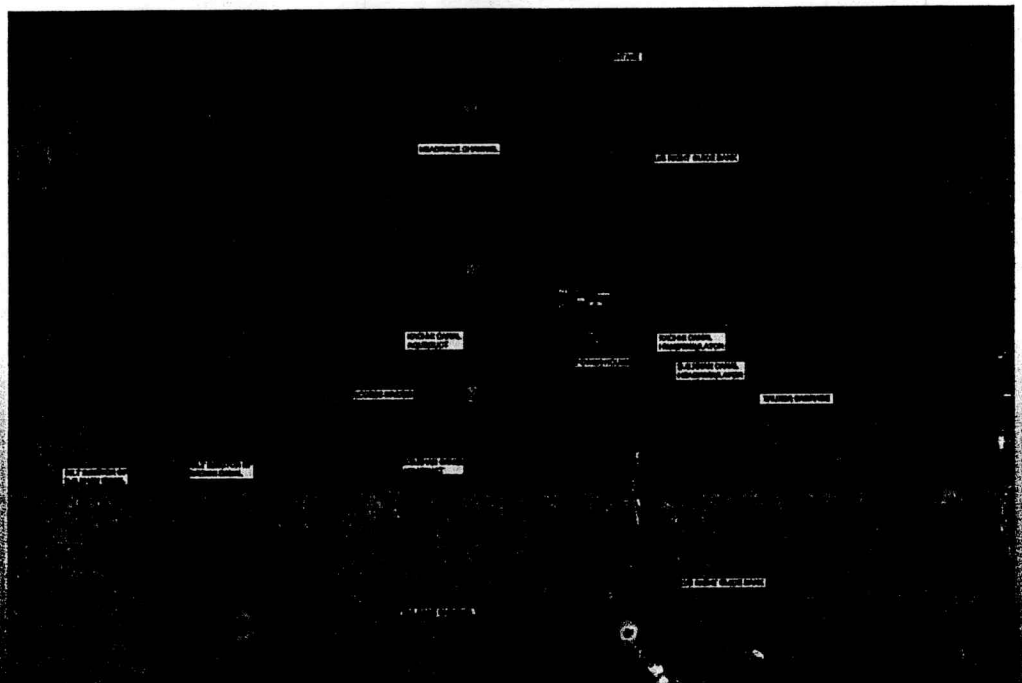
GOVERNMENT OF PUNJAB
ENERGY DEPARTMENT

UPDATED FEASIBILITY STUDY
135MW TAUNSA HYDROPOWER PROJECT

REQUEST FOR PROPOSAL (RFP)
FOR
DEVELOPMENT ON BUILD, OWN, OPERATE AND TRANSFER (BOOT) BASIS AS AN INDEPENDENT POWER PRODUCER (IPP)



VOLUME – 1

INVITATION OF PROPOSALS

INVITATION OF PROPOSALS

The Punjab Power Development Board (PPDB)
Energy Department
Government of the Punjab
Lahore

RFP Notice No. PPDB/ /2015-01

M/S _____

Subject: **REQUEST FOR PROPOSAL: INVITATION OF PROPOSALS FOR DEVELOPMENT OF 135 MW TAUNSA HYDROPOWER PLANT AT TAUNSA BARRAGE ON "BUILD, OWN, OPERATE AND TRANSFER (BOOT)" BASIS AS AN "INDEPENDENT POWER PRODUCER (IPP)"**

Dear Mr. / Ms:

1. In the light of Council of Common Interest (CCI) decision issued under Article 157(3) of the Constitution of the Islamic Republic of Pakistan, the Provincial Governments have been authorized to undertake activities for setting up and operation of Power Projects of more than 50 MW capacity for the Power Sector Development. Government of the Punjab (GoPb) has setup the Punjab Power Development Board (PPDB) in 1995 and framed its own Power Generation Policy in 2006 as revised in 2009 and subsequent amendments thereto, for facilitation in development of power generation projects, through one window facility.

2. PPDB on behalf of GoPb intends to develop 135 MW Taunsa Hydropower Project as a solicited site through private sponsors as IPP and is floating this Request for Proposal (RFP) accordingly.

3. PPDB invites Proposals from the prequalified Bidders/Consortiums/JVs for the subject Project. This RFP is being simultaneously addressed to following prequalified Sponsor/Bidders:

   a. Korea Water Resources (K-Water)
   b. Korea South-East Power Company (KOSEP)
   c. CWE Investment Corporation
   d. The Attock Oil Company
   e. Sapphire Fibers Limited

4. You are invited to submit a comprehensive Proposal in quadruplicate (one original + three copies) in separately sealed envelopes under "Single Stage – Two Envelope" bidding procedure, with all documents and information as detailed in this RFP.
   The complete proposal should be submitted in English language.

5. The basis of selection of IPP (Sponsor/Developer) for the Project will be the lowest evaluated Levelized Tariff as detailed in RFP, achieved through International Competitive Bidding ("ICB") for proposals of solicited site under NEPRA's Competitive Bidding Tariff Regulations-2014. The Project will be implemented on BOOT basis and shall be transferred to the GoPb at the end of project Term of thirty (30) years from Commercial Operation Date (COD) on payment of notional cost of Rs one (01) only.

6. The feasibility studies have already been carried out inter-alia, in June 2013 and 2015 in accordance with the internationally acceptable standards. The Project site is easily accessible through the roads and railway infrastructure.

7. The Sponsor/Bidder will act as detailed in the RFP Documents, which include but not limited to:

   a) Detailed Engineering, Manufacturing/Procurement of Plant/Equipment and Construction/Testing & Commissioning, financing, insurance, obtaining consents/permits, operation and maintenance of the Plant and all activities incidental thereto;

   b) Interaction and coordination with Power Purchaser, who shall be responsible for development, design, engineering, manufacture, financing, insurance, construction, permitting, completion, testing, commissioning of the inter connection facilities and all activities incidental thereto;

   c) The sale of Contract Capacity and Net Energy Output to Power Purchaser; and

   d) The transfer of the Plant to the GoPb at the end of the Term.

9. Bidding Schedule:

Bid validity period: One Hundred & Eighty (180) Days

Date of issuance of RFP documents: ----------
Date of pre-bid meeting: ----------
Last date and time of submission of bid: ----------
Date and time of bid opening: ----------

10. Fee and other charges:

Description	Fee (US$)*	Remarks
Purchase of RFP documents;	4,000	The RFP for pre-qualified bidders shall also include the feasibiiity studies and relevant reports, including standard document for IA, PPA, WUL/WUA agreements etc.
Evaluation Fee:	20,000	To be paid by prequalified sponsors/bidders at the time of Bid submission.
Legal fees	To be paid by Sponsors – for negotiations or review of other legal matters while signing and negotiation on the basis of actual expenses.	

* Or equivalent in PKR at TT & OD Selling exchange rate of the National Bank of Pakistan (NBP), prevailing on the date Thirty (30) days prior to the submission of Proposal.

Bidders may obtain further information and purchase the RFP Documents from the office of the PPDB, at the address given below:

Managing Director
The Punjab Power Development Board,
1ST Floor, Central Design Building,
Irrigation Secretariat, Old Anarkali Lahore, Pakistan
Phone: +92 42 99213885
Fax: +92 42 99213876
E-mail: ppdb.mt@energy.punjab.gov.pk
Website: energy.punjab.gov.pk

Thanks for Participation.

Managing Director,
The Punjab Power Development Board,
Lahore, Pakistan.

SECTION 1

INSTRUCTIONS TO BIDDERS/SPONSORS (ITB)

(A) GENERAL

1. Scope of Bid and Source of Funds

1.1 **Scope of Bid**

Government of the Punjab intends to develop 135 MW Taunsa Hydro Power Project at Taunsa Barrage, District Muzaffargarh. The Project will be developed by the Independent Power Producer (IPP) under Build-Own-Operate-Transfer (BOOT) model in accordance with the provisions of Punjab Power Generation Policy-2006 (Revised-2009). The Bids will be evaluated on the basis of lowest evaluated levelized Tariff in accordance with NEPRA's Competitive Bidding Tariff (Approval Procedure) Regulations-2014. The Project will be developed by the Successful Sponsor through the facilitation under Punjab Power Development Board (PPDB), Government of the Punjab, Energy Department (hereinafter referred to as "Employer").

1.2 In connection with the Invitation for Bids, the Employer issues this Request for Proposal (RFP) for the development of above said Project.

1.3 During accomplishing the Scope of Bid pursuant to the requirements of RFP, unless otherwise stated, definitions and interpretations shall be construed as prescribed in the Standard Agreements attached in Part-III, Section 7 & 8 of RFP.

1.4 **Source of Funds**

The sponsor will finance the Project as an IPP under the BOOT model in accordance with the provincial and federal Power Policies (to the extent applicable). The debt/equity ratio will be 80:20. The total debt & equity will be arranged by the Successful Sponsor.

2. Eligible Bidders

2.1 This RFP is open to all Bidders who have been pre-qualified by PPDB for the Project and have purchased this RFP from PPDB on payment of fee referred in the "Invitation of Proposals".

2.2 The Main Sponsor must not own more than 25% of the total electricity generation capacity in Pakistan at the time of submission of Proposal to PPDB.

2.3 A Bidder, and all partners constituting the Bidder, shall have a nationality of an eligible country, in accordance with Section 5 (Eligible Countries). A Bidder shall be deemed to have the nationality of a country if the Bidder is a national or is constituted, incorporated, or registered 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 RFP including related services.

2.4 A Bidder shall not have a conflict of interest. All Bidders 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:

(i) 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 the Bidder is involved. However this does not limit the participation of a Bidder as a Sub-Contractor in another Bid or of a firm as a Sub-Contractor in more than one Bid.

(ii) A Bidder participated as a consultant in the preparation of the design or technical specifications of the Plant and Services that are the subject of this RFP.

3. Eligible Material, Equipment & Services

3.1 The materials, equipment, and services to be employed in the Project shall have their origin in eligible source countries as defined in Section 5. At the Employer's request, Bidders may be required to provide evidence of the origin of materials, equipment, and services.

3.2 For purposes of Sub-Clause 3.1 above, "services" means the works and all Project related services whatsoever.

4. Cost of Bidding and Evaluation of Bids

The Bidders shall bear all costs associated with the preparation and submission of their Proposals along with purchase of RFP and evaluation fees, including travel to Pakistan, site visits, gathering of information, other investigation, review and analyses etc. The PPDB shall under no circumstance be responsible or liable for such costs, regardless of, without limitation, the conduct or outcome of the bidding or evaluation process.

The cost for the Evaluation of Bid to be submitted by the Bidder shall be paid by each Bidder at the time of submission of its Bids as mentioned in "Invitation of Proposals". Failure to pay the said cost for evaluation of Bid by the Bidder may render its Bid non-responsive.

(B) Bidding Documents

5 Contents of Bidding Documents

5.1 In addition to the Invitation For Bids, the Bidding Documents are those stated below, and should be read in conjunction with any Addenda issued in accordance with Clause 7:

Part – I BIDDING PROCEDURE

Section 1: Instructions to Bidders/Sponsors

Section 2: Bid Data Sheet - BDS

Section 3: Evaluation Criteria (EC)

Section 4: Proposal / Bidding Forms

Section 5: Eligible Countries

Part – II DESCRIPTION OF PROJECT AND EMPLOYER'S REQUIREMENTS

Section 6 (A): Project Description & Development Mechanism

Section 6 (B): Employer's Requirement for Civil Works and other facilities etc.

Section 6 (C): Employer's Requirement for E&M, Plant/Equipment & associated Works etc.

Section 6 (D): Employer's Requirement for O & M and dispatch requirements of the Plant

Section 6 (E): Feasibility Studies, Drawings and other technical reports for understanding the Project and information to the Sponsors / Bidders.

Part – iii DRAFT PROJECT AGREEMENTS AND POLICIES

Draft Standard Project Agreements

Section 7 (A): Tripartite Letter of Support (LOS)

Section 7 (B): Implementation Agreement (IA)

Section 7 (C): Power Purchase Agreement (PPA)

Section 7 (D): Water Use Agreement (WUA)

Section 7 (E): Land Lease Agreement (LLA)

Section 7 (F): Integrity Pact

Polices of the Government and Guidelines/Regulation of NEPRA

Section 8 (A): NEPRA's Mechanism for Determination of Tariff for Hydro Power Projects

Section 8 (B): NEPRA's Competitive Bidding Tariff (Approval Procedure) Regulations, 2014

Section 8 (C): Punjab Power Generation Policy 2006 (Revised 2009)

Section 8 (D): GOP Policy for Power Generation Projects, Year 2002

5.2 The Bidder shall examine carefully the contents of the Bidding Documents. Failure to comply with the requirements of Bid submission will be at the Bidder's own risk. Pursuant to ITB, Clause 24, Bids which are not substantially responsive to the requirements of the Bidding Documents, will be rejected.

5.3 The mechanism for Tariff indexations has further been elaborated in Part – III, Section 7(C), for information only. It is further added that the draft agreements enclosed as Part – III to the RFP are standard approved documents, and will be negotiated/signed between the Successful Sponsor and the respective government entities.

6. Clarification of Bidding Documents

1) Any Bidder requiring any clarification of this RFP must notify PPDB in writing at the addresses set forth in BDS. PPDB will respond in writing to any request for clarification, which it receives not later than twenty eight (28) days before the Deadline for Submission of Proposals.

2) PPDB will endeavor to respond to requests for clarification within fourteen (14) days from the receipt of such a request.

3) In the interest of fairness, PPDB shall make all clarifications available in the form of a circular letter or an Addendum to the RFP to all Bidders. Such circular letters or Addendum will also be made available on PPDB website.

4) The Bidder's authorized representative is invited to attend a pre-bid meeting, as 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. Amendment of Bidding Documents

At any time prior to the deadline for submission of proposals, PPDB may issue addenda in writing to all Bidders; which may delete, modify, or extend any part of this RFP. All addenda issued by PPDB shall be part of this RFP. Such addenda will be made available on PPDB website as well.

1. The receipt of an addendum by Bidder shall be acknowledged promptly in writing with specific reference to the title and date of issuance of the relevant Addendum, and so noted in the Bidder's Proposal.

2. The Bidder's late receipt of any Addendum or failure to acknowledge the receipt of any addendum shall not relieve the Bidder of being bound by such Addendum.

3. To afford 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 submission of Bids in accordance with ITB, Clause 19.

4. Non-binding Representation or Explanation

   a) Unless the addendum to this RFP is issued in the formal manner described in ITB, Clause 7, no interpretation or explanation to the Bidders shall be considered valid or binding on PPDB as to the meaning of this RFP or as to the Project.

   b) The Bidders are cautioned that no employee of the GoPb, PPDB, WAPDA or their consultants or agents is authorized to explain or interpret this RFP. Any interpretation or explanation, if not given in writing by PPDB, must not be relied upon.

(C) PREPARATION OF BIDS

8. Language of Proposal

8.1 The Proposal and all related correspondence and documents shall be written in the English language.

8.2 Supporting documents and printed literature furnished by Bidder with the Proposal may be in any other language provided these are accompanied by an appropriate certified translation of pertinent passages in the English language. Supporting materials which are not translated may not be considered. For the purpose of interpretation and evaluation of the Proposal, the English language translation shall prevail.

9. Documents Comprising the Bid

The Proposal to be prepared by the Bidder shall be simultaneously submitted in two envelopes; Envelope-I and Envelope - II. In Envelope - I, all of the technical and commercial aspects will be submitted while Envelope - II shall contain the Bidders proposed Levelized Tariff and financial model along with backup prices for the tariff. The Envelope - I of all the proposals will be evaluated as per Evaluation Criteria mentioned in Section 3, whereas the Envelope - II of only technically substantial responsive Proposals shall be evaluated according to criteria mentioned in Section 3. The contents of each Envelope of the Proposal are set out in ITB Sub-Clauses 9.1 and 9.2 respectively. The Forms to be used to prepare and complete these Envelopes are provided in Section 4 of this RFP.

9.1 **Proposal – Contents of Envelope-I (Technical)**

The Envelope - I of the Proposal must contain the following items in the form or format of Schedules and Attachments to the Technical Bid mentioned against each item:

Letter of Technical Bid & Schedules to Bid

-	Letter of Technical Bid as per Section 4 of RFP
	Proposed Details of Works, Equipment & Plant including Bid Level Designs by Sponsors/Bidders in conformity to Employer's Requirements (Section 6), as per Schedule A of Section 4
	Proposed Organization for the Project as per Schedule B of Section 4
	Method of Performing Works as per Schedule C of Section 4
	Proposed Programme of Works/Project Schedule as per Schedule D of Section 4
	Works to be Performed by Sub-Contractors as per Schedule E of Section 4
	Construction Machinery and Equipment details as per Schedule F of Section 4
	Non-Material Deviations from Technical and Contractual Provisions as per Schedule G of Section 4
	Specimen JV Agreement as per Schedule H of Section 4
	Current Contract Commitments as per Schedule X of Section 4
	Annexure – B of PQD
	Form EXP – 1: General Experience

	Form EXP – 2(a): Specific Experience
	Form EXP – 2(b): Specific Experience in Manufacturing
	Form EXP – 3: General Information Regarding O&M Contractor
-	List of Attachments to Technical Bid
	Attachment 1 : Power(s) of Attorney
	Attachment 2 : Proposal Security
	Attachment 3 : Lender's Acknowledgement Letter
	Attachment 4 : Bidder's/Sponsor's Information
-	Any other documents prescribed in Technical Provisions to be submitted with the Bid.
-	Alternative Bid if submitted

9.2 Proposal – Contents of Envelope-II (Financial)

The Envelope II of the Proposals must contain the following in the form or format of Schedules mentioned against each:

Letter of Financial Bid/Tariff Proposal & Schedules

-	Letter of Financial Bid/Tariff Proposal as per Section 4 of RFP
	Costs for Major Components of Civil Works and all other Facilities as per Schedule I
	Costs for Major Components of E&M Works and all other Works of Plant (Imported Items) as per Schedule J
	Costs for Major Components of E&M Works and all other Works of Plant (Local Items) as per Schedule K
	Costs for Engineering Services and Detailed Design as per Schedule L
	Costs for Installations, Testing, Commissioning and other Services as per Schedule M
	Annual Operation and Maintenance Costs including Insurance of the Plant and other Obligations as per Schedule N
	Costs of Land, Re-Settlement and Mitigation for Environmental Impact as per Schedule O
	Schedule P: Interest during Construction
	Schedule Q: Sources of Funds (Debt Equity Ratio and values)
	Schedule R: Terms and Conditions of Debt financing
	Schedule S: Repayment Schedule for Lenders
	Schedule T: Financing Costs, legal Fees, contract administration and management costs etc.

	Schedule U:	Financial Model and offered Levelized Tariff (NEPRA's Template)
	Schedule V:	Reference Base Prices for adjustment in Tariff at COD

10. Letters of Bids and Schedules

The Bidder shall enclose completed, signed and sealed Letters of Bids, Schedules (A to X) to Bid and Schedule of Prices furnished in the Bidding Documents including other information as detailed in Clause 9.

11. Bid Prices / Tariff

The Sponsors will quote the Annual Tariff of one to ten, eleven to twenty, twenty-one to thirty year as well as levelized tariff in accordance with NEPRA's Competitive Bidding Tariff (Approval Procedure) Regulations-2014, the necessary assumptions used for the Tariff Model and Competitive Tariff calculations given at Section 7(C) as well as additional instructions on Tariff proposal.

11.1 Unless specified otherwise in Section 6-Employer's Requirements, Bidders shall quote the Tariff(s) for the entire Project on a "single responsibility" basis such that the total Bid Price covers all the Bidder's obligations mentioned in or to be reasonably inferred from the Bidding Documents in respect of the design, manufacture, supply, erection, construction, testing& commissioning plus Financing on equity and debt basis i.e. 20:80 including O&M of the Project for 30 years after commercial operation date (COD) on BOOT basis besides procurement and subcontracting (if any), delivery, construction, installation and completion of all the facilities. This includes all requirements under the IPP's responsibilities for testing, pre-commissioning and commissioning of the facilities and, where so required by the Bidding Documents, the acquisition of all permits, approvals and licenses, etc., operation and maintenance services and such other items and services as may be specified in the Bidding Documents, and / or required for the establishment of the Project and its Operation and Maintenance.

11.2 Bidders shall give a breakdown of the prices in the manner and detail called for in the Schedules identified under Clause 9.2 hereof.

11.3 In the Schedules, Bidders shall give the required details and a breakdown of their prices, including all taxes, duties, levies, and charges payable in the Employer's country as of thirty (30) days prior to the deadline for submission of bids, as follows:

i. Civil Works, Installation and Other Services shall be quoted separately on a lump sum basis against major components as proposed in the Bidding forms which are not limited to, and Bidder may add any other component and its price in the form as deemed appropriate. However, the base rate for reinforcing steel bars, cement, labour and fuel must be quoted with reference to Pakistan Bureau of Statistics. In addition, one-time adjustment for price of re-settlement against the quoted values in the Bid in comparison to actual prices determined by Revenue Department, Punjab / District Price Assessment Committees.

ii. The one-time price adjustment against four items of the civil works for which base rates have to be quoted will be authorized at COD by NEPRA according to its Mechanism for Tariff Determination as attached in Part –III of this RFP.

iii. Financing details and Terms & Conditions of the Loan.

iv. Cost for Operation and Maintenance on annual basis for 30 years after Commercial Operation Date and shall be quoted in respective Schedule delineating its variable and fixed components along with their local and foreign portions.

v. The Bid price should clearly specify the application of custom duties @ 5% of the imported equipment for comparison purpose. The fiscal incentive as per Federal Government Policy-2002 is available on this account.

vi. The Bid prices shall include cost of leased land and private land acquisition.

vii. All of the quoted Bid prices and the offered Tariffs will remain unchanged except to the extent of re-openers as admissible by NEPRA.

12. Currency of Bid

12.1 The Bidder shall propose Tariff and its components thereof in the Proposal in PKR as well as in US-Cents.

12.2 All the payments under the PPA, including Tariff, shall be in **PKR**. However the currency conversion requirements are covered in the relevant agreement(s).

13. Documents Establishing the Bidder Qualification

The Bidders are required to furnish and submit additional information in addition to the contents of Envelope I & II mentioned in Clause 9.1 and 9.2. The Bidders should note that the information and guidance provided in this Clause has been prepared to assist them in completing their submissions. PPDB reserves the right to request any further information and clarification that it may deem necessary to carry out the detailed evaluation of bids. Following list will provide general guidelines for the Bidders to provide information in addition to contents of Envelope I & II, discussed above, with their proposals.

13.1 The documentary evidence of the Bidder's eligibility to Bid shall establish to the Employer's satisfaction that the Bidder, at the time of submission of its Bid is from an eligible source country as defined under Clause 2.

13.2 The Bidder shall provide documentary evidence regarding the qualification status along with their technical and financial strength that it is equivalent or higher than that which was provided at the pre-qualification stage.

13.3 Copies of original documents defining the constitution or legal status and place of registration of the company or firm or, in the case of a joint venture, of each party thereto constituting the Bidder will be submitted.

13.4 Where the Bidder is a joint venture of two or more companies or firms, a statement signed by all parties to the joint venture of the proposed administrative arrangements for the management and execution of the Project, the duties, responsibilities and share of each party, the authorized representative of the joint venture, and an undertaking that the parties are jointly and severally liable to the PPDB for the performance of the project.

13.5 A chart indicating the basic organizational structure(s) of the Bidding Group or each member of the bidding consortium and specifying the responsibilities of each organizational unit of the proposed Project Company is required.

13.6 The qualifications and experience of the key personnel proposed for administration and execution of the Project, during the design, construction and operating phases of the Project.

13.7 Bidders shall provide audited accounts for a minimum of the last 3 years, together with the most recently published interim accounts (if available), an estimated financial projection for the next two years, and an authority from the Bidder (or authorized representative of a joint venture) to seek references from the Bidder's bankers for the:

a) Proposed Project Company (where available);

b) Each proposed shareholder of the proposed Project Company;

c) The parent (and, if any, ultimate parent) company of each proposed shareholder of the proposed Project Company;

d) Proposed consultants; and

e) Proposed contractors

together with a statement, giving details of any balance sheet liabilities including contingent liabilities. In the absence of audited accounts, a statement detailing the financial strength of the institutions and/or individuals involved should be provided.

13.8 Bidders shall provide in each Bid details of shareholders, their respective shareholdings, their respective capital contributions and the proposed capital structure of the Project Company.

13.9 In order to demonstrate their understanding of the form, scope and complexity of the Project, Bidders shall prepare a 'Project Appreciation Statement' setting out the construction, operation and maintenance philosophy that is to be adopted for each significant element of the Project. This statement will include, but not be limited to, details of:

a) The construction method and operations management and maintenance of the Project;

b) The construction methods to be adopted in the construction of all major components of the Infrastructure/Facility.

c) The machinery, Plant and labor needs of the Project and the requirement for associated working and accommodation areas;

d) The operational methodology to be adopted; including tolls/fees/charges collection procedures, monitoring procedures and other service provision; and

The proposed maintenance regime including the organizational system that will be adopted for routine maintenance and repair, longer-term inspection, monitoring and rectification of identified defects and normal deterioration of Infrastructure/Facility.

13.10 The Bidder shall provide statement of land requirements. All cost relating to land requirements, shifting of utilities, resettlement issues etc. shall be borne by the Bidder. PPDB shall however provide all possible assistance in this regard except financial.

13.11 The Bidder shall provide a detailed Work Programme, showing in quarterly intervals the anticipated start-up and construction schedule to achieve the Commercial Operation Date.

In preparing this Work Programme, Bidders are advised that it will be a condition of the Construction Contract that specified sections of the Project are completed according the agreed schedule and the Project is completed, commissioned, and operational on the agreed date. Failure to meet these specified targets will result in the imposition of penalties on the Project Company as mentioned in the Project Agreements.

14. Documents Establishing the Plant Eligibility and Conformity to Bidding Documents

14.1 Pursuant to Clause 9, the Bidder shall furnish, as part of its Bid, documents establishing the eligibility and conformity to the Bidding Documents of all the major parts of Plant and Services which Bidder proposes to perform under the Project Agreements.

14.2 The documentary evidence of the Plant and Services eligibility shall establish to the Employer's satisfaction that they will have their origin in an eligible source country as defined under Clause 3. A certificate of origin issued at the time of shipment will satisfy the requirements of the said Clause.

14.3 The Bidder must submit a proposal, one which conforms to all the terms, conditions and specifications of this RFP without material deviation or reservation, as described in Clause 24 . Failure to comply with this instruction may result in disqualification of the Bidder.

14.4 The Bidder shall submit its proposal. which will comply the requirements of the codes and standards for design, workmanship, materials & equipments, technical design and O&M requirements in response to meet the requirements set forth in Section 6 "Description of Project and Employer's Requirements".

14.5 The Bidder may propose codes and standards from other standard international organizations provided it demonstrates to the satisfaction of PPDB and NEPRA, that these codes and standards meet or exceed the requirements of the designated codes and standards in Section 6 "Description of Project" and Employer's Requirements". Bidder shall submit all the technical data requested in Section 4.

14.6 The Bidder must prepare the Proposal by filling in all blank spaces and submitting documents required by Section 4. No changes shall be made in phraseology. However additional items of works may be added, which the Bidder deems essential to mention. Exceptions are to be listed in Section 4, Schedule G, as specifically provided for this purpose. No exception of the Draft Project Agreements will be entertained at this Bidding stage meant for allocation of site by PPDB. However, the successful Sponsor may discuss the Project Agreements with

relevant government entities at the time of signing of those Agreements. A Proposal that is illegible or that contains omissions, erasures, alterations, additions not called for or irregularities may be rejected, except for those necessary to correct errors made by the Bidder, in which case such corrections shall be initialed by the person or persons signing the Proposal.

15. Proposal Security

15.1 The Bidder shall furnish, as part of its Proposal, a Proposal Security in the aggregate amount of USD 1,000 (one thousand USD) or Equivalent in PKR per MW. The Shortlisted Bidders will extend the Proposal Security upto the issuance of LOS.

15.2 The Proposal Security shall be an irrevocable and unconditional bank guarantee from a recognized bank domiciled or licensed to conduct business in Pakistan. The Proposal Security shall be in the form contained in Section 4. The Proposal Security shall be valid for a period of at least ninety (90) days after the Proposal validity period. In case the Bidder agrees to the PPDB's request for extension of the proposal validity period in accordance with Clause16 hereof, the Proposal Security shall remain valid for a period of at least ninety (90) days after the extended Proposal Validity Period.

15.3 It is advisable for Bidders to check with PPDB well in advance of the Deadline for Submission of Proposals as to the acceptability of the proposed issuing bank of Proposal Security. Also, it is advised to all Bidders to visit PPDB website on regular basis for updates.

15.4 Any Proposal not accompanied by an acceptable Proposal Security shall be rejected by PPDB as non-responsive. The Proposal Security of a Bidder comprising of a JV/Consortium must be in the name of the Lead Bidder submitting the Proposal.

15.5 The Proposal Security of a Bidder shall be forfeited without any notice, demand, or other legal process if any of the following conditions occur:

a. the Bidder withdraws its Proposal during Proposal Validity Period (including any extension in accordance with ITB Clause 16, except as provided in ITB Sub-Clause 16.2; or

b. the Bidder does not accept the correction of its Proposal, pursuant to ITB Clause 24.6; and

c. in the case of Successful Bidder, it fails within the specified time limits to:

(i) furnish the required Performance Guarantee in accordance with ITB Sub Clause 30; or

(ii) finalize the Project Agreements.

15.6 The Proposal Security shall be returned to the unwilling Bidders if they withdraw their Proposals before the Deadline for Submission of Proposals in accordance with ITB Clause 21.

If any Bidder's Proposal is determined to be non-responsive to the requirements of this RFP, the Proposal Security will also be returned to such Bidder.

The Proposal Validity Period of the Technically substantially Responsive Sponsors will be extended, if necessary, pursuant to ITB Clause 16.2. The Proposal Security of all technically Shortlisted Bidders shall remain valid until the issue of the LOS to the Successful Bidder. The Proposal Security of all the technically Shortlisted Bidders including the Successful Bidder shall be returned upon the issuance of the LOS to the Successful Bidder..

16. Validity of Bids

16.1 The Bid shall remain-valid and open for acceptance by the PPDB for a period of at least one hundred and eighty (180) days from the Deadline for Submission of Proposals (the "Proposal Validity Period"). The proposal validity period shall be specified by the Bidder in its Proposal Letter. Any proposal stated to be valid for a shorter period than the proposal validity period shall be rejected by PPDB as non-responsive.

16.2 Prior to expiration of the original proposal validity period, the PPDB may request the Bidders for an extension in the proposal validity period for a specified additional period. Both the request for an extension in the proposal validity period and the response thereto shall be

made in writing. A Bidder may refuse to agree to the request for extension of the proposal validity period without getting forfeited its Proposal Security. The Bidder agreeing to the request for extension of the proposal validity period shall neither be required nor permitted to modify its Proposal and will be required to extend the validity of its Proposal Security accordingly and in compliance with Clause15 in all respects. The provisions of Clause15, regarding release and forfeiture of proposal security, shall continue to apply during the extended proposal validity period.

