to relief from force majeure on terms additional to or broader than those specified in this Clause, such additional or broader force majeure events or circumstances shall not excuse the Contractor's nonperformance or entitle him to relief under this Clause.
72. Optional Termination, Payment and Release	72.1 If the execution of substantially all the Works in progress is prevented for a continuous period of Ninety (90) days by reason of Force Majeure of which notice has been given under GCC 68, or for multiple periods which total more than 150 days due to the same notified Force Majeure, then either Party may give to the other Party a notice of termination of the Contract. In this event, the termination shall take effect Seven (7) days after the notice is given, and the Contractor shall proceed in accordance with GCC 79.5. 72.2 Upon such termination, the Employer shall determine the value of the work done and issue a Payment Certificate, which shall include: (a) the amounts payable for any work carried out for which a price is stated in the Contract; (b) the Cost of Plant and Materials ordered for the Works which have been delivered to the Contractor, or of which the Contractor is liable to accept delivery: this Plant and Materials shall become the property of (and be at the risk of) the Employer when paid for by the Employer, and the Contractor shall place the same at the Employer's disposal; (c) other Costs or liabilities which in the circumstances were reasonably and necessarily incurred by the Contractor in the expectation of completing the Works; (d) the Cost of removal of Temporary Works and Contractor's Equipment from the Site and the return of these items to the Contractor's works in his country (or to any other destination at no greater cost); and (e) the Cost of repatriation of the Contractor's staff and labor employed wholly in connection with the Works at the date of termination.
73. Release from Performance	73.1 Notwithstanding any other provision of this Clause, if any event or circumstance outside the control of the Parties (including, but not limited to, Force Majeure) arises, which makes it impossible or unlawful for either or both Parties to fulfill its or their contractual obligations or which, under the

	law governing the Contract, entitles the Parties to be released from further performance of the Contract, then upon notice by either Party to the other Party of such event or circumstance, (a) the Parties shall be discharged from further performance, without prejudice to the rights of either Party in respect of any previous breach of the Contract; and (b) the sum payable by the Employer to the Contractor shall be the same as would have been payable under GCC 72 if the Contract had been terminated under GCC 72.
G. FINISHING THE CONTRACT	
74. Test on Completion	74.1 The Contractor shall carry out the Tests on Completion (as stated in the SCC) in accordance with this Clause and Clause 48 [Tests] after providing the documents in accordance with Clause 78 [Operating and Maintenance Manuals]. 74.2 The Contractor shall give to the Employer not less than Twenty-one (21) days' notice of the date after which the Contractor will be ready to carry out each of the Tests on Completion. Unless otherwise agreed, Tests on Completion shall be carried out within Fifteen (15) days after this date, on such day or days as the Employer shall instruct. 74.3 Unless otherwise stated in the SCC, the Tests on Completion shall be carried out in the following sequence: (a) pre-commissioning tests, which shall include the appropriate inspections and ("dry" or "cold") functional tests to demonstrate that each item of Plant can safely under-take the next stage,(b); (b) commissioning tests, which shall include the specified operational tests to demonstrate that the Works can be operated safely and as specified, under all available operating conditions; and (c) trial operation, which shall demonstrate that the Works perform reliably and in accordance with the Contract. 74.4 During trial operation, when the Works are operating under stable conditions, the Contractor shall give notice to the Employer that the Works are ready for any other Tests on Completion, including performance tests to demonstrate whether the Works conform with criteria specified in the Employer's Requirements and with the Performance Guarantees. 74.5 Trial operation shall not constitute a taking-over under Clause 76 [Taking Over of the Works]. Unless otherwise stated in the SCC, any product produced by the Works during trial operation shall be the property of the

	Employer. 74.6 In considering the results of the Tests on Completion, appropriate allowances shall be made for the effect of any use of the Works by the Employer on the performance or other characteristics of the Works. As soon as the Works, have passed each of the Tests on Completion described in Clause 74.3 (a), (b) or (c), the Contractor shall submit a certified report of the results of these Tests to the Employer. 74.7 If the Tests on Completion are being unduly delayed by the Employer, Clause 48.7 and/or Clause 74.13, 74.14 shall be applicable. 74.8 If the Tests on Completion are being unduly delayed by the Contractor, the Employer may by notice require the Contractor to carry out the Tests within Twenty-one (21) days after receiving the notice. The Contractor shall carry out the Tests on such day or days within that period as the Contractor may fix and of which he shall give notice to the Employer. 74.9 If the Contractor fails to carry out the Tests on Completion; within the period of 21 days, the Employer's Personnel may proceed with the Tests at the risk and cost of the Contractor. These Tests on Completion shall then be deemed to have been carried out in the presence of the Contractor and the results of the Tests shall be accepted as accurate. 74.10 If the Works, fail to pass the Tests on Completion, Clause 49.1 shall apply, and the Employer or the Contractor may require the failed Tests, and Tests on Completion on any related work, to be repeated under the same terms and conditions. 74.11 If the Works, fail to pass the Tests on Completion repeated under Clause 74.10, the Employer shall be entitled to: (a) order further repetition of Tests on Completion under Clause 74.10; (b) if the failure deprives the Employer of substantially the whole benefit of the Works, reject the Works (as the case may be), in which event the Employer shall have the same remedies as are provided in sub-paragraph (c) of 50.1; or (c) issue a Taking-Over Certificate. 74.12 In the event of sub-paragraph (c), the Contractor shall proceed in accordance with all other obligations under the Contract, and the Contract Price shall be reduced by such amount as shall be appropriate to cover the reduced value to the Employer as a result of this failure. In such case, the extent of the failure shall be defined in the SCC or in the Employer's Requirements, minimum acceptable performance criteria shall also be specified. Unless the relevant reduction for this failure is stated (or its method of calculation is defined) in the Contract, the Employer may require the reduction to be (i) agreed by both Parties (in full

	satisfaction of this failure only) and paid before this Taking-Over Certificate is issued, or (ii) determined and paid under Clause 34. [Employer's Claims] and Clause 32. [Determinations]. 74.13 If the Contractor is prevented, for more than Fifteen (15) days, from carrying out the Tests on Completion by a cause for which the Employer is responsible, the Contractor shall carry out the Tests on Completion as soon as practicable. 74.14 If the Contractor suffers delay and/or incurs Cost as a result of this delay in carrying out the Tests on Completion, the Contractor shall give notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42 [Extension of Intended Completion Date], and (b) payment of any such Cost, which shall be added to the Contract Price. 74.15 After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine these matters.
75. Tests after Completion	75.1 If Tests after Completion are specified in the Contract, this Clause shall apply. Unless otherwise stated in the SCC: (a) The Employer shall provide all electricity, fuel and materials, and make the Employer's Personnel and Plant available; (b) the Contractor shall provide any other plant, equipment and suitably qualified and experienced staff, as are necessary to carry out the Tests after Completion efficiently; and (c) the Contractor shall carry out the Tests after Completion in the presence of such Employer's and/or Contractor's Personnel as either Party may reasonably request. 75.2 The Tests after Completion shall be carried out as soon as is reasonably practicable after the Works have been taken over by the Employer. The Employer shall give to the Contractor Twenty-one (21) days' notice of the date after which the Tests after Completion will be carried out. Unless otherwise agreed, these Tests shall be carried out within Fifteen (15) days after this date, on the day or days determined by the Employer. 75.3 The results of the Tests after Completion shall be compiled and evaluated by the Contractor, who shall prepare a detailed report. Appropriate account shall be taken of the effect of the Employer's prior use of the Works. 75.4 If the Contractor incurs Cost as a result of any unreasonable delay by the Employer to the Tests after Completion, the Contractor shall (i) give notice to the

	Employer and (ii) be entitled subject to Clause 35 [Contractor's Claims] to payment of any such Cost, which shall be added to the Contract Price. 75.5 After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine this Cost. 75.6 If, for reasons not attributable to the Contractor, a Test after Completion on the Works cannot be completed during the Defects Liability Period, then the Works shall be deemed to have passed this Test after Completion. 75.7 If the Works, fail to pass the Tests after Completion: (a) execute all work required to remedy defects or damage, as may be notified by the Employer on or before the expiry date of the Defects Liability Period for the Works, and (b) either Party may then require the failed Tests, and the Tests after Completion on any related work, to be repeated under the same terms and conditions. 75.8 If and to the extent that this failure and retesting are attributable to any of the matters listed below: (a) the design of the Works, (b) Plant, Materials or workmanship not being in accordance with the Contract, (c) improper operation or maintenance which was attributable to matters for which the Contractor is responsible (under Clauses 78 or otherwise), or (d) failure by the Contractor to comply with any other obligation. ; and cause the Employer to incur additional costs, the Contractor shall subject to Clause 34 [Employer's Claims] pay these costs to the Employer. 75.9 If the following conditions apply, namely: (a) the Works, fail to pass any or all of the Tests after Completion, (b) the relevant sum payable as non-performance damages for this failure is stated (or its method of calculation is defined) in the Contract, and (c) the Contractor pays this relevant sum to the Employer during the Defects Liability Period, then the Works shall be deemed to have passed these Test after Completion. then the Works or Section shall be deemed to have passed these Tests after Completion. In such case, the method of calculating the non-performance damages (based on the extent of the failure) shall be defined in the SCC or in the Employer's Requirements, and the minimum acceptable performance criteria shall also be specified. Results lower than minimum acceptable performance criteria, shall be cause of rejection of the

	Works or Section and Cost shall be recovered from the Contractor as determined as per the Clause 32. [Determinations]. 75.10 If the Works, fail to pass a Test after Completion and the Contractor proposes to make adjustments or modifications to the Works or such Section, the Contractor may be instructed by (or on behalf of) the Employer that right of access to the Works cannot be given until a time that is convenient to the Employer. The Contractor shall then remain liable to carry out the adjustments or modifications and to satisfy this Test, within a reasonable period of receiving notice by (or on behalf of) the Employer of the time that is convenient to the Employer. However, if the Contractor does not receive this notice during the relevant Defects Liability Period, the Contractor shall be relieved of this obligation and the Works (as the case may be) shall be deemed to have passed this Test after Completion. 75.11 If the Contractor incurs additional Cost as a result of any unreasonable delay by the Employer in permitting access to the Works or Plant by the Contractor, either to investigate the causes of a failure to pass a Test after Completion or to carry out any adjustments or modifications, the Contractor shall (i) give notice to the Employer and (ii) be entitled subject to Clause 35 [Contractor's Claims] to payment of any such Cost, which shall be added to the Contract Price. 75.12 After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine this Cost.
76. Taking Over of the Works	76.1 Except as stated in Clause 74.11 and Clause 74.12, the Works shall be taken over by the Employer when (i) the Works have been completed in accordance with the Contract, and except as allowed in Clause 76.3(a) below, and (ii) a Taking-Over Certificate for the Works has been issued, or is deemed to have been issued in accordance with this Clause. 76.2 The Contractor may apply by notice to the Employer for a Taking-Over Certificate not earlier than Fifteen (15) days before the Works will, in the Contractor's opinion, be complete and ready for taking over. 76.3 The Employer shall, within Thirty (30) days after receiving the Contractor's application: (a) issue the Taking-Over Certificate to the Contractor, stating the date on which the Works were completed in accordance with the Contract, except for any defects which will not substantially affect the use of the Works for their intended purpose (either until or whilst this work is completed and these defects are remedied); or (b) reject the application, giving reasons and specifying

	the work required to be done by the Contractor to enable the Taking-Over Certificate to be issued. The Contractor shall then complete this work before issuing a further notice under this Clause. 76.4 If the Employer fails either to issue the Taking-Over Certificate or to reject the Contractor's application within the period of Thirty (30) days, and if the Works (as the case may be) are substantially in accordance with the Contract, the Taking-Over Certificate shall be deemed to have been issued on the last day of that period
77. Final Account	77.1 Performance Certificate: Performance of the Contractor's obligations shall not be considered to have been completed until the Employer has issued the Performance Certificate to the Contractor, stating the date on which the Contractor completed his obligations under the Contract. The Employer shall issue the Performance Certificate within Thirty (30) days after the latest of the expiry dates of the Defects Liability Periods, or as soon thereafter as the Contractor has supplied all the Contractor's Documents and completed and tested all the Works, including remedying any defects. If the Employer fails to issue the Performance Certificate accordingly: (a) the Performance Certificate shall be deemed to have been issued on the date Thirty (30) days after the date on which it should have been issued, as required by this Clause, and (b) The Clause 89.1 and sub-paragraph (a) of Clause 77.7 shall be inapplicable. Only the Performance Certificate shall be deemed to constitute acceptance of the Works. 77.2 Within Sixty (60) days after receiving the Performance Certificate, the Contractor shall submit, to the Employer, six copies of a draft Final Account with supporting documents showing in detail in a form approved by the Employer: (a) the value of all work done in accordance with the Contract, and (b) any further sums which the Contractor considers to be due to him under the Contract or otherwise. 77.3 If the Employer disagrees with or cannot verify any part of the draft Final Account, the Contractor shall submit such further information as the Employer may reasonably require and shall make such changes in the draft as may be agreed between them. The Contractor shall then prepare and submit to the Employer the Final Account as agreed. This agreed statement is referred to in these Conditions as the "Final Account". 77.4 However if, following discussions between the Parties and any changes to the draft Final Account which are agreed, it becomes evident that a dispute exists, the Employer shall pay the agreed parts of the draft Final Account in accordance with Clause 55 [Interim Payment Certificate]. Thereafter, if the dispute is finally resolved under Clause 36 [Dispute

	Settlement] or Clause 37 [Dispute Settlement by Arbitration], the Contractor shall then prepare and submit to the Employer a Final Account. 77.5 When submitting the Final Account, the Contractor shall submit a written discharge which confirms that the total of the Final Account represents full and final settlement of all moneys due to the Contractor under or in connection with the Contract. This discharge may state that it becomes effective when the Contractor has received the Performance Security and the out-standing balance of this total, in which event the discharge shall be effective on such date. 77.6 Within Forty-five (45) days after receiving the Final Account and written discharge, the Employer shall pay to the Contractor the amount which is finally due, less all amounts previously paid by the Employer and any deductions in accordance with Clause 34 [Employer's Claims] 77.7 The Employer shall not be liable to the Contractor for any matter or thing under or in connection with the Contract or execution of the Works, except to the extent that the Contractor shall have included an amount expressly for it, in the Final Account. However, this Clause shall not limit the Employer's liability under his indemnification obligations, or the Employer's liability in any case of fraud, deliberate default or reckless misconduct by the Employer.
78. Operating and Maintenance Manuals	78.1 As required under the Contract, the Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the Works, showing the exact as-built locations, sizes and details of the work as executed. These records shall be kept on the Site and shall be used exclusively for the purposes of this Clause. Two copies shall be supplied to the Employer prior to the commencement of the Tests on Completion. 78.2 In addition, the Contractor shall supply to the Employer as-built drawings of the Works, showing all Works as executed, and submit them to the Employer for review under Clause 27 [Design by Contractor]. The Contractor shall obtain the consent of the Employer as to their size, the referencing system, and other relevant details. 78.3 Prior to the issue of any Taking-Over Certificate, the Contractor shall supply to the Employer the specified numbers and types of copies of the relevant as-built drawings, in accordance with the Employer's Requirements. The Works shall not be considered to be completed for the purposes of taking-over under Clause 76 [Taking Over of the Works] until the Employer has received these documents. 78.4 As required under the Contract , prior to commencement of the Tests on Completion, the Contractor shall supply to the Employer provisional operation and maintenance manuals in sufficient detail for the Employer to operate, maintain, dismantle, reassemble, adjust and repair the Plant. The Works shall not be considered to be completed for the purposes of taking-over under Clause 76 [Taking Over of the

	Works] until the Employer has received final operation and maintenance manuals in such detail, and any other manuals specified in the Employer's Requirements. for these purposes.
79. Termination by Employer	79.1 If the Contractor fails to carry out any obligation under the Contract, the Employer may by notice require the Contractor to make good the failure and to remedy it within a specified reasonable time. 79.2 The Employer shall be entitled to terminate the Contract if the Contractor: (a) fails to comply with Clause 64 [Securities] or with a notice under Clause 79.1, (b) abandons the Works or otherwise plainly demonstrates the intention not to continue performance of his obligations under the Contract, (c) without reasonable excuse fails to proceed with the Works in accordance with Clause 41 [Program and Progress], (d) subcontracts the whole of the Works or assigns the Contract without the required agreement, (e) becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events, (f) If the Contractor, in the judgment of the Employer has engaged in corrupt or fraudulent practices in competing for or in executing the Contract, pursuant to GCC 84.1. However, lawful inducements and rewards to Contractor's Personnel shall not entitle termination. (g) The Contractor uses the advance payment for matters other than the contractual obligations, (h) the Contractor stops work for Thirty (30) days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the Employer; (i) the Employer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Employer; (j) the Employer gives two consecutive Notices to update the Program and accelerate the works to ensure compliance with GCC Sub-clause 26.1 and the Contractor fails to update the Program and demonstrate acceleration of the works within a reasonable period of time determined by the Employer; (k) the Contractor does not maintain a Security, which is required;

	(l) the Contractor has delayed the completion of the Works by the number of days for which the maximum amount of liquidated damages can be paid, as defined in the SCC; 79.3 In any of these events or circumstances, the Employer may, upon giving Fifteen (15) days' notice to the Contractor, terminate the Contract and expel the Contractor from the Site. 79.4 However, in the case of sub-paragraph (e) or (f), the Employer may by notice terminate the Contract immediately. 79.5 The Employer's election to terminate the Contract shall not prejudice any other rights of the Employer, under the Contract or otherwise. 79.6 The Contractor shall then leave the Site and deliver any required Goods, all Contractors' Documents, and other design documents made by or for him, to the Employer. All Materials on the Site, Plant, Equipment, Temporary Works, and Works shall be deemed to be the property of the Employer. 79.7 However, the Contractor shall use his best efforts to comply immediately with any reasonable instructions included in the notice (i) for the assignment of any subcontract, and (ii) for the protection of life or property or for the safety of the Works. After termination, the Employer may complete the Works and/or arrange for any other entities to do so. The Employer and these entities may then use any Goods, Contractor's Documents and other design documents made by or on behalf of the Contractor. 79.8 The Employer shall then give notice that the Contractor's Equipment and Temporary Works will be released to the Contractor at or near the Site. The Contractor shall promptly arrange their removal, at the risk and cost of the Contractor. However, if by this time the Contractor has failed to make a payment due to the Employer, these items may be sold by the Employer in order to recover this payment. Any balance of the proceeds shall then be paid to the Contractor. 79.9 The Employer shall be entitled to terminate the Contract, at any time for the Employer's convenience, by giving notice of such termination to the Contractor. The termination shall take effect Thirty (30) days after, the later of the dates on which the Contractor receives this notice or the Employer returns the Performance Security. The Employer shall not terminate the Contract under this Clause in order to execute the Works himself or to arrange for the Works to be executed by another contractor. After this termination, the Contractor shall proceed in accordance with Clause 82. [Cessation of Work and Removal of Contractor's Equipment] and shall be paid in accordance with Clause 83 [Payment upon Termination].

80. Contractor's Entitlement to Suspend Work	80.1 If the Employer fails to comply with Clause 63 [Advance Payment] or Sub Clause 56.1, the Contractor may, after giving not less than Forty-five (45) days' notice to the Employer, suspend work (or reduce the rate of work) unless and until the Contractor has received the reasonable evidence or payment, as the case may be and as described in the notice. The Contractor's action shall not prejudice his entitlements to financing charges under Clause 56.2 and to termination under Clause 81 [Termination by Contractor]. 80.2 If the Contractor subsequently receives such evidence or payment (as described in the relevant Clause and in the above notice) before giving a notice of termination, the Contractor shall resume normal working as soon as is reasonably practicable. 80.3 If the Contractor suffers delay and/or incurs Cost as a result of suspending work (or reducing the rate of work) in accordance with this Clause, the Contractor shall give notice to the Employer and shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) payment of any such Cost, which shall be added to the Contract Price. After receiving this notice, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine these matters.
81. Termination by Contractor	81.1 The Contractor shall be entitled to terminate the Contract if: (a) the Contractor does not receive the reasonable evidence within Forty-five (45) days after giving notice under Clause 80.1 in respect of a failure to comply Employer's Obligation under the Clause 56 [Payments], (b) the Contractor does not receive the amount due within Ninety (90) days after the expiry of the time as per Clause 63.1 within which payment is to be made (except for deductions in accordance with Clause 34 [Employer's Claims]), (c) the Employer substantially fails to perform his obligations under the Contract, (d) the Employer fails to comply with Clause 7 [Assignment], (e) a prolonged suspension affects the whole of the Works as described in Clause 44.5, or (f) the Employer becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events. In any of these events or circumstances, the Contractor may, upon giving Fifteen (15) days' notice to the Employer, terminate the Contract. However, in the case of subparagraph

	(e) or (f), the Contractor may by notice terminate the Contract immediately. 81.2 The Contractor's election to terminate the Contract shall not prejudice any other rights of the Contractor, under the Contract or otherwise.
82. Cessation of Work and Removal of Contractor's Equipment	82.1 After a notice of termination under Clause 79.9, Clause 81 [Termination by Contractor] or Clause 72 [Optional Termination, Payment and Release] has taken effect, the Contractor shall promptly: (a) cease all further work, except for such work as may have been instructed by the Employer for the protection of life or property or for the safety of the Works, (b) hand over Contractor's Documents, Plant, Materials and other work, for which the Contractor has received payment, and (c) remove all other Goods from the Site, except as necessary for safety, and leave the Site.
83. Payment upon Termination	83.1 As soon as practicable after a notice of termination under Clause 79 [Termination by Employer] has taken effect, the Employer shall proceed in accordance with Clause 32 [Determinations] to agree or determine the value of the Works, Goods and Contractor's Documents, and any other sums due to the Contractor for work executed in accordance with the Contract. 83.2 After a notice of termination under Clause 79 [Termination by Employer] other than Termination by Convenience as per Clause 79.9 has taken effect, the Employer may: (a) proceed in accordance with Clause 34 [Employer's Claims], (b) with-hold further payments to the Contractor until the costs of design, execution, completion and remedying of any defects, liquidated damages (if any), and all other costs incurred by the Employer, have been established, and/or (c) recover from the Contractor any losses and damages incurred by the Employer and any extra costs of completing the Works, after allowing for any sum due to the Contractor. After recovering any such losses, damages and extra costs, the Employer shall pay any balance to the Contractor. (d) forfeit the Performance Security If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer. 83.3 After a notice of termination under Clause 81 [Termination by Contractor] or Termination by Convenience as per Clause 79.9 has taken effect, the Employer shall promptly: (a) return the Performance Security to the Contractor,

	(b) pay the Contractor in accordance with Clause 72. [Optional Termination, Payment and Release], and (c) pay to the Contractor the amount of any loss of profit or other loss or damage sustained by the Contractor as a result of this termination.
84. Fraud and Corruption	84.1 If the Employer determines that the Contractor has engaged in corrupt, fraudulent, collusive, coercive or obstructive practices, in competing for or in executing the Contract, then the Employer may, after giving Fifteen (15) days' notice to the Contractor, terminate the Contractor's employment under the Contract and expel him from the Site. 84.2 Should any employee of the Contractor be determined to have engaged in corrupt, fraudulent, collusive, coercive, or obstructive practice during the execution of the Works, then that employee shall be removed in accordance with GCC Clause 18. For the purposes of this GCC 84; (i) "corrupt practice" is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party. (ii) "fraudulent practice" is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation; (iii) "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party; (iv) "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party; (v) "obstructive practice" is (aa) deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to the investigators in order to materially impede a investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or (bb) acts intended to materially impede the exercise of the GON's/DP's inspection and audit rights provided for under GCC 33.4.
85. Black Listing	85.1 Without prejudice to any other rights of the Employer under this Contract, GoN, Public Procurement Monitoring Office (PPMO), on the recommendation of procuring entity, may

	blacklist a Bidder for its conduct for a period of one (1) to three (3) years on the following grounds and seriousness of the act committed by the bidder: (a) if it is established that the Contractor has committed substantial defect in implementation of the contract or has not substantially fulfilled its obligations under the contract or the completed work is not of the specified quality as per the contract. (b) If convicted from a court of law in a criminal offense liable to be disqualified for taking part in procurement contract, (c) If it is established that the Contractor has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.
86. Release from Performance	86.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor, the Employer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which a commitment was made.
87. Suspension of DP Loan/Credit/Grant	87.1 In the event that the DP suspends the loan/ credit/grant to the Employer from which part of the payments to the Contractor are being made: (a) the Employer is obligated to notify the Contractor of such suspension within Seven (7) days of having received the DP's suspension notice; and (b) if the Contractor has not received sums due him within the Thirty (30) days for payment provided for in GCC 56.1, the Contractor may immediately issue a 15-day termination notice.
88. Eligibility	88.1 The Contractor shall have the nationality of an eligible country as stated in SCC. The Contractor shall be deemed to have the nationality of a country if the Contractor is a citizen or is constituted, or incorporated, and operates in conformity with the provisions of the laws of that country. This criterion shall also apply to the determination of the nationality of proposed subcontractors or suppliers for any part of the Contract including related services. 88.2 The materials, equipment, and services to be supplied under the Contract shall have their origin in eligible source countries as stated in SCC and all expenditures under the Contract will be limited to such materials, equipment, and services. At the Employer's request, the Contractor may be required to provide evidence of the origin of materials, equipment, and services. 88.3 For purposes of GCC 88.2, "origin" means the place where the materials and equipment are mined, grown, produced, or manufactured, and from which the services are provided. Materials and equipment are produced when, through

	manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that differs substantially in its basic characteristics or in purpose or utility from its components.
89. Quarries and Spoil Dumps	89.1 Upon receiving the Performance Certificate, the Contractor shall remove any remaining Contractor's Equipment, surplus material, wreckage, rubbish and Temporary Works from the Site. 89.2 Any quarry operated as part of this Contract shall be maintained and left in a stable condition without steep slopes and be either refilled or drained and be landscaped by appropriate planting. Rock or gravel taken from a river shall be removed over some distance so as to limit the depth of material removed at any one location, not disrupt the river flow or damage or undermine the river banks. The Contractor shall not deposit excavated material on land in Government or private ownership except as directed by the Employer in writing or by permission in writing of the authority responsible for such land in Government ownership, or of the owner or responsible representative of the owner of such land in private ownership, and only then in those places and under such conditions as the authority, owner or responsible representative may prescribe. 89.3 If all these items have not been removed within Thirty (30) days after the Employer issues the Performance Certificate, the Employer may sell or otherwise dispose of any remaining items. The Employer shall be entitled to be paid the costs incurred in connection with, or attributable to, such sale or disposal and restoring the Site. 89.4 Any balance of the moneys from the sale shall be paid to the Contractor. If these moneys are less than the Employer's costs, the Contractor shall pay the outstanding balance to the Employer.
90. Local Taxation	90.1 The prices bid by the Contractor shall include all taxes that may be levied in accordance to the laws and regulations in being in Nepal on the date Thirty (30) days prior to the closing date for submissions of Bids on the Contractor's equipment, plant and materials acquired for the purpose of the Contract and on the services performed under the Contract. Nothing in the Contract shall relieve the Contractor from his responsibility to pay any tax that may be levied in Nepal on profits made by him in respect of the Contract.
91. Value Added Tax	91.1 The Contract is not exempted from value added tax. An amount specified in the schedule of taxes shall be paid by the Contractor in the concerned VAT office within time frame specified in VAT regulation.
92. Income Taxes on Staff	92.1 The Contractor's staff, personnel and labor will be liable to pay personal income taxes in Nepal in respect of their salaries and wages, as are chargeable under the laws and regulations for the time being in force, and the Contractor shall perform such duties in regard to such deductions as may be imposed on

	him by such laws and regulations. 92.2 The issue of the Final Account Certificate pursuant to Clause GCC 77 shall be made only upon submittal by the Contractor of a certificate of income tax clearance from the Government of Nepal.
93. Duties, Taxes and Royalties	93.1 Unless otherwise stated in the SCC, the Contractor shall pay all royalties, rents and other payments for: (a) natural Materials obtained from outside the Site, and (b) the disposal of material from demolitions and excavations and of other surplus material (whether natural or man-made), except to the extent that disposal areas within the Site are specified in the Contract. 93.2 Any element of royalty, duty or tax in the price of any goods including fuel oil, and lubricating oil, cement, timber, iron and iron goods locally procured by the Contractor for the works shall be included in the Contract rates and prices and no reimbursement or payment in that respect shall be made to the Contractor. 93.3 The Contractor shall familiarize himself with GON the rules and regulations with regard to customs, duties, taxes, clearing of goods and equipment, immigration and the like, and it will be necessary for him to follow the required procedures regardless of the assistance as may be provided by the Employer wherever possible. 93.4 The Contractor shall pay and shall not be entitled to the reimbursement of cost of extracting construction materials such as sand, stone/boulder, gravel, etc. from the river beds or quarries. Such prices will be levied by the Local Level as may be in force at the time. The Contractor, sub-contractor(s) employed directly by him and for whom he is responsible, will not be exempted from payment of royalties, taxes or other kinds of surcharges on these construction materials so extracted and paid for to the Local Level.
94. Member of Government, etc., not Personally Liable	94.1 No member or officer of GoN or the Employer or the Employer 'Representatives shall be in any way personally bound or liable for the act or obligations of the Employer under the Contract or answerable for any default or omission in the observance or performance of any of act, matter or thing which are herein contained.
95. Compliance with Regulations for Explosives	95.1 No explosives of any kind shall be used by the Contractor without the prior consent of the Employer in writing and the Contractor shall provide, store and handle these and all other items of every kind whatsoever required for blasting operations, all at his own expense in a manner approved in writing by the Employer. 95.2 The Contractor shall comply with all relevant ordinances, instructions and regulations which the Government, or other person or persons having due authority, may issue from time to time regarding the handling, transportation, storage and

	use of explosives.
96. Permission for Blasting	96.1 The Contractor shall at all times maintain full liaison with and inform well in advance, and obtain such permission as is required from all Government authorities, public bodies and private parties whatsoever concerned or affected, or likely to be concerned or affected by blasting operation.
97. Records of Explosives	97.1 Before the beginning of the Defects Liability Period, the Contractor shall account to the satisfaction of the Employer for all explosives brought on to the Site during the execution of the Contract and the Contractor shall remove all unused explosives from the Site on completion of works when ordered by the Employer.
98. Traffic Diversion	98.1 The Contractor shall include the necessary safety procedures regarding and pedestrian traffic diversion that is needed in execution of the works. The Contractor shall include in his costing of works, any temporary works or diversion that are needed during the construction period. All traffic diversion should be designed for the safety of both the motoring public and the men at work. It shall ensure the uninterrupted flow of traffic and minimum inconvenience to the public during the period concerned. As such, adequate warning signs, flagmen and other relevant safety precautionary measures shall be provided to warn motorists and pedestrians well ahead of the intended diversion as directed by the Employer. All traffic devices used shall be designed in accordance with the instruction of Employer.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77.5 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF
LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 3
CONDITIONS OF CONTRACT**

**SECTION II
SPECIAL CONDITIONS OF CONTRACT**

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SECTION II: SPECIAL CONDITIONS OF CONTRACT

The following Special Conditions of Contract shall supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.