17. Format and Signing of Bids

17.1 Bidder shall prepare one (1) original and three (3) copies of the documents comprising the Proposal in the form and manner described in Clause 9 above. The one original of the completed Proposal is to be clearly marked **"ORIGINAL PROPOSAL"**, and all other completed copies are to be clearly marked **"COPY OF PROPOSAL"**. In the event of any discrepancy between the original and any copy, the original shall prevail.

17.2 If the Proposal consists of more than one volume, Bidder must clearly number the volumes constituting the Proposal and provide an indexed table of contents for each volume. All documents should be securely bound.

17.3 The Proposal shall be typed or written in indelible ink. Each sheet shall be initialed by a person or persons duly authorized to sign for the Bidder and bind the Bidder to the Proposal and any resulting agreement and LOS. The Proposal Letter shall be signed by a person or persons duly authorized to bind Bidder to the Proposal and any resulting agreement(s) and LOS. All pages of the Proposal where entries or amendments have been made shall be initialed by the person or persons signing the Proposal.

17.4 If the Proposal is submitted by a Bidder which is a JV/consortium of two or more entities as members, a duly authorized person or persons of each such JV/consortium member shall sign the Proposal and the Proposal Letter.

17.5 The complete Proposal as outlined in Clauses 9, shall be without alterations, omissions, additions, interlineations, or erasures, except as necessary to accord with instructions issued by PPDB or to correct errors made by Bidder. All such corrections shall be initialed by the person or persons signing the Proposal.

The Power of Attorney authorizing all persons who shall initial or sign the Proposal and the Proposal Letter shall be provided by the Bidder in its Proposal as required in Section 4.

17.6 Alternative Bids are allowed and shall be considered as per details given in Section 2 (BDS) of RFP.

(D) SUBMISSION OF BIDS

18. Sealing and Marking of Bids

18.1 The Bidder shall seal the Envelope I & Envelope II as described in Clauses 9 which must bear the signature of the Bidder's authorized representative. The other information required in Clause13 should be included in Envelope I.

18.2 The original and three (3) copies of Envelope I of the Bid shall be sealed into an envelope and shall:

a. be addressed to PPDB; and

b. bear the following identification:

i. Envelope I

ii. BID FOR [mention name of the Project]

iii. The Words "DO NOT OPEN BEFORE----------" *mention date and time of Bid Opening for Envelope I.*

18.3 The original and three (3) copies of Envelope II of the Bid shall be sealed into an envelope and shall:

a. be addressed to PPDB; and

b. bear the following identification:

i) Envelope II

ii) BID FOR [mention name of the Project]

iii) The Words "DO NOT OPEN BEFORE--------" *mention date and time of Bid Opening for Envelope II.*

18.4 The envelopes shall also indicate the name and address of the Bidder to enable the Bid to be returned unopened in case it is declared 'late'.

If the envelope is not sealed and marked as instructed above, PPDB will assume no responsibility for the misplacement or premature opening of the Bid. Any Bid that is found opened prematurely, upon submission will be rejected by PPDB and returned to the Bidder.

18.5 The Proposals must be addressed to PPDB as follows:

Managing Director,
The Punjab Power Development Board,
Energy Department, 1st Floor,
Central Design Building,
Irrigation Secretariat, Old Anarkali,
Lahore, Pakistan.

18.6 Proposal submission to PPDB at the address given in Sub Clause18.5 above must be made by either of the following methods:

- By hand; or
- By prepaid, registered, or certified mail or by overnight courier, in which case PPDB shall not be held responsible either if the Proposal is received late or not received.

18.7 Proposal submitted by facsimile, electronic mail, telex, telegram shall not be accepted.

19. Deadline for submission of Bids

19.1 All the Proposals along with the Evaluation Fee, as per submission requirements mentioned in Clauses 17 & 18, shall reach PPDB's address as given in Section 2, no later than the deadline for the Bid Submission specified in BDS.

19.2 PPDB may, at its discretion, extend the Deadline for Submission of Proposals by issuing an Addendum in accordance with Clause 7.

20. Late Bid

Any Proposal received after the Deadline for Submission of Proposals ("Late Proposal") shall be rejected and returned unopened to the Bidder.

21. Modification, Substitution and Withdrawal of bids

21.1 Bidder may modify or withdraw its Proposal after Proposal has been submitted to PPDB, provided that the modification or notice of withdrawal is received in writing by PPDB prior to Deadline for Submission of Proposals.

21.2 Bidder's modification or notice of withdrawal shall be prepared, sealed, marked and delivered in accordance with the provisions of Clauses18 for the submission of Proposals with envelopes additionally marked **"MODIFICATION"** or **"WITHDRAWAL"** as appropriate.

21.3 No Proposal may, under any circumstances, be modified or withdrawn after the Deadline for Submission of Proposals.

Withdrawal of a Proposal at any time, under any circumstance, during the period between the Deadline for Submission of Proposals and the expiration of the proposal validity period specified by Bidder in the Proposal Letter will result in the forfeiture of the Proposal Security pursuant to Clause 15.

(E) Bid Opening and Evaluation

22.0 Bid Opening

22.1 PPDB will open the Envelope I of the Proposal, including notices of withdrawals and modifications made pursuant to Clause 21, in an open session at a place, date and time given in the BDS, in the presence of Bidders' designated representatives who chose to attend. The Bidders' representative(s) who are present shall sign a register as evidence of their attendance. Representative(s) of each Bidder shall be allowed to attend.

22.2 Envelopes marked **"WITHDRAWAL"** shall be opened first at the Proposal Opening and the name of the Bidder shall be read out. Proposals, for which a notice of withdrawal has been submitted pursuant to Clause 21 above, shall not be opened.

22.3 At the Proposal Opening, PPDB shall examine Proposals to determine whether the requisite Proposal Securities and Evaluation Fees have been furnished and whether the documents have been properly signed. A representative of PPDB will then read out the information accordingly.

22.4 No Proposal shall be rejected at Proposal Opening except for the Late Proposals pursuant to ITB Clause 20.

PPDB shall not return the original or copies of the Proposal submitted by any Bidder (except for the Late Proposals pursuant to ITB Clause 20).

23 Clarification of Bids

23.1 During the examination, determination of responsiveness evaluation and comparison of Proposals, PPDB may at its discretion, request the Bidders for additional information, clarification and verifications with respect to any item contained in their Proposals. PPDB's such request and the Bidders' responses thereto shall be in writing and no change in the Tariff or substance of the Proposal should be sought, offered or permitted, except as required to confirm the correction of arithmetic errors discovered by PPDB in the evaluation of the Proposals in accordance with ITB Clause 24.6.

23.2 During the evaluation if the cost of a major component of the Employer's Requirements in view of Section 6 has not been incorporated in the submitted Bid Forms then the loading equivalent of highest value in any of the competing Bids will be incorporated during the evaluation.

23.2 The Bidder is required to respond to PPDB's request for additional information, clarification or verification within fourteen (14) days after the request has been made.

23.3 To assist in the examination, determination of responsiveness, evaluation and comparison of Proposals, PPDB may also require the Bidder to attend clarification meetings to be held at PPDB's office.

The Bidder shall be responsible for all costs associated with the submission of information additionally requested and with its preparation for and attendance of clarification meetings.

24 Preliminary Examination & Determination of Responsiveness of Bids

The Technical Bid will be evaluated in accordance with this Clause 24 and the successful Bid(s) will be declared "substantially responsive".

24.1 The Bidder shall continue to meet the criteria used at the time of pre-qualification as mentioned in Clause 29.

24.2 Prior to the detailed evaluation of Proposals, PPDB will determine whether each Proposal is of acceptable quality, is complete and substantially responsive to the requirements of this RFP e.g.' bidding for complete Scope of Work, one Bid per Bidder in this Bidding process, Forms of Bid duly filled-in and signed, Schedules and Attachments to Bid have been filled-in and signed, Power of Attorney to sign the Bid, Proposal Security and JV Agreement (in case the Bidder is JV) accompanies the Bid etc. The completeness of the Bids shall be checked vis-à-vis following documentation required to be provided along with the Bid.

24.3 Any material deviation and exceptions taken by the Bidders against the requirements of

Bidding Documents including substantially incomplete Bids shall render the Bids non-responsive.

24.4 A substantially responsive Proposal or a Responsive Proposal is one, which conforms to all the terms, conditions, and specifications of this RFP without "material deviation or reservation".

24.5 A material deviation or reservation is one:

a. which:

1. effects in any substantial way the scope, quality, or performance of the Project: or

2. which limits in a substantial way inconsistent with this RFP, the GoP's, GoPb, PPDB, PPIB's, WAPDA or any other parties' rights or the Bidder's or the Project Company's obligations under the Project Agreements; and

b. the rectification or acceptance of which deviation or reservation would affect unfairly the competitive position of other Bidders presenting "substantially responsive" Proposals.

If a Proposal is not substantially responsive to the requirements of this RFP (i.e. a non-Responsive Proposal), it will be rejected by PPDB. Such determination is solely at the PPDB's discretion.

PPDB may waive any minor non-conformity or irregularity in a Proposal which does not constitute a material deviation or reservation, provided that such waiver does not prejudice or affect the relative ranking of any Bidder.

24.6 CORRECTION OF ERRORS

Proposals determined to be Responsive Proposals shall be checked for any arithmetic errors in computation and summation. Errors shall be corrected by PPDB such that if there is a discrepancy between amounts in figures and in words, the amount in words will govern.

The amounts stated in the Proposal will be adjusted by PPDB in accordance with the above procedure for the correction of errors and shall be considered as binding upon the Bidder. The Bidder will be informed in writing of any arithmetical adjustments made. If the Bidder does not accept the corrected amount of the Proposal, its Proposal shall be rejected and its Proposal Security shall be forfeited in accordance with ITB Clause 15.5.

25. Conversion to Single Currency

For evaluation and comparison purposes, the currency(ies) of the Bid shall be converted into a single currency as specified in the BDS.

26. Detailed Evaluation of Bids

26.1 Detailed Evaluation of Technical Bids

26.1.1 The Employer will carry out a detailed technical evaluation of the bids not previously rejected as being substantially non-responsive, in order to determine whether the technical aspects are in compliance with the Bidding Document. In order to reach such a determination, the Employer will examine and compare the technical aspects of the bids on the basis of the information supplied by the Bidders, taking into account the following:

(a) Overall completeness and compliance with the Employer's Requirements; deviations from the Employer's Requirements; conformity of the plant and services offered with specified performance criteria; suitability of the plant and services offered in relation to the environmental and climatic conditions prevailing at the site; and quality, function and operation of any process control concept included in the bid. The Bid that does not meet minimum acceptable standards of completeness, consistency and detail will be rejected for non-responsiveness;

(b) Other relevant factors, if any, listed in Section 3 (Evaluation Criteria).

26.1.2 In case of alternative technical solutions allowed in accordance with ITB Clause 17.6, and offered by the Bidder, the Employer will make evaluation of the alternative accordingly under the provision given in Sub-Clause 17.6 of Section 2 (BDS) of the RFP.

26.2 Detailed Evaluation of Tariff Bids

Envelopes II [Financial Proposals along with offered Tariff(s)] of all technically substantially responsive Sponsors will be publically opened and evaluated according to evaluation criteria of Section 3.

27. Domestic Preference

A margin of preference will be granted to eligible domestically produced Plant and Equipment in accordance with the following provisions:

(a) The preference margin shall not be applied to the whole facilities but only to the eligible domestically produced Plant and Equipment employed within the Plant.

(b) Plant and Equipment offered from outside the Employer`s country shall be quoted CIP (Section 4, Schedule J) and Plant and Equipment offered locally shall be quoted delivery at site (Section 4, Schedule K);

(c) All other cost components for services and works such as cost for design, local handling, transportation, storage, installation and commissioning shall be quoted separately (section 4, Schedule L – Costs for Engineering Services and Detail Design and Schedule M – Costs for Installations, Testing, Commissioning and other Services)

(d) In the comparison of Bids, the CIP price components of each Bid for Plant and Equipment offered from outside the Employer's country shall be increased by 15%. This price preference will be used for evaluation of the Price Bids and lowest levelized Tariff for recommendation of the Successful Bidder, however the Tariff determination for successful Bidder will be recommended to NEPRA on the basis of actual quoted price without considering this price preference.

(e) No margin of preference shall be applied to any of the services or works included in the Bid; and

(f) Bidders shall not be permitted or required to modify the mix of local and foreign Plant and Equipment after Bid opening.

28. Process to be Confidential

28.1 After the Bid Opening, information relating to the examination, clarification, evaluation and comparison of Bids and recommendations concerning the award of the LOS shall not be disclosed to Bidders, or other persons not officially concerned with such process, until the award of the LOS is announced.

28.2 Any effort by a Bidder to influence PPDB in the process of examination, clarification, comparison and evaluation of Bids, or decisions concerning award of the LOS, may result in the rejection of that Bidder's Bid(s).

(F) AWARD OF LOS

29. Qualification

The Bidder shall continue to meet the criteria used at the time of pre-qualification. Updating and reassessment of the following information which was previously considered during pre-qualification will be required:

- Eligibility;
- Pending Litigation; and
- Financial Strength
- Technical Strength
- Project implementation methodology

In the event, the pre-qualified Bidder ceased to qualify the criteria used at the pre-qualification stage then the Bid shall be considered as non-responsive.

30. Issuance of LOS

PPDB shall evaluate and rank Envelope – II of only those Bidders, who are technically substantially responsive, as determined in accordance with Clauses 24 and 26.

The evaluation and ranking for lowest levelized evaluated Tariff will be submitted to NEPRA along with relevant details, for its approval and notification of the Successful Bidder.

NEPRA may notify the Successful Bidder based on lowest evaluated Levelized Tariff, as determined under Competitive Bidding Tariff Regulations-2014 and will inform PPDB accordingly.

Based on the Notification made by NEPRA, PPDB will require the submission of Performance Guarantee from Successful Sponsor, in addition to the payment of feasibility studies, legal and any other charges, PPDB will Award the site by issuance of Tri-partite LOS.

(G) ADDITIONAL INSTRUCTIONS

1. Performance Guarantee

When a Successful Bidder fulfills the requirements of this RFP during clarification meetings and finalizes the Project Agreements invited to do so in accordance with Clause 30, the PPDB shall issue a notice to that Bidder asking it to furnish or pay, as the case may be, within twenty eight (28) days of the date of such notice:

a. the Performance Guarantee in the aggregate amount of USD 5,000 (five thousand USD) or Equivalent PKR per MW of the Contract Capacity proposed by Successful Bidder in its proposal;
b. the audited feasibility study cost,
c. cost of Due Diligence Report,
d. expense incurred during Updation of feasibility study, and
e. the legal expenses in the form of a bank draft or pay order (no cash) drawn upon a scheduled bank in Pakistan.

1.2 The Performance Guarantee shall be an irrevocable and unconditional direct-pay letter of credit from a recognized bank domiciled or licensed to conduct business in Pakistan. The Performance Guarantee shall remain valid at least three (03) months after the Financial Close.

1.3 The Successful Bidder should check with PPDB well in advance as to the acceptability of the proposed issuing bank of Performance Guarantee.

2. Sufficiency of Bid

2.1 Each Bidder shall satisfy himself before bidding as to the correctness and sufficiency of his Bid and of the rates and prices entered in the Schedule of Prices and Tariff(s). Except insofar as it is otherwise expressly provided in the Agreement(s), the rates and prices entered in the Schedule of Price and Tariff(s) shall cover all his obligations under the Agreement(s) and all matters and things necessary for the proper completion of the Project.

3. One Bid per Bidder

Each Bidder shall submit only one Bid either by himself, or as a partner in a joint venture. A Bidder who submits or participates in more than one Bid will be disqualified and Bids submitted by him shall not be considered for evaluation and award.

4. Bidder to inform himself

The Bidder is advised to obtain for himself at his own cost and responsibility all information that may be necessary for preparing the Bid and entering into an Agreement(s) for execution of the Works/plant. This shall include but not be limited to the following:

(a) Inquiries on Pakistan Income Tax to the Commissioner of the Income Tax and Sales Tax, Multan / D.G Khan.

(b) Inquiries on customs duties and other import taxes, to the concerned authorities of Customs and Excise Department.

(c) Information regarding port clearance facilities, loading and unloading facilities, storage facilities, transportation facilities and congestion at Pakistan seaports.

(d) Investigations regarding transport conditions and the probable conditions which will exist at the time the Plant will be actually transported.

5. Site Visit

5.1 The Bidder is advised to visit and examine the Site and the surrounding areas and obtain or verify all information, it deems necessary for the preparation of the Proposal.

5.2 The Bidder shall submit a written request to PPDB at least fourteen (14) days in advance of such site inspection. PPDB will grant Bidder or its agents written permission to visit the Site or, if necessary, to enter into certain premises for such purpose. The Bidder or its agents will only be granted permission on the express condition that Bidder agrees to follow all instructions of PPDB and to release and indemnify PPDB and its agents from and against all liability in respect thereof and to be responsible for personal injury (whether fatal or otherwise), loss of or damage to property and any other loss, damage, costs and expenses however caused, which, but for the exercise of such permission, would not have arisen.

5.3 Failure to investigate the Site or subsurface conditions fully shall not be grounds for Bidder to subsequently alter its Bid nor shall it relieve the Bidder from any responsibility for appropriately estimating the difficulty or costs of successfully completing the Project. Furthermore, the Tariff shall not become adjustable due to any such reason during finalization of Project Agreements or subsequently during the implementation of the Project.

5.4 PPDB may plan and arrange a combined Site visit for all the interested Bidders. PPDB shall inform all the Bidders of details of such Site visit at least fourteen (14) days prior to the visit. The representatives of PPDB shall accompany the Bidders, if necessary, to brief the Bidders about the site and facilitate the site visit; the power purchaser may join them during the site visit.

6. Integrity Pact

PPDB shall be entitled to terminate the contract and recover from the successful Bidder the amount of any loss resulting from such termination if the successful Bidder shall have offered or given to any person any gift or consideration of any kind as an inducement or reward for doing, or forbearing to do, any action in relation to obtaining, or in the execution of the LOS or any other contract with PPDB, or for showing favor to any person in relation to the LOS or any other contract with PPDB, or if any of the like acts shall have been done by any person employed by the Successful Bidder or acting on its behalf (whether with or without the knowledge of the Successful Bidder), or if the Successful Bidder shall have come to any agreement with another Bidder or number of Bidders whereby an agreed quotation or estimate shall be offered as a Bid to PPDB by one or more Bidders.

7. Bidders to be Careful

Bidder should take care of local laws, statutes, regulations, Government investment policies in order to make the Bids complying with regulations of Pakistan.

PPDB shall not assume any responsibility and shall stand indemnified against any or all information provided in the Bidding Documents as far as the Project data and figures are concerned. The Bidders are instructed to carry out their own detailed studies to confirm the Project viability and submit the bids accordingly. The Project documents merely provide information which is deemed useful by PPDB for the Bidders to execute the Project. It may be further understood that PPDB is providing this information with best of intents and has tried its best to provide as correct as possible information.

If there arises any further need of addition to the existing Bidding Documents, the same shall be attended through addendum. All such addenda shall form part of the Bidding Documents.

SECTION 2

ADDITIONAL INSTRUCTIONS FOR PROPOSAL PREPARATION [BID DATA SHEET]

B. BIDDING DOCUMENTS

6.1)	For **clarification purposes** only, the Employer's address is: Attention: Managing Director, PPDB Address: The Punjab Power Development Board, Irrigation Secretariat, Old Anarkali, Lahore City: Lahore ZIP Code: 54000 Country: Pakistan Telephone: +92 42 99213885 Facsimile number: +92 42 99213876 Electronic mail address: ppdb.mt@energy.punjab.gov.pk
6.4)	A Pre-Bid meeting will take place as follows : Date & Time: Approximately 60 days before the date of Bid Opening. Exact date and time will be intimated later. Place: Committee Room, The Punjab Power Development Board, Irrigation Secretariat, Old Anarkali, Lahore, Punjab

C. PREPARATION OF BIDS

17.3	The written confirmation of authorization to sign on behalf of the Bidder shall consist of notarized Power of Attorney.
17.6	Alternative Technical Bids shall be permitted. The same shall be submitted broadly in line with the requirements of Section 6 of the RFP. The configuration and other characteristics of the Power Plant offering the better techno-economic solutions may be proposed by the Bidder along with detailed justifications including information necessary for complete evaluation of the proposed alternatives by the Employer, drawings, design calculations, technical specifications, break down of the prices and proposed installation methodology and other relevant details. While doing so it must be demonstrated and ensured by the Bidder that the irrigation requirements of Taunsa Barrage, off-taking canal system and allied structures are not affected/disturbed due to the proposed alternative configuration of the Power Plant. It is, however, clarified that the alternative Bid of only the Successful Sponsor of the original Bid will be taken into cognizance and processed. The Employer reserves the right to accept or reject the alternative Bid without giving any reasons.

D. SUBMISSION OF BIDS

19.1	For bid and evaluation fee submission purposes , the Employer's address is Attention: Managing Director, PPDB Address: The Punjab Power Development Board, Irrigation Secretariat, Old Anarkali, Lahore

	City: Lahore ZIP Code: 54000 Country: Pakistan Telephone: +92 42 99213885 Facsimile number: +92 42 99213876 The deadline for bid submission is Date: ---- Time: ---
22.1	The bid opening of Technical Bids shall take place at the address and date given in Sub-Clause 19.1 here above, after 30 minutes of deadline of submission of Bids.

E. EVALUATION, AND COMPARISON OF BIDS

25	The currency that shall be used for Bid evaluation and comparison purposes to convert all bid prices expressed in various currencies into a single currency is: Pak Rupees (PKR) The source of the exchange rate shall be: Telegraphic Transfer and On Demand (TT&OD) composite exchange rate (selling) published by National Bank of Pakistan The date for the selling exchange rate shall be: the date thirty (30) days prior to dead line for submission of Bids

SECTION 3

EVALUATION CRITERIA AND GENERAL DESCRIPTION

This Section contains all the criteria that the Employer shall use to evaluate Bids in accordance with Clause 13, 24 and 26 of Section 1. The Bidder shall provide all the information requested in the forms included in Section 4 (Bidding Forms). All Bids will be evaluated to determine whether the Plant offered by the Bidder comply with the Employer's Requirements (Section 6) of the Request for Proposal. For this purpose, the data submitted by the Bidders will be compared with the technical features/data of the Project detailed in the Employer's Requirements (Section 6) of the RFP for technical substantive responsiveness. After public opening of the financial Bids of the technically substantive responsive Bidders, the offered price(s) and Tariff(s) will be evaluated to rank for the lowest Bidder.

1. EVALUATION

1.1 QUALIFICATION

The qualification of the Bidder will be compared along with its originally provided Technical & Financial strengths and project implementation methodology as per Clause 13 of the RFP. The Bidder will provide all such data along with any litigation appeared during the intervening period of pre-qualification date and Bid submission date through the same performa "Annexure – B" of PQD duly updated.

The Sponsors, already qualified with respect to broader parameters are also required to establish the relevant construction and manufacturing experience at their own or through the Sub-Contractors.

Subcontractors/manufacturers for the following major items of supply or services must meet the following minimum criteria, herein listed for that item. Failure to comply with this requirement will result in rejection of the subcontractor.

Item No.	Description of Item	Minimum Criteria to be met	Submission Requirement / Documents
1	General Experience of Construction	Experience as contractor, subcontractor, or management contractor for at least last three (3) years prior to the Bid submission deadline.	Form EXP - 1
		a) Contract of similar size and nature Completed within the last 10 (Ten) years at least one Hydropower Project of at least 100 MW or higher on Turnkey basis. The Project must have been in satisfactory operation. To substantiate the above, Bidder shall submit authenticated user's certificate and other relevant documents.	Form EXP – 2(a)

2	Specific Experience	**b) Manufacturing Experience** Manufacturers of the major components of the plant, material and equipment shall have a minimum experience in the following key activities. Manufacturer of the major components i.e. Turbines, Governors, Generators, Power Transformers, Protection and C&I system, have supplied for at least two different Power Plants which are performing satisfactorily for the last five years. If Bidder is not the manufacturer, the Bidder shall obtain from the experienced manufacturer as above, its authorization to supply the E&M Equipment.	Form EXP - 2(b)

In addition to above, all equipment / plant items shall comply with other requirements stipulated in the Employer's Requirements.

In the case of a Bidder who offers to supply and install major items of supply under the agreement that the Bidder did not manufacture or otherwise produce, the Bidder shall provide the manufacturer's authorization, using the form provided in Section 4 (Proposal/Bidding Forms), showing that the Bidder has been duly authorized by the manufacturer or producer of the related plant and equipment or component to supply and install that item in the Employer's country. The Bidder is responsible for ensuring that the manufacturer or producer complies with the requirements of ITB Clauses 4 and 5 and meets the minimum criteria listed above for that item.

1.2 Technical Evaluation

The detailed evaluation of technical Bid will be made as per ITB Clause 9.1 and 26. The critical elements of the technical specifications which must be adhered to in the Bidder's Proposal shall be compared and evaluated as per Employer's Requirements inclusive of technical specifications Section 6, Part – II of RFP.

1.3 Financial and Tariff Evaluation

Any adjustments in price that result from the procedures outlined below shall be added, for purposes of comparative evaluation only, to arrive at an "Evaluated Project Price i.e. Capital Expenditure (CAPEX)". This will however be only for the purpose of comparison of Bids, whilst the corresponding Project price and Tariff(s) quoted by Bidders shall remain the same.

1.3.1 Quantifiable Deviations and Omissions

The evaluation of the Quantifiable Deviations and Omissions from the RFP obligations shall be based on the evaluated cost of fulfilling the obligations in compliance with the requirements under this Bidding Document. The Employer will assess the cost of such non-material technical and commercial deviations and add the same in the Bid price for the purpose of ensuring fair comparison of Bids.

1.3.2 Domestic Preference

A margin of preference will be granted to eligible domestically produced Plant and Equipment in accordance with criteria given under ITB Clause 27.

1.3.3 Time Schedule

Time to complete the Project from LOS to COD shall be four (04) years for Phasing of the Investment, computing the Interest During Construction (IDC), Insurance of Works till COD and L/C costs etc.

1.3.4 Operating and Maintenance Costs

O & M cost shall be a factor in evaluation.

1.3.5 Costs for Land, Re-Settlement and Mitigation Measures

Costs for Land, Re-Settlement and Mitigation Measures as reflected in the feasibility study by NESPAK shall be taken for evaluation of the Tariff. The adjustment for this price element shall be made at the time of COD according to actual price, notified by Revenue Department, Government of the Punjab.

1.3.6 Payment for previous Studies

Under the provisions of Punjab Power Generation Policy-2006 (Revised 2009), the costs of feasibility studies in case of a solicited site, is to be recovered from the Successful Sponsor, therefore a price of Rs. [redacted] shall be taken as a cost component for calculation of the Tariff.

1.3.7 Permissible Openers

Base unit rate / price of the permissible openers as mentioned in ITB Clause 11.3 shall also be quoted along with Forms for prices of various works so that Successful Sponsor may request the NEPRA for adjustment in Tariff at COD.

1.3.8 Exchange rate

Exchange rate of US Dollar ($) vs. Rupees (Rs.) will be of thirty (30) days prior to Bid opening date i.e. Rupees (Rs) vs. US Dollar ($) (TTOD Selling) to convert the Bid Prices into a single currency for working out the Tariff. The same exchange rate shall also be a reference for exchange rate adjustment.

1.3.9 Custom duty

The Bid price should clearly specify the application of custom duties @ 5% of the imported equipment for comparison purpose. The fiscal incentive as per Federal Government Policy-2002 is available on this account.

1.3.10 Water Use Charges

Revised water use charges @ Rs. 0.45 per kWh shall be taken as per Federal Government Policy-2015 instead of Rs. 0.15 per kWh. The value of generated energy / delivered energy will be taken for calculation of water use charges.

1.3.11 Tariff Model

The Bidder is required to design, procure, construct, test, commission and operate 135 MW Taunsa Hydropower Project in IPP mode under BOOT model for a term of 30 years. After 30 years the project will be handed over to the Government of the Punjab at a price of Rs. one(1).

For this project the bidder is required to quote the Tariff(s) for 01 to 10, 11 to 20 and 21 to 30 and a levelized Tariff in accordance with NEPRA's Standard Template included in the Bidding Forms and in line with NEPRA's Mechanism for determination of Tariff for hydropower projects.

A reference Tariff model has been proposed in line with benchmark parameters by NEPRA's Tariff determination method for Hydropower Projects. The Sponsors shall use the same template to work out their offered levelized Tariff in view of Competitive and Non – Competitive elements and the assumptions as mentioned below

Reference assumptions adopted by NEPRA and/or Policy, including relevant Tariff information:

- The evaluated capital cost of the Project according to Bid Forms will be considered.
- Debt : Equity shall be taken as 80 : 20 and any increase in the equity utilization will be treated as debt while comparing the Tariff
- The Debt and Equity amounts along with their interest rates shall be quoted. The bi-furcation of local and foreign debt shall be provided along with their interest rates in KIBOR and LIBOR respectively.
- The financing charges, legal fees, administrative and project management costs etc. shall be provided.
- Return on equity will be 17% of Equity injected.
- Return on Equity During Construction (ROEDC) will be 17% of Equity injected.
- Redemption of Equity will be provided after the expiry of loan period. For the purposes of Tariff evaluation a twelve (12) years loan repayment period will be assumed. The Bidders can compete by arrangement of loan period from 10 to 12 years.
- Financial close is required to be achieved within 180 days from the issuance date of LOS.
- Equity Draw Down Period (from year 0-1, 1-2, 2-3, 3-4) will be assumed as --,--,--, -- percentage of the equity expensed, respectively.
- Loan Draw Down (from year 0-1, 1-2, 2-3, 3-4) will be assumed as --,--,--, -- percentage of the loan expensed, respectively.
- Project construction period will be 3.5 years from the designated financial close date.
- The discount rate shall be taken as 10%.

- The following Tariff re-openers will be provided and the reference rates from the relevant sources adopted by NEPRA are given as under:
- The project will be evaluated at 135 MW Capacity, 55 % annual plant factor as reference hydrological conditions

Design Discharge:	3155.5 Cumecs
Rated Head:	5.8 meters

- The fixed and O&M cost components with regard to its local and foreign portion bifurcation shall have to be provided as given in schedule N.
- The consultancy charges for Owner's Engineer will be a part of Project Management and Contract Administration.

Elements for competition of Tariffs

The major elements and assumptions for quoting lowest levelized Tariff, inter-alia, includes the following:

- Capital cost of the Project
- O&M charges

- Debt amount, repayment period and interest rate
- Reduction in debt draw down than specified
- Insurance of the plant & equipment till COD and at operation stage
- The financing charges, legal fees, administrative and project management costs etc.

The Bidder shall quote the lowest levelized Tariff as required by NEPRA's Competitive Bidding Tariff Regulations-2014 and also in line with assumptions as mentioned in this criterion.