SPECIAL CONDITIONS OF CONTRACT

A. General	
GCC 1.1 (f)	Substitute the text entirely with the following: “Contract” means the Contract Agreement, any addenda referred to in the Contract Agreement, the Letter of Acceptance, these Conditions, the General Conditions of Contract, the Employer’s Requirements, the Tender and the written acceptance thereof, the Schedules, the JV Undertaking (if applicable) together with such other documents as may be expressly agreed or are listed in the Contract Agreement between the Parties. It consists of the documents listed in Clause GCC 2.3.
GCC1.1 (m)	Replace the entire Clause with the following: Unless otherwise stated in the Contract Agreement, the Commencement Date shall be the date as notified by the Employer. The Employer shall give the Contractor not less than 15 days’ notice of the Commencement Date. The Contractor shall commence the design and execution of the Works as soon as is reasonably practicable after the Commencement Date and shall then proceed with the Works in due expedition and without delay.
GCC 1.1 (t)	The Employer is Remit Hydro Limited, 4th Floor, Citizen Investment Trust Building, New Baneshwor, Kathmandu, Nepal.
GCC 1.1 (u)	The Employer’s Representative shall be as notified by the Employer.
GCC 1.1 (z)	The Intended Completion Date for the whole of the Works shall be: 1460 days from the Commencement Date.
GCC 1.1 (cc)	Substitute the text entirely with the following: “Party” means the Employer or the Contractor, as the subject or the context requires, and “Parties” mean collectively both the Employer and the Contractor.
GCC 1.1 (ii)	Substitute the text entirely with the following: “Site” means the places, where the Works are to be executed and to which Plant and Materials are to be delivered and any such other places provided by the Employer or as may be designated in the Contract or subsequently agreed by the Employer’s Representatives as forming part of the Site.
GCC 1.1 (qq)	“Works” shall mean the Permanent Works and the Temporary Works or either of them as appropriate under Engineering, Procurement and Construction of Civil and Hydromechanical Works of Ghunsa Khola Hydroelectric Project. For details of Works, refer to Section 1: Scope of Works, Volume 2 : Employer’s Requirements
Add the following new Clauses 1.1 “ss” to Clause 1.1 “dddd”	

GCC 1.1 (ss) Advance Payment Guarantee	"Advance Payment Guarantee" means the bank guarantee under Clause 63 [Advance Payment].
GCC 1.1 (tt) Contract Agreement	"Contract Agreement" means the agreement entered into by the Parties in accordance with Clause 4 [Contract Agreement], including any annexed memoranda.
GCC 1.1 (uu) Foreign Currency	"Foreign Currency" means United States Dollars (USD).
GCC 1.1 (vv) Performance Security	"Performance Security" means the security under Clause 64 [Securities].
GCC 1.1 (ww) Schedule of Payments	"Schedule of Payments" means the Bid Price Schedule or any document(s) entitled Payment Schedule (if any) in the Schedules showing the amounts and manners of payments to be made to the Contractor.
GCC 1.1 (xx)Tender	"Tender" or "Bid" means all documents forming part of the Contractor's signed offer together with such modifications and additions thereto as may be agreed between the Parties prior to the award of the Contract.
GCC 1.1 (yy)Time for Completion	"Tender" or "Bid" means all documents forming part of the Contractor's signed offer together with such modifications and additions thereto as may be agreed between the Parties prior to the award of the Contract.
GCC 1.1 (zz) Employer's Requirements	"Employer's Requirements" means the documents entitled employer's requirements, as included in the contract, and any additions and modifications to such document in accordance with the contract. Such documents describe the purpose(s) for which the Works are intended, and specify key personnel (if any), the scope, and/or design and /or other performance, technical and evaluation criteria, for the Works. Throughout the General Condition of Contract, any terms including Specification and Drawings" if any, are to be replaced by "Employer's Requirements".
GCC 1.1 (aaa) Dispute	"Dispute" means any situation where: a) One Party makes a claim against the other Party (which may be a Claim, as defined in these Conditions, or a matter to be determined by the Employer's Representative under these Conditions, or otherwise); b) The other Party (or Employer' Representative, under Clause 32 [Determination] or otherwise) rejects the claim in whole or in part; and c) The first Party does not acquiesce (by giving a Notice of Dissatisfaction

	under Sub-clause 32.2 or otherwise), provided however that a failure by the other Party to oppose or respond to the claim, in whole or in part, may constitute a rejection if, in the circumstances, the Arbitrator(s), deem it reasonable for it to do so.
GCC 1.1 (bbb) Exception al Event	“Exceptional Event” means an event or Circumstance as defined in the Clause 67 [Definition of Force Majeure].
GCC 1.1 (ccc) Goods	“Goods” means Contractor’s Equipment, Materials, Plant and Temporary Works, or any of them as appropriate.
GCC 1.1 (ddd) Joint Venture	“Joint Venture or JV” means a joint venture, association, consortium or other unincorporated grouping of two or more persons, whether in the form of a partnership or otherwise.
GCC 1.1 (eee) Local Currency	“Local Currency” means the Nepalese Rupee (NRs).
GCC 1.1 (fff) Materials	“Month” means a calendar month according to the Gregorian calendar.
GCC 1.1 (ggg) Permanen t Works	“Permanent Works” means the works of a permanent nature which are to be executed by the Contractor under the contract.
GCC 1.1 (hhh) Program	“Program” means a detailed time program prepared and submitted by the Contractor to which the Employer has given (or is deemed to have given) a Notice of No Objection under Clause 41 [Program and Progress].
GCC 1.1 (iii) Provisiona l Sum	“Provisional Sum” means a sum (if any) which is specified in the Contract by the Employer as a Provisional Sum, for the execution of any part of the Works or for the supply of Plant, Materials or services under Sub- Clause 51.3.
GCC 1.1 (jjj) Performan ce Certificate	“Performance Certificate” means the certificate issued by the Employer (or deemed to be issued) under Sub- Clause 77.1.
GCC 1.1 (kkk) Non- Performan ce Damages	“Non-Performance Damages” means the damages to be paid by the Contractor to the Employer for the failure to achieve the guaranteed performance of the Plant and/or the Works or any part of the Works (as the case may be), as specified in the Schedule of Performance Guarantees.
GCC 1.1	“Notice” means a written communication identified as a Notice and issued in

(III) Notice	accordance with Clause 15 [Communication].
GCC 1.1 (mmm) Notice of Dissatisfac tion or NOD	“Notice of Dissatisfaction or NOD” means the Notice one Party may give to the other Party if it is dissatisfied with an Employer’s Representative’s determination under Clause 32 [Determination].
GCC 1.1 (nnn) QM System	“QM System” means the Contractor’s Quality Management System (as may be updated and/or revised from time to time) in accordance with Clause 47 [Quality Assurance].
GCC 1.1 (ooo) Review	“Review” means examination and consideration by the Employer (or The Employer’s Representative) of a Contractor’s submission in order to assess whether (and to what extent) it complies with Contract and/or with the Contractor’s obligations under or in connection with the Contract.
GCC 1.1 (ppp) Statement	“Statement” means a statement submitted by the Contractor as part of an application for payment under Clause 55 [Interim Payment Certificate] or Clause 77 [Final Account].
GCC 1.1 (qqq) Taking- over Certificate	“Taking-over Certificate” means a certificate issued (or deemed to be issued) by the Employer in accordance with Clause 76 [Taking Over of the Works].
GCC 1.1 (rrr) Unforesee able	“Unforeseeable” means not reasonably foreseeable by an experienced Contractor by the Base Date.
GCC 1.1 (sss)Year	“Year” means 365 days.
GCC 1.1 (ttt) Claim	“Claim” means a request or assertion by one Party to the other Party for an entitlement or relief under any Clause of these Conditions or otherwise in connection with, or arising out of, the Contract or the execution of the Works.
GCC 1.1 (uuu) Prohibited Activities	“Prohibited Activities” means any of the following: a) Furnishing substantially inaccurate or incomplete information or giving false or forged evidence of any kind to the Employer or Employer’s Representatives in connection to the performance of the Contract; b) Engaging or deploying unqualified, inexperienced or less qualified individual against the Employer’s Requirements, if any; c) Non-observance to the just and humane conditions of work and/or activities involving exploitive forms of forced or child labour. d) Refusing or failing, upon request, to produce to the Employer or the Employer’s Representatives any document, book, record, or correspondence or copy of it concerning the execution of the Contract, which is required to maintain records; e) Abandonment, rejection or relinquishment or unjustified cessation of Work under the Contract for a period of 30 days or more; f) Failure in any material way to comply with provisions of the prevailing

	Laws of Nepal; and g) Committing any offence under any Laws applicable to or for the prevention of corruption or bribery, in respect of fraudulent acts or in respect of any attempt or conspiracy to defraud.
GCC 1.1 “Latent Defect” (vvv)	“ Latent Defect ” means any defect in the Works attributable to: a) the design of the Works for which the Contractor is responsible; b) Plant, Materials or workmanship not being in accordance with the Contract; or c) failure of the Contractor to comply with any other obligation under the Contract, which reasonable examination by the Employer prior to expiry of the Defects Notification Period would not have disclosed.
GCC 1.1 (www) Guaranteed Value and Maximum Accepted Deviation	Guaranteed Value and Maximum Accepted Deviation “Guaranteed Value” and “Maximum Acceptable Deviation” shall have the meanings given to them in the Schedule of Guarantees and shall apply only to those guarantees contained in the Schedule of Guarantees.
GCC 1.1 (xxxx) Project	“ Project ” means Ghunsa Khola Hydroelectric Project, which is located in Taplejung District of Nepal.
GCC 1.1 (yyyy) Project Manager	The term “ Project Manager ” refers to the employee of the Remit Hydro Limited, who has been assigned responsibility for overseeing and managing the proper and timely implementation of the Ghunsa Khola Hydroelectric Project.
GCC 1.1 (zzzz) Testing Plan	“ Testing Plan ” means all necessary preparations to plan, arrange, direct, manage, inspect and test the Works submitted by the Contractor for test requirements under Clause 74 [Tests on Completion] and Clause 75 [Tests after Completion] of the Contract.
GCC 1.1 (aaaa) Government Authority or Authorities	“ Government Authority or Authorities ” means any national, state, local/municipal level authority or administrative or regulatory body or taxing authority or quasi-judicial authority in Nepal having jurisdiction over the Project and the Parties of this Contract or any action or transaction contemplated in connection with this Contract in Nepal.
GCC 1.1 (bbbb) Amendment to Contract	“ Amendment to Contract ” means subject to any Variation instructed by the Employer in accordance with Clause 53 [Variations] and 59 [Price Adjustments] or any amendments in Contract made by the Parties for whatsoever reason. No amendment of the Contract shall be valid unless it is in writing, is dated, expressly refers to the Contract and is signed by duly authorized representatives of the Parties.
GCC 1.1 (cccc) “Chief Executive	“ Chief Executive Officer ” means a person In-Charge of Remit Hydro Limited.

Officer"	
GCC 1.1 (dddd) Snagging List	"Snagging List" or "Punch List" means a list of minor defects and/or outstanding works that need to be rectified by the Contractor before completion of the whole of the Works, even though these issues are not significant enough to prevent the issuance of a Taking Over Certificate under Clause 76 [Taking Over of the Works].
GCC 2.1	At the end of the sub-paragraph (c) delete "and" and at the end of sub-paragraph (d) delete the full stop and replace with a semi-colon, and insert the following sub-paragraphs: e) unless otherwise stated in the Employer's Requirements, the "International System of Units" (the metric system) shall apply to this Contract in every respect; f) the words "include", "including" or "for example" shall be deemed to be followed by the expression "without limitation" or "but not limited to", whether or not they are followed by such phrases or words of like import; g) references to any Clause, Sub-Clause, Appendix or Annex are references to the clauses, sub-clauses, appendices or annexes of these Conditions of Contract, h) where a word, term, phrase or abbreviation is defined, another part of speech or grammatical form in respect of that word or expression will have a corresponding meaning, i) a reference to anything (including an amount) is a reference to the whole and each part of it, j) whenever the date for the performance of any payment obligation falls on a date that is not a working day (being a day on which banks are not generally open for business in Nepal), such date shall be extended to the next succeeding working day, k) Bid/Tender, Bidder/Tenderer, Bidding/Tendering, and other similar expressions are synonymous for purposes of these Bidding and Contract Documents. l) Price Schedule, Bid Price Schedule, Activity Schedule, Priced Activity Schedule, Millstone and other similar expressions are synonymous for purposes of these Bidding and Contract Documents. m) Delay damages, Liquidated damages and other similar expressions are synonymous for purposes of these Bidding and Contract Documents. n) Defects Liability Period, DLP, Defects Notification Period and DNP are synonymous for the purpose of this Contract. o) "Employer's Requirements" and "Employer's Work Requirements" are synonymous for the purpose of this Contract. p) "may" means that the Party or person referred to has the choice of whether to act or not in the matter referred to; q) "shall" means that the Party or person referred to has an obligation under the Contract to perform the duty referred to; r) "consent" means that the Employer of the Contractor (as in case may be) agree to, or gives permission for, the requested matter; s) "including", "include" and "includes" shall be interpreted as not being limited to, or qualified by, the stated items that follow'; t) Words indicating persons or parties shall be interpreted as referring to natural or legal persons (including corporations and other legal entities); and u) "execute the Works" and execution of the Works" means design, construction and completion of the Works and the remedying of any defects.