The evaluation report along with all the documents will be submitted to NEPRA for their approval and notification of the Successful Bidder, offering lowest levelized Tariff. Upon the notification of NEPRA, PPDB will issue a Letter of Support (LOS) to Successful Bidder, as per Policy provisions.

SECTION 4

PROPOSAL/BIDDING FORMS

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

Table of Contents

ENVELOPE - 1

Letter of Technical Bid

Date: Location:

The Punjab Power Development Board,
C/o Energy Department,
Irrigation Secretariat,
Old Anarkali, Lahore.

The undersigned
Last Name: _____
First Name: _____
Title / Position: _____
Company: [_____Bidder_____] (the "Lead Bidder")
acting as the legal representative of [_____Bidder_____] (the "Bidder") pursuant to the [power of attorney] [powers of attorney] attached hereto as Attachment 1, located at the following address:

Address: _____
Telephone: _____
Fax: _____
Email: _____

hereby certify, represent, warrant and agree, on behalf of the Bidder that:

1. This Proposal Letter, along with its Attachments 1 to 8 and Schedules A to H, forms our Proposal and is submitted pursuant to the Request of Proposals dated [_____] issued by the Punjab Power Development Board (PPDB), Government of the Punjab (the "GOPUNJAB") as amended, modified, supplemented or varied through [list all

   Addenda with title and date] issued by PPDB (the "RFP") for the development and implementation of a _____ MW to hydro power generation plant at _____, on Built, Own, Operate and Transfer ("BOOT") as Independent Power Producer (IPP). All capitalized terms used but not otherwise defined herein shall have the meanings assigned to such terms in the RFP.

2. Having examined and being fully familiar with all the provisions of the RFP (including its attachments, exhibits and appendices and all the above Addenda), receipt of which is hereby duly acknowledged, and having evaluated, following our own studies undertaken under our responsibility, the nature and scope of the contractual obligations to be executed, the financing structure, the project agreements and any other regulation associated to the Project or its execution, we hereby offer:

   a. to undertake the Project in compliance with all requirements of the RFP,

   b. to provide to Power Purchaser ____ MW of Contract Capacity at the COD, to sell the electricity generated exclusively to Power Purchaser for the Term of thirty (30) years;

      - in accordance with the Power Purchase Agreement ("PPA") and other project agreements attached to the RFP, except as such draft PPA and other project agreements have been clearly marked in our Proposal to reflect our desired modifications thereto.

      - in accordance with the project implementation schedule enclosed as Schedule D hereto.

3. We hereby agree that this Proposal constitutes our firm, irrevocable offer that is binding upon us

and will remain valid for a period of one hundred eighty (180) days from the deadline for submission of proposals (the "proposal validity period"), except as such period may be extended by us at the request of PPDB.

4. We hereby acknowledge and agree that the feasibility studies received with the RFP is a confidential document and shall not be used for any other purpose but the preparation of this proposal and implementation of the Project (if we were to be selected as the Successful Bidder) and shall not be disclosed to any other party not involved in the preparation of this Proposal). We hereby also, on behalf of other parties involved in the preparation of this Proposal, commit to maintaining the confidentiality of the feasibility studies.

5. We have provided and attached hereto a Proposal Security in the form of a bank guarantee No. [_____] dated [_____] issued by [name of issuing bank] in the amount of USD (state amount in words) (USD *[show amount in figure]*) or equivalent in Pakistani Rupees (state amount in words) (PKR *[show amount in figure]*) in accordance with the form of Proposal Security provided at Attachment 2 hereof.

6. We have also attached as Attachment 4 hereto, a letter issued by [name of Lenders] (the "Lenders") supporting our Proposal in accordance with the form of the Lender Acknowledgement Letter provided at Attachment 3 hereof.

7. We certify that (i) the information submitted as part of this Proposal is complete and accurate and accept that any misrepresentation contained in it may lead to our disqualification and forfeiture of the Proposal security. (ii) the Proposal has been submitted in the legal name of the Bidder [consortium whose members] [who] will be bound to this Proposal and to the development of the Project, (iii) we accept the documents, terms and conditions and disclaimers of the RFP documents.

8. We understand the Responsive criteria and process for evaluation of Proposals and selection of Successful Bidder established in Sections 1, 2 and 3 of the RFP and acknowledge that PPDB is not obligated to accept our Proposals and may at any time reject our Proposal at its sole discretion.

9. We commit ourselves, if we were to be selected as the Shortlisted Bidders, to extend the validity of our Proposal and our Proposal Security until the issue of the LOS to the Successful Bidder.

10. We, including any subcontractors or manufacturers for any part of the agreement, have or will have nationalities from eligible countries, in accordance with ITB Clause 2.

11. We, including any subcontractors or suppliers for any part of the agreement, fulfill legal requirements in accordance with ITB Sub-Clause 2.3.

12. We are not participating, as a Bidder in more than one bid in this bidding process in accordance with ITB Sub-Clause 2.4.

13. Our firm, its affiliates or subsidiaries, including any Subcontractors or Suppliers for any part of the agreement, has not been declared ineligible under the laws or official regulations of Pakistan.

14. We agree to permit PPDB 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 PPDB.

15. We commit ourselves, if we are invited by PPDB to do so, to clarify our Proposal and finalize the draft Project Agreements and to do so in good faith, and to furnish the Performance Guarantee. We also commit ourselves that we shall pay the Audited Feasibility Studies Cost, NESPAK's Due Diligence Report of updating of Feasibility Studies and other Legal Expenses as specified to _____within 07 days on the communication by PPDB in this regard.

In _____ (location) on this _____ (date)

The Bidder/Lead Bidder (in case of JV/Consortium) duly authorized to execute the Proposal for and on behalf of the Bidder shall sign below. However all other member jointly & severally will be responsible to abide by the agreement.

For and on behalf of the Bidder

Notarized signature and seal
Attach attested copy of CNIC

Or

Equivalent in case of foreign nationals

SCHEDULE A

PROPOSED DETAILS OF WORKS, EQUIPMENT & PLANT INCLUDING BID LEVEL DESIGNS BY SPONSORS/BIDDERS, IN CONFORMITY TO EMPLOYER'S REQUIREMENTS

Initials of Signatory to Bid:.....

SCHEDULE B

PROPOSED ORGANIZATION OF THE PROJECT

(The Bidder shall provide the proposed Organization chart of the Project)

The Bidder will indicate the Contractor's strength, particularly the key personnel who will be employed for the Head Office and for Site Office involved in management, supervision, engineering of the Works to be done under the Contract together with their names, qualification, experience, positions held and their nationalities.

Initials of Signatory to Bid:.....

SCHEDULE C

Method of Performing Works

The Bidder is required to submit hereunder a narrative outlining the method of performing the Works. The narrative should indicate in detail and include but not be limited to:

- A list of all major items of constructional and erection plant, tools and vehicles proposed to be used in carrying out the Works at Site, including number of each kind, make, type, capacity of all equipment, working condition, which shall be deployed by him for Design, Manufacture, Supply, Erection, Construction, Testing & Commissioning on IPP mode plus self Financing and O&M for 30 years after Commercial Operation Date (COD) including but not limited to Civil Works 120 MW Taunsa Hydropower Project at Taunsa Barrage, Pakistan in sufficient detail to demonstrate fully that the equipment /Civil Works will meet all the requirements of the Specifications.
- The procedure for Design, Supply, Erection, Construction, Testing & Commissioning in IPP mode having debt: equity ratio of 80:20.
- Details regarding mobilization in Pakistan, the type of facilities including personnel accommodation, office accommodation, provision for maintenance and for storage, communications, security and other services to be used.

Initials of Signatory to Bid:.....

SCHEDULE D

PROPOSED PROGRAMME OF WORKS/PROJECT SCHEDULE

(Bidder shall provide its detailed Bidder's Project Schedule which supports and confirms the Project Development Schedule contained in Section 3 of the RFP starting from the establishment of the Project Company.

Bidder's Project Schedule shall be submitted in a Primavera Project Planner v.6 format which shall address all the milestones in the above-referenced Clause and those additional milestones shown in Table VI-1 below for development, financing, engineering, procurement, shipping, construction and commissioning activities, necessary to demonstrate a complete and accurate knowledge of the Project as well as the Bidder's knowledge of procedures and prevailing conditions in Pakistan.

The Bidder's Project Schedule shall address all details of the implementation of the Project. For all milestones in Table VI-1 below, the Bidder shall specify the day, month and year for commencing and completing the milestone. The list of milestones in this table is not intended to be inclusive, but rather to include appropriate milestones to allow PPDB to evaluate proposals. It is the Bidder's sole responsibility to identify and complete all the appropriate milestones necessary for the completion of the project whether included here or not. This includes the identification and acquisition of all necessary Consents.) The Project Completion Date from issuance of LOS to accomplishment of COD shall be four (04) years or earlier.

TABLE VI-1: Bidder's Project Schedule

	Milestone	Commencement Date	Completion Date
A. Assumption			
1.	Issue of Letter of Support (LOS)		
B. Commencement of Project Development			
1.	Incorporate Project Company		
2.	Sign Project Agreements		
3.	Approval of Tariff by NEPRA		
4	Grant of Generation License by NEPRA		
5	EPC Contract signed		
6.	Submit EIA Study to PPDB		
7.	Obtain all necessary Consents and submit to PPDB		
C. Financial Closing			
1.	Finalize financing documents and submit to PPDB		
2.	Satisfaction of conditions precedent to loan disbursements and availability of funds		
3.	Financial Closing		
D. Drawdown and Construction Start			
1.	Equity and Debt drawdown		
2.	Mobilization advance (at least 10% of Project's total cost)		
3.	Issue of notice to proceed to the EPC contractor		

	Milestone	Commencement Date	Completion Date
4.	Mobilization of EPC contractor to the Site		
E. Engineering and Procurement			
1.	Preliminary Engineering		
2.	Detailed Engineering		
3.	Solicitation and Award of Contracts for Major Equipment		
4.	Procurement of Hydro turbines		
5.	Procurement of Generators		
6.	Procurement of Electrical Equipment		
7.	Procurement of Allied Equipment		
F. Civil Works			
1.	Site Investigations, Detailed Engineering and Model Testing		
2.	River Diversion and construction of Intake and HRC works		
3.	Construction of Power House and other Civil Works		
4.	Diversion and construction of Road and Railway bridges		
5.	Construction of Tailrace and other associated works		
3.	Completion of Major Civil Structures		
G. Mechanical and Electrical Works			
1.	Delivery of Major Equipment (i.e. Turbines and Generators)		
2.	Erection and Installation of Turbine		
	Unit No.1		
	Unit No.2		
	Unit No.3		
	Unit No.4		
	Unit No.5		
	Unit No.6		
	Unit No.7		
	Unit No.8		
	Unit No.9		
H. Commissioning (Units 1-9)			
1.	Initial Synchronization		
2.	Reliability Run Test		
3.	Performance Test		
4.	Contract Capacity Test		
5.	Scheduled Commercial Operations Date		

(Bidder to add or delete rows and adjust the Major Tasks, as necessary)

Initials of Signatory to Bid:.....

SCHEDULE E

Works to be Performed by Subcontractors

The following Subcontractors and/or manufacturers are proposed for carrying out the item of the plant and services indicated. Bidders are free to propose more than one for each item but upto maximum of three against each item of the Plant and Services.

Major Items of Plant and Services	Proposed Subcontractors/Manufacturers	Nationality

Initials of Signatory to Bid:.....

SCHEDULE F

Construction Machinery and Equipment Details

The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key equipment for accomplishing the Work in accordance with Technical Specifications. A separate Form shall be prepared for each item of equipment, or for alternative equipment proposed by the Bidder.

Item 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	

Omit the following information for equipment owned by the Bidder.

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

Initials of Signatory to Bid:.....

SCHEDULE G

Non- Material Deviations from Technical and RFP Provisions

The Bidder shall declare/list the deviations, if any, hereunder as per ITB Sub-Clause 9.1. Separate sheets shall be used for deviations from Technical Specifications and deviations from RFP Provisions. The attention of the bidders is however drawn to the provisions of ITB Sub-Clause 24.3 regarding rejection of Bids that are not substantially responsive to the requirement of the Bidding Documents.

For better understanding, the deviations identified in this Schedule shall pertain to the non-material deviation in technical and contractual conditions and does not include deviations in Project Agreements which may be dealt with relevant entities by the Successful Bidder.

The Bidder shall also provide the additional price hereunder if any, for withdrawal of the deviation. The price adjustment for these declared deviations will be added in its Bid Price during evaluation of the Bids to bring the Bids at par as per Clause 1.3 of Section 3. The undeclared deviations which have not been listed by the Bidder in this form shall not be considered by the Employer for incorporation in the Agreement, if awarded to the Bidder, and it shall be deemed that the Bidder complies with the specified requirements of the Bidding Documents.

Sr. No.	Ref. of Specified Requirement	Deviation	Price for Withdrawal of Deviation

Initials of Signatory to Bid:.....

SCHEDULE H

Specimen JV Agreement

(On Joint Venture's Letter Head)

THIS JOINT DEED OF UNDERTAKING executed on this..... day of..... Two Thousand and .....by..... a company incorporated under the laws of ..... and having its Registered Office at .....(hereinafter called the "Party No.1" which expression shall include its successors, executors and permitted assigns) and M/s.....a company incorporated under the laws of..... and having its Registered Office at..... (herein after called the "Party No.2" which expression shall include its successors, executors and permitted assigns) and M/s.. .. .. .a Company incorporated under the laws of..... and having its Registered Office at..... (hereinafter called the "Party No.3" which expression shall include its successors, executors and permitted assigns) for the purpose of making a Bid and entering into a contract [hereinafter called the "Contract"{in case of award)] against the Identification No.....for _____[Name of Works] associated with _____ (hereinafter called the "**Employer**").

WHEREAS the Party No.1, Party No.2 and Party No.3 have entered into an Agreement dated .....

AND WHEREAS the Employer invited Bids for the design, manufacture, Supply of Equipment Materials, Installation, Testing & Commissioning stipulated in the Bidding Documents under _____ associated with _____.

AND WHEREAS and 'Qualification& Evaluation Requirement of the Bidder', and technical provisions forming part of the Bidding Documents, inter-alia, stipulates that an Undertaking of two or more qualified partners, meeting the requirements of 'Qualification & Evaluation Requirement of the Bidder', as applicable may bid, provided the Joint Venture fulfills all other requirements and in such a case, the Letter of Bids (Technical & Price Bids) shall be signed by the Partner –In Charge so as to legally bind all the Partners of the Joint Venture, who will be jointly and severally liable to perform the Contract and all obligations hereunder.

AND WHEREAS the Bid is being submitted to the Employer vide proposal No.....dated..... by Party No.1 based on this Undertaking between all the parties; under these presents and the Bid has been signed by the Partner –In Charge.

NOW THIS UNDERTAKING WITNESSETH AS UNDER:

In consideration of the above premises and agreements all the parties of this Deed of Undertaking do hereby declare and undertake:

1. In requirement of the award of the Contract by the Employer to the Joint Venture Partners, we, the Parties do hereby undertake that M/s..... the Party No.1, shall act as Lead Partner and further declare and confirm that we the parties to the Joint Venture shall jointly and severally be bound unto the Employer for the successful performance of the Contract and shall be fully responsible for the design, manufacture, Supply, and successful performance of the equipment in accordance with the Contract:

2. In case of any breach or default of the said Contract by any of the parties to the Joint Venture, the party(s) do hereby undertake to be fully responsible for the successful performance of the Contract and to carry out all the obligations and responsibilities under the Contract in accordance with the requirements of the Contract.

3. Further, if the Employer suffers any loss or damage on account of any breach in the Contract or any shortfall in the performance of the equipment in meeting the performances guaranteed as per the specification in terms of the Contract, the Party(s) of these presents undertake to promptly make good such loss or damages caused to the Employer, on its demand without

any demur. It shall not be necessary or obligatory for the Employer to proceed against Lead Partner to these presents before proceeding against or dealing with the other Party(s), the Employer can proceed against any of the parties who shall be jointly and severally liable for the performance and all other liabilities/obligations under the Contract to the Employer.

4. The financial liability of the Parties of this Deed of Undertaking to the Employer, with respect to any of the claims rising out of the performance or non-performance of the obligations set forth in this Deed of Undertaking, read in conjunction with the relevant conditions of the Contract shall, however not be limited in any way so as to restrict or limit the liabilities or obligations of any of the Parties of this Deed of Undertaking.

5. It is expressly understood and agreed between the Parties to this Undertaking that the responsibilities and obligations of each of the Parties shall be as delineated in Annexes attached with this undertaking. It is further undertaken by the parties that the above sharing of responsibilities and obligations shall not in any way be a limitation of joint and several responsibilities of the Parties under the Contract.

6. It is also understood that this Undertaking is provided for the purposes of undertaking joint and several liabilities of the partners to the Joint Venture for submission of the Bid and performance of the Contract if awarded and that this Undertaking shall not be deemed to give rise to any additional liabilities or obligations, in any manner or any law, on any of the Parties to this Undertaking or on the Joint Venture, other than the express provisions of the Contract.

7. This Undertaking shall be construed and interpreted in accordance with the provisions of the Contract.

8. In case of an award of a Contract, we the parties to this Deed of Undertaking do hereby agree that we shall be jointly and severally responsible for furnishing a Contract performance security from a bank in favour of the Employer in the currency/currencies of the Contract.

9. It is further agreed that this Deed of Undertaking shall be irrevocable and shall form an integral part of the Bid and shall continue to be enforceable till the Employer discharges the same or upon the completion of the Contract in accordance with its provisions, whichever is earlier. It shall be effective from the date first mentioned above for all purposes and intents.

IN WITNESS WHEREOF, the Parties to this Deed of Undertaking have through their authorized representatives executed these presents and affixed Common Seals of their companies, on the day, month and year first mentioned above.

Common Seal of .....
has been affixed in my/ our
presence pursuant to Board of
Director's Resolution dated .....

Name .....

Designation .....

Signature .....

WITNESS :

I. .....

II. .....

For Lead Partner (Party No.-1)
For and on behalf of M/s
.....

(Signature of the authorized
representative)

Common Seal of .....
has been affixed in my/ our
presence pursuant to Board of
Director's Resolution dated .....

For Party No.-2
For and on behalf of M/s.....

(Signature of the authorized

Name ..... representative)

Designation .....

Signature .....

WITNESS :

I. .....

II. .....

Common Seal of .....
has been affixed in my/ our
presence pursuant to Board of
Director's Resolution dated .....

For Party No.-3
For and on behalf of M/s.
.....

Name .....

Designation .....

Signature .....

(Signature of the authorized
representative)

WITNESS :

I. .....

II. .....

Notes:

1. In the event that the successful Bidder is a joint venture formed of two or more companies, the Employer requires that the parties to the joint venture accept joint and several liabilities for all obligations under the Contract.

2. The maximum number of J.V. partners is three (3).

SCHEDULE X

Current Contract Commitments

Initials of Signatory to Bid: .....

Annexure – B of PQD

Form EXP – 1: General Experience

Each Bidder or member of a JV/Sub-Contractor must fill in this form

General Experience				
Starting Month Year	Ending Month Year	Years	Contract Identification and Name Name and Address of Employer Brief Description of the Works Executed by the Bidder/Sub-Contractor	Role of Bidder/Sub-Contractor

Form EXP – 2(a): Specific 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			US$
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 Clause 2 of Section 3			

Form EXP - 2(b): Specific Experience in Manufacturing

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			US$
If partner in a JV or subcontractor, specify participation of total contract amount	Percent of Total	Amount	
Employer's Name Address Telephone Number Fax Number E-mail			
Description of the key activities in accordance with Clause 2 of Section 3			

Form EXP – 3:
GENERAL INFORMATION REGARDING O&M CONTRACTOR

In case the Sponsor/Bidder intends to maintain and operate the Project through O&M Contractor/ Sub-Contractor after COD, the details and information of the O&M Contractor shall be furnished in the Form Exp – 3.

Form Exp – 3: General Information about O&M Contractor

Sr. #	Item	Information
1	Name of O&M Contractor	
2	Legal Form (status)	*[e.g. company, corporation, partnership, JV/consortium, individual]*
3	Country of Registration/Incorporation	
4	Home Office Address	
5	Telephone/Fax/Email	
6	Name and Position of Contact Person for the Project	
7	Address of Contact Person	
8	Telephone/Fax/Email of Contact Person	
9	Area of Main Business	
10	Number of Staff in Main Business	*Engineers:* *Others:*
11	Number and Years of (Power) Projects under Operation	

ATTACHMENT 1

POWER(S) OF ATTORNEY

Instructions for Bidders:

1. If the Bidder is not a joint venture/consortium, it will furnish a power of attorney (specimen attached) authorizing the person who signs the Proposal and other documents forming parts of the Proposal to sign for and on behalf of the Bidder and to bind the Bidder to the signed Proposal and document and any subsequent agreement.

2. If the Bidder is a joint venture/consortium:

   - Each member of the joint venture/consortium (other than the Lead Bidder) shall furnish a power of attorney authorizing the Lead Bidder to act and receive instructions on behalf of all the joint venture/consortium members and to submit the Proposal for and on their behalf.

   - Each member of the joint venture/consortium (including the Lead Bidder) shall furnish a power of attorney authorizing the person who signs the Proposal and other documents forming parts of the Proposal to sign for and on behalf of the Bidder (which term includes all members of joint venture/consortium) and to bind the Bidder to the signed Proposal and document and any subsequent agreement.)

   - All members of the joint venture/consortium are also responsible to abide by all the laws/clauses of the agreement.

Specimen of Power of Attorney

IMPORTANT NOTICE: Power of Attorney to be printed on stamp paper, signed and notarized. In the case of a Pakistani Attorney, a copy of his national identity card ("NIC") should be attached with the Power of Attorney. In the case of a non-Pakistani Attorney, a copy of his passport should be attached.

KNOW BY ALL MEANS THAT by this Power of Attorney (**"Power of Attorney"**),

_____ *[Insert name of JV/Consortium Sponsor]* having its registered office at [□], does hereby nominate, appoint and authorize *Mr.* _____ s/o of _____, r/o _____ (whose specimen signature appears below) on behalf of _____ *[Insert name of JV/Consortium Sponsor]* hereinafter referred to as the **"Attorney"**, to :

(i) sign and submit to Punjab Power Development Board (PPDB), or its authorized nominee the Statement of Qualifications and all other documents and instruments (**"*RFP*"**) required to submit a Hydro Power Project of 120 MW capacity located at Taunsa;

(ii) execute all such deeds, documents and instruments as may be considered necessary and expedient in relation to the foregoing;

(iii) do and carry out all other actions as may be required by PPDB in connection with the Project, and

(iv) to immediately notify PPDB in writing of any impending or actual revocation as well as any change in the terms of this Power of Attorney.

_____ *[Insert name of JV/Consortium Bidder]* does hereby ratify and confirm whatever the Attorney shall do by virtue of these present.

WITNESSES:

1._____

2._____

[INSERT NAME OF GUARANTOR]

For: _____

By: _____

NOTARY PUBLIC:

_____

(Specimen Signature of Authorized Attorney)

ATTACHMENT 2

PROPOSAL SECURITY

The Punjab Power Development Board,
C/O Energy Department,
Irrigation Secretariat,
Old Anarkali, Lahore,

Guarantee No. _____
Guarantee Amount __ _____
Guarantee Executed on _____
Expiry Date _____

Considering that our client _____ (hereinafter referred to as the "Bidder", which expression shall mean and include its successors, executors, assigns, administrators and legal representatives whether jointly or severally) is submitting to the Punjab Power Development Board, Government of the Punjab (hereinafter referred to as "PPDB", which expression shall mean and include its successors, executors, assigns, administrators and legal representatives whether jointly or severally) a proposal (hereinafter referred to as the "Proposal") for the development of ____ MW power plant at _____ in the Punjab on Build Own. Operate and Transfer (BOOT) (hereinafter referred to as the "Project") in response to the Request of Proposals dated [_____] issued by PPDB as amended, modified, supplemented or varied through Addenda issued by PPDB from time to time (hereinafter referred to as the "RFP"):

On the request of the Bidder, we, the undersigned, responsible delegates and representatives of the *[name of bank]* (hereinafter referred to as the "Guarantor", which expression shall mean and include its successors, executors, assigns, administrators and legal representatives whether jointly or severally), authorized to sign and make decisions in its name declare by this guarantee (hereinafter referred as the "Proposal Security"), that the Guarantor do hereby guarantee unconditionally and irrevocably to pay PPDB up to a sum of United States Dollar *[amount in words] (USD [amount in figures])* or equivalent in Pak. Rs. in accordance with the following:

1. Immediately upon receipt of PPDB's first written request stating either:

a. that the Bidder has withdrawn its Proposal during the proposal validity period specified in the RFP; or

b. that the Bidder has failed to accept the correction of its Proposal, in accordance with RFP; or

c. that the Bidder, when invited by PPDB to do so, has failed within the time limits specified in the RFP to:

(i) furnish the required Performance Guarantee in accordance with the RFP: or

(ii) finalize the Project Agreements in accordance with the RFP.

Notwithstanding any objection of the Bidder or of any other party, the Guarantor shall pay to PPDB the above mentioned amount or any other amount(s) PPDB may demand, provided that such amount(s) shall not exceed the above mentioned amount, by any method of payment which is acceptable to PPDB. The decision of PPDB as to the Bidder's default, delay or failure in performance listed above shall be final and unquestionable.

2. Any payments made to PPDB on its request shall be net and free of and without any present or future deductions such as for the payment of any taxes, executions, duties, expenses, fees, deductions or retentions regardless of the nature thereof or the authority levying the same.

3. The undertakings in this Proposal Security constitute direct, unconditional and irrevocable obligations of the Guarantor. The Guarantor shall not be exonerated from all or any part of such obligations for any reason or cause whatsoever, such as changes in the terms and conditions of

the RFP or extension of the proposal validity period of the RFP or changes in the scope of the Project or nature of the work required to be executed or failure to perform or the carrying out of any act or procedure by PPDB or by a third party that would or could exempt or release Guarantor from its obligations and liabilities under this Proposal Security.

4. The Guarantor hereby binds itself unconditionally and irrevocably and undertakes and guarantees to pay on first written demand of PPDB, without protest or demur and without reference, notice or recourse to the Bidder or any other person, without requiring PPDB to prove or to show grounds or reasons for such demand and hereby expressly waive all rights to deny its obligations to PPDB irrespective of any dispute, difference or disagreement between the Bidder and PPDB or contestation by any other party/person.

5. This Proposal Security sets forth in full the terms of Guarantor's undertaking and this undertaking shall not be modified, amended, or amplified in any way by reference to any document, instrument or agreement referred to therein, and any such reference shall not be deemed to incorporate by reference any document, instrument or agreement.

Guarantor

_____

Authorized signature-and bank seal

Witness:-

1-

2-

Witness to attach copy of CNIC

ATTACHMENT 3

LENDER ACKNOWLEDGEMENT LETTER

Date:

The Punjab Power Development Board,
C/o Energy Department,
Irrigation Secretariat,
Old Anarkali, Lahore,

Dear Sir:

This refers to the Request of Proposals dated [_____] issued by the Punjab Power Development Board (PPDB) Government of the Punjab as amended, modified, supplemented or varied through *[list all Addenda with title and date issued by PPDB (the "RFP")* for the development and implementation of a ____ MW Hydel power generation project at _____ in the Punjab on a Build, Own, Operate and Transfer (BOOT basis). All capitalized terms used but not otherwise defined herein shall have the meanings assigned to such terms in the RFP.

We hereby acknowledge and confirm that:

1. We have reviewed the RFP in its entirety;

2. We have also reviewed in detail with (the "Bidder") the draft Project Agreements attached as PART III to the Bidder's Proposal to PPDB dated *[date of Proposal]* and presented the matters related to the financing of the Project to our credit committee and senior management.

3. Based on our review and credit committee process, we require no modifications to, and have no other issues with the draft Project Agreements attached to the Bidder's Proposal, except as clearly marked by the Bidder on copies of same as part of Bidder's Proposal and listed in Schedule G (Deviations from Technical & Contractual Provisions) to the Bidder's Proposal, in accordance with the requirements of the RFP.

4. Our proposed term sheet is included in the Bidder's Financial Proposal which contains in its entirety all material terms that we require to be included in the Financing Documents in the event Bidder is selected as the Successful Bidder by PPDB.

[The Lender]

_____

Authorized signatories

ATTACHMENT 4

BIDDER/SPONSOR'S INFORMATION

1.0 LEGAL FORM AND ORGANIZATION OF BIDDER

(In Table IV – 1 and Table IV – 2. the Bidder shall provide the required information regarding each member of the Bidder JV/consortium, as prequalified or with any change in the JV/consortium as approved by the PPDB pursuant to the RFP.)

TABLE IV – 1: Legal Form and Organization of Bidder

Sr. #	Item	Information
1	Name of Bidder	*[Lead Bidder/Main Sponsor]*
2	Home Office Address	*[Other members of Bidder JV/consortium]*
3	Telephone/Fax/Email	
4	Regional Office Address	
5	Telephonic / Fax / Email	
6	Authorized Person for contact for the Project	
7	Contact Address of Authorized Person	
8	Telephone/Fax/Email of Authorized Person	
9	Legal Form (Status)	*[e.g. company, corporation, partnership, JV/consortium, individual]*
10	Memorandum and Articles of Association and Form A, Form 29	*[To be attached by Bidder]*

TABLE IV – 2: Legal Form and Organization of Bidder Members

Sr. #	Item	Lead Bidder	Other Member	Other Member
1	Name			
2	Legal Form	*[e.g. company, corporation, partnership, Consortium/JV, individual]*	*[e.g. company, corporation, partnership, consortium/JV, individual]*	*[e.g. company, corporation, partnership, consortium/JV, individual]*
3	Country of Registration / Incorporation			
4	Home Office Address			
5	Telephone/Fax/ Email			
6	Name and Position of Contact Person			
7	Address of Contract Person			
8	Telephone/Fax/ Email of Contract Person			
9	Share in Total Equity of the Project (%)			
10	Organizational Charts	*[To be attached by Bidder]*	*[To be attached by Bidder]*	*[To be attached by Bidder]*

(Bidder to add or delete column as required)

7.0 INFORMATION REGARDING ENVIRONMENTAL CONSULTANT

(The Bidder shall provide herein a description of the proposed Environmental Consultant for the period indicating, inter alia;

- *the name, nationality and address of the organization;*
- *the name, nationality and address of the project manager;*
- *the scope of work; and*
- *the relevant experience and qualifications of the organization and the project manager.)*

8.0 INFORMATION REGARDING INSURANCE ADVISOR

(The Bidder shall provide herein a description of the proposed Insurance Advisor for the Project, including inter alia:

- *the name, nationality and address of the organization;*

- *the name, nationally and address of the lead person;*
- *the scope of work: and*
- *the relevant experience and qualifications of the organization and the lead person.)*

9.0 INFORMATION REGARDING LEGAL ADVISORS

(The Bidder shall provide herein a description of the local and foreign Legal Advisor to the Bidder or the Project Company, indicating, inter alia;

- *the name, nationality and address of the organizations;*
- *the name, nationality and address of the lead lawyers;*
- *the scope of work: and*
- *the relevant experience and qualifications of the organization and the lead lawyers.)*

ENVELOPE - 2

Letter of Financial Bid/Tariff Proposal

Date: Location:

The Punjab Power Development Board,
C/O Energy Department,
Irrigation Secretariat,
Old Anarkali, Lahore.

The undersigned
Last Name: _____
First Name: _____
Title / Position: _____
Company: [_____Bidder_____] (the "Lead Bidder")

Acting as the legal representative of [_____Bidder_____] (the "Bidder") pursuant to the [power of attorney] [powers of attorney] attached hereto as Attachment 1, located at the following address:

Address: _____

Telephone: _____

Fax: _____

Email: _____

hereby certify, represent, warrant and agree, on behalf of the Bidder that:

1. This Proposal Letter, along with Schedules I to V, forms our Proposal and is submitted pursuant to the Request of Proposals dated [_____] issued by the Punjab Power Development Board (PPDB), Government of the Punjab (the "GOPUNJAB") as amended, modified, supplemented or varied through [list all

   Addenda with title and date] issued by PPDB (the "RFP") for the development and implementation of a _____ MW to hydro power generation plant at _____, on Built, Own, Operate and Transfer ("BOOT") as Independent Power Producer (IPP). All capitalized terms used but not otherwise defined herein shall have the meanings assigned to such terms in the RFP.

2. Having examined and being fully familiar with all the provisions of the RFP (including its attachments, exhibits and appendices and all the above Addenda), receipt of which is hereby duly acknowledged, and having evaluated, following our own studies undertaken under our responsibility, the nature and scope of the contractual obligations to be executed, the financing structure, the project agreements and any other regulation associated to the Project or its execution, we hereby offer:

   a. to undertake the Project in compliance with all requirements of the RFP,

   b. to provide to Power Purchaser ____ MW of Contract Capacity at the COD, to sell the electricity generated exclusively to Power Purchaser for the Term of thirty (30) years;

      - in accordance with the Power Purchase Agreement ("PPA") and other project agreements attached to the RFP, except as such draft PPA and other project agreements have been clearly marked in our Proposal to reflect our desired modifications thereto.

- at a Levelized Tariff in Pak Rs_____ / kWh as calculated in Schedule O hereto and at Tariff shown in Table VIII-1 thereof, and
- in accordance with the project implementation schedule enclosed as Schedule D hereto.

3. We hereby agree that this Proposal constitutes our firm, irrevocable offer that is binding upon us and will remain valid for a period of one hundred eighty (180) days from the deadline for submission of proposals (the "proposal validity period"), except as such period may be extended by us at the request of PPDB.

4. We have also attached as Attachment 4 of Section4 hereto, a letter issued by [name of Lenders] (the "Lenders") supporting our Proposal in accordance with the form of the Lender Acknowledgement Letter provided as Attachment 3 of Section4 of the RFP.

5. We certify that (i) the information submitted as part of this Proposal is complete and accurate and accept that any misrepresentation contained in it may lead to our disqualification and forfeiture of the Proposal security. (ii) the Proposal has been submitted in the legal name of the Bidder [consortium whose members] [who] will be bound to this Proposal and to the development of the Project, (iii) we accept the documents, terms and conditions and disclaimers of the RFP documents.

6. We understand the Responsive criteria and process for evaluation of Proposals and selection of Successful Bidder established in Sections 1, 2 and 3 of the RFP and acknowledge that PPDB is not obligated to accept our Proposals and may at any time reject our Proposal at its sole discretion.

7. We commit ourselves, if we were to be selected as the Shortlisted Bidders, to extend the validity of our Proposal and our Proposal Security until the issue of the LOS to the Successful Bidder.

8. We agree to permit PPDB 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 PPDB.

9. We commit ourselves, if we are invited by PPDB to do so, to clarify our Proposal and finalize the draft Project Agreements and to do so in good faith, and to furnish the Performance Guarantee. We also commit ourselves that we shall pay the Audited Feasibility Studies Cost, NESPAK's Due Diligence Report of updating of Feasibility Studies and other Legal Expenses as specified to _____within 07 days on the communication by PPDB in this regard.

In _____ (location) on this _____ (date)

The Bidder/Lead Bidder (in case of JV/Consortiim) duly authorized to execute the Proposal for and on behalf of the Bidder shall sign below. However all other member jointly & severally will be responsible to abide by the agreement.

For and on behalf of the Bidder

_____

Notarized signature and seal
Attach attested copy of CNIC

Or

Equivalent in case of foreign nationals

Price Schedules

PREAMBLE

General

1. The Price Schedules for Hydropower Plant are divided into separate Schedules as follows:

Schedule I:	Costs for Major Components of Civil Works and all other Facilities
Schedule J:	Costs for Major Components of E&M Works and all other works of Plant (Imported Items)
Schedule K:	Costs for Major Components of E&M Works and all other works of Plant (Local Items)
Schedule L:	Costs for Engineering Services and Detail Designs
Schedule M:	Costs for Installations, Testing Commissioning and other Services
Schedule N:	Costs of Operation and Maintenance Services and other obligations
Schedule O:	Resettlement and Mitigation for Environmental Impact
Schedule P:	Interest during Construction
Schedule Q:	Sources of Funds
Schedule R:	Terms and Conditions of Debt financing
Schedule S:	Repayment Schedule for Lenders
Schedule T:	Miscellaneous Costs of the Sponsors
Schedule U:	Financial Model and offered levelized Tariff and its Breakup in view of NEPRA'S Competitive Bidding Tariff Regulations-2014 and ITB's
Schedule V:	Reference Base Prices for Adjustment of the Tariff at COD

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 reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling in the rates and prices. The entered rates and prices shall be deemed to cover the full scope as aforesaid, including overheads and profit.

2. If bidders are unclear or uncertain as to the scope of any item, they will seek clarification in accordance with ITB 7 prior to submitting their bid.

Schedules of Rates and Prices

Schedule I:
Costs for Major Components of Civil Works and all other Facilities

Item	Description	Qty.	Total Price[1]	
			Local Currency Portion	Foreign Currency Portion
1	2	3	4	5
A	Civil Works	L.S		
A-1	Diversion of River and Intake Structure	L.S		
A-2	Head Race Channel	L.S		
A-3	Power House including Intake and Outlet bays	L.S		
A-4	Tailrace channel	L.S		
A-5	Remodeling of Silt Ejectors	L.S		
A-6	Aqueducts for D.G Khan and Kachi Canal	L.S		
A-7	Diversion and Railway Bridge	L.S		
A-8	Diversion and Road Bridge	L.S		
A-9	Access Bridge	L.S		
A-10	Leading Cut D/S Tailrace	L.S		
A-9	Camp Office and Operating Facility	L.S		
A-10	Any other major component	L.S		

Name of the Bidder: _____

Signature of the Bidder: _____

[1] *Specify currency in accordance with ITB.*

Schedule J:
Costs for Major Components of E&M Works and all other works of Plant (Imported Items)

Item #	Description	Country of Origin	Qty.	Unit Price[1]		Total Price[1]	Taxes and Duties
				Foreign Currency	CIP	Foreign Currency	Local Currency
1	2	3	4	5	6	7 = 4 x 6	8

Name of Bidder _____

Signature of Bidder _____

The Bidder shall provide breakdown of the Plant with rates and prices and list of mandatory spare parts showing prices for each part.

Specify currencies in accordance with ITB.

Country of Origin Declaration Form

Item	Description	Country

Schedule K:
Costs for Major Components of E&M Works and all other works of Plant (Local Items)

Item	Description	Qty	EXW Unit Price[1]	Total EXW Price[1]	Sales Tax	Total Price
1	2	3	4	5 = 1 x 2	6	7 = 5 + 6

Name of Bidder _____

Signature of Bidder _____

The Bidder shall provide breakdown of the Plant with rates and prices and list of mandatory spare parts showing prices for each part.

[1] *Specify currency in accordance with ITB.*

Schedule L:
Lump Sum Cost for Engineering Services and Detail Design

Item	Description	Qty.	Total Price[1]	
			Local Currency Portion	Foreign Currency Portion
1	2	3	4	5
		Grand Summary		

Name of Bidder _____

Signature of Bidder _____

[1] *Specify currency in accordance with ITB.*

Schedule M:

Lump Sum Costs for Installations, Testing Commissioning and other Services including Insurance of Works till COD

Item	Description	Qty.	Total Price[1]	
			Local Currency Portion	Foreign Currency Portion
1	2	3	4	5
		L.S		

Name of Bidder _____

Signature of Bidder _____

[1] *Specify currency in accordance with ITB.*

Schedule N:

Annual Operation and Maintenance Costs including Insurance of Plant and Other Obligations

Item	Description	Qty.			Total Price[1]	
					Local Currency Portion	Foreign Currency Portion
1	2	3			4	5
1	Fixed O&M Costs	L.S				
2	Variable O&M Costs	L.S				
3	Insurance of Plant during operation	L.S				

Name of Bidder _____

Signature of Bidder _____

[1] *Specify currency in accordance with ITB.*

Schedule O:

Lump sum costs of Land, Resettlement and Mitigation for Environmental Impact

Item	Description	Unit	Total Price[1]
			Local Currency Portion
1	2	3	4
1	Land	L.S	
2	Resettlement compensation	L.S	
3	Mitigation for Environmental Impact	L.S	
4	Any other relevant cost(s)	L.S	

Name of Bidder _____

Signature of Bidder _____

[1] *Specify currency in accordance with ITB.*

Schedule P:

Interest during Construction

Cost Disbursement Schedule w.e.f. LOS to COD

The Bidder shall provide the details of Debt and Equity and shall also provide the details of annual drawdown/phasing and ultimately the calculation of interest during construction (IDC) in local and foreign currencies.

Name of the Bidder: _____

Signature of the Bidder: _____

Schedule Q:

Sources of Funds

	Sources	Foreign Currency (Million)	Local Currency (PKR Millions)	Equivalent Total (PKR Millions)
	1	2	3	(2 + 3) = 4
1)	Total Project Cost			
2)	♦ Main Sponsor Name:			
	♦ (Member of Bidder Consortium) Name:			
	♦ (Member of Bidder Consortium) Name:			
	♦ (Member of Bidder Consortium) Name:			
	♦ (Any other source) Name:			
	♦ (Any other source) Name:			
	Total Equity:			
3)	Debt Financing			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	♦ (Lender) Name:			
	Total Debt:			
4)	Stand-by Credit Facility (in addition to total Project Cost)			

(Note: Bidder shall add or delete the titles or heads as required)

Name of the Bidder: _____

Signature of the Bidder: _____

[1] *Specify currency in accordance with ITB*

Schedule R:

Terms and Conditions of Debt Financing

Description	[Lender]	[Lender]	[Lender]	[Lender]
Amount (in Million Rs.)				
Currency of Loan				

Description	[Lender]	[Lender]	[Lender]	[Lender]
Availability Period				
(Months from Financial Closing)				
Final Maturity (Years from Financial Closing)				
Grace Period (Years from Financial Closing)				
Repayment Period (Years from COD) Ten years				
Repayment Period Frequency (Months)				
Quarterly				
Interest Rate (%) 3months KIBOR (Bid)+3% as on _____				
Upfront Fees (%)				
Commitment/Drawdown Fees (%)				
[Other Fees (%)]				

(Bidder to add or delete columns as necessary)

Name of the Bidder: _____

Signature of the Bidder: _____

[1] *Specify currency in accordance with ITB*

Schedule S:

Repayment Schedule for Lenders

Repayment Date	Principal Amount Repayment (PKR Millions)	Interest Amount (PKR Millions)	Total Payment (PKR Millions)
[Date]			
[Date]			
[Date]			
[Date]			
.....			
.....			
[Date]			

(Bidder to add or delete rows as necessary)

[This table shall be provided for each Lender or Loan Separately]*

Name of the Bidder: _____

Signature of the Bidder: _____

Schedule T:

Financing Costs, Legal Fees, Contract Administration and Management Costs etc.

Item	Description	Unit	Total Price
			Local Currency
1	2	3	4
1	Financing Cost	L.S	
2	Legal Fees	L.S	
3	Contract Administration	L.S	
4	Project Management Costs	L.S	
5	L/C Charges (if any)	L.S	
6	Any other justifiable price and its detail	L.S	

Name of Bidder _____

Signature of Bidder _____

Schedule U:

Financial Model and Offered Levelized Tariff

Agreement Year	Energy Charge (Rs./kWh)			Capacity Charges (Rs./kW/Month)								Total CP @ 55% PLF (Rs./kWh)	Total Tariff	
	Water Use Charges @ Rs. 0.45/kWh	Var. O&M Cost	Total	Fixed O&M Cost	Insurance	Principal	Interest	Total Debt	ROE during Const. @17%	ROE @17%	Total		Rs./kWh	Cents/kWh
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
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Levelized Tariff														
Rs./kWh														
Cents/kWh														
Average Tariff														
1-10														
11-20														
21-30														
1-30														

- The Bidder shall also provide the assumptions and parameters used for computing the offered tariffs.
- The CD containing excel based calculations, links and formulas shall also be provided without hiding any cell along with hard copies and instruction if any.

Name of the Bidder: _____

Signature of the Bidder: _____

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Schedule V:

Reference Base Prices for Adjustment in Tariff at COD

Item	Description	Unit	Reference Price (PKR) 30 Days Earlier to Bid Submission
1	2	3	4
1	Cement	Ton	
2	Reinforcing Steel Bars Grade 40	Ton	
3	Reinforcing Steel Bars Grade 60	Ton	
4	Labour	Person	
5	Fuel	Liter	
		Total:	

Name of Bidder _____

Signature of Bidder _____

SECTION 5

ELIGIBLE COUNTRIES

All countries of the World with whom the Government of Islamic Republic of Pakistan has commercial relations, except those under international Sanctions by the United Nations Organization.

Part – II

DESCRIPTION OF PROJECT AND EMPLOYER'S REQUIREMENTS

SECTION 6 (A)
PROJECT DESCRIPTION

DESCRIPTION OF PROJECT

1.0 BACKGROUND

Pakistan's energy requirements have expanded at a rate of seven to eight percent annually creating a growing gap between supply and demand. Although conventional thermal power generated by coal, oil, and gas is expected to meet a large percentage of future demand, there is also enormous scope for more environmentally friendly options. The Government of Pakistan's (GOP) Renewable Energy Policy of 2006 emphasizes the development of renewable and clean energy in the country.

Due to depletion of conventional energy resources, the development of renewable energy resources in Pakistan has gained momentum over the past three to four years. The goal is to have power generation from renewable energy (RE) resources, which can fulfill approximately ten percent of the country's overall energy requirements by the year 2015. Short gestation low-head hydropower on the existing barrages and canal falls can contribute a considerable share in generating sustainable power. Provincial Governments have been authorized under the Constitution of Pakistan to undertake activities in the Power Sector Development. Government of the Punjab had setup the Punjab Power Development Board (PPDB) in 1995 and framed its own Power Generation Policy in 2006 and revised in 2009, for implementation of power generation projects, through one window facility. WAPDA has assessed hydro power generation potential of 600 MW in the Punjab in the year 2002 at 317 locations.

Government of Punjab intends to develop 135 MW135 MW Taunsa HPP under the Policy. The feasibilities of the project have been completed in June 2013 and June 2015. The Project will be developed in private sector as an IPP.

2.0 LOCATION AND ACCESS OF PROJECT AREA

Taunsa Hydropower Station would be built adjacent to the existing Taunsa Barrage on the Indus River, in Muzaffargarh, Punjab. The barrage is about 30 km southeast of Taunsa town. It is 120 km from Multan, where there is an international airport. A wide network of roads and railway leads to the project area. The nearest town is Kot Addu, 10 km southeast of Taunsa Barrage on the left bank of the Indus River. Dera Ghazi Khan (D.G. Khan) is located some 60 km south of Taunsa Barrage, on the right bank of the Indus River. The project area is about 420 km from Lahore, 320 km from Faisalabad and 750 km from Karachi.

Location of the Project is attached as **Figure-1**.

3.0 GEOGRAPHICAL LOCATION OF TAUNSA HYDROPOWER PROJECT

The proposed project area is located in the Indus alluvial plain where the area opened up to form a large alluvial plain of Indus deposits containing sands and silts from thousands of years. The plain is virtually flat, having an approximate general slope of 0.18 m per km towards the sea.

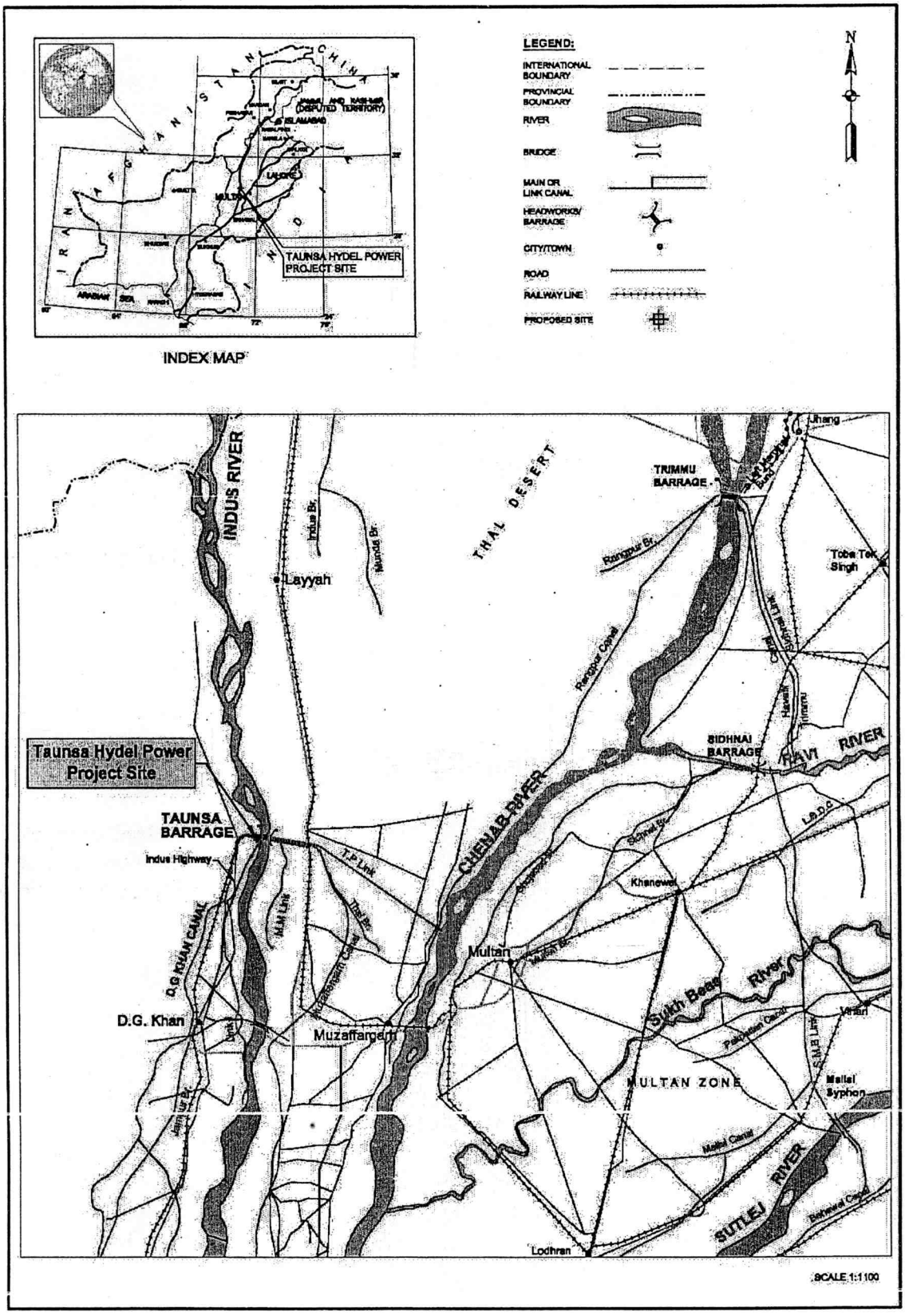

Figure 1: Location of the Project

Taunsa barrage was designed for a flood discharge of 28,300 m^3/s. However, greater than expected retrogression downstream of the barrage had necessitated construction of a

subsidiary weir at 280 m downstream of the barrage to raise tail water level, reduce water head difference, and decrease erosion on the downstream river bed. Two irrigation canals, Muzaffargarh (235 m^3/s) and Taunsa – Panjnad (TP) Link (397 m^3/s), take water from left side of the barrage while the other two canals, Dera Ghazi Khan (410 m^3/s) and Kachhi (170 m^3/s), take water from right side of the barrage. The proposed Taunsa hydropower project is located on the right side, where there are D.G. Khan and Kachhi Canals off taking from this barrage across River Indus.

The highest monthly mean temperature of the project area is about 35.4 °C and the lowest monthly mean temperature is about 12.9 °C; the mean annual precipitation ranges from 1.2 mm to 49.6 mm and the annual mean precipitation is about 210 mm; the mean annual wind speed range from ranges 0.4 knots to 6.8 knots and the mean annual relative humidity ranges from 22.7% to 88.6%.

(1) Precipitation: The annual precipitation is between 1.2 mm to 49.6 mm, average annual precipitation is 210mm. The runoff of Indus River at Taunsa barrage is unevenly distributed in one year which mainly concentrates in July to September, accounting for 55% of annual rainfall. Winter rains generally occur during the months of January, February and March, whereas October, November and December are normally the months of least precipitation.

(2) Air temperature: The air temperature in summer is within the range of 30°C～35°C and the air temperature in winter is within the range of 12.9°C～14.8°C.

(3) Wind speed
The average annual wind speed is 0.4 knots to 6.8 knots.

(4) Humidity
Average annual relative humidity ranges from 22.7% to 88.6%.

According to the tests of the mineral composition of the suspended load done by Tianjin Geology and Mineral Resources Company, the result shows the suspended load contain 80% of quartz, 5.0% of plagioclase, 5.0% of calcspar, 6.4% of potassium feldspar, 2.0% of dolomite, and 1.6% TCCM (total content of clay mineral).

4.0 ENGINEERING GEOLOGY

Structures of the project are relatively concentrated, and their engineering geology conditions are almost the same, taking the powerhouse as an example, the geology at powerhouse area is as follows:

The powerhouse area is covered with Quaternary loose to medium dense deposits, comprising mainly of man-made fill, alluvial silty sand/sandy silt described as follows:

- Fill material mainly composed of fine sand and silty clay, with few gravels and fragments of brick and concrete 1 to 3 m thick, dominantly present on the embankments of Indus River and approach channel, and scatters at area between the approach channel and powerhouse.
- Silty clay/clayey silt light grey to dark brown, soft to firm, non-homogeneous with plant roots at the top, generally 1 to 4 m thick, at places up to 5 m thick.
- Silty sand/sandy silt, light grey to dark grey, fine to medium grained, moist to wet,

medium dense to dense more than 50 m thick as appeared in the borehole logs.

Groundwater at powerhouse area mainly includes pore water in Sandy silt of Quaternary loose to medium dense alluvial deposits. It is fed by Indus River, canal water and rainfall. The ground water level varies between 2.0 m to 6.0 m deep below the surface level.

Seismic liquefaction potential of sand material at the powerhouse foundation was identified and judged by relative density criterion, which indicates no liquefaction potential exists at the powerhouse foundation sands.

For stability analysis of side slopes, the shear strength is assumed to be c=12 kPa and angle of internal friction Φ=18° for silty clay; c=0 and Φ=30° for loose to slightly dense sand with traces of silt.

4.1 FLOOD DESCRIPTION

Taunsa Barrage was commissioned in March 1959 and rehabilitated with addition of a sub-weir downstream of the barrage in 2009. The barrage has a safe capacity and design capacity of 21,238 m^3/s and of 28,317 m^3/s, respectively.

Tarbela Dam was commissioned in 1976 almost 18 years after commissioning of Taunsa Barrage. Keeping in view the flood mitigation capacity of Tarbela Dam, the peaks for the post Tarbela duration i.e., since 1976, have been selected for flood frequency analysis at Taunsa Barrage. In a recent study of National Flood Protection Plan-IV, an effort has been made to estimate maximum discharge that can be passed through proposed breaching section whose location was recommended in flood fighting plan.

The 2010 flood event originated from extraordinary rainfall in Kabul and Swat catchments during monsoon season that resulted in exceptionally high flood peaks along Swat and Kabul Rivers. The catchments above Tarbela and Mangla were also contributed by the same storm event, resulting in high inflow peaks in their reservoirs. Ravi and Chenab Rivers remained calm during propagation of flood wave in Indus River.

River training works on each side of Indus River have been provided both upstream and downstream side of the barrage to properly guide the river, safe passage of the flood discharge and protection of the settlements.

The flood season ranges from May to September in each year. According to the Flood Fighting Plan of 2015, the ever recorded highest flood discharge approached at barrage, is 30,741 m^3/s in 2010, whereas, the lowest in record is 5,845 m^3/s in 2004.

4.2 HYDRAULIC MACHINERY, E&M EQUIPMENT AND STEEL WORKS

According to the varying water head of Taunsa Hydropower Plant, Double Regulatory Bulb Turbines are recommended, with rated water head of 5.8m. Nine (9) units are recommended with total installed capacity of 135 MW. The salient features of the Project and details of hydraulic machinery have been provided in Section 6(B), 6(C) and 6(D).

5.0 OPERATION OF BARRAGE DURING AND AFTER HYDROPOWER DEVELOPMENT

The safety and smooth operation of the Barrage and off-taking canals along with allied structures shall be ensured during the conjunctive operation of the Plant, Barrage, Canals and associated structures at all times. Functioning of existing Barrage shall not be disturbed and structure of the barrage and operations shall be protected for all civil, mechanical and electrical components. Any shortcoming and deficiencies reported/observed in civil, mechanical and electrical components of Barrage due to operation of the plant by the staff of Irrigation and Power Department, Government of Punjab. The reported short comings and deficiencies must be attended by the Project Company.

General Requirements

For the establishment and successful commencement of the Project, especially considering the safety of the Taunsa Barrage and allied Structures, certain general requirements needs to be met by the Sponsor/Bidder.

1. 01 No. Overhead gantry crane (outside) and 02 No. Overhead travelling cranes (inside) the powerhouse.
2. Pond level will be maintained according to irrigation requirements.
3. Minimum flushing discharge requirement for the barrage shall be based on historic flushing discharge through the barrage.
4. After detailed design, the bidder will have to perform the physical model testing at IRI to ensure the safety, respective flows of the Barrage and Canals and avoidance of Sedimentation in the Upstream of the Barrage (report of previous model test attached).
5. Compliance with the time schedules for achievement of the COD.
6. Confirmation of payment of Feasibility costs of CWE Feasibility as well as NESPAK's DDR & updated feasibility report in this regard.
7. Confirmation of the plant Construction, Equipment and Controls with the International Standards and/or those given in this RFP Document.

SECTION 6(B)
EMPLOYER'S REQUIREMENTS FOR CIVIL WORKS

1. SCOPE OF CIVIL WORKS AND SERVICES

1.1. GENERAL

The general description of the project is given in Section-6(A).

1.2. SCOPE OF CIVIL WORKS

Since the Project is to be developed in the IPP mode, therefore the major components of the civil works shall include but not be limited to the following:

1. Intake Structure and Diversion Arrangement
2. Provision of Log Booms at the start of power channel for diversion of heavy Trash
3. Headrace and Tailrace Channels
4. Powerhouse and ancillary works
5. Intake and Outlet Bays of Powerhouse
6. Power House access Bridge
7. Aqueducts for crossing of D.G. KHAN and KACHHI Canals across powerhouse
8. Railway Bridge and diversion works
9. Road Bridge and diversion works
10. Re-routing of Silt Ejector channel
11. Leading Cut for Tailrace Channel
12. Camp Office and Operating Facility
13. Any other major component which may be essential at detail design stage
14. Civil works for 132 kV Grid sub-Station
15. Ancillary and environmental works necessary for compliance of relevant laws
16. Temporary diversion arrangements for off-taking Canal(s) on right side of the Barrage (during construction)

The Bidder shall design the civil works, procure the necessary equipment and materials, construct, install, test, start-up and commission all the civil and electrical/mechanical components of the project as described in the Part-II. The civil works described herein including the electrical/mechanical works shall be performed by the Bidder,

The Bidder shall be responsible for all aspects of design and construction of the Project in accordance with the design criteria, standards and specifications furnished herein, and in accordance with additional and supplementary design criteria and specifications prepared by the Bidder and accepted by the Employer.

The scope of work to be carried out by the Bidder shall also include, but not limited to:

a. Preparation of all detailed design criteria, design analyses, design calculations
b. Model testing to ensure the detail design and sustainability of existing Irrigation system, its regime and to acquire NOC from Irrigation Department, Punjab.
c. Construction specifications, detailed construction drawings, Quality Control and Quality Assurance procedures and Environmental Management Plans necessary for the complete construction of the Project
d. Temporary and permanent access roads, cross drainage structures and infrastructure facilities
e. Layout plan of the Project including equipment layout in the powerhouse
f. Additional site investigations and laboratory testing needed to develop the detailed designs
g. Preparation of detailed construction drawings for civil works in coordination with E&M works
h. Telecommunication and e-mail facility
i. Quality Plan and Quality Assurance system
j. Preparation of Construction Programme and Method Statements
k. Construction of Civil Works
l. Fabrication, delivery to site, erection, dewatering pumps and other electrical and mechanical equipment
m. Operation and Maintenance (O & M) Manuals for operating the Powerhouse and allied facilities.

n. As-built drawings for records.
o. All temporary works required to construct the Project, including processing and concrete batching plant offices, field cabins and living accommodation for Bidder's staff and site laboratory buildings, steel fabrication workshop, maintenance workshops, storage facilities, first aid facilities and other utilities etc.

1.3. DESCRIPTION OF THE CIVIL WORKS

1.3.1. Construction of Headrace and Tailrace

I. The intake structure of the headrace channel should be bell-mouthed and should be designed in such a way that it should pass on or allow its design discharge with +20% allowance.
II. The intake structure and power channel shall be designed against the head water level of barrage pond, as defined by Irrigation Authorities for Kharif and Rabi season.
III. The power canal shall be designed with non-silting, non-scouring velocity (as defined in the feasibility study report approx 1.5 m/s (5.0 ft/sec)), to carry a maximum discharge of 3155.5 cumecs with an allowance of +20%.
IV. The power channel shall be lined with stone pitching/lining of suitable design according to International Standards and Specifications.
V. The rated discharge of the headrace and tailrace channel should be adequate for a power generation of 135 MW gross plus +20% additional operational generation capability.
VI. The Power Channel should be designed, constructed, maintained and operated in such a way that safety of the Barrage, Canals and associated irrigation regime should be ensured at all costs.
VII. The material used should be new and in accordance with the International Standards and Specifications.
VIII. The head loss in the power channel of the plant should be minimum (reference Table 6.3 of updated FS NESPAK).
IX. The provision of aqueducts shall not create any head loss, so that the operation of Canal is not to be affected in comparison to its historical flows.
X. It should be ensured that there is adequate Free Board above the Surge wave height at full load rejection so that there will be no overflowing of water in the Barrage and Power Channel upon the sudden shut down. The hydrology and hydrological conditions for the plant operation should be adopted in such a way that there should be a balance of excess energy produced, to that of reduced energy produced at low water levels than the designated water flows.
XI. The head loss due to provision of aqueducts for Kachhi Canal and DG Khan Canal should be optimized taking care of canal command (reference to Table 6.9 of Updated FS of NESPAK)
XII. Design and construction of Leading Cut from end of tailrace to join the active river creeks.