	In any list in these Conditions, where the second-last item of the list is followed by “and” or “or” or “and/or” then all of the list items going before this item shall also be read as if they are followed by “and” or “or” or “and/ or” (as the case may be).		
	The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.		
GCC 2.2	Sectional Completion (Milestones) are:		
	No.	Milestone	Days for Completion after Commencement Date
	MS – 14	Survey and preliminary design of civil and hydromechanical works (indicator shall be submission of Preliminary design report with drawings)	180
	MS – 75	Completion of Excavation and primary support to headrace tunnel including length of rock trap (that includes the excavation and primary support of headrace tunnel from all fronts) (indicator shall be complete breakthrough of Headrace Tunnel and completion of primary support)	730
	MS 97	First stage mass concrete works (below machine hall level) in Powerhouse cavern (indicator shall be the completion of first stage concrete of turbine casing so that the Lot 2 contractor can install the turbine casing)	730
	MS – 98	Powerhouse concrete works above machine hall level and concrete works of office, control room, switchgear and battery room (indicator shall be the completion of the concrete works in Electrical Overhead travelling Crane so that it allows the Lot 2 Contractor to install the EoT Crane)	690
	MS – 130	Pressure testing of the entire water conveyance system successfully completed	1350
	MS – 131	Testing of all hydraulic structures including hydromechanical and electromechanical equipment successfully completed and commissioned all complete	1460
GCC 2.3	Delete the documents listed as (a) to (i) in this Clause 2.3 and substitute with the following:		
	a. b. c. d. e. f. g. h. i. j. k. Contract Agreement; Letter of Acceptance; Memorandum of Understanding and/or Minutes of Contract Negotiations if any; Letters of Technical Bid and Price Bid; All addenda issued if any; Special Conditions of Contract; General Conditions of Contract; Employer's Requirements; Activity Schedule; The Complete Bidding Forms and Schedules submitted in the Bid; and Any other documents forming part of the Contract.		

GCC 3.1	The Contract shall be governed by the Law of Nepal .
GCC 3.4	The language of Communication shall be English . The ruling language of the Contract is English .
GCC 5	Rename this Cause as “ Employer’s Use of Contractor’s Documents ”.
GCC 6.1	Replace “obtain communication of” by “communicate” in second sentence of this Sub-clause. Replace “They” by “These documents (in whole or in part)” and insert “prior” before “consent” in the last sentence of this Sub-clause.
GCC 7.2	Add new Clause 7.2 after the end of the Clause 7.1. Any modification in the constitution of the Contractor or of a Joint Venture with regard to the participation of its members which has the effect of modifying the effective control of the Contractor shall be deemed to be an assignment that requires the prior approval of the Employer under Sub-clause 7.1.
GCC 8.1	In the second Sentence delete “six copies” and replace with “ four (4) hard copies and an electronic ” copy.
GCC 9.1	Replace “Contractor’s and the Employer’s Personnel” in the first sentence of this Sub-Clause with “Contractor”.
GCC 9.2	Replace “Each of them” by “The Contractor” in this Sub-Clause. Insert the Following at the end of this Sub-Clause: The Employer and the Employer’s Personnel shall treat all information provided by the Contractor marked “Confidential” as confidential.
GCC 10.1	Delete “and” at the end of paragraph (a) and replace “.” at the end of paragraph (b) by “ ; ”) and add the following new paragraph (c) and (d) as: (c) within the time(s) stated in the Employer’s Requirements, the Contractor shall provide such assistance, and all documentation, as described in the Employer’s Requirements or otherwise reasonably required by the Employer, so as to obtain the Employer any permits, permission, license or approval under the Contract; and (d) the Contractor shall comply with all permits, permission, license or approvals obtained by the Employer.
GCC 12.3	Replace “.” by “,” at the end of this Sub Clause and add the following: “and shall issue and receive Notice and Communications under Clause 15 [Notices and Communications]”.
GCC 12. 4	Add “except the authority to receive and or give Notice under Clause 15 [Notices and Communications]” and the authority to receive instructions under Clause 33 [Instructions, Inspections and Audits]” after “authority” in the first sentence of this Sub Clause.
GCC 12.5	Add the following at the end of this Sub-Clause: The Contractor’s Representative and Contractor’s Key Personnel shall be qualified, experienced and competent in the main engineering discipline

	applicable to the Works.
	Insert the following new Sub-Clause 12.6 as follows:
GCC 12.6	The Contractor's Representative shall be a full-time employee of the Contractor (in case of joint ventures, of the lead partner) for at least 1 year prior to the bid submission date. The whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Contract and shall be based at the Site for the whole time that the Works are being executed at the Site. If the Contractor's Representative is temporarily absent, a suitable replacement shall be temporarily appointed. The Employer's Representative shall monitor closely the engagement plan including the requirement of presence of Contractor's Representative on Site. In case of non-fulfillment, the Employer's Representative may withhold the certification of the Contractor's payment as per Clause 55 [Interim Payment Certificate]. Further, if the situation needs to be rectified, a Notice to Correct may be issued in accordance with Sub-Clause 79.1.
GCC 13.1	Add the following at the end of this Sub-Clause: If the Employer's Representative is a legal entity, the Employer's Representative shall give a Notice to the Parties of the natural person (or replacement) appointed and authorized to act on its behalf.
GCC 13.5	Add the following at the end of this Sub-Clause: The Employer's Representative shall not delegate the authority to: (a) act under Clause 32 [Determinations]; and (b) issue a notice to correct under Sub-Clause 79.1.
GCC 14.1 (c)	Replace this paragraph in its entirety with the following: If the Contractor questions any Instruction, Notice or Communication given by the delegated person, the Contractor may by giving a Notice refer the matter to the Employer. The Employer shall promptly confirm, vary or reverse the Instruction, Notice or Communication.
GCC 15	Rename this Clause as " Notices and Communications "
GCC 15.1	Add "Notices and" at the beginning of this Sub Clause.
GCC 15.1(a)	The agreed electronic transmission shall be by means of email. Add the following new paragraph at the end of this Clause 15.1 (a) Email, Letters, Notices and Communication shall be attached in PDF format, Drawings shall be in CAD, Programmes shall be in the latest version of Primavera P6 or similar CPM based software.

GCC 15.1(b)	Employer's Address: Employer : Remit Hydro Limited Address : Citizen Investment Trust Building, New Baneshwor, Kathmandu, Nepal Telephone No. : +9771 01 4581780 Email: : procurement@remithydro.org.np Contractor's Address: To be Notified by the Contractor
	Add the following new paragraph (c) at the end of this Sub-Clause:
	(c) The Notices and Communications shall be identified as "Notices" or "Communications" as in case may be and shall include reference to the provision(s) of the Contract under which it is issued.
	Add the following new Sub-Clause 15.2 as
GCC 15.2	These Notices and/or Communications shall have effect when they are received (or deemed to have been received) at the recipient's current address. An electronically transmitted notice or communication is deemed to have been received on the day after transmission, provided that no non-delivery notification was received by the sender. All the Notices and/or Communications shall be copied to the Parties and/or Employer's Representatives as in case may be as stated under the Contract.
GCC 16.1	Delete the first sentence of the Sub-Clause 16.1 and replace with: The Contractor shall not be permitted to subcontract works with a total accumulated value greater than 25% of the Contract Price. Nature of Works that agreed to be subcontracted and Details of Sub-Contractors: 1. Civil Works 2. Hydro-mechanical works 3. Engineering Design Works Qualification Criteria of Sub Contractors: The proposed sub-contractor shall meet the requirements as stated in the Volume 1: Bidding Procedure, Section III– Evaluation and Qualification Criteria, 2.8 Subcontractors.
	Add the following new Sub-Clause 16.5 as
16.5	If a Subcontractor's obligations extend beyond the expiry date of the relevant Defects Notification Period and the Employer, prior to this date, instructs the Contractor to assign the benefit of such obligations to the Employer, then the Contractor shall comply with the same.
GCC 17.1	The Employer shall notify the schedule of Other Contractors.
GCC 18.2	Add the following new paragraph (e) after paragraph (d) as: (e) is found, based on reasonable evidence, to have engaged in corrupt, fraudulent, collusive or coercive practice.

GCC 19	Rename this Clause as “ Care of Works and Indemnities ”
GCC 19.4	Delete this Sub-Clause in its entirety and substitute with the following: The Contractor shall take full responsibility for the care of Works, Goods, Plants and Equipment, and Contractor’s Documents, from the Commencement Date to the date stated as Taking Over Date as stated in the Taking Over Certificate. After the issuance of the Taking Over Certificate, the Contractor shall be responsible for the care of any work which is outstanding and identified as the Snagging List in the Taking Over Certificate until its outstanding work has been completed. If any loss or damage happens to any of the above items while the Contractor is responsible for their care, arising from any cause whatsoever other than those for which the Employer is liable, the Contractor shall, at his own cost and risk, rectify the loss or damage complying with the Contract and/or to the satisfaction of the Employer.
GCC 21.1	Delete this Sub-Clause in its entirety and substitute with the following: From the Commencement Date until the Defect Liability Certificate has been issued, the followings are the Employer's Risks: a. war, hostilities (whether war be declared or not), invasion, act of foreign enemies; b. rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war; c. riot, commotion or disorder by persons other than the Contractor’s Personnel and other employees of the Contractor and Subcontractors; d. strike or lockout not solely involving the Contractor’s Personnel and other employees of the Contractor and Subcontractors; e. encountering munitions of war, explosive materials, ionising radiation or contamination by radioactivity, except as may be attributable to the Contractor’s use of such munitions, explosives, radiation or radioactivity; or f. Occurrence of natural disaster such as earthquake, fire, excessive rainfall (atibrishti), flood and landslide in such a way that affects the component of the project adversely or the Contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic. provided that the event or circumstance is of the kind described in sub-paragraphs (b) to (e), occurs in Nepal.
GCC 21.3, 21.4 and 21.5	Read Sub-clauses 21.3, 21.4 and 21.5 as 21.2, 21.3 and 21.4 respectively.
GCC 21.3	Delete Sub-para (b) in this Sub-Clause in its entirety and substitute with the following: (b) subject to Clause 70 [Consequences of Force Majeure], payment of any such Cost, which shall be added to the Contract Price.

GCC 22.5	Delete this Sub-Clause in its entirety and substitute with the following: The Contractor shall bear all the risk including geological, professional and technical risk during execution of the project in design, procurement, construction and during the Defects Liability Period.
GCC 23.1	Delete this Sub-Clause in its entirety and substitute with the following: 23.1 Without limiting either Party's obligations or responsibilities under the Contract, the Contractor shall effect and maintain all insurances for which the Contractor is responsible with insurers and in terms, both of which shall be subject to consent by the Employer. These terms shall be consistent with any terms agreed by both Parties before signing the Contract Agreement. The insurances required to be provided under this Clause are the minimum required by the Employer, and the Contractor may, at the Contractor's own cost, add such other insurances the Contractor may deem prudent. The Contractor shall also be responsible for the following: (a) notify the insurers of any changes in the nature, extent, or programme for the execution of the Works and ensure those changes; and (b) the adequacy and the validity of the insurances in accordance with the Contract at all times during the performance of the Contract.
GCC 23.2	In the first sentence of paragraph 1 after the word "events" delete "which are due to the Contractor's risks". The minimum insurance amounts and deductibles shall be: - The minimum cover for loss of or damage to the Works, Plant and Materials is 115% of the Accepted Contract Amount with the maximum deductible of 10% of the claim amount or NRs. 1,000,000 whichever is less. - The minimum cover for loss or damage to Equipment is full replacement cost with the maximum deductible of 10% of the claim amount or NRs. 1,000,000 whichever is less. - The minimum for insurance of other property (other than the Works) is NRs. 20,000,000 with unlimited number of occurrences. The maximum deductible for insurance of other property is 10% of the claim amount or NRs. 1,000,000 whichever is less - The minimum cover for personal injury or death insurance is - for the Contractor's employees as that specified in the Labor act of Nepal and - for Employer and Employer's Representatives is NRS 2,500,000.00 per person with an unlimited number of occurrences. - for other people is not less than NRS 1,500,000.00 per person with an unlimited number of occurrences. - Motor Vehicle Liability Insurance with a limit of indemnity of not less than as specified under the directives of Insurance Authority of Nepal . - The minimum cover for Liability for breach of professional duty in an amount not less than 2% of Accepted Contract Amount. All the insurances shall cover and maintain for the period from the Commencement Date to the date until the Taking over Certificate of the Works

	is issued. Thereafter, the insurances shall continue until the date of the issue of the Performance Certificate in respect of any incomplete work or for the loss or damage arising from any cause occurring before the date of the issue of the Taking-Over Certificate for the Works, and for any loss or damage occasioned by the Contractor in the course of any operation carried out by the Contractor for the purpose of complying with the Contractor's obligations under Clause 49 [Correction of Defects] and Clause 75 [Tests after Completion]. The insurance coverage for injury to persons and damage to property (other than the Works), injury to Employer and Contractor's personnel shall also be maintained until the Performance Certificate is issued.
GCC 23.9	Delete this Sub-Clause in its entirety and substitute with the following: If the Contractor fails to effect and keep in force any of the Insurances required under Clause 23 [Insurances], then, and in any such case, the Employer may effect and keep in force such insurances and pay premiums as may be necessary and recover the same from the Contractor from time to time by deducting the amounts so paid from any moneys due to the Contractor or otherwise recover the same as a debt from the Contractor. The provisions of Clause 34 [Employer's Claim] and Clause 35 [Contractor's Claim] shall not apply to this Sub-Clause.
Sub-Clause 23.14	After the end of Sub-Clause 23.13, add new Sub-Clause 23.14 and 23.15 as follows: Off Site Insurance: Where the Contract involves manufacturing and/or fabrication of the Works or parts thereof at places other than at the Site, the Contractor shall satisfy the Employer that all Materials and Plant for incorporation in the Works are adequately insured during manufacture and/or fabrication and shipment to the Site. In the event of the Employer having an insurable interest in such Materials and Plant during manufacture and/or fabrication and shipment, then such interest shall be noted by endorsement to the relevant insurance policies.
Sub-Clause 23.15	23.15 Nothing in this Clause limits the obligations, liabilities or responsibilities of the Contractor, under the other terms of the Contract or otherwise. Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with these obligations, liabilities or responsibilities. However, if the Contractor fails to effect and keep in force an insurance which is available and which it is required to effect and maintain under the Contract, and the Employer neither approves the omission nor effects insurance for the coverage relevant to this default, any moneys which should have been recoverable under this insurance shall be borne by the Contractor.
GCC 24.1	Site Data and Reports are as provided in Volumes 4 and 5 of Bidding Documents.
GCC 24.2	Delete “ and” at the end of (d) and add “, and” at the end of (e). Add the following new Sub-Paragraphs (f) and (g) after sub-paragraph (e) as: (f) existing conditions and nature of existing roads and bridges and other

	means of access to the Site, and (g) stability of existing slopes in the Site.
GCC 26.3	Add the following at the end of this Sub-Clause: Dust, nuisance arising from any construction activity and movement of equipment and vehicles at or near the Site and in the Access Route shall be adequately controlled by the Contractor at his own cost as per the Employer's Requirements and if not stated, to the satisfaction of the Employer's Representative.
GCC 26.4	Add the following at the end of this Sub-Clause: If the Contractor fails to clean and reinstate all part of the Site, promptly after the issue of Performance Certificate, the Employer may sell and/or clean and/or reinstate the Site at his own cost and shall deduct the amounts equivalent to the costs reasonably incurred in connection with the cleaning and/or reinstating the Site less an amount equal to the moneys from the sell from any future Contractor's Payments under the Contract.
GCC 27.1	Add the following at the end of this Sub-Clause: The Contractor shall at his own expense carry out all additional investigations, studies and design work and prepare construction and working drawings as necessary for performance of all Permanent Works and Temporary Works. The Contractor shall use Internationally recognized original softwares for the purpose of design.
GCC 27.8	Replace "approval" by "No-objection (which may include comments, concerning minor matters which will not substantially affect the Works)". Replace "and shall get approval letter and shall start the work" by " for review and No-objection as per this Clause" at the last sentence of this Sub-Clause.
GCC 27.10	Replace the word "approval" by "No-objection" in this Sub-clause.
GCC 27.12	Insert " or any other aspect of the Works" after the word "Works" in the first sentence of this Sub-Clause.
GCC 28.1	Delete " and" at the end of (d) and add ", and" at the end of (e). Add the following new sub paragraph (f) after sub paragraph (e) as: (f) Comply with all environmental, social and safety requirements of the project including provisions under the Environment Impact Assessment (EIA) Report of the Project, which the Employer shall have made available to the Contractor.
GCC 30.1	The right of access to and Possession of Site Date(s) shall be: As notified by the Employer within 30 days after the date of Contract Agreement.
GCC 30.5	After Sub-Clause 30.4, Add the following Sub-Clause 30.5: The Contractor shall bear all costs and charges for special and/or temporary rights-of way which may be required for the purposes of the Works, including those for access to the Site. The Contractor shall also obtain, at the Contractor's risk and cost, any additional facilities outside the Site which may

	be required for the purposes of the Works. The Contractor shall make available and coordinate the use of such special and/or temporary rights-of-way, including access to Site to Other Contractors, employed by the Employer. Such use by Other Contractors shall be free of charge.
GCC 31.2	Add the following at the end of sub-paragraph (a) of this Sub-Clause: The Contractor shall maintain the Access Road from the Hadrung Bridge (located near the tail race outlet point) to all the project structures from the Commencement Date until the Taking Over Certificate has been issued. The maintenance of the Access Route should be in such a way that there will be no obstacles for the Contractor's and Employer's vehicles and personnel movement throughout the year.
GCC 32	Delete this Sub-Clause in its entirety and substitute with the following: 32.1 When carrying out his/her duties under this Clause, the Employer's Representative shall not be deemed to act for the Employer. Whenever these Conditions provide that the Employer' Representative shall proceed in accordance with this Clause 32 [Determination] to agree or determine any matter, the Employer' Representative shall consult with each Party in an endeavor to reach agreement. If the agreement is not achieved, the Employer's Representative shall make a fair determination in accordance with the Contract, taking due regard of all relevant circumstances. 32.2 The Employer's Representative shall give notice to both Parties of each agreement or determination, with supporting particulars. Each Party shall give effect to each agreement or determination, unless the Party gives notice of his dissatisfaction with a determination within Fifteen (15) days of receiving it. After then, the Parties shall proceed as per Clause 37 [Dispute Settlement by Arbitration].
GCC 37.1	Any dispute arising out of or in connection with this Contract, including any question regarding its existence, validity or termination, shall be referred to and finally resolved by arbitration administered by Nepal Council of Arbitration (NEPCA) in accordance with the arbitration rules of the United Nations Commission on International Trade Law (UNCITRAL). The arbitration tribunal shall consist of three (3) arbitrators. The seat of arbitration shall be Kathmandu, Nepal and the Language of arbitration shall be English. The Law governing this arbitration shall be the Law of Nepal.
GCC 38.12	The list of Key Personnel and their Qualifications: The list of Key Personnel is included in the Volume 1: Bidding Procedures, Section III: Evaluation and Qualification Criteria.
GCC 38.13	Add GCC 38.13 after GCC 38.12 as follows: The Contractor may employ foreign staffs who are necessary for execution of the work. The Contractor shall be responsible for making all arrangements for and shall bear all costs relating to the obtaining of all necessary visas, permits, documents or other official permission for the movement of staff or labour from place to place one country to another as may be necessary for the purposes of or in connection with the work. The Employer will assist the Contractor in obtaining Residence Permits and Entry Visas for expatriate personnel employed by the Contractor. The Employer

	will also assist the Contractor in obtaining the necessary residence permits for the above named employees' dependents. The Contractor shall comply with Government Laws governing work permits and residence requirements. The Contractor shall be responsible for observance by his sub-contractors of the provisions for this sub-clause. The Contractor shall comply with all relevant laws and regulations in force in Nepal, which become applicable on him for execution of work, including Workmen Compensation Act, Labour Act, Sales Tax, Income Tax, etc. Any liability which later accrues on Employer due to non-compliance by Contractor shall be to the Contractor's account. Detailed plan regarding this should be submitted by the Contractor within two months from the date of issue of Letter of Award. Subject to any provision to the contrary contained in the Contract, the Contractor shall have option to work continuously by day and by night and on locally recognized holiday or days of rest subjected to approval from the Employer which shall comply with the relevant laws of Nepal.
C. Time Control	
GCC 41.1	The Contractor shall submit for approval a Program for the Works within Thirty (30) days from the Commencement Date.
GCC 41.2	Delete "and" at the end of (c) and insert the following new Sub-paragraphs (d) to (j) after Sub-paragraph (c) as: (d) the Commencement date and the intended Completion date, of Works and each Sections (if any); (e) the time for detailed design by the Contractor including additional investigations and review periods; (f) the date right of access to and possession of the Site is to be given to the Contractor; (g) all activities (to the level of detail specified in the Employer's Requirements), logically linked and showing the earliest and latest start and finish dates for each activity, the float (if any), and the critical path(s); (h) the dates of all locally recognized holidays; (i) all key delivery dates of Plant and Materials; (j) for revised programme and for each activity: the actual progress to date, any delays to such progress and the effects of such delays on the other activities; and Rename Sub-Paragraph (d) as (k) and add the following at the end of this Sub-Paragraph as: (iii) if a revised programme, identification of any significant change(s) to the Baseline Programme; and (iv) the Contractor's proposal to overcome the effects of any delay(s) on the progress of the Works. The Employer shall review the initial programme within 21 days after the submission of the Contractor and give notice of the required corrections (if any). The Contractor shall then promptly after receiving such notice resubmit the programme for the Employer's review. The Employer shall give no-objection within 7 days after the employer receives the corrected programme and this programme shall be the baseline Programme for the execution of the Works.
GCC 41.3	Add the following at the end of this Sub-Clause:

	The Employer may at any time give a Notice to the Contractor to submit the revised programme, the Contractor shall within 14 days after receiving such Notice submit the revised programme to the Employer.
GCC 42.1	Delete this Sub-Clause in its entirety and substitute with the following: The Contractor shall be entitled subject to Clause 35 [Contractor's Claims] for extension of intended completion date if and to the extent that the completion for the purpose of Clause 76 [Taking Over of the Works] is or will be delayed by any of the following causes: (a) a Variation is issued by the Employer under Clause 53 [Variations]; (b) a cause of delay not attributable to the Contractor giving an entitlement to extension of intended completion date under any Clauses of these Conditions; (c) any delay caused by the or attributable to the Employer, the Employer's Personnel, or Employer's other Contractors on the Site; or (d) any delay caused by the events of Force Majeure as indicated in Sub-Clause 67.1 [Force Majeure].
	Add the following new Sub-Clause 43.3 after Sub-Clause 43.2 as:
43.3	If, at any time: - actual progress is too slow to complete the Works within the Intended Time for Completion, and/or - progress has fallen (or will fall) behind the current programme under Clause 41 [Program and Progress], Other than as a result of a cause listed in Clause 42 [Extension of the Intended Completion Date], then the Employer may instruct the Contractor to submit, under Clause 41 [Program and Progress], a revised programme and supporting report describing the revised methods which the Contractor proposes to adopt in order to expedite progress and complete within the Time for Completion. Unless the Employer notifies otherwise, the Contractor shall adopt these revised methods, which may require increases in the working hours and/or in the numbers of Contractor's Personnel and/or Goods, at the risk and cost of the Contractor. If these revised methods cause the Employer to incur additional costs, the Contractor shall subject to Clause 34 [Employer's Claims] pay these costs to the Employer, in addition to delay damages (if any) under Clause 61 [Liquidated Damages].
GCC 45.3	Regular progress meetings shall be held on weekly and monthly basis. Beside the regular progress meetings, either Party may require the other party to attend the management meetings at any time.
D. Quality Control	
GCC 48.1	Refer to Volume 2: Employer's Requirements of Bidding Documents.
GCC 48.4	Add the following at the end of this Sub-Clause: If the test is to be undertaken outside the Country, the Contractor shall provide and make all necessary arrangements for the Employer's Personnel to attend and witness all tests undertaken outside the Country and costs therefore shall

	be deemed to be included in the Contract Price stated in the Contract Agreement. Notification by the Contractor for inspection and testing which does not allow the Employer sufficient time to obtain visas for the country(s) where inspection or testing will be carried out, shall not be deemed a delay for which the Employer is responsible.
Sub-clause 48.7	<i>Delete this Sub-Clause in its entirety and replace by the following:</i> The Employer may instruct the Contractor to carryout additional tests and those additional tests show that the tested Plant, Material or Works is not accordance with the Contract, the Cost and any delay incurred thereof shall be the Contractor's Responsibilities. If the Contractor suffers delay and/or incurs additional Cost in complying such instructions and the additional tests showed that the tested Plant, Material or Works is accordance with the Contract, the Contractor shall be entitled subject to Clause 35. [Contractor's Claims] to: (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42. [Extension of Intended Completion Date], and (b) payment of any such Cost, which shall be added to the Contract Price After receiving this notice, the Employer's Representative shall proceed in accordance with Clause 32. [Determinations] to agree or determine these matters.
	<i>Add the following new Sub-Clause 48.9 and 48.10 as</i>
48.9	In the event of any Plant, Materials or Works (or parts) fails to pass tests under this Clause, the provisions of Clause 49 [Correction of Defects] shall apply.
Sub-clause 48.10	Factory Tests and Inspections: The Contractor shall be responsible for all the costs and expenses of all the factory tests and inspections, including the travelling costs (economy class flights, hotel costs, meals and other necessary travelling expenses) of the Employer and Employer's Representative. For each test the participation is limited to one person from the Employer's Representative and two people from the Employer.
GCC 49.1	The Defect Liability Period is 1825 days from the taking over of whole of Works.
GCC 50.1	Delete this Sub-Clause in its entirety and substitute with the following: If the Contractor has not corrected a Defect within the time specified in the Employer's notice, the Employer shall assess the cost of having the Defect corrected, and remedial work shall have to be executed at the risk and cost of the Contractor. The Employer may (at his option): (a) carry out the work himself or by others, in a reasonable manner and at the Contractor's risk and cost, and the Contractor shall subject to Clause 34 [Employer's Claims] pay to the Employer the costs reasonably incurred by the Employer in remedying the defect or damage; (b) accept the damaged or defective works in which case, the Employer shall be entitled to Employer's Claim under Clause 34 [Employer's Claims] for:

	(i) Payment of Non-performance damages by the Contractor in full satisfaction of this failure; and/or (ii) reduction in the Contract Price and such reduction shall be in full satisfaction of this failure only and in the amount as shall be appropriate to cover the reduced value to the Employer as a result of this failure. Then the Employer shall proceed in accordance with Clause 32 [Determinations] to determine the Non-performance Damages or reduction in the Contract price. (c) if the defect or damage deprives the Employer of substantially the whole benefit of the Works or any major part of the Works, terminate the Contract as a whole, or in respect of such major part which cannot be put to the intended use. Without prejudice to any other rights, under the Contract or otherwise, the Employer shall then be entitled to recover all sums paid for the Works or for such part (as the case may be), plus financing costs and the cost of dismantling the same, clearing the Site and returning Plant and Materials to the Contractor.
E. Cost Control	
GCC 51.3	For each Provisional Sum, except payments under Day Works, the overhead and profit shall be 15% (10 % overhead and 5% profit) of actual amount payable to the Contractor.
GCC 51.6	In Sub-paragraph (b), replace “Clause 53.5” with “Sub-clause 53.6”. Add the following new paragraphs at the end of this Sub-clause. A. The following special tax conditions shall apply to advance income tax under this Contract: a) Advance income tax assessed in accordance with the prevailing Income Tax Act of Nepal (Tax Deductions at Source) of the amount due before the addition of VAT shall be deducted from each payment certificate under the Contract prior to payment to the Contractor. Each of such ‘Advance Income Tax’ deduction shall be deposited to the concerned tax authorities and copies of the deposit slips will be provided to the Contractor. No reimbursement shall be made by the Employer for the advance income tax paid by the Contractor. B. The following special tax conditions shall apply to Customs Duty (Import Tax) for construction equipment and machinery under this Contract: a) Contractor’s construction equipment and machinery, including their essential tools and spare parts, imported by the Contractor for the sole purpose of executing the Contract which will be exported out of Nepal upon completion of the Works shall be exempt from payment of customs duties levied in Nepal. b) In order to be eligible for this exemption, the Contractor shall deposit the amount or provide a bank guarantee to the Government of Nepal Customs Department, with a copy to the Employer, equal to the amount of applicable custom duties assessed in accordance with the prevailing laws, rules and regulations of Nepal for those imported items at the time of import. The amounts of deposit so provided will be refunded, or the bank guarantees will be released by the Custom Department, after the submission of re-export certificates with respect

	to these items issued by the Customs Department. c) If the Contractor disposes of any of these imported items in Nepal, he shall pay all customs duties and taxes applicable on such items under the laws and regulations of Nepal in force at the time. d) In the event that the value of the imported spare parts for each item of the construction equipment and machinery exceeds 10% of the CIF to port of entry (Nepal Boarder) value of the respective item of imported construction equipment and machinery, the Contractor shall be liable to pay all applicable taxes and duties on the import of these imported spare parts. C. The following special conditions shall apply to Registration for Tax under this Contract: a) The Contractor and any foreign Subcontractors or Nominated Subcontractors employed on the Works, if not already registered in Nepal, shall be required to be registered with the concerned Inland Revenue Office for the purpose of the Contract. The Contractor shall complete this registration no later than 45 days after the date of signing the Contract Agreement. Certified copies of the Income Tax Registration Certificate(s) shall be submitted to the Employer within 15 days after registration. b) The Final Payment Certificate pursuant to Clause 77 [Final Account] shall be issued only after submission by the Contractor to the Employer of an Income Tax Clearance Certificate from the Government of Nepal for himself and any foreign Subcontractors or Nominated Subcontractors employed on the Works. D. The following special tax conditions shall apply to Import Duty and Value Added Tax (VAT) for metal parts of the hydro-mechanical equipment imported for this Project under Milestones MS-17 to MS-34 of Volume II, Section V Activity Schedule. a) VAT is not applicable on import of metal parts of hydro-mechanical equipment required for the project under this Contract. b) A special customs duty rate of 1% of the CIF to port of entry (Nepal Boarder) value shall be paid on metal parts of hydro-mechanical equipment imported by the Contractor for executing the Project under this Contract. c) The Contractor shall state separately in his Statements (payment invoices) the amounts paid at this special customs duty rate of 1% and these amounts shall be reimbursed by the Employer to the Contractor.