1.3.2. Power House

The power house shall be reinforced concrete structure and shall be of suitable size to accommodate 9 No. of Double Regulated Bulb Turbines, Generators and all other ancillary equipments required for the safe operation of the Plant. The Control room shall comprise the following, but not limited to:

- A sub-structure of reinforced concrete housing auxiliary rooms and the turbines and generators.
- A superstructure of reinforced concrete, above ground, comprising the machine hall, control room and operating facilities.

1.3.3. Railway Crossing

The existing railway line crossing shall have to be incorporated in the Plant structure acceptable to Pakistan's Railway Authorities and the same is required to be incorporated in consultation with Railway Authorities. During construction period unhindered Railway line operation shall be ensured.

1.3.4. Road Crossing

The existing road crossing shall have to be incorporated in the plant structure acceptable to the Provincial Highway Authorities with possible extension. During construction period unhindered road operation shall be ensured.

1.3.5. Aqueducts

The existing Head Regulators of Kachhi Canal and D.G. Khan Canal will not be disturbed, however, the Canals D/S to their Head Regulators will cross the power channel through aqueducts to be constructed on Draft Tube part of the power house, as indicated in the layout plan option no. 2 of NESPAK's updated feasibility study. Further, the design discharge capacity of the aqueducts will be same as of the head regulators and shall be designed in a way with minimum head loss of transitions etc., subject to approval of Irrigation Department, Punjab before implementation.

1.3.6. Trash Racks

The design of the Trash racks and its cleaning mechanism shall be in accordance with relevant Standards to ensure minimum head loss and to check the passing of anticipated trash.

1.3.7. 132 kV Grid Station

The civil structures in the Switch yard should conform to single line diagram provided in the NTDC load flow study in addition to provision of control building, communication equipment, SCADA provision and space for two number additional line bays for future extension.

1.3.8. Re-routing of Silt Ejectors

In the event any re-routing/modification is required in the existing Silt Ejectors, due to provision of Power Channel and Powerhouse then the same will be required, so as to ensure the safe operation of the Barrage, Canals and Power Channel.

1.3.9. Provision of Log Booms for Diversion of Heavy Trash

Provision of necessary Log Booms at intake of headrace channel for the heavy trash may be ensured for the safe operation of Powerhouse.

1.3.10. Security, Health and Safety

The Bidder will be responsible for the security, safety and health of the employees, during construction and operation stage in accordance with Laws and Regulations and relevant International Standards.

1.3.11. Quality Assurance/Quality Control

The Bidder shall implement quality assurance plan in accordance with the requirements of ISO 9001:2008 procedures.

1.3.12. Environmental Compliance

1.3.12.1. Environmental Compliance and Miscellaneous

The Successful Bidder will update the EIA Report at detailed design stage and will obtain the NOC from EPA for environmental compliance. The Sponsor during construction and operation will ensure compliance of the environmental laws and mitigation measures as defined in the EIA.

BASIC DESIGN REQUIREMNTS FOR CIVIL WORKS

1.4. GENERAL

Hydrological parameters include description of climatic conditions; mean monthly flows, local runoff conditions, local peak flood estimation and sedimentation conditions at proposed Taunsa Hydropower Project. This data is given in the Feasibility Report attached with the Bidding Documents / RFP and is provided for the information of the Bidder. Updated discharge and water level data is available in the feasibility studies.

All hydraulic and other reinforced concrete structures shall be designed in accordance with applicable Design Standards and Codes of Practice.

In general American Standards or equivalent shall be used, however where appropriate, British Standards as issued by BSI may be used. Care shall be taken not to mix the use of American and British Standards on any one structure. Where appropriate, local standards may be used in conjunction with American or British Standards, however care shall be taken to avoid conflicts generally and particular care of factors of safety and specifications of materials. It shall be made clear at the commencement of calculations for each structure, which standards are being adopted.

For bidding purposes American Standards shall be used however if any standard is not available for an item then comparable British Standards may be used on approval of Employer.

1.5. TOPOGRAPHIC and Geological SURVEY REQUIREMENTS

The Bidder shall verify the existing topographical and geological surveys provided in the already conducted Feasibility studies. The feasibility studies provided along with this RFP are for information and understanding the Project, to be undertaken by the Bidder. The Bidder will base their detailed design according to their own conducted above said studies and has to ensure the safe operation of the Project and all the associated Barrage and allied structures.

1.6. HYDRAULIC DESIGN CRITERIA

1.6.1. Headrace and Tailrace Canals

Headrace and Tailrace Channels shall be designed for a capacity of 3155 cumecs with an allowance of +20% as a bye pass arrangement on right side of the Barrage.

1.6.2. Hydraulic Parameters

The power house shall be designed for the following discharge.

- Rated discharge for power generation: 2589 m^3/s +20% allowance
- Maximum power canal discharge: 3155 m^3/s

The hydrological curve based on ten (10) daily flow data through the Barrage for the period of 1991 to 2014 is provided in the feasibility studies by NESPAK. However, the Sponsor will update the hydrology and relevant data at a detailed design stage to ensure its responsibility and requirement of the Project for 135 MW Capacity and estimated annual Energy.

The Bidder will provide the manufacturers Discharge Flow vs. Generated Energy conforming to available flows during the year and the discharge and generated values to be taken as guaranteed values for future dispatch of the plant.

1.6.3. Surge Wave Height and Freeboard

The surge wave height will be calculated for worst case scenario i.e. complete load rejection in most unfavorable time during peak flow season.
It should be ensured that there is adequate Freeboard above the Surge wave height at full load rejection so that there will be no overflowing of water in the Barrage and Power Channel upon the sudden shut down.

The hydraulic designs of Headrace and tailrace Channels along with other features shall also confirm to Punjab Irrigation Department Manual of Practices (MIP).

1.6.3.1. Tailwater Rating Curve

Tailwater rating curve will be established through analysis of gauge discharge data. The historical flow series of river at Taunsa shall be used.

1.6.4. Slope Protection

1.6.4.1. General

The stone protection for headrace and tailrace canal bank slopes will be designed against transverse forces due to the velocity and turbulence from current action.

1.7. GEOTECHNICAL DESIGN REQUIREMENTS

The following geotechnical information will be required for the design of Project structures.

1.7.1. Soil Classification

Classification of soil in field shall be carried out using ASTM D2488-00, "Practice for Description and Identification of Soils (Visual-Manual Procedure)" and in the laboratory using ASTM D2487-00, "Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)".

1.7.2. Grain Size Analysis of Foundation Material

The grain size distribution of foundation material is determined by undertaking sieve analysis of representative samples of foundation materials according to British Standard BS 1377:1975 "Methods of Testing Soils for Civil Engineering Purposes" - Test 7, or similar American or other recognized national standards.

1.7.3. Soil Permeability and Seepage Analysis

The coefficient of permeability, for subsurface flow analysis, will be determined through field testing in bore holes. These values will be evaluated, in the light of the estimated values reported in literature like "USBR", "Essentials of Soil Mechanics and Foundations by David F. Mcarthy" etc.

Seepage analysis will be carried out using the "SEEP/ W" software. Results shall be used for seepage control measures, reduce uplift pressure under the powerhouse structure and control exit gradients to avoid piping.

Permeability of soil along with the sub surface stratification will then be used for:

- Estimating the seepage flow under the structure and possible remedial measures

- Estimate the exit gradient at the downstream end of structure, and take measures to avoid piping and erosion
- Estimating the uplift pressures underneath the structure, particularly the powerhouse, and incorporating measures to reduce it

1.7.4. Compacted Fills

AASHTO Standards shall be used for compacted fills under and around the structures like powerhouse, headrace and tailrace embankments and cofferdams etc.

1.7.5. Typical Properties of Compacted Soils

1.7.6. Shear Strength of Soils

The values of shear strength parameters (cohesion and the angle of internal friction) will be determined by performing laboratory tests on selected soil samples obtained through undisturbed sampling methods. Adina boreholes shall be drilled to obtain undisturbed samples for performing laboratory tests, if deemed necessary.

1.7.7. General Design Requirements

a. The foundations must be safe against shear failure (generally known as bearing capacity failure).
b. The foundations must not undergo excessive settlements (both total and differential settlements).
c. The foundations must be placed at an adequate depth so as to be safe from surface erosion (caused by run-off and/or wind), scouring (surcharge loading from burial shall be ignored in these cases) and seasonal variations. The depth must be sufficient to avoid lateral squeezing of soil from underneath the foundations, provide adequate resistance to the horizontal forces, and must bear on a firm stratum of adequate bearing capacity (BC).
d. The effect of proximity of foundations to slopes or excavations should be considered
e. The foundations must be safe against deterioration caused by harmful salts (i.e. SO_4, Cl, etc.) present in the sub-soils and/or groundwater, and other environmental forces
f. The foundations should be built preferably with local materials, equipment and labour. The foundation must be environment friendly.
g. The foundations should be checked to ensure safety against overturning, sliding and uplift.
h. The effect of layered soils beneath and around proposed foundation will be given due considerations.
i. Target factor of safety for embankment slope are given below;

Condition	F.O.S
Upstream and downstream slope, Construction Conditions	F≥1.3
Upstream Slope subjected to instantaneous drawdown conditions	F≥1.2
Downstream slope-subjected to steady state seepage conditions	F≥1.5

1.7.7.1. Bearing Capacity of Shallow Foundations

Shallow foundations shall be designed considering ultimate bearing capacity, tolerable settlement and, where necessary, stability against overturning, uplift and sliding.

1.7.7.2. Shear Criterion for Bearing Capacity

The factors of safety given in Table on next page will be used to assess bearing capacity based on the shear criterion.

Table: Bearing Capacity F.O.S for Different Loading Conditions

Loading Condition	Acceptable minimum Factor of Safety for Spread Footing Bearing Capacity Calculations
Normal	3.0
Extreme	2.0

a. For concentric loading

Brinch Hansen's Bearing Capacity equation used widely in central Europe and adopted by Euro Code 7 (Geotechnics) will be utilized for ultimate bearing capacity analysis of shallow foundations for footings subjected to concentric loading with horizontal base and bearing on cohesionless soils.

b. For general loading conditions including eccentric foundations

For footings subjected to general loading (e.g. abutment walls, retaining walls etc.) with tilted base and close to slope, the Brinch Hansen's general bearing capacity equation will be used.

The other methods and documents that will be consulted for the evaluation of bearing capacity of shallow foundations shall include Meyerhof's method, Vesic method, "NAVFAC DM-7.02, Foundations and Earth structures", "Principles of Foundation Engineering, 6th Edition, Braja M. Das", Bearing Capacity of Soils by U.S. Army Corps of Engineers (EM 1110-1-1905), "Tomlinson M.J; "Foundation Design and Construction"; 6th Ed. 1996", and "Bowles J.E; "Foundation Analysis and Design"; 5th Ed. 1995".

1.7.7.3. Settlement Criterion for Allowable Bearing Pressure

Provisionally the settlement limits shall be as given in the following Table (adapted from Canadian Foundation Engineering Manual, 1985 and AASHTO, 1996):

Table Settlement Limits for Different Structures

Bridges and stop log openings (statically determinate structures)	$\delta/L < 1/200$
Piers with gates (sensitive structures)	$\delta/L < 1/750$
Retaining Walls	$\delta/L < 1/150$

Refer Feasibility Study for Design parameters of soil and foundations

a. **Plate Load Tests**

To estimate the modulus of sub-grade reaction and settlement of raft foundations of the powerhouse and other structures plate load tests will be carried out according to procedures given in ASTM D1194.

1.7.7.4. Seismic Earth Loadings

Stability under seismic loading on retaining walls shall be checked using the "Mononobe-Okabe Method" described in the "Stability Analysis of Concrete Structures by U.S. Army Corps of Engineers (EM 1110-2-2100), for computation of dynamic lateral soil pressures on lateral forces on retaining structures according to "NAVFAC DM-7.02, Foundations and Earth structures".

1.7.7.5. Seismic Water Loadings

Water that is above the ground surface and adjacent to, or surrounding a structure will increase the inertial forces acting on the structure during an earthquake. These hydrodynamic forces will be estimated using seismic coefficient method proposed by "Westergard" described in "Stability Analysis of Concrete Structures by U.S. Army Corps of Engineers (EM 1110-2-2100)" and "Gravity Dam Design by U.S. Army Corps of Engineers (EM 1110-2-2200)".

1.7.7.6. Design of Retaining Walls and Structures

In designing retaining walls, the following factors shall be considered:

- The earth pressure shall be assumed to extend to the base of the wall or, in the case of base with a "key", to the bottom of the key
- The effects of water pressure to half of the wall height on the retained side of the wall shall be considered, being the situation for rapid draw down during flood recession or canal dewatering
- Full uplift pressures shall be considered on the base of the wall
- The restraining effects of passive pressures at the toe of gravity and cantilever retaining walls founded below excavation level shall be ignored or reduced by a factor of 2 (this does not apply to cut off retaining walls). This is because passive pressure can be removed by excavation or scour at the toe. Passive pressures would also only be mobilized at large displacements which would not normally be expected to develop in these structures
- A minimum surcharge loading of 10kN/m2 shall be used on the ground surface above the wall
- In cohesive soils, a water filled tension crack with a depth of $2c/\gamma$ shall be assumed to exist for analysis
- Drainage by means of weep holes backed with filters to prevent loss of fines from the backfill material shall be provided to all retained walls
- The forces on the wall could include the following:
  - Weight of any supported structure: dead + live (for example, an aqueduct trough or bridge deck)
  - Weight of any soil above the base of the structure
  - Self weight of wall
  - Active soil pressure (including dry soil above the water table, saturated soil below the water table and water pressure)
  - Uplift pressures on the base
  - Lateral forces generated by earthquake, both in water and soil

Walls need to be checked for sliding, overturning, floatation of structure and over stressing of the soil foundation.

1.7.7.7. Coffer Dams

Coffer dams shall be designed and constructed such that they are stable for specified loading conditions during the works.

1.7.8. Dewatering of Areas to be excavated

- Dewatering shall be a continuous operation and interruption due to any reason shall not be permitted
- Ground water level in the excavation area should always remain adequately lower than the level of excavation at any time and finally during construction of the structure so that the concrete shall be laid in dry conditions.
- Due to breach of cofferdam or for other reasons the excavated area may be flooded. To avoid major damage to persons or partly completed works proper and immediate protective measures should be taken
- The dewatering shall be accomplished in a manner that will prevent loss of fines from the foundation and maintain stability of slopes to be excavated

1.7.9. Instrumentation

Instrumentation will be required to monitor settlement, displacement, pore water pressures and gradients under the structures. The following instruments are envisaged:

- Extensometers
- Leveling Pins
- Steel Plate
- Triaxial Joint Meter
- Piezometers
- Pressure Measuring Gauges
- V-Notch Weir

The Bidder has to select the best locations for installing the instruments before placement of concrete and covering the exposed areas.

1.8. STRUCTURAL DESIGN

1.8.1. General

Structural design of all structures shall be carried out in accordance with the following applicable design standards, codes of practice and guidelines listed in this section. In the event of conflict between the standards and guidelines, the most conservative of the standards or guidelines shall apply. In general American codes and standards shall be used. Where sufficient guidance is not available from American codes and standards, British Standards (BS) as issued by British Standards Institution (BSI) may be used. Care shall be taken not to mix the use of American and British standards on any one structure. Where appropriate, local standards may be used in conjunction with American or British standards, however, care shall be taken to avoid conflicts generally and particular care paid to the consistency of factors of safety and specifications of materials. British standards shall not be used for the design of highway bridges. It shall be made clear at the commencement of calculations for each structure, which standards are being adopted.

The parameters and design requirement specified herein shall be used to develop Design Briefs, Construction Drawings, Data and Construction Specifications to be submitted by the Bidder. These memoranda, drawings, data and specifications shall be developed from information provided by the Employer, additional studies and field investigations carried out

by the Bidder and other requirements of these Contract Documents. The Bidder shall be responsible for ascertaining the validity of all information made available by the Employer. The information provided by the Employer shall be considered minimum standards to which the work is to be designed. The Bidder shall use a more conservative approach to the design where in his professional judgment such is appropriate.

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 and in strict compliance with the criteria adopted for permanent works.

1.8.1.1. Compliance To Authorities

In addition to the Design requirements, the design shall also conform to the requirements of all relevant local, state and federal authorities where approvals for that section of works is needed from the relevant authorities.

1.8.1.2. Units Used for Design Calculations and Design

International System (SI) of units shall be used for structural analyses, calculations and design drawings.

1.8.1.3. Requirements for Designs and Calculations

Design calculations should be supplemented with narratives where required to support technical analyses. Each set of calculations should start with a summary sheet, which shows all assumptions, references applicable codes and standards, and lists the conclusions. Calculations should include engineering sketches to facilitate review. Calculations should contain references to code, paragraph of code used, standards, and text books used for specific portion of calculation. References to drawing numbers where the results of the calculations have been used should be contained in the calculations.

1.8.2. Referenced Design Standards and Codes of Practice

1.8.2.1. General Codes and Guidelines

The codes, standards and guidelines that are to be followed in general are listed below:

a. "Building Code Requirements for Reinforced Concrete (Metric Version)", ACI 318M 2008, American Concrete Institute (ACI), 2008
b. "Building Code Requirements for Reinforced Concrete (Metric Version) Commentary," ACI 318R-2008, American Concrete Institute, 2008
c. "Code Requirements for Environmental Engineering Concrete Structures (ACI 350M-06) and Commentary (Metric Version)," American Concrete Institute, 2006
d. "Building Code of Pakistan (BCP): Seismic Provisions," Ministry of Housing, Govt. of Pakistan, Islamabad, 2007
e. "Strength Design for Reinforced-Concrete Hydraulic Structures (Technical Engineering and Design Guides As Adapted from the U.S. Army Corps of Engineers (USACE) Engineering Memo EM 1110-2-2104, 1992), ASCE Press, 1993
f. "Engineering and Design - Planning and Design of Hydroelectric Power Plant Structures," US Army Corps of Engineers EM 1110-2-3001, October 2008
g. "AASHTO LRFD Bridge Design Specifications, SI Units, 4th Edition," American Association of State and Highway Transportation Officials, 2007
h. "Code of Practice Highway Bridges," Highway Department, Govt. of West Pakistan, Lahore, 1967
i. "Design and Construction of Bridges and Culverts," "Chief Engineer's Technical Memo No. 4 (Revised) Part-I, Public Works Department, Government of West Pakistan, Lahore
j. Design Guides RCC Bridges and Culverts, Central Design Office (CDO), Water and Power Development Authority (WAPDA), Publication No. 214, 1991
k. "Steel Construction Manual, 13th Edition," American Institute Of Steel Construction (AISC), 2006

l. "Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-05," American Society of Civil Engineers, 2005
m. "Wind Load Provisions of ASCE 07-2", American Society of Civil Engineers, 2002
n. Bridge Rules, Government of Pakistan, Ministry of Communications (Railway Wing)

1.8.2.2. Reinforced Concrete Design

In addition to the codes and guidelines listed above following guidelines and specifications may be also be adhered to for design of concrete structures:

a. "ACI Manual of Concrete Practice," American Concrete Institute, 2009
b. "Notes on ACI 318-2008 Building Code Requirements for Structural Concrete," Portland Cement Association (PCA), 2008
c. "Concrete Manual: A Manual for the Control of Concrete Construction," United States Department of the Interior, 2001
d. "ASTM A615 / A615M - 09b Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement", American Society for Testing Materials (ASTM)
e. "ASTM A185 / A185M - 07 Standard Specification for Steel Welded Wire Reinforcement," American Society for Testing Materials (ASTM)

1.8.2.3. Design of Retaining Structures

In addition to codes and guidelines listed n section 3.1.1, following guidelines may be followed for design of earth retaining structures:

a. "Retaining and Flood Walls," Technical Engineering and Design Guides As Adapted from the US Army Corps of Engineers, No 4, EM 1110-2-2502), American Society of Civil Engineers, 1993
b. "Design of Sheet Pile Walls," Technical Engineering and Design Guides as Adapted from the U.S. Army Corps of Engineers, No. 15, American Society of Civil Engineers, 1996

1.8.2.4. Seismic Design of Structures

In addition to codes and guidelines listed in section 3.1.1, following guidelines may be followed for seismic design of structures:

a. "Response Spectra and Seismic Analysis for Concrete Hydraulic Structures," US Army Corps of Engineers EM 1110-2-605, June 1999
b. "Engineering and Design - Earthquake Design and Evaluation of Concrete Hydraulic Structures," US Army Corps of Engineers EM 1110-2-6053, May 2007

1.8.2.5. Structural Steel Works

In addition to the codes and guidelines listed in section 2.4.2. above following guidelines and specifications may be also be adhered to for design of structural steel works:

a. "Specification for Structural Steel Buildings ANSI/AISC 360-05," American Institute Of Steel Construction (AISC), 2005
b. "ASTM A36 / A36M - 08 Standard Specification for Carbon Structural Steel,", American Society for Testing Materials (ASTM)
c. "ASTM A572 / A572M - 07 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steels," American Society for Testing Materials (ASTM)
d. "ASTM A242 / A242M - 04(2009) Standard Specification for High-Strength Low-Alloy Structural Steel," American Society for Testing Materials (ASTM)

1.8.3. Computer Software's

For the analysis and design of hydraulic structures and other ancillary structures following software's may be used:

a. SAP 2000, Computers and Structures Inc., Berkeley California, USA
b. ETABS, Computers and Structures Inc., Berkeley California, USA
c. SAFE, Computers and Structures Inc., Berkeley California, USA
d. CSICOL, Computers and Structures Inc., Berkeley California, USA
e. PROKON and GEAR computer software shall be used
f. Geo Studio, Geo-Slope International, Calgary, Alberta, Canada
g. Geo 5, GINT, Inc, Santa Rosa, California, USA

1.8.4. Design of Bridges

For the analysis and design of Road Bridges AAHSTO LRFD Bridge Design Specifications shall be used, whereas Railway Bridge, the main line loading as stipulated in "Bridge Rules", Government of Pakistan, Ministry of Communications (Railway Wing) shall be used.

1.8.5. Material Strengths

The following grades of concrete and reinforcement given in Table on next page shall be considered in designing concrete structures:

Type of structure	6 inch dia. cylinder strength at 28 days	Steel reinforcement
Powerhouse structure	28 MPa (4,000 psi)	Grade 60 ASTM A615
Retaining walls and floors on headrace and tailrace channels	28 MPa (4,000 psi)	Grade 60 ASTM A615
Road cum Railway Bridge and Access Bridge Piers Transum and Pile Cap	28 MPa (4,000 Psi) with top 0.3 m layer of 27.6 MPa (4,000 Psi)	Grade 60 ASTM A615
Approach slab, NJ Barrier, Walkways, Trenches etc.	21 MPa (3,000 psi)	Grade 60 ASTM A615
Piles	28 MPa (4,000 psi)	Grade 60 ASTM A615
Retaining Walls and floors of Aqueducts	28 MPa (4,000 psi)	Grade 60 ASTM A615
Prestressed Concrete Construction	35 Mpa (5,000 psi)	Prestressing Steel, Grade 270 A-416 ASTM Non prestressed Steel Grade 60 A615, ASTM
Blinding concrete	10 MPa (1000 psi)	Nil

- All reinforcement steel shall be deformed bars of Grade 60 and 40, having minimum yield strengths of 420 MPa 60,000 (psi) and 280 MPa (40,000 psi) respectively, as per ASTM A 615
- For gates, stop logs, hoist and other structural items including superstructures, the structural mild steel designated ASTM A36, ASTM A-242 or equivalent, shall be used
- The bricks shall have a minimum crushing strength of 2,000 psi, (14 MPa) when tested flat as per ASTM C-67

1.8.6. Aggregates

The concrete aggregates shall be of a quality as provided in the USBR "Concrete Manual" with the following maximum sizes:

- Mass concrete 75 mm
- Plain and reinforced cast-in-situ concrete 40 mm
- Precast members 25 mm

1.8.7. Design Loadings

Structures shall be designed to resist all dead and live loads, temperature effects, hydrostatic loads and earth pressures. The dead loads consist of the actual weight of the structure plus any permanent superimposed loads. The live loads consist of temporary imposed loads, wind, earthquake, water and loads imposed during construction. Earthquake loads intensities are to be considered with the Peak Ground Acceleration (PGA) as per Pakistan Building Code (Seismic Provision-2007). Where elements could be pre-cast, lifting forces shall be considered and lifting points and / or methods indicated.

1.8.7.1. Categories of Loading Conditions

The loads acting on structures may be classified as follows based on their probability of occurrence and the duration for which they may be expected to occur:

Normal Loading: Normal loads are those loads which have a reasonable probability of occurring simultaneously, and where the various canals, river, tail water, and ground water levels are likely to persist for extended periods of time.

Unusual Loading: Unusual loads and loading conditions are those that rnay occur from time to time during the life of the structure but not for prolonged duration of time. Under this loading condition the temporary effects of earthquake forces or maximum design wind loading are combined with normal loads or high flood condition is combined with normal loads. It is common accepted practice not to combine two exceptional loadings, for example, Design Basis Earthquake should not be combined with High Flood Level Loading. Similarly, Design Basis Earthquake Loading should not be combined with Maximum Design Wind Loading.

The powerhouse units shall also be checked for partially completed units with headrace/tailrace water and for hydraulic force, on the structure due to electrical tripping of units. The headrace/tailrace retaining walls and floor shall also be designed for differential hydraulic loads due to sudden drawdown of water.

Extreme Loading: Extreme loads are those combinations expected to be very rare occurrences with very low probability of occurrence such as those involving Maximum Credible Earthquake or Probable Maximum Flood.

1.8.7.2. Dead Loads

The dead loads consist of self weight of structure and permanent superimposed loads. The unit weights of various materials for computing dead loads are given in Table below:

Material Type	Unit Weight	
	(KN/m^3)	(lb/ft^3)
Reinforced Concrete	24.0	150
Plain Concrete	23.0	144
Stone masonry	23.0	140
Water	9.8	62.4
Brick masonry	19.0	120

Material Type	Unit Weight	
	(KN/m^3)	(lb/ft^3)
Dry earth	16.0	100
Compacted earth	18.0	120
Saturated earth	21.0	135
Steel	77.0	490
Bitumen	13.7	87
Cement	14.1	90
Timber – Hard	7.1 – 12.6	45 – 80
Timber – Soft	4.7 – 7.1	30 - 45

1.8.7.3. Live Loads

The live loads are for roofs, beams and floors of the power house machine hall, service bay etc. and for the structural elements of staff residential buildings. The unit loads of various components of a building for computing live loads are given in the Table: The live loading intensities for structural design shall be in accordance with ASCE/SEI 7-05, 2005.

Hydropower structures may be subjected to loading intensities much in excess of ordinary buildings. These high loads may arise from high load of electro-mechanical equipment or loads imposed by cranes. Such unusual loads shall be taken into account by seeking information from suppliers of electro-mechanical equipment. Guidance regarding loading intensities to adopt may be taken from USACE EM 1110-2-3001, October 2008.

Some recommended live load intensities from the above referred sources are listed in Table below for illustrative purpose:

Buildings	(KN/m^2)	(lb/ft^2)
Floor (Residential)	1.90	40
Roof (Residential)	0.95	20
Floor (Office)	3.80	80
Roof (Office)	1.90	40
Verandah, Balcony	3.80	80
Stairs, landings	4.80	100
Gantry deck (outdoor powerhouse)	14.4	300
Transformer deck	14.4	300
Draft tube deck	14.4	300

1.8.7.4. Wind Loads

Wind pressure will be applied to the exposed area of all structures in accordance with Wind Load Provisions of ASCE 07-2, 2002, for a maximum wind velocity of 160 km/hr (100 mph) acting horizontally in any direction.

1.8.7.5. Earthquake Load

The powerhouse and ancillary structures shall be designed for Design Basis Earthquake (DBE) that corresponds to an earthquake that has a ten percent (10%) probability of exceedance in 50 years, which is equivalent to an earthquake with a Return Period of 475 years.

The earthquake loading for Taunsa hydropower project will be selected according to the new Building Code of Pakistan (Seismic Provisions - 2007).

The powerhouse structure shall be designed using the Response Spectrum Method. These structures shall be so designed that no damage occurs as a result of Design Basis Earthquake. This may be accomplished by adopting a Response Modification Factor equal to 1.0, in the analyses and designs.

The ancillary buildings may be designed using the Static Force Procedure outlined in Building Code of Pakistan. For ancillary buildings, Response Modification Factors may be taken as those specified in the Building Code of Pakistan.

The design of retaining structures is usually carried out using Psuedostatic Seismic Coefficients. Psuedostatic Seismic Coefficients that may be adopted for design of retaining structures and for stability analyses of structures are also listed in table on previous page.

1.8.7.6. Hydrodynamic Forces

The hydrodynamic pressures and forces that would act upon structures under earthquake conditions shall be computed using the Westergaard Parabola Method.

1.8.7.7. Water Pressure at Piers

The effect of the stream flow on piers shall be calculated as per AASHTO LRFD Code for Bridges.

1.8.7.8. Uplift Pressures

For most hydraulic structures founded on soil, uplift is assumed to vary from headwater to tailwater using the line of seepage method. This method of determining uplift pressure variation along the base of structures is considered to be acceptable. For refined analyses, flow net method may be used to determine uplift pressures. Stability of machine hall raft against floatation shall be determined without taking into account weight of turbines and other mechanical and electrical (E&M) equipment.

1.8.7.9. Earth Pressures

Lateral earth pressures due to backfill under static conditions may be computed by the Coulomb's Method, taking into account the effects of any soil saturation or submergence. A surcharge of 975 kg/m^2 (200 lb/ft^2) will be added for computing earth pressure for small height walls.

The earth pressures behind retaining walls shall be determined taking into account the possibility of development of active pressures behind the walls and at-rest pressure for powerhouse walls. For estimating earthquake induced pressures behind retaining walls Monanobe-Okabe Theory may be used. In general, the retaining structures shall be designed using the guidelines and procedures in EM 1110-2-2502.

For determining the forces and pressures acting on sheet pile walls guidelines and procedures given in USACE EM 1110-2-2504 should be used.

1.8.7.10. Special Loadings

Crane loading: Crane load must include the weight of the crane bridge, the trolley and the dynamic effect of the braking in addition to the maximum carrying capacity of the crane. Manufacturer supplied information regarding these parameters may be used in the designs and analyses. The maximum capacity of the crane hook can also be determined from the weight of the heaviest part to be lifted.