GCC 53.5	Add the following paragraphs at the end of Sub-clause 53.5: Each variation shall be evaluated in accordance with this Clause. For each item of work forming part or (all) of a Variation, the appropriate rate for the price of the item shall be the rate specified for such an item specified in the Schedule of Rates and Prices or, if there is no such item, the rate price specified for similar work. However, a new rate or price shall be appropriate for an item of work for which no rate or price is specified in Schedule of Rates and Prices and no specified rate or price is appropriate because the item of work is not of similar character or is not executed under similar conditions, as any item in the Contract. Each new rate or price shall be derived from any relevant rates or prices in the Schedule of Rates and Prices, with reasonable adjustments taking account of all relevant circumstances. If no rates or prices are relevant for the derivation of new rate or price, it shall be derived from the Cost-plus Profit of executing the work. The value of overhead charges and profits are to be considered while calculating new rates, shall be 15%. Until such time as an appropriate rate or price is agreed or determined, the Employer's Representative shall determine a provisional rate or price for the purposes of Interim Payment Certificates.
GCC 55.1	In the first Sentence, delete "six" Copies and insert four (4) hard copies and an electronic copy.
GCC 55.2	Add following Sub-paragraphs after (d): (e) any amounts to be added and or/deducted for Plants and Materials under Sub-clause 55.5; (f) any other additions or deductions which have become due under the Contract or otherwise, including those under Sub-clause 32 [Determinations]; (g) any amounts to added for Provisional Sums under Sub-clause 51.3; (h) any amount to be added for release of Retention Money under Sub-clause 60.2; Renumber Sub-paragraph (e) and (f) as (i) and (j).
GCC 55.3	The payment shall be made after completion of each milestone in Full or Partial as specified in the Activity Schedule. However, for certain Milestones, partial payment is also applicable pursuant to Clause 55.4.
GCC 55.4	Delete the Sub-clause entirely and insert the following: The Works under the project are divided into numbers of Milestones as per the Activity Schedule provided in Section V, Volume 2 of the bidding document. The payments are made after completion of each Milestone. However, partial payments are also allowed for the number of Milestones. The lists of the Milestones and payment modality for partial payment is provided in Bid Price Schedule in Section 5: Activity Schedule of Volume 2: Employer's Requirements. If the Employer's Representative considers that the percentage weightage under the Activity Schedule for Milestones does not reflect the actual weightage as per the works of Activity, the Employer's Representative may revise the

	percentage Weightage of Milestones.
GCC 55.5	Delete the Sub-clause entirely and insert the following: The Contractor is entitled under the Contract to an interim payment for Plant and Materials which are not yet on the Site for the Hydromechanical Plant and Equipment under MS-17 to MS-34 of Volume II Section V Activity Schedule after receipt of following documents through irrevocable letter of credit (LC) opened in favor of Contractor's bank: a) Six (6) copies of supplier invoice showing contract no., goods description, quantity, unit price and total amount; b) Original and six (6) copies of negotiable, clean, on-board bill of lading marked freight prepaid and 6 copies of non negotiable bill of lading; c) Six (6) copies of Detailed Packing list identify contents of each package; iv) Insurance Policy/Certificate; d) Manufactures / supplier's warranty certificate; e) Dispatch authorization issued by the employer with the factory inspection report; f) Certificate of origin. The costs and bank charges towards opening and maintaining LC of the issuing bank shall be borne by the Employer and all the costs and bank charges associated to advising/beneficiary bank shall be borne by the Contractor. The TDS as per the prevailing rules of Nepal shall be deducted during the payment through the LC.
.	Add the following new Sub-Clause 55.8 after Sub-Clause 55.7 as:
55.8	Within 90 days after the Date of Completion of the Works, the Contractor shall submit to the Employer four (4) hard copies and an electronic copy of a statement at completion with supporting documents, showing: a) Value of work done in accordance with Contract up to the date stated in Taking Over Certificate for the Works; b) Any further sums which the Contractor considers to be due; and c) An estimate of any other amount which the Contractor considers will become due to him under the contract, estimated amount shall be shown separately in the statement of completion. The Employer's Representative shall then issue an Interim Payment Certificate in accordance with Sub-clause 56.1.

GCC 56.1	Delete this Sub-Clause in its entirety and substitute with the following: Within Thirty (30) days of receipt and acceptance of the monthly statement referred to in GCC Clause 55.1 [Interim Payment Certificate], the Employer's Representative shall issue to the Employer an Interim Payment Certificate, certifying the amounts due to the Contractor. However, the Employer's Representative shall not be bound to certify any payment under this Clause, if the net amount thereof, after all retentions and deductions, would be less than 0.2% of the Contract Price. However, in such case, the unpaid certified amount will be added to the next interim payment, and the cumulative unpaid certified amount will be compared to the minimum amount of interim payment. The Employer shall make the payment due to the Contractor under any Interim Payment Certificate issued by the Employer's Representative pursuant to this Clause, or to any other term of the Contract, within Thirty (30) days of the date of each such certificate into a bank account or accounts nominated by the Contractor.
GCC 56.2	Foreign Currency Portion: 2% per annum. Nepalese Rupees Portion: 5% per annum.
GCC 57.1	Replace this Sub-Clause in its entirety with the following: The Contract Price shall be adjusted in accordance with this Sub-Clause to take account of any increase or decrease in the Cost resulting from the changes in the taxes (VAT) and custom duties (for hydromechanical plant and equipment only), to the extent that the changes have been made after the Base Date. However, the Contract Price shall not be adjusted for changes in the Income Tax or any similar taxes.
GCC 58.1	Delete this Sub-Clause in its entirety and substitute with the following: The currency applicable shall be Local Currency in Nepalese Rupees (NRs) and Foreign Currency in United States Dollars (USD). The maximum ratio of Foreign Currency to Local Currency with respect to the Contract Price shall be 60:40 percent. For the purpose of payments in Foreign Currency, the exchange rates established by Nepal Rastra Bank as the selling rates prevailing on the Base Date shall apply for the duration of the Contract so that no currency exchange risk shall be borne by the Contractor. The Contractor shall note that during the progress of the Works, the foreign currency requirements of the outstanding balance of the Contract Price may be adjusted by agreement between the Employer and the Contractor in order to reflect any changes in foreign currency requirements for the Contract. Any such adjustment shall be affected by comparing the percentages quoted in the bid with the amounts already used in the Works and the Contractor's future needs for imported items.
GCC 60.1	The proportion of payments retained is five (5%) percent.

GCC 60.2	Delete this Sub-Clause in its entirety and substitute with the following: The Contractor shall include in a Statement (a) the first half of the Retention Money upon the issue of Performance Certificate in accordance with Sub Clause 77[Final Account] by the Employer; and (b) the second half of the Retention Money upon the submission of tax return to the concerned Internal Revenue Office. In the next interim payment, after the Employer receives any such statement, the Employer shall release the corresponding amount of Retention Money.
GCC 61.1	Replace “charge liquidated damage” by “ be entitled to claim subject to Clause 34 [Employer’s Claims] to the payment of liquidated damages by the Contractor for this default.” The liquidated damages for each major Milestone of the Works is 0.02 percent of the quoted price of total Works covered in the Milestone in Activity Schedule per day. The list of major milestones is stated in GCC 2.2.
GCC 61.2	Replace “the Contractor shall subject to Clause 34 [Employer’s Claims] pay delay damages to the Employer” by “ the Employer shall be entitled to claim subject to Clause 34 [Employer’s Claims] to the payment of liquidated damages by the Contractor”. The liquidated damages for the whole of the Works are 0.05 % of the Contract Price per day.
GCC 61.3	The total amount of liquidated damage for the whole of the Works shall not exceed Ten (10) percent of the Contract Price. Delete the last sentence of this Sub-Clause.
GCC 62.1	The Bonus shall be 0.05 percent of Contract Price per day.
GCC 62.2	The total amount of Bonus shall not exceed Ten (10) percent of the Contract Price. Add the following at the end of this Sub-Clause: The Bonus under this Sub Clause shall not be applicable if the project could not be completed before initial intended completion date by whatsoever reasons may be. In such case, the Contractor shall not be entitled for claim towards the bonus payment.
GCC 63.1	Delete this Sub-Clause in its entirety and substitute with the following: The Employer shall make an advance payment equal to Fifteen (15%) percent of the Accepted Contract Amount less Provisional Sum, Dayworks and VAT, in the proportions of the currencies defined under Sub-Clause 58.1, as an interest free loan for mobilization and design.

	The Contractor shall submit (at the Contractor's cost) an Advance Payment Guarantee in amounts in the proportions of the currencies equal to the advance payment, to the Employer. This guarantee shall be issued by Class A Commercial Bank in Nepal and shall be in the form of an on-demand, unconditional and irrevocable guarantee acceptable to the Employer. The guarantee issued by a foreign bank shall be counter guaranteed by a Class A Commercial bank of Nepal. The total advance amount shall be paid in two equal installments as described below: - The first installment of Five (5) percent in in the proportions of the currencies shall be paid within 30 days after the Employer receives the Advance Payment Guarantee together with the Contractor's application for the Advance Payment after the signing of Contract Agreement. - The second installment of Five (5) percent in the proportions of the currencies shall be paid within 30 days after the complete mobilization of the Contractor to the Site, and the Employer receives the Advance Payment Guarantee together with the Contractor's application for the Advance Payment. The complete mobilization to the Site shall mean the completion of Milestones MS-1 and MS-3 as mentioned in the (Activity Schedule) Bid Price Schedule. Notwithstanding the time limits defined for the Advance Payment under this Sub-Clause, the foreign portion of the Advance Payment shall be subjected to the necessary approval of currency exchange received from Nepal Rastra Bank.
GCC 63.3	Delete this Sub-Clause in its entirety and substitute with the following: The Contractor shall ensure that the Advance payment Guarantee is valid and effective until the advance payment has been fully repaid, but its amount may be progressively reduced by the amount repaid by the Contractor. If the advance payment has not been repaid by the date 30 days before the expiry date of the Guarantee: (a) The Contractor shall extend at Contractor's cost, the validity of this guarantee until the advance payment has been repaid; (b) The Contractor shall immediately submit evidence of this extension to the Employer; and (c) If the Employer does not receive this evidence 7 day before the expiry date of this guarantee, the Employer shall be entitled to claim under the Guarantee the amount of Advance Payment, which has not been repaid.
GCC 63.4	Delete this Sub-Clause in its entirety and replace it with the following: The advance payment shall be repaid through percentage deductions from the interim payments certified by the Employer's Representative in accordance with this Clause. Deductions shall commence in the Interim Payment Certificate in which the total of all interim payments certified (excluding the advance payment and retention money) to the Contractor exceeds twenty thirty (30%) percent of the Contract Price less Provisional Sums, Dayworks and VAT. The deductions shall me made at such rate of the respective interim payments such that the total advance amount shall be fully repaid prior to the time when

	80 percent of the Contract Price less the amount in the Provisional Sum, Dayworks and VAT has been certified for payment.
Sub-clause 63.6	Insert the following new Sub-Clause 63.6 after 63.5 as follows: If the advance payment has not been repaid before the issue of the Taking-Over Certificate for the Works, or before termination of the Contract under any Clauses under this Contract, the Employer shall be entitled to claim under the Guarantee the amount of Advance Payment, which has not been repaid.
GCC 64	Rename this Clause as “Performance Security”
GCC 64.1	The Performance Security is the amount calculated as per the following provisions as the case may be: Case I: i) If the bid price of the bidder selected for acceptance is up to 15 (Fifteen) percent below the approved cost estimate (including the Provisional Sum), the performance security amount shall be 5 (five) percent of the bid price. Case II: ii) For the bid price of the bidder selected for acceptance is more than 15 (fifteen) percent below of the cost estimate (including Provisional Sum), the performance security amount shall be determined as follows: Performance Security Amount = $[(0.85 \times \text{Employer's Cost Estimate} - \text{Bid Price}) \times 0.5] + 5\% \text{ of Bid Price}$. The Bid Price and Cost Estimate shall be inclusive of the Value Added Tax. The performance security shall be denominated in the types and proportions of currencies in which the Contract Price is payable.
GCC 64.3	Delete this Sub-Clause in its entirety and replace it with the following: The Performance Security shall be in the form of an on-demand, unconditional and irrevocable bank guarantee acceptable to the Employer. issued by Class A Commercial Bank in Nepal. The guarantee issued by a foreign bank shall be counter guaranteed by a Class A Commercial Bank of Nepal.
GCC 64.4	Add the following at the end of Sub-clause 64.4: Performance of the Contractor's obligation under the Contract shall not be considered to have been completed until the Employer has issued the Performance Certificate to the Contractor, stating the date on which the Contractor fulfilled the Contractor's obligation under the Contract. The Employer shall issue the Performance Certificate to the Contractor within Thirty (30) days after the latest of the expiry dates of the Defect Liability Period or as soon thereafter as the Contractor has: (a) supplied all the Contractor's Documents and, if applicable, the Employer has given (or deemed to have given) a Notice of No-objection to the as-built records; and (b) completed and tested all the Works (including remedying defects) in accordance with the Contract. Only the Performance Certificate shall be deemed to constitute acceptance of the Works.
GCC 64.6	Add the following at the end of this Sub-Clause as:

	or promptly after the date of termination of the Contract if terminated under Sub-Clause 79.9 or Clause 72 [Optional Termination, Payment and Release] and Clause 73 [Release from Performance].
Sub-Clause 64.7	After the end of Sub-Clause 64.6, add the Sub-Clause 64.7 as follows: Assignment and Novation of Manufacturer's Warranties: The Contractor shall procure that any warranty, express or implied, with respect to any Plant or Materials used in the construction of the Works made or given by the manufacturer, any Subcontractor, any supplier, or any other seller thereof, will be made in favour of the Employer, or will be assigned or otherwise made available to the Employer or such entity that the Employer nominates. The Contractor must ensure that all warranties given by the manufacturer, Subcontractor or supplier thereof, or any other seller thereof, will be capable of novation from the Employer to any entity to be nominated by the Employer. To the extent that the warranties cannot be made in favour of the Employer, assigned or otherwise made available to the Employer, the Contractor agrees (at its cost) to use its best endeavours to enforce such rights as the Contractor may have, for the benefit of the Employer. The Works shall not be considered to be completed for the purposes of being Taken Over under Sub-Clause 76.1 [Taking Over the Works and Sections] until the Employer has received such warranties and confirmation that the warranties are capable of novation from the Employer to any entity to be nominated by the Employer.
F. Force Majeure	
GCC 67.1	Delete this Sub-Clause in its entirety and substitute with the following: "Force Majeure" means an event or circumstance which: (i) is beyond a Party's control; (ii) the Party could not reasonably have provided against before entering into the Contract; (iii) having arisen, such Party could not reasonably have avoided or overcome; and (iv) is not substantially attributable to the other Party. A Force Majeure Event may comprise but is not limited to any of the following events or circumstances provided that conditions (i) to (iv) above are satisfied: (a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies; (b) rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war; (c) riot, commotion or disorder by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors; (d) strike or lockout not solely involving the Contractor's Personnel and other employees of the Contractor and Subcontractors; (e) encountering munitions of war, explosive materials, ionising radiation or contamination by radio-activity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity; (f) natural disaster such as earthquake, fire, Excessive rainfall (atibrishti), flood and landslide, tsunami, volcanic activity, hurricane, or typhoon if

	occurs and affects the component of the project adversely or the Contractor cannot perform the work due to the notification from the Government of Nepal during the occurrence of any pandemic.
GCC 70.1	Delete this Sub-Clause in its entirety and substitute with the following: If the Contractor is prevented from performing its substantial obligations under the Contract by Force Majeure of which notice has been given under Sub-clause 68.1, and suffers delay and/or incurs Cost by reason of such Force Majeure, the Contractor shall be entitled subject to Clause 35 [Contractor's Claim] to (a) an extension of time for any such delay, if completion is or will be delayed, under Clause 42 [Extension of Intended Completion date]; and (b) if the event or circumstance is of the kind described in sub-paragraphs (a) to (e) of Sub-clause 67.1 and, in the case of subparagraphs (b) to (e), occurs in Nepal, payment of any such Cost, including the costs of rectifying or replacing the Works and/or Goods damaged or destroyed by events of Force Majeure, to the extent they are not indemnified through the insurance policy referred to in GCC 23 [Insurance].
GCC 72.1	In the last of sentence of this Sub-Clause, replace "GCC 79.5" with "Clause 82 [Cessation of work and Removal of Contractor's Equipment].
GCC 72.2	Replace the first sentence of this Sub-clause with the following: After the date of termination, the Contractor shall, as soon as practicable, submit detailed supporting particulars (as reasonably required by the Employer's Representative) of the value of the work done, which shall include: Add the following at the end of this Sub-Clause as: The Employer's Representative shall issue a payment certificate for the amount agreed or determined, without the need for Contractor to submit the Statement.
G. Finishing the Contract	
GCC 74.1	Tests shall be carried out as per the requirements stipulated in Volume 2: Employer's Requirement. And at the end of the Sub-Clause, add the following: The Contractor shall also coordinate with Other Contractors under Clause 17 [Other Contractors] in carrying out these tests.
GCC 74.2	Insert the following after "Tests on Completion" in the first sentence of this Sub-Clause as: " , with a detailed programme showing the timing and resources and the Contractor's detailed methodology to carry out such tests"
GCC 74.6	Replace "Clause 74.3 (a), (b) or (c)" with "Clause 74.3 (a), (b) and (c)" in the last sentence of this Sub-Clause.
GCC 74.12	Delete this Sub-Clause in its entirety and replace it with the following: In the event of Sub-Paragraph (c) above, the Contractor shall then proceed in accordance with all other obligations under the Contract, and the Employer shall be entitled subject to Clause 34 [Employer's Claims] to payment by the Contractor or a reduction in the Contract price as described under Sub-Clause 50.4. In such case, the minimum acceptance performance criteria shall be as specified in the Employer's Requirements or elsewhere specified in the Contract. Unless the relevant reduction for this failure is stated (or its method of calculation is defined) in the Contract, the Employer may require the reduction

	to be (i) agreed by both the Parties (in full satisfaction of this failure only) and paid before this Taking-Over Certificate is issued, or (ii) determined and paid under Clause 34 [Employer's Claims] and Clause 32 [Determinations].
GCC 75.1 (b)	Insert the following after “equipment” in this Sub-paragraph as: “, apparatus, assistance, documents, instruments, labour”
GCC 75.2	Insert the following after first sentence of this Sub-Clause as: The Tests after Completion shall be carried out when the river discharge is sufficient for full load rejection of the Plant, the Lot 2 Contractor's Works have been taken over by the Employer and the full load power evacuation is available.
GCC 75.9	Non-performance damages shall be calculated as a present value of the losses occurred to the Employer due to failure to pass Tests after Completion or failure to remedy the defects under this Contract. The time period shall for calculation of present value shall be 30 years and the discount rate shall be 10%. The minimum acceptable performance criteria are defined in the Employer's Requirements.
GCC 76.1	Delete this Sub-Clause in its entirety and substitute with the following: Except as stated in Clause 74.11 and Clause 74.12, the Works shall be taken over by the Employer when: (i) the Works have been completed in accordance with the Contract and passing of Tests on Completion under Clause 74 [Tests on Completion] and except as allowed in Sub-clause 76.3(a) below; (ii) The Contractor has submitted the Operating and Maintenance Manuals and As-built Records under Clause 78 [Operating and Maintenance Manuals and As Built Records] as per Employer's Requirements; and (iii) a Taking Over Certificate for the Works has been issued or is deemed to have been issued in accordance with this Clause.
GCC 76.4	Delete this Sub-Clause in its entirety and replace it with the following: If the Employer fail either to issue the Taking-Over Certificate or to reject the Contractor's application within the period of Thirty (30) days after the Contractor's application, and if the Works or Sections(as the case may be) are substantially completed in accordance with the Contract, and the conditions of Sub-Paragraph (i) to (ii) of Sub-Clause 76.1 are fulfilled, the Taking Over Certificate shall be deemed to have been issued on the last day of that period.
GCC 78	Rename this Clause “ Operating and Maintenance Manuals and As Built Records ”
GCC 78.1	Insert “of As-Built Records” after “Two copies” in the last sentence of this Sub-Clause.

GCC 78.3	The numbers of copies and the date by which As-built Drawings are to be submitted by the Contractor shall be as specified in Volume 2: Employer's Requirements.
GCC 78.4	The numbers of copies and the date by which Operation and Maintenance Manuals are to be submitted by the Contractor shall be as specified in Volume 2: Employer's Requirements.
	Add the following new Sub-Clause 78.5 after Sub-clause 78.4 as
Sub-clause 78.5	The Contractor shall submit the updated As-built Records and Operating and Maintenance Manuals to the Employer as per Employer's Requirements after incorporating errors and defects (if any), which are found during the Tests on Completion.
GCC 79.1	Delete this Sub-Clause in its entirety and replace it with the following: If the Contractor fails to carry out any obligation under the Contract, the Employer may, by giving a Notice to the Contractor, require the Contractor to make good the failure and to remedy it within a specified time ("Notice to Correct" in these Conditions). The Notice to Correct shall: a) describe the Contractor's failure; b) state the Sub-Clause and/or provisions of the Contract under which the Contractor has the obligation; and c) specify the time within which the Contractor shall remedy the failure, which shall be reasonable, taking due regard to the nature of the failure and the work and/or other action required to remedy it. After receiving a Notice to Correct the Contractor shall immediately respond by giving a Notice to the Employer describing the measures the Contractor will take to remedy the failure and stating the date on which such measures will be commenced in order to comply with the time specified in the Notice to Correct. The time specified in the Notice to Correct shall not imply any extension of the time for Completion.
GCC 79.2 (l)	The maximum number of days is: 200 Calendar Days.
GCC 81.1 (e)	Replace the Sub-Paragraph (e) in its entirety with the following: (e) A prolonged suspension affects the whole of the Works as described in Sub-Clause 44.1 for more than 90 days,
GCC 81.1	Replace the last sentence of this Sub-Clause with the following: In any of these events or circumstances, the Contractor shall be entitled to give a 15 days Notice under Sub-clause 81.1 to the Employer of the Contractor's intention to terminate the Contract. Unless the Employer remedies the matters within such days, the Contractor may by giving a second Notice to the Employer terminate the Contract. The date of termination shall be the date the Employer

	receives the second Notice of the Contractor. However, in the case of Sub-paragraph (e) or (f), the Contractor may by notice terminate the Contract immediately.
GCC 83.2	Replace this Sub-Clause 83.2 in its entirety with the following: After a notice of termination under Clause 79 [Termination by Employer] other than Termination by Convenience as per Clause Sub-79.9 has taken effect, the Employer shall be entitled subject to Clause 34 [Employer's Claims] to payment by the Contractor of: (a) the additional costs of execution of the Works, and all other costs reasonably incurred by the Employer; (b) any loss or damage suffered by the Employer in completing the Works. After recovering any such losses, damages and extra costs, the Employer shall pay any balance to the Contractor; (c) Liquidated damages, if the Works or a Section have not been taken over by the Employer under Clause 76 [Taking Over of the Works] and if the date of termination for Contractor's default under Clause 79 [Termination by Employer] occurs after the Intended Completion Date (including extensions, if any). The Employer may forfeit the Performance Security and shall withhold further payments to the Contractor until the costs of design, execution, completion and remedying of any defects, liquidated damages (if any), and any costs or losses or damages stated from (a) to (c) above have been established. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer.
GCC 88.1	All countries
GCC 88.2	All countries
GCC 89.1	Add the following at the end of this Sub-Clause as: The Contractor shall also reinstate all parts of the Site which were affected by the Contractor's activities during execution of the Works and are not occupied by the Permanent Works.
GCC 91	Replace the first sentence of this Sub-clause as follows: The Contract is not exempted from the Value Added Tax (VAT) except for the importation of metal parts of hydromechanical equipment.
G. Additional Clauses	
Add the following Clauses 99 to 107	
99. Import and Customs Laws and Regulations	In connection with the performance of this Contract, the Contractor acknowledges that the Laws of the Country which may specifically refer to import and customs regulations shall apply to the furnishing and shipment of any products or components required for the Works. The Contractor specifically acknowledges that the Laws of Nepal may prohibit, among other things, the importation of certain products or components.

100. Parent Company Guarantee	If applicable, the Contractor shall provide a Parent Company Guarantee, by the ultimate parent company of the Contractor, at the time of signing the Contract Agreement. If, at any time and for any reason, the Parent Company Guarantee is not enforceable, then the Employer is entitled to suspend any and all payments to the Contractor until the Contractor has provided the Employer with a new, satisfactory and enforceable Parent Company Guarantee form an entity, with sufficient financial standing to guarantee the performance of all of the Contractor's obligations under the contract.
101. Assignment and Novation of Manufacturer's Warranties	The Contractor shall procure that any warranty, express or implied, with respect to any Plant or Materials used in the construction of the Works made or given by the manufacturer, any Subcontractor, any supplier, or any other seller thereof, will be made in favor of the Employer, or will be assigned or otherwise made available to the Employer or such entity that the Employer nominates. The Contractor shall ensure that all warranties given by the manufacturer, Sub-Contractor or supplier thereof, or any other seller thereof, will be capable of novation from the Employer to any entity to be nominated by the Employer. The Works shall not be considered to be completed for the purposes of being Taken Over under Clause 76 [<i>Taking Over of the Works</i>] until the Employer has received such warranties and confirmation that the warranties are capable of novation from the Employer to any entity to be nominated by the Employer.
102. Illegal Payment	The Employer reserves its right to terminate the Contract without giving the Contractor any prior notification, if the Contractor or any of his Subcontractors, agents or its staff found in corrupt practices of any kind at any stages of the execution of this Contract. For the purpose of this provision, "corrupt practices" means offering, giving, receiving or soliciting of, directly or indirectly, anything of value to influence the action of any representative, official employee or agent of the Employer or of the Employer's Representative in the selection process or in the execution of the Contract. However, the Contractor shall be provided an opportunity to produce its explanation before the Employer proceed to expel or terminate the Contractor. If in case, the Contract is terminated, the Employer is entitled to recover all costs associated with the Contractor's removal from Site, the identification and appointment of others to complete the outstanding Works and the amount of any loss resulting from such termination.
103. Fuel Supply	The Contractor is required to plan and coordinate his total fuel use at the Works, for his total requirements for the duration of the project. Storage of Fuel Supply: - Locations and methods for storing fuel at the Site or the like shall be complied with the Employer's Requirements and the appropriate laws of Nepal; - The Contractor shall provide sufficient fuel storage capacity to provide for project needs, including fuels specified to be

	provided for the Employer. The Contractor's storage tanks shall always have at least Thirty (30) days fuel supply on hand at current usage. The fuel supply shall be divided into storage at two or more different locations to minimize the risk of loss of supply.
104. Sufficient Stock of Materials	Due to climatic and geological conditions, particularly during the wet season, the Contractor may encounter problems with access to the Site. Therefore, having regard to Nepal being landlocked, the remoteness of the Site, climatic and geological conditions, the Contractor shall at all times plan and arrange for sufficient stock of major materials, which including, but not limited to, cement, explosives, detonators, reinforcing steel bars, rock support materials, fuel, to provide uninterrupted operations. Failure to provide sufficient stock at Site or shortage of materials shall be in no case the reasons for claim for extension of time or any cost thereof.
105. Temporary Utilities	The Contractor shall be responsible for the provision of all power, water and other services, the Contractor or any of his Sub-Contractors may require, for the performance of the Works. The Contractor shall, at his own risk and cost, provide any apparatus necessary for his use of these services and for measuring the quantities consumed, and shall make arrangements with the relevant authorities, organizations or companies for such supply and payment. The Contractor may, at his own convenience, risk and cost, request to avail of national grid electricity supply being aware that energy and power may be subject to interruption upon time to time during the duration of Project. The Contractor shall make his own arrangement for generating power from stand-by generators in case the power supply from the national grid is not available. The Contractor shall not be entitled to any extension to any Time for Completion or any additional costs or other compensation whatsoever from the Employer in connection with the unavailability of sufficient supplies of electricity, water, gas and other services as may be required for the Works.
106. Land Owners and Access Route Owners	Notwithstanding any other provision of the Contract, the Contractor shall: - establish and maintain a regular and direct dialogue with the owners of the land on which the Site is located, the owners of any access routes on, near or to the Site and other major users of the access routes on, near or to the Site, in order to co-ordinate their respective activities and usage requirements; - be responsible for paying any levy, Tax or any amount payable to the Landowners or Access Route Owners, or complying with any other conditions of the Landowners or Access Route Owners, in order to secure on going access to the Site; - pay any costs, including costs associated with the maintenance and capital upgrade or improvement of any access route on, near or adjacent to the Site, which are reasonably incurred by an Access Route Owner as a result of or in connection with the

	Contractor's use of that access route; d) take all reasonable precautions to prevent damage or deterioration to access routes on, near or to the Site, including all public roads and bridges adjacent to the Site; e) choose transportation routes, select vehicles and distribute deliveries to the Site, so as to minimize the traffic impact in, on or around the Site; f) permit the Landowners and Access Route Owners to have free and unrestricted access to the access routes on, near or to the Site, as and when they reasonably require; g) fully co-operate with the Access Route Owners, in relation to the maintenance of access routes on, near or to the Site and to inform the Employer if he considers that the carrying out of maintenance activities on access routes is materially hindering the Contractor's ability to access the Site; h) carefully co-ordinate and interface the Works with any maintenance, upgrading or capital improvement activities to be carried out by the Access Route Owners; and i) fully comply with any use and safety rules imposed from time to time by the Access Road Owners.
107. Right of Inspection by the Financier	Upon instruction from the Employer, the Contractor shall permit the Financier and/or persons appointed by the Financier to inspect the Site and provide them with the audited Contractor's general ledger, accounts and records relating to the Performance of the Contract.

**REMIT HYDRO LIMITED
GHUNSA KHOLA HYDROELECTRIC PROJECT (77 MW)**

**BIDDING DOCUMENT
FOR
CONSTRUCTION
OF**

**LOT 1 – CIVIL AND HYDROMECHANICAL WORKS
(Under EPC Contract)**

**VOLUME 3
CONDITIONS OF CONTRACT**

**SECTION III
CONTRACT FORMS**

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SECTION III: CONTRACT FORMS

This Section contains forms which, once completed, will form part of the Contract. The forms for Performance Security and Advance Payment Security, when required, shall only be completed by the successful Bidder after contract award.