For cranes used for lifting stop-logs and gates, the possibility of a stop-log and the gate getting stuck and resulting in overloading of the crane and supporting structures shall be considered in the design.

The wheel loads of cranes and other moving equipment shall be considered and analyzed as a moving load for maximum effects.

Impact loading: This shall include impact loads associated with vehicular loading and crane loading.

Hydraulic thrust on turbine runner: This shall also be considered in the stability analysis of the powerhouse and the design of turbine foundations.

Forces on generator during normal operation: The generator foundations shall be designed for generator dead load, load due to inertia and forces due to electromagnetic effects under normal operation of the generator.

Short circuit torque of the generator torque: This shall also be considered while designing the generator foundations as these forces can be significantly larger than the forces under normal operation of the generator.

Resonance effects of electromechanical equipment: The rotating turbine and generator components can excite the foundations of these machines and result in undesirable vibrations. The foundations of these machines shall be so designed to preclude any possibility of undesirable vibrations.

1.8.8. Load Factors and Combinations For Design and Analysis

For non hydraulic structures, load factors and combinations specified in ACI-318 may be used for design and analysis. For hydraulic structures, same may be used with the modifications recommended by USACE EM-1110-2-2104 summarized as under:

- The load factor for lateral fluid pressure, F, should be taken as 1.7 instead of the value prescribed by ACI-318
- The factored load combination for total factored design load, U, prescribed in ACI-318 shall be increased by multiplying it with Hydraulic Factor Hf = 1.3, except for members in shear.
- For members in direct tension, Hydraulic Factor Hf = 1.65
- For the load cases involving design wind or Earthquake, the design load combination shall be:

$$U = H_f (0.75\, U_{W \text{ or } E})$$

Where,

$U_{W \text{ or } E}$ = Non-hydraulic factored loads including wind or earthquake effects

Hf is the Hydraulic Factor for control of cracking taken as 1.3 and Hft is the Hydraulic Factor in Tension taken as 1.65.

1.8.9. Serviceability Requirements

The designs shall ensure that undesirable deflections and cracking do not occur. For this purpose the serviceability requirements of ACI-318, ACI-350 and USACE EM 1110-2-2104, 1992 shall be adopted.

1.8.10. Stability Analyses and Criteria

Stability analysis will be carried out for structures for most severe conditions of horizontal and vertical forces. Stability criteria are aimed at ensuring the overall safety of structure against overturning and sliding in accordance with Geotechnical Design Requirements. Strength and adequacy of structural members shall satisfy the same design assumptions, with appropriate

load factors applied. For structures which will be subjected to water loads, the additional hydrodynamic forces which would be caused by earthquake acceleration shall be included. Loads shall be assumed to act either singly or in combination to give the worst effect.

Stability criteria for the gravity structures are established for the following loading conditions:

1.8.10.1. Loading Conditions

The following cases will comprise the loading combinations:

Load Case		Description	Load Category
Case 1	Construction	- Structure Completed - No headwater and tailwater	Unusual
Case 2	Normal Operation	Normal headwater + highest tail water + service loads	Usual
Case 3	Inspection and Maintenance	One regulator bay empty, Otherwise as in Case 2	Unusual
Case 4	Emergency	Full headwater, no tail water	Unusual
Case 5	Earthquake	As in case 2 + seismic loads	Unusual

1.8.10.2. Safety Factors

Stability safety factors for the structures shall not be less than the values shown in Table below:

Table: Stability Safety Factors for the Structures

Loading Category	Resultant Location	Minimum Sliding FS	Foundation Bearing Pressure
Usual	Middle 1/3	2.0	≤ allowable
Unusual	Middle 1/2	1.7	≤ allowable
Extreme	Within Base	1.3	≤ 1.33 ´ allowable

1.8.10.3. Maximum and Minimum Spacing for Steel Reinforcement

The information provided shall be considered as minimum requirements for the works

Minimum: The clear distance between parallel bars should not be less than 1.5 times the nominal diameter of the bar nor less than 1.5 times the size of maximum coarse aggregate. Bar ϕ43 (#14) and ϕ57 (# 18) should not be spaced centre-to-centre closer than 150 mm (6 in.) and 200 mm (8 in.), respectively. When parallel reinforcement is placed in two layers, the clear distance between layers should not be less than 25 mm (1 in.) In horizontal layers, the bars in the upper layers should be placed directly over the bars in the lower layers. In vertical layers, a similar orientation should be used. In construction of mass reinforced concrete structures, bars in a layer should be spaced 300 mm (12 in.), centre-to-centre, where possible to facilitate construction.

Maximum: The maximum centre-to-centre spacing of both primary and secondary reinforcement should not exceed 450 mm (18 in.).

1.8.10.4. Concrete Protection for Reinforcement

The minimum cover for reinforcement should conform to the dimensions given in the following for various concrete sections. The dimensions indicate the clear distance from the edge of reinforcement to the surface of the concrete.

Concrete Element	Minimum Concrete Cover	
	(mm)	(in.)
Formed surface in contact with foundation	75	3
Unformed surface in contact with foundation	100	4
Retaining walls exposed to earth and water	50	2"
RC walls not exposed to water	(In accordance with ACI 318)	
Beam, girder, column and wall – dry condition	40	1.5
Beam, girder, column and pier – exposed to water and weather	50	2
Slabs – not exposed (dry condition)	19	0.75

The information provided shall be considered as minimum requirements for the works.

1.8.10.5. Splice and Development Length

Splicing: Bars shall be spliced only as required and it is better that splices shall be indicated on the drawings. Splices at points of maximum tensile stress should be avoided. Where such splices must be made these should be staggered. Splices may be made by lapping of bars or butt welded splicing. Lapped splices are made in up to and including bar ϕ36 (# 11), whereas, butt welded splices are made for bars larger than ϕ36 (#11). The minimum splices/development length required shall be based on ACI-318.

The bar couples can also be used with the approval of the Engineer.

The information provided shall be considered as minimum requirements for the works

1.8.10.6. Minimum Reinforcement (or Temperature Shrinkage Reinforcement)

A minimum area of reinforcement is required to control the cracking, which occurs in the concrete due to temperature, shrinkage and creep. It enables cracking to be uniformly distributed and, therefore, minimizes individual crack width.

The temperature and shrinkage reinforcement requirements shall be in accordance with USACE EM 1110-2-2104, 1992. In general the area of temperature and shrinkage reinforcement should be 0.0028 times the gross-sectional area, half in each face, with a maximum area equivalent to ϕ29 @ 300mm (#9@12") in each face. Generally, temperature and shrinkage reinforcement for thin sections shall not be less than ϕ13@300mm (#4@12") in each face. . Where the thickness of the section exceeds 380 mm (15 in.), a thickness of 380 mm (15 in.) should be used in determining the temperature or minimum reinforcement. For concrete gravity structures like piers, divide walls, abutments etc. minimum temperature reinforcement may be provided with area equivalent to ϕ29@300mm (#9@12") or, ϕ19@125mm (#6@5") in each face.

The information provided shall be considered as minimum requirements for the works.

1.8.10.7. Hooks and Bends

The standard dimensions and bend radii for hooks shall be in accordance with ACI-318 code.

1.8.11. Minimum Member Thickness

Walls with height greater than 3m (10 ft.) shall be a minimum of 300 mm (12 in.) thick and shall contain reinforcement in both ways. Walls and slabs of rigid frame construction generally

will have a minimum of 300 mm (12 in.) thickness; however, normally a 500 mm (20 in.) minimum thickness shall be used.

1.8.12. Concrete Joints

There are four types of joints (construction, contraction, expansion and control) are generally used in concrete construction. One joint may be combination of the two or more of these types. The joints for the structures which are subjected to internal and external hydrostatic pressure (uplift) shall be provided with rubber or polyvinyl chloride (PVC) water stop of suitable sizes.

1.8.12.1. Construction Joints

These shall be provided where necessary for the practical placing of concrete. They shall usually, but not necessarily, be vertical or approximately horizontal. Vertical construction joints shall be kept to a practicable minimum. The reinforcement steel shall be continued across the construction joint. Unless required to resist heavy shear caused by lateral loads, keys shall not be placed in construction joints. Where necessary to ensure water tightness in construction joint, water stop shall be provided. Construction joints may be used to avoid corner cracks due to settlement of fresh concrete at the sides of wall openings or at the junction of walls and slabs.

1.8.12.2. Contraction Joint

These shall be used to relieve tensile stresses induced in the concrete by shrinkage. Contraction joints differ from construction joints since means are used in the former case to prevent bond between the joint faces, and the reinforcement does not cross the joint face. Concrete on one side of the joint is cast first, and after the form is removed from the joint face, the joint is painted with suitable compound to prevent bond with the concrete placed against it. Water stop shall be placed in contraction joints to provide water tightness, where necessary. Contraction joints also serve as construction joints.

1.8.12.3. Expansion Joints

These are used to eliminate or reduce compressive stresses that would otherwise result from thermal expansion, creep, or settlement of the concrete. Expansion joints usually are either 25 mm (1 in.) or 20 mm (3/4 in.) and the space is filled with elastic joint filler. Water stop shall be placed in expansion joints to provide water tightness, where necessary. Expansion joints also serve as construction joints to take up rotation and displacement.

1.8.12.4. Control Joints

These joints consist of weakened places where cracks, if any, will occur and are provided in concrete walls to prevent unsightly random cracking. Control joints will be positioned at points of reduced shear and bending moment. Reinforcement running perpendicular to the joint will be reduced by 50% at the joint, subject to stress requirements. A crack will be induced by forming a rebate of 40 mm (3/4 in.) wide and 13 mm (1/2 in.) deep on each exposed face; this rebate will be sealed with joints sealant.

1.8.13. Water Stops

Water stops in joints shall be of polyvinyl chloride (PVC) of type and sizes manufactured by the approved concerns. Sizes of water-stops for various types of joints will be as indicated below:

Table Size of Water Stop with respect of Type of Joint

Sr. No.	Type of Joints	Size of Water Stops
i	Construction (Water-stops to be provided only as specifically directed)	225 mm (9 in.), 2-bulbs
ii	Contraction Less than 400 mm concrete thickness 400 mm or greater concrete thickness	 225 mm (9 in.), 2-bulbs 225 mm (9 in.), 3-bulbs
Where reinforcement is continued through an expansion or contraction joint, it shall be de bonded as for a contraction joint and caps provided over the free ends to allow movement.		
iii	Expansion Less than 13 mm joint width 25 mm joint width with concrete thickness less than 400 mm. With concrete thickness 400 mm or more	 150 mm (6 in.), 3-bulbs 150 mm (6 in.), 3-bulbs 225 mm (9 in.), 3-bulbs

For high head of water, rubber waterstops shall be used.

2. BID SUBMISSIONS

2.1. GENERAL

The following documents are to be submitted with the bid for the purpose of evaluation.

a. Completely filled schedules and data sheets for E&M equipment
b. Letter of Technical Bid along with schedules
c. Complete list of any technical or commercial deviations
d. Comprehensive list of drawings to be submitted by the Bidder during Detailed Engineering
e. Outline test and commissioning plan for tests on completion
f. Technical specification
g. Hydraulic design and head loss calculations
h. Power and energy studies
i. Bid design covering basic feature of Civil and E&M works
j. Bid drawings for Civil and E&M works

2.2. BID DESIGN

The Bidder shall submit as a minimum to define its offer, the Bid Drawings, Bid Design Criteria, Data and Design Briefs and Construction Specifications. The Design Briefs shall be intended to represent the type and quantity of information required to evaluate the Bids and to highlight:

a. Design parameters and methodology
b. Design criteria and
c. Operating characteristics of the Project and its component parts.

2.3. BID DRAWINGS CIVIL

As a minimum the following drawings should be necessary to define the project civil works:

a.	General	Site layout
b.	General	Project plans
c.	General	Project elevations and sections
d.	General	Details of any proposed site investigations or exploration undertaken by Bidder
e.	General	Borehole logs of any drill hole by Bidder
f.	General	Location quarries, borrow areas and construction

		infrastructure
g.	General	Site roads
h.	Powerhouse	General plan
i.	Powerhouse	Excavation
j.	Powerhouse	Plan and section
k.	Powerhouse	Details
l.	Aqueducts	Plans and sections
m.	Intake, HRC and TRC	Plans and Sections
n.	Railway and Road Bridges	Plans and Sections
o.	Diversion Works	Plans and Sections
p.	Leading Cut	Plans and Sections
q.	Switchyard	Plan and sections
r.	Building/infrastructures	General plan
s.	Building/infrastructures	Details

3. SPECIFICATIONS

3.1. CIVIL WORKS

3.1.1. Referenced Documents

The design shall be based on the applicable portions of the codes, standards, methodology and publications stated below. The latest issues shall apply, and equivalent standards from other authorities may be used where demonstrably equivalent. In the event of conflict, the most conservative standards shall apply:

- "Standard Specification for Highway Bridges" - American Association of State Highway and Transportation Officials
- "New Standard Wind Load Requirements" - by J. P. Thompson, ENR, February 14, 1957
- "Analysis and Design of Small Reinforced Concrete Buildings for Earthquake Forces" - Published by Portland Cement Association
- "Uniform Building Code" - International Conference of Building Officials
- "Hydraulic Design of Reservoir Outlet Structures" - COE Publication No. EM-1110-2-1602
- "Structural Design of Spillways and Outlet Works" - COE Publication No. EM-1110-2-2-2400
- "Guidelines for the Design and Construction of Small Embankment Dams." Division of Safety of Dams, California Department of Water Resources
- American Society for Testing and Materials (ASTM) Section 4, Volumes 4.02 and 4.08 for Concrete, Soil and Rock Materials
- "Earth Manual", United States Department of Interior, Bureau of Reclamation (USBR)
- Seepage Analysis and Control for Dams, Engineer Manual EM 1110-2-1901, US Corps of Engineers
- Embankment Dams, Granular Filters and Drains, Bulletin 95, ICOLD 1994
- Other local codes and standards that are equivalent or superior to the codes and standards listed above
- Department of the Army, Corps of Engineers, Engineering Manual EM 1110-2-1902, "Engineering and Design, Stability of Earth and Rockfill Dams" April, 1970
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- Chief Engineer's Technical Memo No. 4 (Revised) Part-I, 'Design and Construction of Bridges and Culverts', Public Works Department, Government of West Pakistan, Lahore
- Standard Specification for Highway Bridges, 1995', the American Association of State Highway and Transportation Officials, (AASHTO)
- Code of Practice - Highway Bridge', 1967, Highway Department, Government of West Pakistan
- Design Guides RCC Bridges and Culverts, CDO (WAPDA, Water) Publication No. 2.14, 1991

3.1.2. Basic Design

Materials Concrete works

- Portland Cement Type I complying with ASTM C 150. Portland Cement Type III may be used when high early strength is required (in foundation). The total Alkali content in the mix shall be less than 3.2 kg/m3.
- Micro silica may be included in the mix for improvement of pumpability and more cohesive consistency. (Maximum 12 % of cement weight).
- The aggregate shall be tested for ASR permissible value. Low alkali cement shall be used to bring the ASR with in permissible limits.
- When sulphate content in ground water exceeds 150 ppm, achieve sulphate resistance by the use of micro silica (minimum 5 percent of the cement weight) and a low ratio (≤ 0.45) of: (water)/(cement and silica). The amount of water in the concrete includes added water, sand moisture and water from additives, silica slurry etc.
- The aggregate shall be a well grained as per specification described in this section.
- Use admixtures in accordance with ASTM C 1141.
- Accelerating admixture should not contain water-soluble chlorides or materials corrosive to steel. The accelerator shall not contain Alkali, unless otherwise accepted in writing by

the Employer. Setting accelerators shall be a certified product supplied by an approved Supplier.

3.1.2.1. Scope

Coverage

This contains requirements for:

- manufacture, transportation, placement, finishing, repair and curing of concrete
- supply and placing of reinforcement
- formwork
- joints, joint materials, joint treatment and bearing pads
- all other work associated with cast-in-place and pre-cast concrete

3.1.2.2. Reference Standards

Standards referred to in this Chapter are listed below with their serial designation and are declared to be a part of this specification unless stated otherwise. Work shall be performed in accordance with the reference standards. The Bidder shall maintain one(1) copy of latest revision of each document at site.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M 307	Standard Specification for Micro-silica for use in Concrete and Mortar

American Concrete Institute (ACI)

ACI 207.1 R	Mass Concrete
ACI 211	Standard Practice for Selecting Proportions for Normal, Heavyweight and .Mass Concrete
ACI 301	Standard Specification for Structural Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R	Hot Weather Concreting

American Society for Testing and Materials (ASTM)

ASTM A 82	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184M	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 572	Standard Specification for material of Cut offs
ASTM C 29	Standard Test Method for Unit Weight and Voids in Aggregate
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates.
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete specimens
ASTM C 40	Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
	Standard Test method for Soundness of Aggregates By Use Of

ASTM C 88	Sodium Sulfate or Magnesium Sulfate
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 117	Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates By Washing
ASTM C 125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C 127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate By Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Standard method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete
ASTM C 142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143	Standard Test Method for Slump of Portland Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 151	Standard Test Method for Autoclave Expansion of Portland Cement
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	Standard Method Of Sampling Freshly Mixed Concrete
ASTM C 173	Standard Test Method for Air Content of Freshly Mixed Concrete By the Volumetric Method
ASTM C 186	Standard Test Method for Heat of Hydration of Hydraulic Cement
ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 227	Standard Test Method for Potential Alkali Reactivity of Cement Aggregate Combinations (Mortar-Bar Method)
ASTM C 231	Standard Test Method for Air Content Of Freshly Mixed Concrete By the Pressure Method
ASTM C 260	Standard Specification for Air Entraining Admixtures for Concrete
ASTM C 289	Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
ASTM C 309	Standard Specification for Liquid Membrane-Forming .Compounds for Curing Concrete
ASTM C 441	Standard Test Method for Effectiveness Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 566	Standard Test Method for Total Moisture Content Of Aggregate By Drying
ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 617	Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C 618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM D 75	Standard Practice for Sampling Aggregates

British Standards Institution (BS)

- BS 812 Testing Aggregates Part 105. Methods for Determination of Particle Shape Flakiness Index
- BS 812 Testing Aggregates Part 117. Methods for Determination of Water Soluble Chloride Salts
- BS 812 Testing Aggregates Part 118. Methods for Determination of Sulphate Content
- BS 4871 Approval Testing of Welders Working to Approval Welding Procedures
- BS 5135 Metal-arc Welding of Carbon and Carbon Manganese Steel

3.1.3. Aggregate

Aggregates shall comply with the requirements stated in table 5.1 and 5.2 below.

Table 5.1 Fine Aggregates

Requirement for:	Limitation	Test
Organic Impurities	Not darker than standard	ASTM C 40
Material Finer than 0.075 mm	Max. 5% by weight	ASTM C117
Aggregate Size	Mix design requirement	ASTM C136
Clay Lumps and Friable Particles	Max. 3% by weight	ASTM C142
Alkali Reaction	Within innocuous limit of graph in figure X1.1	ASTM C289
Sodium Sulfate Soundness	Max. 10%	ASTM C88
Magnesium Sulfate Soundness	Max. 15%	ASTM C88
Specific Gravity	Min. 2.3	ASTM C128
Water Absorption	Max. 3%	ASTM C l28
Water soluble chloride salts	To be part of overall limit of 0.15% by weight of cement	BS 812. Part 117
Sulfate content	To be part of overall limit of 4% by weight of cement	BS 812. Part 118

Table 5.2 Coarse Aggregates

Requirement for:	Limitation	Test
Material Finer than 0.075mm	Max. 1% by weight	ASTM C117
Aggregate Size	Mix design requirement	ASTM C136
Clay Lumps and Friable Particles	Max. 5% by weight	ASTM C142
Alkali Reaction	Within innocuous limit of graph in figure X 1.1	ASTM C289
Sodium Sulfate Soundness	Max. 12%	ASTM C88
Magnesium Sulfate Soundness	Max. 18%	ASTM C88
Specific Gravity	Min. 2.3	ASTM C128
Particle Shape	Flakiness Index less than 40	BS 812 section 105.1
Abrasion Loss, Dry and Saturated	Max. 50 % Max 30 % for Concrete Class E	ASTM C131
Water Soluble Chloride Salts	To be part of overall limit of 0.15% by weight of cement	BS 812. Part 117
Sulfate Content	To be part of overall limit of 4% by weight of cement	BS 812. Part 118

Aggregates shall be stored in accordance with ACI 304R. Aggregates from stockpiles shall be arranged and used in a manner to avoid excessive segregation and prevent contamination with other materials or sizes of aggregates.

Aggregates may be cooled by the methods stated in ACI 305R. Allow for variations in surface moisture by making adjustments to the mixing water quantities at the batching plant. Alternatively, aggregate may be cooled by the use of liquid nitrogen prior to their entering the mixture.

3.1.4. Architectural Works

3.1.4.1. Scope

a. Coverage

This contains requirements for building works, architectural works and finishes for all Permanent Works.

The work to be performed will include but shall not be limited to:

- Construction of concrete-block walls
- Carpentry and joinery
- Doors, windows and internal partitions, frames and furniture
- Glass and glazing
- Caulking
- Internal floor, wall and ceiling finishes including terrazzo, ceramic tiles, acoustical tiles, vinyl tiles, plastering, rendering and suspended ceilings
- Roofing system
- Painting of internal walls and ceilings
- Schedule of finishes will be prepared by the Bidder and approved by the Employer and will be generally in accordance with the room finishing schedules shown in the Drawings.

b. Reference Standards

Standards referred to in this Chapter are listed below with their serial designation and are declared to be a part of this specification unless stated otherwise; Work shall be performed in accordance with the reference standards. The Bidder shall maintain one copy of the latest revision of each document at Site.

American Society for Testing and Materials (ASTM)

ASTM A 167	Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet And Strip Low-Carbon Steel Externally And Internally Threaded Standard Fasteners
ASTM A 307	Standard Specification for Quicklime for Structural Purposes
ASTM C 5	Standard Specification for Gypsum Plaster
ASTM C 28	Standard Specification for Building Brick (Solid Masonry Units Made From Clay Or Shale)
ASTM C 62	Standard Specification for Load-Bearing Concrete Masonry Units
ASTM C 90	Standard Specification for Aggregate for Masonry Mortar
ASTM C 144	Standard Specification for Portland Cement
ASTM C 150	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 207	Standard Test Method for Drying Shrinkage Of Concrete Masonry
ASTM C 426	Standard Specification for Grout for Masonry
ASTM C 476	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 578	Standard Specification for The Manufacture, Performance And Testing Of Metal Suspension Systems for Acoustical Tile And Lay-In Panel Ceilings
ASTM C 635	Standard Specification for Installation Of Metal Ceiling Suspension
ASTM C 636	Systems for Acoustical Tile And Lay-In Panel Ceilings

ASTM D 226	Standard Specification for Roofing Felt
ASTM D 312	Standard Specification for Roofing Asphalt

3.2. USE OF SITE

3.2.1. Setting Out of Site Installation

Setting out of site installation shall be carried out in accordance with the approved drawings.

Should in any instance discrepancies occur between the drawings and the actual conditions at site (topography, geology, etc.) the Bidder shall immediately notify the Employer's Representative and prepare an alternate proposal.

3.2.2. Regular Maintenance and Cleaning of Site Installation

During the entire construction period and until the end of the Project, the Bidder has to clear the site. The Bidder shall provide a daily refuse collection and disposal service including loading, transportation and dumping at areas, where prior permission from the concerned authority has been obtained, in order to keep the site in a proper, clean and safe condition.

3.2.3. Temporary Access

The construction and maintenance of temporary access roads from public roads to the site (including crossings) as well as temporary roads within the site boundaries and permanent site roads used as temporary access shall be included in the site installation. The Bidder shall undertake proper maintenance of all roads being used by the Bidder during the entire construction period, both permanent and existing roads, as well as all temporary roads.

Maintenance and cleaning of all roads used during construction to minimize danger enhance use and reduce breakdown, including existing public roads, and bridges, shall be performed promptly by the Bidder, upon notification by the Employer, and shall include removal of slides, road surface repair and drainage system cleaning and upgrading, over the total construction period.

The design and construction or modification of access roads shall be according to Pakistani Standards for both, temporary or permanent roads. These roads will be triple surface treated, designed and constructed in accordance with the AASHTO specifications.

The work shall include the provision of such traffic control signals, lighting and signs as the Bidder may require or as requested by public authorities. All roads shall also be for the use by the Employer and the Employer's Representative.

3.2.4. Car Park Areas

Site installation shall include the construction, maintenance and removal of the temporary car park areas as indicated on the layout plan for site installation to be submitted by the Bidder.

3.2.5. Storage Areas

The Bidder's site installation shall include the construction, maintenance and removal of temporary storage areas at the site and at off site locations chosen by the Bidder. They shall be indicated in the general layout drawings, inclusive of any additional temporary storage areas in or about the site required in connection with the construction works and as allotted by the Employer's Representative. Temporary storage area shall include drainage facilities, sumps, oil traps, separators and isolation in case of storing chemicals and oil. Any land not located within the site which the Bidder considers necessary for his site installation, shall be acquired by the Bidder at his own expense.

Storage areas and all other areas which are to be used for any project's construction activity shall, as a minimum, be furnished with a drainage layer of sand and gravel with a minimum thickness of 200mm.

3.3. PROGRAMME AND PROGRESS REPORTS

3.3.1. Programme

The Bidder shall submit the proposed programme for the design and execution of the Works in accordance with overall time line of the Project up to COD. The proposed programme shall be in two levels of details as follows:

- The Overall Programme which shows the major work items of the Works.
- The Detailed Working Programme which shows further breakdown of the major work items into activities involved in the sub-items.

The Bidder shall identify critical activities and key dates and shall present the programme in bar chart form indicating activities and dates critical to completion of the Work on time.

3.4. QUALITY ASSURANCE/ QUALITY CONTROL

3.4.1. Description

The Bidder shall be completely responsible for implementing a Quality Assurance Plan covering all the Works contained in the Contract including the design. The Quality Assurance Plan will be prepared by the Bidder and reviewed and authorized by the Employer's Representative and will be implemented by the Bidder. Specifically it will be managed by the Bidder's Resident Quality Assurance Manager. The Bidder's Quality Assurance Plan shall ensure the control and quality of all design functions, all fabrication by the vendors and sub-Bidders and all construction activities carried out by work forces and sub-Bidders.

3.4.2. The Bidder's Quality Assurance Plan

The Bidder's Quality Assurance Plan shall meet all the requirements of the International Standards Organizations. As appropriate the Bidder shall impose on his designers, vendors, fabricators and sub-Bidders the requirements of IS0 9001:2000, 14001:2004 and 18000:2000.

3.5. BIDDER'S TEMPORARY FACILITIES

3.5.1. Description

a. The Bidder shall submit a plan, with original and two copies, showing the proposed layout for the construction camp keeping in view available facilities. The camp shall include the following features:

- Accommodation for Bidder's personnel.
- Offices for Bidder.
- Canteen and recreational facilities.
- Open storage and working areas.
- Maintenance and storage buildings.
- Water supply and distribution.
- Electricity arrangements and Lighting system.
- Communications system.
- Sewage disposal system.
- Sanitary landfill.
- Roads within the camp boundary.
- Mosque

b. The camp shall be planned to make best use of the designated area to provide a desirable, pleasant living area and an efficient and well laid out working area. Residential areas, working areas, and waste disposal areas, shall be suitably separated, and the existing vegetation shall be maintained as much as possible to provide screens between the different sections. The required grading shall be planned to balance cut and fill as far as possible, and to minimize the need for material from the borrow areas, and surplus Spoil.

c. The vegetation shall be cleared as required and disposed of, any topsoil shall be stockpiled, and at the end of the work all disturbed areas shall be graded and reseeded.

3.5.2. Materials and Equipment

a. Housing Accommodation for Bidder's Personnel

The Bidder shall make available adequate accommodations for his site construction/ operative personnel employed on the work and site offices subject to the approval of Employer.

b. Canteen and Recreational Facilities

The Bidder shall make available canteen and catering facilities for his own needs. The capacity shall be adjusted to the peak manpower requirement at site. The canteen shall be able to serve hygienic meals of reasonable price at all times of the day in accordance with the number of shifts. Adequate recreational facilities shall be provided.

c. Maintenance and Storage Buildings

Bidder shall provide all temporary maintenance and storage buildings that may be required at the site for safe and proper storage of tools, materials and equipment.

d. Water Supply and Distribution

The Bidder shall make provision for the supply of industrial and potable water in sufficient quantities for the demands at the project site during the entire construction period and Defects Liability Period.

The water supply shall include the complete equipment such as wells, pumps, filters, chlorination units, storage tanks as required, all necessary tools, spare parts connection to the distribution system and all related civil works. Prior to execution, the Employer's Representative shall approve the plans and the locations. The water distribution system shall be designed and installed by the Bidder and shall be maintained during the entire construction period and Defects Liability Period.

e. Communication Systems

The Bidder shall furnish and completely install a telephone system as site communication facility for his own requirements.

During the entire construction period and Defects Liability Period, the Bidder shall be responsible for the maintenance of the entire telephone system inclusive of rental and call charges.

f. Sewage and Sanitary System

The Bidder shall design, execute and maintain a sewerage system for all of his site installations and facilities in accordance with Pakistan standards. The treated wastewater shall be discharged as per approved procedures.

At all workshops and other areas where losses of lubrication oil can occur, the Bidder shall provide oil traps, oil separators or other measures to avoid environmental pollution. The oil shall be properly disposed at location and method approved by the relevant authorities and the Employer.

g. Other Facilities

The Bidder shall provide and maintain throughout the work all electrical power and wiring requirements to facilitate the work of all trades and services associated with the work and to provide electricity supply and adequate indoor and outdoor lighting for the construction camp and all the work, as required throughout the camp.

h. First Aid Facilities

- A first aid station shall be provided to serve all personnel at the site. The first aid station shall be equipped as required by State and Federal agencies having jurisdiction.
- A qualified emergency medical technician shall be on duty at the first aid station on each working shift.
- The Bidder shall furnish proof to the Employer that he has a continual arrangement with an approved hospital and medivac arrangements for the emergency evacuation and admittance at any time and subsequent medical and hospital care for injured employees.

3.6. UTILITIES

3.6.1. Water Supply System

The Bidder shall make provision for the regular supply of industrial and potable water in sufficient quantities for the demands at the Project site during the entire time for Completion, Defect Liability Period and Period during which the Bidder rectify the defects.

The water supply shall include the complete equipment like wells, pumps, filters, chlorination units, storage tanks as required, all necessary tools, spare parts connection to the distribution system and all related civil works. All cost shall be included in the price of the Bidder's water supply system. Prior to execution, the approval of the Employer's Representative shall be obtained for the plans and the locations.

3.6.2. Water Distribution System

The water distribution system shall be designed and installed by the Bidder and shall be maintained during the entire time for Completion, Defect Liability Period and Period during which the Bidder rectify the defects.

The pertinent price shall include all costs for civil works, furnishing and installation of pipes, fittings, valves making good existing system and connections to the buildings and treatment plants, ready for operation.
Prior to execution, the Bidder shall submit all necessary layouts and detailed drawings to the Employer's Representative for approval.