LETTER OF INTENT

[on letterhead paper of the Employer]

Date:

To: *[Name and address of the Contractor.....]*

Subject: *[Issuance of letter of intent to award the contract.....]*

This is to notify you that, it is our intention to award the contract*[insert date]* for execution of the*[insert name of the contract and identification number, as given in the SCC]* to you as your bid price of Nepali Rupees..... *[insert amount in figures and words in the Nepali Rupees]* as corrected and modified in accordance with the Instructions to Bidders is hereby selected as substantially responsive lowest evaluated bid.

Authorized Signature:

Name:

Title:

CC:

[Insert name and address of all other Bidders, who submitted the bid]

Notes on Letter of Intent

The issuance of Letter of Intent is the information of the selection of the bid of the successful bidder by the Employer and for providing information to other unsuccessful bidders who participated in the bid as regards to the outcome of the procurement process. This standard form of Letter of Intent to Award should be filled in and sent to the successful Bidder only after evaluation and selection of substantially responsible lowest evaluated bid.

LETTER OF ACCEPTANCE

[on letterhead paper of the Employer]

Date:

To: *[Name and address of the Contractor.....]*

Subject: *[Notification of Award]*

This is to notify that your Bid dated**date** for execution of the.....**name of the contract and identification number, as given in the SCC** for the Contract price of US Dollar *[insert amount in figures and words in US dollar]*, and Nepali Rupees *[insert amount in figures and words in Nepali Rupees]*, resulting in the Total Contract Price in Nepali Rupees *[insert amount in figures and words in Nepali Rupees]* as per the currency exchange rate prevailing on the base date, as corrected in accordance with the Instructions to Bidders is hereby accepted in accordance with the Instruction to Bidders.

You are hereby instructed to contact this office to sign the formal contract agreement within Thirty [30] days with Performance Security of..... in accordance with the Conditions of Contract, using for that purpose the Performance Security Form included in Section IV (Contract Forms) of this Bidding Document.

Authorized Signature:

Name and Title of Signatory:

CONTRACT AGREEMENT

THIS AGREEMENT made the day of.... between.....
name of the Employer (*hereinafter “the Employer”*), of the one part, and
.....name of the Contractor (*hereinafter “the Contractor”*), of the other part:

WHEREAS the Employer desires that the Works known as name of the Contract should be executed by the Contractor and has accepted a Bid by the Contractor for the execution and completion of these Works including warranty, operation and maintenance and the remedying of any defects in the sum of NRs
[insert amount of contract price in words and figures including taxes] (*hereinafter “the Contract Price”*) through Engineering, Procurement and Construction (EPC) method as a Lumpsum Contract.

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.
 - (a) Contract Agreement;
 - (b) Letter of Acceptance;
 - (c) Memorandum of Understanding (MoU) and/or Minutes of Contract Negotiations if any;
 - (d) Letter of Technical and Price Bid;
 - (e) All addenda issued if any;
 - (f) Special Conditions of Contract;
 - (g) General Conditions of Contract;
 - (h) Employer's Requirements;
 - (i) Activity Schedules;
 - (j) The Complete Bidding Forms and Schedules submitted in the Bid; and
 - (k) Instruction to Bidders;
3. In consideration of the payments to be made by the Employer to the Contractor as indicated in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of Nepal on the day, month and year indicated above.

Signed by



for and on behalf the Contractor in the presence of
Witness, Name Signature, Address, Date

Signed by.....

for and on behalf of the Employer in the presence of
Witness, Name, Signature, Address, Date

PERFORMANCE SECURITY

(On letterhead paper of the Commercial Bank or Financial Institution eligible to issue
Bank Guarantee as per prevailing Law)

..... **Bank's Name, and Address of Issuing Branch or Office**
..... Beneficiary: Name and Address of Employer
Date:

Performance Guarantee No.:

We have been informed that **[insert name of the Contractor]** (hereinafter called "the Contractor") has been notified by you to sign the Contract No. **[insert reference number of the Contract]** for the execution of **[insert name of contract and brief description of Works]** (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Contractor, we... **[insert name of the Bank]** hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of **[insert name of the currency and amount in figures*] (... .. insert amount in words)** such sum being payable in Nepali Rupees, upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation(s) under the Contract, without your needing to prove or to show grounds for your demand or the sum specified therein.

This guarantee shall expire, no later than the..... Day of **, and any demand for payment under it must be received by us at this office on or before that date.

.....

Seal of Bank and Signature(s)

Note:

All the italicized text is for guidance on how to prepare this demand guarantee and shall be deleted from the final document.

* The Guarantor shall insert an amount representing the percentage of the Contract Price specified in the Contract in Nepali Rupees.

** Insert the date thirty days after the date specified for the Defect Liability Period. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months], in response to the Employer's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee".

LETTER OF COMMITMENT FOR BANK'S UNDERTAKING FOR LINE OF CREDIT

Bank's Name, and Address of Issuing Branch or Office
(On Letter head of the Commercial bank or any Financial Institution eligible to issue Bank
Guarantee as per prevailing Law)

Date:

Contract No:

Name of Contract :

To:

[Name and address of the Employer]

CREDIT COMMITMENT No: *[insert number]*

We are pleased to know that *[name of Contractor]* (hereinafter called "the Contractor") has been awarded the Contract for the execution of the Works of ***[description of works]*** for above contract.

Furthermore, we understand that, according to your conditions, the Contractor's Financial Capacity i.e. Liquid Asset must be substantiated by a Letter of Commitment of Bank's Undertaking for Line of Credit.

At the request of, and arrangement with, the Contractor, we *[name and address of the Bank]* do hereby agree and undertake that *[name and address of the Contractor]* will be provided by us with a revolving line of credit, for execution of the Works viz. *[insert name of the works]*, for an amount not less than NRs *[in figure]* (*in words*) for the sole purpose of the execution of the above Contract. This Revolving Line of Credit will be maintained by us until ***[Insert "Initial Contract Period"]*** months by the Procuring Entity.

This committed line of credit shall not be terminated or cancelled without the prior written approval of Employer.

In witness whereof, authorised representative of the Bank has hereunto signed and sealed this Letter of Commitment.

Signature

Name:

Designation:

Signature

Name:

Designation:

ADVANCE PAYMENT SECURITY

(On letterhead paper of the Commercial Bank or Financial Institution eligible to issue
Bank Guarantee as per prevailing Law)

..... **Bank's Name, and Address of Issuing Branch or Office**.....

Beneficiary:**Name and address of employer**

Date:

Advance Payment Guarantee No.....

We have been informed that has entered into Contract No.**Name and Address of Employer**.....**name of the Contractor**.....(hereinafter called "the Contractor")..reference number of the Contract.....dated with you, for the execution of ...contract and brief description of Works (hereinafter called "the Contract").

Furthermore, we understand that, according to the Conditions of the Contract, an advance payment in the sum..... name of the currency and amount in figures*... (**.... amount in words**) is to be made against an advance payment guarantee.

At the request of the Contractor, we..... **name of the Bank** hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of.....name of the currency and amount in figures*... (**..... amount in words**) upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation under the Contract because the Contractor used the advance payment for purposes other than the costs of mobilization in respect of the Works.

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Contractor as indicated in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that eighty (80) percent of the Contract Price has been certified for payment, or on the day of**, whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

.....

Seal of Bank and Signature(s)

Note:

All italicized text is for guidance on how to prepare this demand guarantee and shall be deleted from the final document.

*The Guarantor shall insert an amount representing the amount of the advance payment in Nepali Rupees of the advance payment as specified in the Contract.

** Insert the date Thirty days after the expected completion date. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request

must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months], in response to the Employer's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee"

Section VII - Activity Schedule (ACS)

Contract ID:

IFB No.:

1.1 The bid price for the contract is NRS (in Figures)
(in Words). [To be fulfilled by the bidder as Lumpsum]
 [It is assigned for different activities as follows.]

S. No	DESCRIPTION OF ACTIVITY	PERCENTAGE OF BID PRICE
1	General and Preliminary Works (Contractor's Infrastructures, Construction Facilities, Access Road, Bridge and Others)	12.73% of the Contract Price
2	Survey, Investigation, Design and As-Built Documentation	2.45% of the Contract Price
3	Importation price of Hydromechanical Equipment (CIF port of Entry (Nepal Boarder) Price)	7.68% of the Contract Price
4	Civil Works	73.18% of the Contract Price
5	Hydro-Mechanical Works (Delivery to the Site, fabrication, Installation, Testing and Commissioning)	3.29% of the Contract Price
6	Completion of Works	0.67% of the Contract Price
Total Bid Price		100% of the contract price

1.2 Weightage of the bid price for different stages of the contract shall be as specified below.

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
1	MS-1	0.85	2	50	Partial
2	MS-2	0.68	4	25	Partial
3	MS-3	0.84	1	100	Full
4	MS-4	0.09	2	50	Partial
5	MS-5	0.37	1	100	Full
6	MS-6	1.85	2	50	Partial
7	MS-7	2.89	10	10	Partial
8	MS-8	3.31	10	10	Partial
9	MS-9	0.56	1	100	Full

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
10	MS-10	0.17	1	100	Full
11	MS-11	0.02	1	100	Full
12	MS-12	1.09	4	25	Partial
13	MS-13	0.61	2	50	Partial
14	MS-14	0.85	1	100	Full
15	MS-15	0.97	2	50	Partial
16	MS-16	0.02	1	100	Full
17	MS-17	0.32	1	100	Full
18	MS-18	0.04	1	100	Full
19	MS-19	0.18	1	100	Full
20	MS-20	0.22	1	100	Full
21	MS-21	0.17	1	100	Full
22	MS-22	0.04	1	100	Full
23	MS-23	0.05	1	100	Full
24	MS-24	0.08	1	100	Full
25	MS-25	0.05	1	100	Full
26	MS-26	0.05	1	100	Full
27	MS-27	0.17	1	100	Full
28	MS-28	0.15	1	100	Full
29	MS-29	0.52	1	100	Full
30	MS-30	0.12	1	100	Full
31	MS-31	0.17	1	100	Full
32	MS-32	0.05	1	100	Full
33	MS-33	0.17	1	100	Full

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
34	MS-34	5.13	10	10	Partial
35	MS-35	0.45	2	50	Partial
36	MS-36	1.82	5	20	Partial
37	MS-37	1.19	4	25	Partial
38	MS-38	0.23	1	100	Full
39	MS-39	1.24	5	20	Partial
40	MS-40	0.21	1	100	Full
41	MS-41	4.40	10	10	Partial
42	MS-42	3.32	10	10	Partial
43	MS-43	0.49	1	100	Full
44	MS-44	0.88	2	50	Partial
45	MS-45	0.68	1	100	Full
46	MS-46	1.26	2	50	Partial
47	MS-47	0.16	1	100	Full
48	MS-48	0.69	1	100	Full
49	MS-49	0.28	1	100	Full
50	MS-50	1.42	4	25	Partial
51	MS-51	0.49	1	100	Full
52	MS-52	0.18	1	100	Full
53	MS-53	0.39	1	100	Full
54	MS-54	0.06	1	100	Full
55	MS-55	0.63	2	50	Partial
56	MS-56	0.61	2	50	Partial
57	MS-57	0.14	1	100	Full

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
58	MS-58	0.53	4	25	Partial
59	MS-59	0.38	4	25	Partial
60	MS-60	0.52	2	50	Partial
61	MS-61	0.23	1	100	Full
62	MS-62	0.68	4	25	Partial
63	MS-63	1.18	5	20	Partial
64	MS-64	0.36	1	100	Full
65	MS-65	1.12	4	25	Partial
66	MS-66	0.98	4	25	Partial
67	MS-67	1.12	4	25	Partial
68	MS-68	0.98	4	25	Partial
69	MS-69	0.09	1	100	Full
70	MS-70	0.31	3	33.33	Partial
71	MS-71	3.00	5	20	Partial
72	MS-72	0.38	5	20	Partial
73	MS-73	0.10	1	100	Full
74	MS-74	0.86	2	50	Partial
75	MS-75	7.41	20	5	Partial
76	MS-76	0.80	5	20	Partial
77	MS-77	3.24	10	10	Partial
78	MS-78	0.32	5	20	Partial
79	MS-79	0.75	10	10	Partial
80	MS-80	0.04	1	100	Full
81	MS-81	0.51	1	100	Full

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
82	MS-82	0.53	2	50	Partial
83	MS-83	0.45	1	100	Full
84	MS-84	0.38	1	100	Full
85	MS-85	0.58	2	50	Partial
86	MS-86	0.17	2	50	Partial
87	MS-87	1.55	10	10	Partial
88	MS-88	1.55	10	10	Partial
89	MS-89	0.17	1	100	Full
90	MS-90	0.28	1	100	Full
91	MS-91	2.02	5	20	Partial
92	MS-92	0.67	2	50	Partial
93	MS-93	0.15	1	100	Full
94	MS-94	0.71	2	50	Partial
95	MS-95	0.27	1	100	Full
96	MS-96	3.48	10	10	Partial
97	MS-97	3.13	10	10	Partial
98	MS-98	1.00	4	25	Partial
99	MS-99	0.48	1	100	Full
100	MS-100	0.11	1	100	Full
101	MS-101	0.24	1	100	Full
102	MS-102	1.17	2	50	Partial
103	MS-103	1.39	4	25	Partial
104	MS-104	1.09	2	50	Partial
105	MS-105	0.35	1	100	Full

SN OF ACTIVI TY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
106	MS-106	0.05	1	100	Full
107	MS-107	2.35	4	25	Partial
108	MS-108	0.87	2	50	Partial
109	MS-109	0.29	1	100	Full
110	MS-110	0.18	1	100	Full
111	MS-111	0.38	1	100	Full
112	MS-112	0.14	2	50	Partial
113	MS-113	0.02	2	50	Partial
114	MS-114	0.08	2	50	Partial
115	MS-115	0.09	2	50	Partial
116	MS-116	0.07	2	50	Partial
117	MS-117	0.02	2	50	Partial
118	MS-118	0.02	2	50	Partial
119	MS-119	0.04	2	50	Partial
120	MS-120	0.02	2	50	Partial
121	MS-121	0.02	2	50	Partial
122	MS-122	0.07	2	50	Partial
123	MS-123	0.07	2	50	Partial
124	MS-124	0.22	2	50	Partial
125	MS-125	0.05	2	50	Partial
126	MS-126	0.07	2	50	Partial
127	MS-127	0.02	2	50	Partial
128	MS-128	0.07	2	50	Partial
129	MS-129	2.02	2	50	Partial

SN OF ACTIVITY	DESCRIPTION OF ACTIVITY	WEIGHTAGE IN PERCENTAGE TO THE BID PRICE	STAGE FOR PAYMENT	PERCENTAGE WEIGHTAGE	PAYMENT PROCEDURE
130	MS-130	0.18	1	100	Full
131	MS-131	0.31	1	100	Full
132	MS-132	0.18	1	100	Full
133	MS-133	0.17	1	100	Full