Every two (2) weeks, the Bidder shall, at his cost, furnish analyses of the potable water. The quality of water shall comply with Pakistan Regulations for drinking water. If the water produce is not suitable for consumption then the Bidder is to provide mineral water.

3.6.3. Sewerage System

The Bidder shall design, execute and maintain a sewerage system for all of his site installations and facilities to the approval of the Employer's Representative during the entire

time for Completion, Defect Liability Period and Period during which the Bidder remedies the defects.

The sewerage system shall be in accordance with the capacity of the water supply system comprising sewer pipes in all dimensions, manholes, complete sewage treatment plants and all other installations and civil works to put the complete system into operation.

The treated wastewater shall be discharged downstream of water intake structures located in the vicinity of the site installation area.

At all workshops and other areas where losses of lubrication oil can occur, the Bidder shall provide oil traps, oil separators or other measures to avoid environmental pollution. The oil shall be properly disposed at location and method approved by the relevant authorities.

3.7. ENVIRONMENTAL PROTECTION and MISCELLANEOUS

3.7.1. Environmental Management

The Bidder shall comply with all legal duties and obligations regarding the protection of the environment as laid down Laws and Regulation of Governments of Pakistan and Punjab.

3.7.2. Water Quality

The Bidder shall submit proposals for the Employer's Representative's approval for all waste water and foul effluent from offices, workshops and site accommodation to be collected and treated at a waste treatment plant prior to discharge into open water courses or into ground water.

Where construction methods involve pumping of ground water, the Bidder shall submit proposals for monitoring and the disposal of water discharges.

3.7.3. Waste Management

The Bidder is fully responsible for the day-to-day management on waste collection and disposal. The Bidder must make arrangements for waste management for the collection and the disposal of domestic and industrial refuse, by handling, transport or storage of schedules wastes outside the premises and its safe disposal at a location approved by the Employer Representative.

The Bidder must ensure that all the necessary utensils such as proper storage containers or bins for refuse and kitchen wastes, special storage containers for scheduled wastes, temporary sewerage plants or toilet facilities are provided at the premises.

The Bidder must also comply with the following environmental conditions throughout the construction stage:

a. All effluents produced must be treated to comply Laws and Regulations of Government of Pakistan before discharge into area approved by the Employer's Representative. The effluent shall never be discharged into canal or river without treatment;

b. Temporary sewage treatment for toilet facilities in accordance with the specifications as prescribe by the Law and Regulation must be provided at the Bidder's site office and worker's camps before the commencement of any works;

c. Open burning of solid wastes including biomass waste and construction debris is strictly not permitted;

d. Handling and disposal of scheduled wastes must comply with the requirements of the Law and Regulations of Government of Pakistan;

e. Waste oil and grease arising from the earthworks and construction activities must not be disposed into any nearby watercourse. These wastes must be stored in proper drums/containers and either reused or disposed at the site as approved/licensed by the Director General of Environmental Quality.

3.7.4. Avoidance of Nuisance

The Bidder shall take all reasonable precautions to avoid causing a nuisance with dust noise or vibrations arising from his operations. This provision is in addition to but not in substitution for the provisions of the Conditions of Contract.

The Bidder shall not obstruct, as far as possible, the normal rights of way of the users of the public roads and where this is necessary and unavoidable, he shall provide barriers, roads signs, warning lights, etc. required for proper traffic control including getting the necessary permits from the Police Department and other local authorities and paying all fees in connection therewith.

The Bidder shall be responsible for clearing and cleaning all existing streets, roads, drains, etc. at regular intervals, or when directed by the Employer's Representative and keep the approaches to the site clear of mud and obstruction.

The Bidder shall be liable and shall indemnify the Employer in respect of any claims or proceedings arising out of his neglect in taking care to avoid creating a nuisance when carrying out the Works.

3.7.5. Borrow and Disposal of Materials

a. Surplus Suitable Materials

The Bidder shall dispose off all surplus suitable materials to areas designated by the Employer. The surplus suitable materials shall be compacted to the requirements for earthworks Specification.

b. Borrow Pits and Stockpiles

The Bidder shall submit proposals for the Employer's Representative's approval giving the location of borrow pits and stockpiles and proposals for their management to ensure acceptability of the materials.

The Bidder shall be responsible for locating borrow pits and stockpiles, in addition to, designated borrow pits and stockpiles. Whether the Bidder obtains materials from the designated or his own borrow pit, it shall be the responsibility of the Bidder to ascertain the suitability of the pit with respect to the quantity and quality of the materials, which shall be acceptable to the Employer's Representative. The Bidder shall pay all necessary leases, fees, taxes, levies or royalties to the appropriate authorities and observe all relevant regulations. The Bidder shall keep the borrow pits free from ponding water and the excavation neat and tidy and shall carry out necessary erosion protection and other mitigation measures as acceptable to the Employer's Representative.

Where suitable material is stockpiled for later use the Bidder shall ensure that the formation is cleared of all vegetation unless otherwise approved by the Employer's Representative. Stockpiled material shall be finished with a sloping, compacted surface to ensure run-off to keep the stockpile free of ponding water. Where required the Bidder shall provide a drainage ditch around the stockpile to prevent the ingress of water or other measures acceptable to the Employer's Representative. The Bidder shall also be responsible for disposal of surplus materials to designated places as approved by Employer's Representative.

3.7.6. Notice to Service Authorities

The Bidder shall make at his own expense all necessary arrangements for notifying the service authorities of required connections, removals and relocations of all public utilities and services affected by the Works.

Sufficient time shall be allowed for such notification as may be required by the relevant authorities so that appropriate action can be taken regarding the execution of the removals and relocation.

3.7.7. Utilities and other Services

The Bidder shall be responsible for locating the position of all utilities, including mains, overhead and underground cables, pipes, sewers and drains, and where necessary shall adopt such methods of excavation as may be required by the appropriate authorities or Employers to ensure that no damage is caused to them.

The Bidder shall make good, at his own expense, any damage whatever to existing utilities to the complete satisfaction of and in accordance with the instructions of the relevant authority or Owner concerned, and shall keep the Employer indemnified at all times from all claims, costs and expenses which may be brought against or incurred by the Employer for or on account of any damage (whether permanent, temporary or recurring) to the said utilities. All utilities, which are encountered in the course of the Works, shall be adequately supported, slung up, strutted or otherwise protected from damage to the satisfaction of the persons or authority in which they may be vested.

Due allowance shall be made by the Bidder for the effect on the phasing of the Works of relocations to existing public and private mains and utilities necessitated by the Works. The Bidder shall ensure that such existing mains and utilities are not interrupted without the written consent of the relevant authority or the owner of the utilities concerned.

If any privately owned utilities for water, electricity, telephone, drainage. etc., passing through the Site are affected by the Works, the Bidder shall provide an approved equivalent alternative service in full working order to the satisfaction of the Employer of the utility and the Employer's Representative, before the cutting of the existing utility, and until the completion of the permanent replacement of the utility.

3.7.8. Prohibition of Advertising

The Bidder shall treat the Contract and everything written as private and confidential. In particular, the Bidder shall not publish any information, advertisement, drawing or photograph relating to the Works and shall not use the site for advertising purposes, except with the written consent of the Employer and subject to such conditions as he may prescribe.

3.8. PROJECT RECORDS

3.8.1. Project Record Documents and Samples

Bidder shall maintain at Project site one record copy of:

a. Construction Drawings
b. Specifications
c. Approved Shop Drawings, Product Data and Samples
d. Approved Construction Drawings and Erection Sequence Drawings for E&M Equipment.
e. Approved control, protection and instrumentation Drawings
f. Field Test Records
g. Inspection Certificates
h. Manufacturer's Certificates

Record Documents and samples shall be stored in Bidder's Field Office apart from documents used for construction. Files, racks, and secure storage for Record Documents and samples shall be provided.

Record Documents shall be maintained in a clean, dry and legible condition. Record Documents shall not be used for construction purposes.

Record Documents and samples shall be available for inspection by Employer's Representative.

3.8.2. Maintenance of Project Records

On completion of works, the Sponsor / Bidder shall maintain relevant records of civil works for which adjustment in Tariff is permissible by NEPRA.

SECTION 6(C)
PROJECT REQUIREMENTS FOR E&M, PLANT/EQUIPMENT & ASSOCIATED WORKS ETC.

1. GENERAL

The major components for E&M works along with their salient ratings and Standard Specifications are given hereunder. These requirements have been tailored for the project development in the IPP mode and its operation by the Sponsor for a term of 30 years. The main components described hereunder may not be construed as the total E&M requirements of the project. Bidder should add any equipment/device, control elements etc. necessary for complete and reliable operation/performance of the Power Plant.

The Turbines, Generators, Governing systems, Controls, Transformers and allied system for 135 MW Taunsa HPP shall be designed to operate at 20% additional flows.

1. Turbines & Governors
2. Cooling Water System
3. Compressed Air System
4. High Pressure Hydraulic Oil Systems
5. Lubrication Oil Purification System
6. Cranes
7. Power Station Elevator
8. Fire Protection System
9. Potable Water and Sewerage
10. Heating, Ventilation and Air Conditioning System (HVAC)
11. Drainage, Dewatering and Oil Separating System
12. Hydraulic Steel Structures (Intake Stoplogs, Draft Tube Gates, Trashrack Cleaning Machine etc.)
13. Generators & Exciters and Generator Condition Monitoring System
14. Generator Main Transformers(GMTs)
15. Station Auxiliary Transformers (SATs)
16. Medium Voltage (MV) Switchgear
17. Low Voltage (LV) Switchgear / LV Power Distribution
18. Medium Voltage (MV) & Low Voltage (LV) Cables
19. Protection and Relay Equipment
20. DC Supplies & Uninterruptible Power Supply (UPS) System
21. Lighting and Small Power Services
22. Earthing System
23. Control and Instrumentation System
24. Emergency Diesel Generator (EDG)
25. Fire Detection & Alarm System
26. Gas Insulated Switchgear (GIS) sub-station and its major equipment
27. SCADA and Telecommunication Systems
28. Transmission line bays

1 HYDROMECHANICAL EQUIPMENT

1.1 TURBINES AND GOVERNORS

1.1.1 Turbines

Turbines shall be designed for frequent daily start and stop and shall operate continuously between the guaranteed minimum and maximum output and within the head range specified, without exceeding the permissible stresses and bearing temperatures and without undue cavitation/abrasion. The working stresses, also under the worst transient conditions, shall be moderate. No undue deformation shall occur and smooth running, without harmful vibration, shall be ensured and the most unfavorable alternative shall be used as design parameters for the various components.

1.1.1.1. Scope of Work

The scope of work covers the technical requirements to design, work tests, delivery to site, store, shop assemble, erect, test and commission nine (9) double regulated Bulb turbines and all accessories / ancillaries but not limited to the followings:

1. Bulb turbine from stay ring to draft tube liner including stay ring with inner and outer cone, stay columns, distributor with upper ring and lower ring, wicket gates, operating ring and hydro-mechanical operating system, runner chamber and draft tube liner, main shaft, bearing, shaft seal, runner with hub, blades and its operating system, oil head, hatch cover with foundation elements or anchoring.
2. Piping, fittings, valves, filters/strainers, flow meters, pressure gauges, thermometer, instruments for oil, water, air, and closed loop cooling water system as separately specified in these specifications.
3. Lubrication system with cooling as specified in the specifications.
4. Compressed air system as specified separately in these specifications.
5. Governors, Control and instrumentation as separately specified in these specifications.
6. Special tools for erection
7. Spare parts as necessary for three (3) years turbine operations and details or templates needed for re-profiling of turbine blades as required during maintenance.
8. Guaranteed turbine performance characteristics based on the previously executed model test being the basis for the design of the offered turbines.

1.1.1.2. Standards and Codes

The turbines shall be designed installed, tested and commissioned satisfactorily as per the followings standards and codes:

- IEC 60193A International Code for Model Acceptance of Hydraulic Turbines.
- IEC 60609 Cavitation pitting evaluation in hydraulic turbines.
- IEC 60041 International code for the field acceptance tests of hydraulic turbines.
- IEC 60545 Guide for commissioning, operation and maintenance of hydraulic turbines
- IEC 60994 Guide for field measurement of vibrations and pulsations in hydraulic machines
- NEMA MG 5.2 National Electrical Manufacturers Association.

1.1.1.3. Functional Specifications

The turbines shall be double regulated type. The turbine and generator shall be horizontally installed and connected with a common shaft. The rotating part of the turbine generator unit shall be of two fulcrum and double overhung structure. Rotation of the unit shall be clockwise when viewed downstream from the generator end.

All removable parts of the turbine, including the runner, main shaft, and gate mechanism etc. shall be able to be removed from the turbine and generator pits by the powerhouse gantry crane.

1.1.1.4. Type and Arrangement

The horizontal shaft bulb turbines with adjustable blades shall have general dimensions (setting height, distance between unit centerline, length of intake and draft tube, sill elevation and clear height of intake and draft tube section) as per general arrangement drawings.

1.1.1.5. General Turbine Design Requirements

The turbines shall be designed to facilitate inspection, maintenance and major overhaul. It must be possible to disassemble any unit without interfering with adjacent units and without having to do civil work on any part of the powerhouse structure.

The turbines shall operate within permissible range to minimize vibration affecting operation of the power station. Loss of metal due to cavitation and/or excessive abrasion shall be within the specified limits.

1.1.1.6. Setting Height

The turbine centreline should be set approximately 8.5 m below the rated operating T.W.L of 129.5 masl, however, any modification as necessary shall be performed during the Basic Design stage.

1.1.1.7. Power Output

The rated power output with nine generating units operation shall be 15.3 MW for each unit (137.7 MW for nine units) under rated net head of 5.8 m. Maximum discharge shall be as high as possible in the whole head range, but shall be limited by the conditions of cavitation and vibration free operation depending on the given turbine net head and suction head.

1.1.1.8. Rated and Runaway Speed

The rated turbine speed shall be 73.2 rpm. The maximum runaway speed which may occur under maximum head shall be 244 rpm for preliminary generator dimensioning.

Technical Parameters

Rated Power Output (MW)	15.3
Minimum Power Output (MW)	5.8
Runner Centreline Elevation	129.5 masl
Setting to TWL (m)	-8.5
Rated Head (m)	5.8
Type of turbine	Bulb Double Regulated
Rated Speed (rpm)	73.2
Maximum Runaway Speed (rpm)	244

1.1.1.9. General Description of Turbine Structure

Nine (9) Bulb turbines shall be horizontally installed in Taunsa Hydropower Project and this bulb turbine shall be designed with double regulated (blades of runner, wicket gates of distributor). The turbine shall consist of:

- Inlet part
- Distributor
- Runner
- Runner Chamber
- Oil head and oil pipes
- Shaft
- Shaft seal and guide bearing
- Draft tube liner

1.1.2 GOVERNORS

1.1.2.1 Scope of Work

The scope of work covers the technical requirements to design, test, deliver to site, store, erect and commission satisfactorily the complete governing system with all main and auxiliary components and comprising of nine (9) digital governors, nine (9) pressure oil units including air or nitrogen/oil accumulator and sump tanks, control equipment and elements, as well as all connecting pipes and their accessories, valves, measuring instruments, control elements, electric cables between different components of equipment and between the governor and guide vane servomotors and between the governor and blade servomotor. Any parts and components, devices, control elements and software not specified in the technical specifications, but necessary for complete & reliable performance of the governing functions shall also be furnished. The governing system shall satisfy all requirements for interfacing with the control system of the whole station and national grid system.

Spare parts necessary for three (3) years operation shall be provided.

1.1.2.2 Standards and Codes

The governing system shall be designed, installed, tested and commissioned in accordance with the following standards and codes:

•	IEC 60308	International Code for Testing of control system for Hydraulic Turbines.
•	ANSI/ASME	PTC 29-1980 Speed governing systems for Hydraulic Turbine – Generator Units
•	IEEE Std.	1207-2004 IEEE Guide for the application of Turbine Governing Systems for Hydroelectric Generating Units

1.1.2.3 Type and Description

The governing system shall include a dual digital control unit, electro-hydraulic actuator, feedback devices, pressure oil tank, oil sump tank, oil pumps, nitrogen/air pressure system and accessories.

The governor shall be digital electro-hydraulic type, i.e. microcomputer governor, based on proportional, integral and derivative regulations. Two micro-processing control units shall be on hot standby for each other, so in case one fails, the other can be in operation automatically.

The governing system shall meet all requirements for the automatic control and manual control of the bulb turbine.

Digital governor's frequency response shall confirm to Pakistan Grid Code.

1.1.2.4 Functional Requirements

The Governing system shall be designed for the following functions:

- Speed Control
- Output (Load) Control
- Flow Control

- Turbine Creep Detection
- Sequence Control
- Remote Control
- Manual Control
- Emergency Shutdown
- Dual Regulation

1.2 REFERENCE HYDROLOGICAL CONDITIONS

The reference hydrological conditions to be used for the design and performance guarantees of generating units is given hereunder in Table 1.1 & 1.2.

Table 1.1: 10-Daily Hydological Data downstream of Barrage from 1991-2014

10-Daily	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg. Cusecs	Avg. Cumecs
Jan-I	20,126	18,579	15,767	22,858	11,175	9 870	15,840	22,230	12,910	10,950	16,620	18,036	8,729	12,494	17,619	16,290	17,222	15,843	16,532	16,598	18,781	18,060	22,421	19,524	16,461	466
Jan-II	15,238	20,960	19,607	26,052	22,917	4 010	20,880	27,410	13,120	21,590	20,240	17,289	12,985	9,086	18,055	16,873	19,442	25,541	19,363	16,982	15,197	21,078	32,355	18,207	18,936	536
Jan-III	26,884	44,434	30,943	34,660	27,940	15,718	54,118	28,764	30,782	36,773	21,055	24,322	23,154	34,650	28,067	17,933	21,801	26,483	23,686	22,393	16,196	28,266	37,515	27,405	28,656	811
Feb-I	36,134	50,855	35,264	29,326	26,742	37,630	41,730	15,580	25,950	29,350	23,860	23,610	23,305	37,016	27,695	18,569	32,931	25,824	27,644	29,349	30,768	36,725	52,926	38,667	31,561	894
Feb-II	43,488	43,018	40,524	27,606	39,238	35,800	40,060	16,350	28,230	31,490	23,470	20,323	30,143	43,715	40,821	20,726	55,756	31,152	34,824	34,095	42,003	42,941	44,420	36,445	35,443	1,004
Feb-III	40,203	39,888	49,166	38,961	43,696	45,378	36,588	39,000	41,563	34,000	19,488	16,694	22,392	31,370	43,434	26,016	41,649	29,250	37,337	37,706	43,303	41,836	49,284	38,707	36,954	1,046
Mar-I	40,691	49,508	49,353	36,164	40,928	47,860	35,460	53,370	37,240	34,810	20,840	21,229	30,562	25,594	34,142	30,149	38,105	27,643	39,847	41,257	40,017	37,024	49,356	43,787	37,706	1,068
Mar-II	50,099	50,016	54,978	34,743	40,695	45,390	38,800	44,380	42,330	33,140	12,630	18,280	35,556	21,389	33,285	27,822	36,700	27,167	38,679	39,642	33,601	21,555	41,269	43,262	36,059	1,021
Mar-III	83,589	55,314	47,675	37,226	37,639	50,218	35,409	41,982	41,355	23,645	13,745	24,272	25,816	24,024	72,311	22,040	57,501	23,755	41,440	34,189	33,199	21,893	46,220	42,244	39,038	1,105
Apr-I	99,519	53,795	35,742	34,316	47,232	38,839	27,349	45,649	34,509	26,769	13,259	26,114	28,960	18,438	34,940	17,500	75,820	22,492	32,942	27,448	33,882	29,042	45,299	39,530	37,058	1,049
Apr-II	139,259	58,659	61,851	34,155	37,621	42,409	30,091	97,629	35,519	25,729	20,339	20,599	32,691	26,535	38,144	25,983	68,611	36,043	39,934	26,814	25,417	40,058	41,491	43,831	43,725	1,238
Apr-III	98,348	110,852	81,737	35,246	71,119	57,499	45,479	75,509	49,274	34,249	28,119	27,887	49,744	25,294	44,968	29,003	82,228	37,673	50,819	40,155	34,756	41,440	44,250	47,809	51,802	1,467
May-I	67,613	80,679	98,487	20,768	42,832	33,177	42,398	107,557	36,467	557	0	9,235	37,921	17,572	49,129	16,971	65,387	18,797	31,293	18,435	35,485	29,096	25,451	35,067	38,349	1,086
May-II	71,679	53,956	58,331	43,881	54,386	43,627	50,227	82,527	62,707	39,057	12,247	18,873	39,858	27,815	60,748	56,459	83,965	32,646	42,042	34,310	52,850	28,760	23,436	59,094	47,228	1,337
May-III	92,811	74,378	60,606	56,407	59,342	80,601	38,155	135,391	96,437	82,437	58,501	61,233	62,856	88,801	89,897	112,669	84,752	71,899	75,557	56,267	89,577	33,880	57,652	67,803	74,488	2,109
Jun-I	68,940	70,502	112,946	89,632	60,644	101,132	65,402	168,572	116,712	60,332	64,362	83,592	102,301	76,299	93,998	121,610	90,943	92,400	111,989	83,484	106,821	51,840	83,225	79,419	90,087	2,551
Jun-II	279,640	131,159	121,958	121,312	136,275	181,912	115,062	129,864	124,950	42,782	89,512	138,145	138,511	109,224	116,068	94,964	129,948	130,588	126,069	93,927	110,821	83,520	133,784	106,899	123,945	3,510
Jun-III	283,671	266,810	135,425	138,015	204,251	191,452	134,082	82,792	155,022	75,742	120,402	131,965	174,244	141,311	159,266	94,488	147,442	152,892	99,379	120,417	133,288	117,640	145,167	147,673	148,326	4,200
Jul-I	299,934	258,677	145,508	282,045	149,646	357,686	149,126	194,766	159,836	131,264	90,676	136,496	204,517	125,978	345,039	122,770	175,861	157,354	129,260	163,993	153,813	150,664	155,441	193,966	184,513	5,225
Jul-II	334,236	295,808	250,683	482,305	317,834	271,646	168,026	340,466	131,276	124,746	124,396	128,462	239,596	143,110	346,157	151,573	190,578	157,240	134,132	191,345	136,568	167,146	156,358	198,151	215,952	6,115
Jul-III	308,895	386,171	232,507	415,965	498,157	181,193	176,262	293,411	149,775	131,130	137,471	105,376	268,696	120,420	355,214	137,622	153,769	174,794	147,283	255,678	129,483	147,122	208,854	186,929	220,049	6,231
Aug-I	274,975	323,139	124,047	390,334	305,178	354,836	173,586	220,916	261,148	135,556	99,466	75,423	272,604	105,299	310,644	353,538	161,774	190,627	181,436	645,411	126,235	148,192	275,222	163,676	235,553	6,670
Aug-II	159,664	268,083	104,879	389,506	250,720	371,726	149,966	195,736	269,866	101,286	104,896	167,315	133,179	80,143	182,393	308,166	186,904	194,521	223,578	626,202	110,193	131,663	349,842	165,207	218,068	6,175
Aug-III	203,534	233,879	90,853	287,653	246,326	177,873	227,491	187,009	115,873	79,436	140,427	112,039	131,029	87,460	144,471	209,890	155,801	109,238	153,085	348,881	97,813	127,731	189,349	110,073	165,301	4,681
Sep-I	167,515	200,772	76,601	290,855	162,480	111,216	110,296	125,086	96,866	78,636	78,636	165,161	95,686	79,065	93,593	119,032	115,389	100,581	95,052	198,973	154,003	129,022	137,105	96,698	128,597	3,642
Sep-II	149,417	311,707	76,044	111,993	49,080	104,766	102,576	115,486	80,506	84,506	84,506	77,869	73,589	60,648	95,335	51,268	80,831	80,329	72,746	141,242	131,251	150,116	83,048	27,146	99,834	2,827
Sep-III	72,396	76,588	73,857	19,241	38,523	70,556	62,256	51,436	68,156	93,576	93,576	56,524	50,304	43,375	60,997	48,857	62,494	58,474	60,607	70,427	46,948	81,094	80,938	27,936	61,214	1,733
Oct-I	68,033	64,530	81,558	64,913	71,663	77 017	79,167	38,457	65,737	83,137	82,201	47,976	65,743	39,273	60,113	63,228	65,659	62,446	59,185	52,817	42,023	50,319	62,718	60,560	62,020	1,756
Oct-II	50,548	45,062	57,141	51,790	62,998	65 037	79,317	48,177	60,437	57,617	46,312	46,605	49,813	37,920	43,720	45,394	46,275	42,607	37,639	43,335	33,486	43,469	56,551	55,918	50,299	1,424
Oct-III	37,149	41,814	41,903	34,372	41,302	47 024	63,215	36,233	42,297	43,015	37,577	30,840	28,282	28,468	26,860	29,364	34,941	32,256	32,451	47,545	29,440	40,685	51,151	46,473	38,528	1,091
Nov-I	45,074	43,458	42,119	33,749	39,215	43 520	53,360	32,230	41,510	36,840	30,520	30,133	37,875	37,418	36,633	41,430	39,848	38,499	38,833	48,180	32,700	44,991	50,664	49,291	40,337	1,142
Nov-II	47,001	41,962	40,388	32,711	36,013	43 180	42,620	36,320	42,850	33,780	25,560	29,227	35,061	38,660	40,418	39,810	37,791	36,814	39,266	47,987	32,984	40,760	49,381	44,997	38,981	1,104
Nov-III	38,507	36,220	40,249	34,742	42,364	40 880	37,020	43,940	43,520	29,850	25,810	31,509	36,568	33,310	41,093	40,549	34,347	38,063	37,421	46,082	42,367	41,994	45,434	42,265	38,505	1,090
Dec-I	38,728	37,350	39,371	40,571	41,499	40 340	37,480	43,090	38,720	21,410	27,220	30,961	36,764	28,500	35,652	37,700	34,403	35,846	38,326	42,118	46,202	42,819	44,475	39,536	37,370	1,058
Dec-II	37,459	38,962	34,884	38,076	40,070	35 860	35,530	37,460	33,600	14,420	19,480	30,385	37,387	20,593	29,569	23,819	31,713	28,483	31,817	39,199	37,933	35,835	38,987	32,387	32,663	925
Dec-III	26,564	31,923	27,438	22,915	30,385	26 855	28,973	26,027	21,382	18,500	15,582	19,476	33,439	11,143	24,400	16,914	20,284	20,781	24,652	32,338	30,165	22,818	26,865	26,460	24,428	692
Average	108,821	111,369	74,739	107,918	95,225	96 715	73,428	91,133	75,234	53,947	50,639	56,208	75,274	52,540	90,969	72,416	77,185	66,302	66,782	105,978	64,149	64,469	84,386	69,529	78,556	2,225

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Table 1.2: Discharge available for power generation and corresponding head & tail water levels

10-Daily	Discharge after Historic Average Flushing Flow	Avg. U/s WL (m)	Avg. D/S WL (m)
Jan-I	153	131.50	126.94
Jan-II	223	131.03	127.21
Jan-III	498	132.38	127.99
Feb-I	622	134.70	128.16
Feb-II	732	135.07	128.39
Feb-III	774	135.08	128.48
Mar-I	763	135.33	128.52
Mar-II	716	135.33	128.42
Mar-III	800	135.18	128.57
Apr-I	740	135.23	128.48
Apr-II	929	135.23	128.68
Apr-III	1,158	135.38	128.88
May-I	1,136	135.57	128.55
May-II	1,387	135.85	128.77
May-III	2,159	136.06	129.45
Jun-I	2,432	136.19	129.74
Jun-II	3,391	136.24	130.14
Jun-III	4,081	136.27	130.42
Jul-I	4,928	136.30	130.72
Jul-II	5,818	136.31	130.90
Jul-III	5,934	136.31	130.93
Aug-I	6,220	136.29	131.01
Aug-II	5,725	136.28	130.92
Aug-III	4,231	136.31	130.62
Sep-I	3,547	136.36	130.19
Sep-II	2,732	136.28	129.85
Sep-III	1,638	136.23	129.12
Oct-I	1,422	136.08	129.14
Oct-II	1,090	135.68	128.84
Oct-III	757	135.22	128.55
Nov-I	818	135.29	128.60
Nov-II	780	135.45	128.56
Nov-III	766	135.49	128.55
Dec-I	749	135.43	128.50
Dec-II	616	135.19	128.22
Dec-III	383	134.66	127.74

1.3.1 MINIMUM FUNCTIONAL SPECIFICATIONS AND PERFORMANCE GUARANTEES

1.3.2 Minimum Functional Specifications

The Minimum Function Specifications shall be as outlined in the following paragraphs. The Bidder shall adjust technical details where required to suit with the design of the Complex provided that the Minimum Functional Specifications are equaled or exceeded.

The Complex shall consist of nine (9) Turbine Generator Units and shall use water from the Indus River, passed via the head race channel, creating a maximum gross head of 6.91 m with a 10-daily average Plant flow rate of 382.75 m^3/s.

The site shall be approximately at elevation of 139.5 masl.

Each Unit shall be designed to operate independently and together with other Units in the Complex in parallel over a wide range of conditions.

1.3.3 Performance Requirements

1.3.3.1 Rated Gross Head at Power Station

"Rated Gross Head" is defined as the gross head prevailing at the power station with nine Units operating at rated opening, under which each turbine shall produce the specified rated and guaranteed output, given that (a) the headwater level is at el. 136.28 masl and tailrace channel and the tailrace water level is at el. 129.85 masl.

For the avoidance of doubt, the Rated Gross Head shall be the difference between the water level measured at the power station intake immediately upstream from the trash racks and the water level measured at the tail race immediately downstream from the draft tube outlet.

The Rated Net Head is defined as the Rated Gross Head minus any losses through the power station that are not included with the losses attributable to the turbine and generator unit efficiencies.

Maximum and minimum gross head limits shall be determined for the selected turbine characteristics.

1.3.3.2 Maximum Net Head

The Maximum Net Head shall be determined for one unit operation given that (a) the headwater level is at el. 134.66 masl (b) losses occurring in the headrace channel, water passages, and tailrace channel and the tailrace water level is at el. 127.74 masl and with the minimum unit discharge at minimum unit output.

1.3.4 Performance Guarantees

Rated Net Head. "Rated Net Head" defined as the net head with all the nine turbine units in operation at rated powerhouse discharge of 2583 m3/s (287 m3/s per unit). Each turbine under these conditions shall produce the specified rated and guaranteed output, given that;

- the headwater level is at EL. 136.28 masl;
- losses occurring in the water passage as per proposed design and head loss calculations and;.
- the tailwater level is at EL. 129.85 masl.

Maximum Net Head. "Maximum Net Head" is defined as the net head at 10-daily average discharge of 382.75 m^3/s at which the turbine is operated in normal continuous mode, given that;

- the headwater level is at EL. 134.66 masl, and
- losses occurring in the water passage as per proposed design and head loss calculations and;.
- the tailwater level is at EL. 127.74 masl.

Minimum Net Head. "Minimum Net Head" for the turbine units is defined as the net head with all the nine turbine units in operation at minimum net head at discharge of 3118 m^3/s at which the turbines are operated in normal continuous mode, given that;

- the headwater level is at EL.136.29 masl, and
- losses occurring in the water passage as per proposed design and head loss calculations and;.
- the tailwater level is at EL. 131.01 masl.

1.3.5 Turbine

1.3.5.1 General.

Guarantees for each turbine shall be given for prototype conditions at reference hydrological conditions in the format displayed in Table 1.3 hereinafter.

The guarantees for efficiency, maximum load and cavitations and vibration levels etc., shall be verified by site commissioning tests according to IEC 60041 and related standards. The rate and size of sediments passing through the turbines shall be taken into account to prevent excessive abrasion of the turbine parts (runner, guide vanes etc.).

Model tests on a homologous turbine model to demonstrate a satisfactory design and the validity of the guarantees given shall be carried out. The tests shall be conducted in accordance with IEC Publication no 60193, latest revision including amendments and supplements.

A satisfactory design and the validity of the guarantees shall be validated by test results based on site tests on homologous, or nearly homologous, turbines. The tests should be conducted in accordance with IEC Publication no. 60041 and related standards.

1.3.5.2 Capacity.

The turbine is guaranteed to develop not less than the output stated below without exceeding any cavitation or operating limit when operated at reference upstream water level of EL. 136.28 masl and tailwater level of 129.85 masl:

Table 1.3 Guaranteed Capacity of Turbine Unit

	Net Head (m)	Output (kW)
@ (_____) % Guide Vanes opening	_____ (rated)	____ (max.)
@ Full Guide Vanes opening corresponding to maximum flow (287 m3/s x 9 units = 2583 m3/s)	_____	____ (max.)

1.3.5.3 Efficiency.

The efficiency of the turbine operating at the rated speed is guaranteed to be not less than stated below:

Table 1.4 Guaranteed Efficiency of Turbine Unit

With the (____) % guide vanes opening and rated output of _____ kW under the "Rated Net Head" of _____ m	flow Q _____ m^3/s
Efficiency at Rated Discharge and "Rated Net Head" Stated above	_____ % efficiency (minimum 93.6%)
Best efficiency point under the "Rated Net Head" of _____ m	flow Q _____ m^3/s
Corresponding Efficiency	_____ %
With the output of _____ kW under the maximum net head of _____ m	flow Q _____ m^3/s
Corresponding Efficiency	_____ %
Best efficiency point under the rated net head of _____ m	flow Q_____ m^3/s
Corresponding Efficiency	_____ %

In addition to the above the following operating parameters and corresponding efficiencies as given in Table 1.5, shall be guaranteed.

Table 1.5: Unit Performance Characteristics

Percentage of rated discharge per unit	No. of Units	Unit Flow	Plant Flow	Upstream Water Level	Downstream Water Level	Net Head	Turbine efficiency	Generator efficiency	Output at Generator Terminals per Unit	Output at Generator Terminals (Plant)
		m^3/s	m^3/s	masl	masl	m	%	%	MW	MW
125	9									
110	9									
100	9									
90	9									
Min(___)	9									
100	8									
90	8									
80	8									
70	8									
Min(___)	8									
100	7									
90	7									
80	7									
70	7									
Min(___)	7									
100	6									
90	6									
80	6									
70	6									
Min(___)	6									
100	5									
90	5									
80	5									
70	5									
Min(___)	5									
100	4									
90	4									
80	4									

Percentage of rated discharge per unit	No. of Units	Unit Flow	Plant Flow	Upstream Water Level	Downstream Water Level	Net Head	Turbine efficiency	Generator efficiency	Output at Generator Terminals per Unit	Output at Generator Terminals (Plant)
		m^3/s	m^3/s	masl	masl	m	%	%	MW	MW
70	4									
Min(___)	4									
100	3									
90	3									
80	3									
70	3									
Min(___)	3									
100	2									
85	2									
75	2									
50	2									
min(___)	2									
100	1									
90	1									
75	1									
50	1									
25	1									
min(___)	1									

Note 1: ρg = 9.804 kN/m3 Note 2: The minimum operating discharge is to be specified by the Bidder.
Note 3: A measuring tolerance must be considered as verifying the guarantee by IEC code.

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1.4 COOLING WATER SYSTEM FOR THE UNITS

1.4.1 Scope of Work

The Scope of Work covers the technical requirements to design, works tests, deliver to site, store, erect, site tests and setting to work of the cooling water system for the nine turbine/generator units and their associated standby cooling water systems.

1.4.2 Standards and Codes

The cooling water system shall be designed installed, tested and commissioned satisfactorily as per the following standards and codes:

- USACE US Army Corps of Engineers. EM 1110-2-4205
- USBR United States Bureau of Reclamation

1.4.3 Functional Specifications

The generator is cooled by a closed-circuit ventilation system via air-water coolers. The bearing oil is cooled in a closed circuit with oil-water-coolers, which are mounted on the oil high tank. Surface cooler elements are attached on the river water intake passage, which release the heat caused by the generator and bearings continuously to the river water.

1.4.4 Generator Cooling Air Circulation

The generator is cooled by a closed ventilation system with air-water coolers. In case of a stator core in direct contact with the machined housing, a part of the heat loss is directly released to the river water via the stator frame.

1.4.5 Cooling Water System

The source of water for the head tank system shall be ground water pumped from the ground. The cooling water is pumped through the system via two pump units, but only one of these is in operation; the other one is used as standby. The static pressure in the system is kept stable to some extent via the expansion tank in case of temperature changes.

The heat released from the generator (via air-water coolers) and bearing (via oil-water coolers on oil high tank) or optionally from the turbine governor (via oil-water coolers) to the cooling water circuit is disbursed to the river water via surface coolers, which are mounted on the upstream side in the water intake passage.

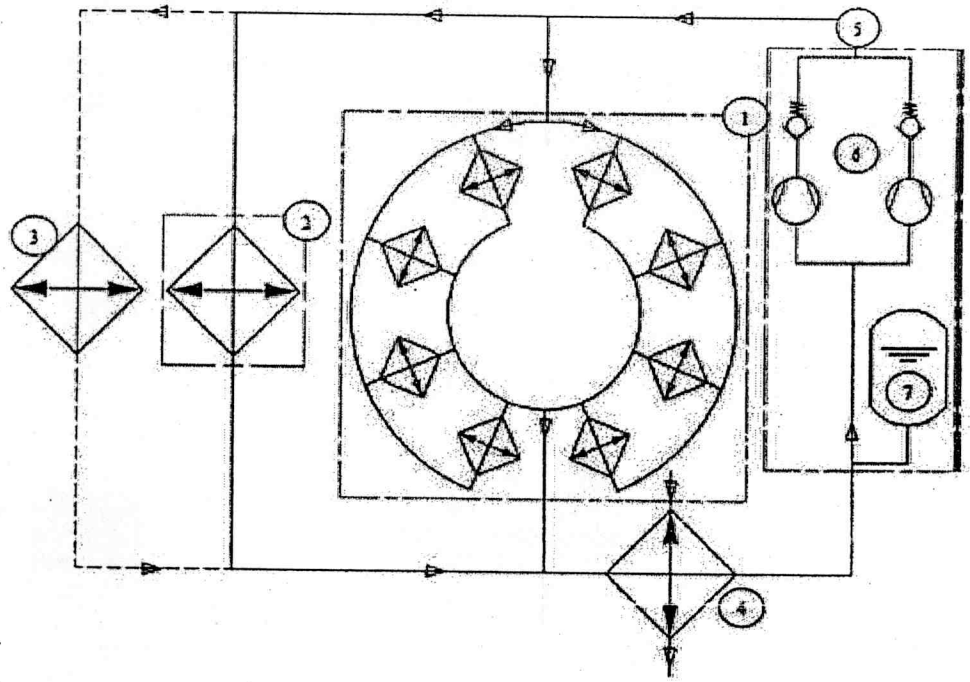

Fig.: Cooling water system
1 Cooling water circuit of generator
2 Cooling water circuit of bearing
3 Cooling water circuit of turbine governor
4 Surface cooler
5 Cooling water plant
6 Cooling water pumps and check valves
7 Expansion tank

1.5 COMPRESSED AIR SYSTEM

1.5.1 Scope of Work

The scope of work covers the technical requirements to design, deliver to site, store, install, test and commission compressed air system comprising of compressors, air receivers, pressure gauges, piping, alarms, controls and any other equipment required for satisfactory operation of turbine, governor, generator mechanical brakes and shaft standstill sealings and service air requirments.

1.5.2 Functional Specifications

Powerhouse is equipped with common compressed air supply system for all the units. The compressed air system comprises compressed air supply and storage tanks. The capacity of compressor is such that the compressed air supply required for the turbine, governor, and generator brakes can be met for minimum 2 operations.

Governor oil pressurization and maintenance requires compressed air system. An independent compressed air system is to be provided for Governors. This system provides compressed air to pressure tank, generator brakes, and other high pressure components of the powerhouse. The system includes air filters, compressors, after-coolers, storage tanks, valves, piping, hoses etc.

Service air system gets the air from the main compressor station separately, with a low pressure of approx. 5 bars and is supplied to workshop, service bay, dewatering pipes, measuring devices and service air / tank.

1.5.3 Standards and Codes

The high and low pressure compressed air systems shall be designed installed, tested and commissioned as per the following standards and codes:

USACE	US Army Corps of Engineers
USBR	United Slates Bureau of Reclamation
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers

1.6 HIGH PRESSURE HYDRAULIC OIL SYSTEMS

1.6.1 Scope of Work

The scope of work covers the technical requirements to design, deliver to site, store, install, test and commission high pressure hydraulic oil systems comprising of pressure oil units including air/nitrogen/oil accumulators and sump tanks, control equipment, connecting piping and accessories, valves, pressure gauges, measuring instruments, alarms, controls and any other equipment required for satisfactory operation.

1.6.2 Functional Specifications

The oil supply equipment shall be of closed loop type. Oil circuits for the control of runner and distributor shall be separate. Pumps and control elements shall be of the same type for both circuits. All oil piping shall be dimensioned for maximum oil velocity not exceeding 4 m/s.

1.6.3 Functional Requirements

In closed loop nitrogen/oil system the pumps shall fulfil the functions of pressure oil supply and discharge control thus acting as pump and as well as control valve. Working pressure shall correspond to the differential pressure between opening and closing side of the servomotor as required moving the servomotor piston. Pumps shall discharge in both directions without changing direction of rotation.

In case of complete power failure in the power plant, one unit shall be able to start within 10 minutes after power failure, by stored energy in air/nitrogen cylinders. Should the outage last longer, the emergency diesel set needs to start automatically, supplying sufficient power to operate governor pressure pumps and to start one unit.

1.7 LUBRICATION OIL PURIFICATION SYSTEM

1.7.1 Scope of Work

The scope of work covers the technical requirements to design, install, delivery to site, works tests and commission of two (2) mobile oil purifiers for use of the turbine guide bearing, generator thrust bearing oil, governor oil purification and generator transformer oil.

1.7.2 Standards and Codes

The lubrication oil purification system shall be designed, installed, tested and commissioned as per the following standards and codes:

- USACE US Army Corps of Engineers

1.7.3 Functional Specifications

One mobile centrifugal type of sufficient capacity to purify turbine and generator lubricating oil and the governor oil in approx. 2 hrs shall be provided while the other mobile purifier shall be provided as specified for generator transformer oil, with integral cartridge type filter shall be furnished complete with all mechanical and electrical accessories.

1.8 CRANES

1.8.1 Introduction

Five (5) cranes shall be provided out of which:

- One (1) gantry crane of adequate capacity shall be installed outside powerhouse building for handling heavy equipment e.g. turbine, generator and transformers from the laydown area to the specific installation locations through the openings in turbine hall roof, This gantry crane shall also erect/install and operate the stop logs on upstream and draft tube gates on the downstream of the powerhouse
- Two (2) cranes namely Powerhouse bridge cranes shall be installed in the powerhouse for maintenance purposes
- One (1) monorail shall be installed in workshop for ease of handling equipment for repair.
- One (1) monorail for GIS for ease of installation & maintenance of GIS equipment

The crane design shall be in accordance with internationally recognized standards. An approved international standard shall also be applied for designing and manufacturing of steel structures, choice of material and crane hoists, safety, tolerances etc.

1.8.2 Scope of Work

The scope of work covers the technical requirements to design, works tests, deliver to site, store, install and test the powerhouse bridge crane, auxiliary crane and workshop crane and rails complete including control system, walkways, ladders, runway conductor, cables, all embedded and fixing parts, embedded plates, sole plates, anchors, cleats etc.

1.8.3 Standard and Codes

The powerhouse cranes shall be designed, installed, tested and commissioned as per the following standards and codes:

- AWS American Welding Society
- FEM Federation Europeene De La Manutention
- DIN Deutche Industrie Normen
- ASTM American Society for Testing and Materials
- CMMA Crane Manufacturers Association of America

1.8.4 Technical Requirements

The gantry crane shall be an electrically operated outdoor type, with an operator's cab located on the upstream side and raised above the deck for ensuring good visibility of all crane operations. The gantry crane shall operate on rails extending over the full length of the deck. The main hoist shall be capable of lifting and to move at least the heaviest equipment and/or assembly to be installed in the power station. The crane shall be required to handle trashracks, intake stoplogs, draft tube gates and installation / dismantling of turbines, generators and transformers etc. the crane shall also be capable of operating through pendant control system on the floor.

The powerhouse bridge cranes shall be electrically operated. Cranes shall be of double girder (except workshop crane) overhead travelling type with a main hoist installed in a trolley running on the bridge girders. Each crane shall also be provided with a supplementary electrically operated monorail hoist for handling minor parts.

Crane motors shall be provided with creep drive for operation at 10% of normal speed. All crane movement shall be operated by a pendant control.

Cranes shall be designed so that parts can easily be replaced. The crane design shall also take into account the location of the crane within the power station to ensure good accessibility when maintenance or repair is required.

1.8.5 Functional Specifications

Gantry crane shall be installed outside powerhouse building for heavy equipment e.g. turbine, generator and transformers from the laydown area to the specific installation locations through the openings in turbine hall roof, This gantry crane shall also operate the stop logs on upstream and draft tube gates on the downstream of the powerhouse.

The powerhouse bridge cranes as well as the auxiliary crane shall be installed to operate over the machine hall and erection bay for maintenance purposes of the bulb turbines, generators, transformers and their auxiliaries.

Each crane (except workshop crane) shall be required to lift loads up to the maximum hoisting capacities of main and auxiliary hoists, traverse and travel the maximum length of the erection bay and machine hall as appropriate.

Cranes key parameters/characteristics shall be determined with preliminary values as follows:

Description	Unit	Gantry Crane	Bridge Cranes	Workshop Monorail	GIS Monorail
Span, rail C-C	m	37.5	18.7	-	-
Rail elevation	masl	139.5 (U/s side)	141.0	137.0	149.0
	masl	142.0 (D/s side)			
Main Hoist					
Rated capacity	t	175	30	5	10
Auxiliary Hoist					
Rated Capacity	t	25	5	-	-
Rail length	m	276	236	20	20

1.9 POWER STATION ELEVATOR

1.9.1 Introduction

Power station elevator shall be installed for easy and safe transport of personnel and materials during operation and maintenance of the Complex. The elevators design shall be in accordance with internationally recognized standards. An approved international standard shall also be applied for designing and manufacturing of structures, choice of material and elevator motors, safely, tolerances etc.

1.9.2 Scope of Work

The scope of work covers the technical requirement to design, deliver to site, store, erect, site tests and setting to work of two (2) elevators.

1.9.3 Standards and Codes

The elevators shall be designed installed, tested and commissioned as per the following standards and codes:

- EN 81 European Standard
- BSI (5655) British Standard
- ISO (4190) International Standards Organization
- ISO (4344) International Standards Organization
- ISO (7465) International Standards Organization

1.9.4 Functional Requirements

Each elevator shall have a load capacity of 2.0 tons, and a speed of 45 m/min. The elevators shall serve each of the plant floors.

The elevators hoist way machinery shall include the electric motor, brakes, and gear-type speed reducer, mounted on a common base, and shall be installed in the elevator machine room. Shock absorbers shall be located at the bottom of the elevator pit.

1.10 FIRE PROTECTION SYSTEM

1.10.1 Scope of work

The scope of work covers the technical requirements to design, deliver to site, store, erect, tests and commission of the fire protection system for the turbines, generators, transformers, cable and pipe galleries, MV & LV switchgear and electrical equipment rooms, control room, mechanical equipment area, workshop building and office area.

1.10.2 Standards and Codes

The fire protection system shall be designed, installed, tested and commissioned as per the following standards and codes:

• NFPA (All Parts) National Fire Protection Association

1.10.3 Introduction

The power station fire protection equipment and systems covered under this section include:

- fire water tank filling system
- distribution piping systems
- automatic deluge systems for the generator step-up transformers and governor pumping sets
- automatic sprinkler systems for storage areas and throughout the turbine floor, cable and pipes gallery to protect major cable tray and pipes runs
- standpipe system and fire hose cabinets at suitable locations
- portable fire extinguishers

1.10.4 Design Requirements

The source of water for the head tank system shall be ground water pumped from the ground and a single embedded suction line shall connect to pumps in the power station. The head tanks shall be set at an elevation to provide adequate pressure. Pumps shall be at a location and elevation to assure adequate suction head. The fire protection system shall be used as a reliable source of water to provide emergency backup supply for the generator bearing coolers and turbine shaft seal.

The Bidder shall be responsible for the design of the fire protection system. Water quantity, sprinkler layouts, fire detection and alarm shall comply with the requirements of the appropriate NFPA standards. All necessary deluge valves, controls, cabinets, annunciators, detectors and sprinkler nozzles shall be obtained from one source to assure interchangeability and reduction of spares required.

The Bidder shall provide a wet standpipe installation with fire hose cabinets at key points and at all levels in the power station and transformer area.

Bidder shall provide portable extinguishers of appropriate type and rating in key areas of the power station and transformer area. Portable fire extinguishers shall be provided at all entrances to the power stations.

Under normal Complex operation, the fire protection systems shall operate automatically giving alarm in the Central control Room without affecting other water systems. All annunciations of system operation and status shall be repeated on the main fire detection and alarm panel. Each deluge valve

shall be controlled by temperature rate of rise detection systems together with other tripping, devices appropriate to the equipment being protected.

The function of the fire protection water supply system shall be to provide a reliable source of water at all times under adequate pressure to supply the various fixed protection systems standpipes and hose cabinets in the power stations.

1.11 POTABLE WATER AND SEWERAGE

1.11.1 Introduction

The potable water and sewage systems covered under this section include:

- water supply pressure regulation and source from the power station cooling water system
- chlorination system
- retention tank
- plumbing fixtures for the station washrooms
- sewage treatment system

The potable water systems and sewerage treatment system shall provide the services necessary for the power station and Office areas and shall be capable of maintaining the required service throughout the life of the Works.

The potable water for the power station shall be taken from the fire fighting water tank (located at roof of the powerhouse complex), treated and passed to a storage tank and distribution system for the power station washrooms.

Waste from the washrooms shall be collected and gravity fed to a sewage treatment plant or septic treatment system, then drained by gravity to the tailrace downstream from the draft-tube gates.

1.11.2 Design Requirements

Water taken from the fire fighting water tank shall be automatically filtered and chlorinated then stored in a storage tank. The tank shall be at an elevation sufficient to provide the necessary water pressure for the plumbing fixtures or, instead a pumped pressurization system shall be provided.

The water supply shall pass through a double bank of multi clement-activated carbon cartridge filter and shall be chlorinated by a water meter sodium hypochloride system which shall leave residual chlorine concentration of 0.5 parts per million of free chlorine in the water.

The sewage treatment system shall be a gravity fed package and fully enclosed system and shall include an integral chlorine contact chamber before discharging to the tailrace.

The washroom fixtures shall be industrial grade first quality throughout.

The following fixtures shall be provided at the DC battery areas:

- one service sink.
- one emergency eyewash and shower.

1.12 HEATING, VENTILATION AND AIR CONDITIONING SYSTEM (HVAC)

1.12.1 Introduction

All buildings, the power station, and the control room shall be provided with ventilation, heating and air conditioning as required for the proper operation of the Works.

1.12.2 Scope of Work

The scope of work covers the technical requirements to design, deliver to site, store, erect, test and commission the HVAC system for the powerhouse and control building.

1.12.3 Standards and Codes

The HVAC system shall be designed installed, tested and commissioned as per the following standards and codes:

- ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers
- AMCA 500 Air Movement Contractors Association
- ASTM American Society for Testing and Materials
- ASME American Society of Mechanical Engineers
- SMACNA Sheet Metal and Air Conditioning Contractor's National Association
- ARI American Refrigeration Institute

1.12.4 General Requirements

The design of ventilation, heating and air conditioning shall be executed in accordance with American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) standards or equivalent European Standards.

Ventilation shall be provided for all rooms and buildings. Heating shall be provided for all rooms and buildings which shall be used by personnel if ambient conditions indicate heating is required.

Air conditioning shall be provided for the switchgear rooms, control rooms and all other Office rooms or buildings with equipment which requires air conditioning.

Suitable facilities for smoke release (in case of fire) shall be provided for the machine hall, control room, switchgear room, service rooms, battery room and the diesel generator room.

Electrical power supply for standby units and the equipment fans for smoke release shall be supplied with electrical power from the normal switches as well as from the diesel generator set. Battery and sanitary rooms shall be provided with separate ventilation and exhaust.

1.12.5 Ambient Weather Conditions

Air conditioning, heating and ventilation equipment for the facilities shall be designed and sized for the facilities based on the location and anticipated ambient conditions.

1.12.6 Performance and Design Criteria

Air conditioning heating and ventilation equipment shall be designed to maintain the acceptable temperature and relative humidity conditions, ventilation rates and noise levels.

1.13 DRAINAGE, DEWATERING AND OIL SEPARATING SYSTEM

1.13.1 Scope of work

The scope of work covers the technical requirements to design, works tests, deliver to site, store, erect and commission satisfactorily the drainage, dewatering and oil separating system.

1.13.2 Standards and Codes

The drainage, dewatering and oil separating system shall be designed, manufactured. installed, tested and commissioned as per the following standards and codes:

- USACE US Army Corps of Engineer Manuals
- ASTM American Society for Testing and Materials
- ANSI American National Standard Institute

1.13.3 Functional Specifications

The powerhouse drainage and dewatering system shall be designed to dispose of the station water collected in the drainage and dewatering sump from the floors and galleries of the powerhouse and online dewatering of unit waterway after lowering of the intake stop logs and draft tube gates for annual and emergency inspections.

The powerhouse oil separating system shall collect the spillover oil from all five transformer oil pits plus the water from deluge fire fighting system and separate oil from water before their separate disposal.

The drainage, dewatering and oil separating system shall comprise the following equipment:

1.13.4 Drainage System

Drainage pumps shall be installed in a suitably sized pit on elevation 109.80 masl. Pipes connect to the hermetically sealed sump pit. Pumps and motors can be easily accessed for maintenance.

The control of drainage system shall be fully automatic. Pumps shall be started and stopped by level switches. One alarm signal shall appear if the maximum level in the drainage pit is reached. The arrangement should be such that in case of failure of main pump the standby pump should operate automatically at a predetermined water level.

The drainage pit shall be water tight in order to prevent flooding of powerhouse in case of malfunctions of pumps. The water tightness shall be provided and guaranteed.

In case of emergency, the drainage pump line should be interconnected to the dewatering line enabling dewatering pumps to be utilized for drainage.

One pipe from the generator side and one from draft tube side shall merge into a common pipe header, leading into the drainage pit. Each pipe shall have a manually operated gate valve which must be kept safely closed during normal operation. All piping for cooling water system shall be PVC in embedded portion and hot dip galvanized steel in the area of valves.

As far as possible, the piping is arranged without being embedded in concrete. The design of piping system shall be in accordance with relevant international standards and common engineering practice. The scope of supply comprises pipes and accessories. Welding of pipe joints and painting of exposed pipes are performed al workshop as far as practicable. Standard gate valves shall be used.

1.13.5 Dewatering System

The dewatering system shall be designed to not require more than 2 hours (when using 2 pumps) for complete dewatering of one turbine using all dewatering pumps. The dewatering pumps shall be installed in a suitably sized pit on elevation 109.80 masl. Pipes connect to the hermetically sealed sump pit. Pumps and motors can be easily accessed for maintenance.

The control of the dewatering system is done by level switches installed in the drainage pit. All valves are manually controlled.

1.13.6 Oil Separating System

A concrete sump shall be constructed at such a location that all five transformers pits shall be connected to it. The size of the pit shall be sufficient to handle the transformer oil plus water from fire protection deluge system.

2. HYDRAULIC STEEL STRUCTURES

2.1 GATE EQUIPMENT

2.1.1 GENERAL

Gate equipment will be provided at the intake and draft tube structures of the turbine units to prevent entry of large size trash into the turbines, to close the bays during erection and to carry out any future repair and maintenance of the turbine units. Gate equipment comprises of trashracks, trashrack cleaning machine, stoplogs, draft tube gates and their embedded parts. A gantry crane will be provided for handling of the gate equipment.

The design will be based on general guidelines of the Technical Specifications for Gates and Penstocks (TSGP), U.S. Army Corps of Engineers and U.S. Bureau of Reclamation.

2.1.2 DESCRIPTION OF GATE EQUIPMENT

2.1.2.1 TRASHRACKS

There will be nine (9) sets of trashracks; one (1) set will be installed at intake of each turbine unit to avoid entry of large size particles into the turbine unit and to prevent the turbine clogging. Each set of trashracks will comprise of seven (7) sections. Each section will be lifted by a lifting beam with the help of the gantry crane. An automatic trashrack cleaning machine will be provided on independent rails for cleaning of the trashracks.

2.1.2.2 TRASHRACK CLEANING MACHINE

Trashrack cleaning machine will be provided on power intake deck and will cover all intakes for cleaning operations. Trashrack cleaning machine will consist of welded steel construction carriage, cabin, rake, trash container and a 5 ton hydraulically operated rotating jib grab to pick up large wooden planks, other heavy items and silt mixed with trash on the crest level deposited in flood seasons upstream of the intakes. The machine will operate automatically and manually. Automatic operation will be carried out through automatic timer and on signal from pressure differential detectors (predetermined head loss) installed on trashracks. Manual control will be directly from cabin. Information about automatic operation on trashracks will be transferred to the powerhouse control room. Width of rake will be compatible with the width of trashrack. Trash container will be of standard type and will be suspended on the carriage so that trash may be collected during automatic operation of cleaning machine.

2.1.2.3 INTAKE STOPLOGS

Nine (9) sets of stoplogs having six (6) sections will be provided at each upstream of intake to close all the bays during erection works and for future repair and maintenance of the turbines, auxiliaries etc. Nominal size of each bay opening is 16 m wide x 16 m high.A gantry crane and lifting beam will be provided to handle the stoplog sections. The stoplogs sections will be individually lifted by a lifting beam hooked on gantry crane. Slots for the stoplogs will be provided upstream of each turbine. For proper seating of the stoplogs, a flushing device shall be provided to remove the sediments in the bottom of the guide grove.

2.1.2.3.1 Functional requirements and general arrangement:

i. Stoplogs will be provided during erection and for dewatering of the bays for inspection of turbines, auxiliaries, etc.

ii. The stoplogs will be designed to operate under balanced head condition.

iii. Gantry crane will handle the stoplog sections for repair & maintenance of the turbine units, auxiliaries, etc.

iv. Trashracks will be installed at power intake structure to prevent entry of large size trash and to avoid the risk of clogging of the turbines.

2.1.2.3.2 Storage

Stoplogs for the intakes will be stored in stoplog storage area located on leftside of the intake especially allocated for the purpose. Proper concrete foundations will be made to store each section independently with required stability.

2.1.2.3.3 Lifting Beam

The lifting beam will be of welded steel construction equipped with two semi-automatic engaging and disengaging hooks suitable to lift the stoplog sections of different CG points. The hooks will be mounted on corrosion resisting steel pins and self-lubricating bushes. The beam shall be led within guides of stoplogs, and for this purpose equipped with two pairs of side wheels with self-lubricating bearings.

2.1.2.3.4 Gantry Crane

The gantry crane of 175/25 ton capacity will be used for handling of intake stoplogs during erection and maintenance of turbine units, auxiliaries, etc.

2.1.2.4 DRAFT TUBE GATES

Nine (9) sets of hydraulically operated vertical lift fixed wheel type gates will be provided in the draft tube of each unit. The operating system will consist of two (2) double acting hydraulic cylinders and a hydraulic power and control unit. The gates will be used for isolation of tailrace water from the bay and will be designed to operate under unbalanced head condition. For proper seating of the draft tube gates, a flushing device shall be provided to remove the sediments in the bottom of the guide grove.

2.1.2.4.1 Functional Requirements and General Arrangement

Vertical lift gate equipment in draft tubes will be designed to meet the following functional requirements:

i. Draft tube gates will be provided for emergency closure in case of sudden closure of the turbine units.

ii. Draft tube gates will be provided for dewatering of the bays and for inspection of the turbine units, auxiliaries, etc.

iii. Draft tube gates will be capable to close under unbalanced head condition with the predetermined speed as required for the turbines,

iv. Double acting hydraulic hoisting system for draft tube gates will be provided for operation. The 175/25 t gantry crane operating on the runway spanning the entire structure will be provided for repair & maintenance of the draft tube gates.

2.2 MAIN PARAMETERS OF GATE EQUIPMENT

Main parameters of all the gate equipment to be installed for the Project are given hereunder:

2.2.1 TRASHRACKS

Type	Plane dismantle able, consisting of sections
No. of Trashracks	9 sets.
Sill elevation	113.00 m
No. of sections per set	7
Nominal size of opening	16.0 m wide x 26.5 m high
Embedded parts	9 sets
Clear space between bars	125 mm
No. of lifting beams	1

2.2.2 TRASHRACK CLEANING MACHINE

i) Rake

Width of rake	Compatible with trashrack

Hoist Capacity	15 tons.
Rake ascending speed	15 m/min (max.) stepless
Rake lowering speed	30 m / min (max.) stepless
Cleaning machine travel speed	10 m / min (max.) stepless
Travelling rails span	4 m
ii) Jib Grab	
Angle of Rotation	190°
Grab Lifting Capacity	5 ton
Operation Mechanism	Hydraulically operated

2.2.3 INTAKE STOPLOGS

Type of stoplogs	Vertical-lift (Sliding Type)
Width of stoplog opening	16 m
Total height of stoplogs opening	16 m
Elevation of sill of stoplogs	113.00 m
No. of sets of stoplogs	9 sets
Sections per set	6
Embedded parts	9 sets

2.2.4 LIFTING BEAM

No. of lifting beams	2
Type of construction	semi automatic type

2.2.5 DRAFT TUBE GATE

Type of Gate	Vertical lift fixed wheel gate
No. of sets of draft tube gates	9 sets
Type of Hoist	Hydraulically operated
Sill level	115.75 m
Tail Water EL.	131.0 m
Width of opening	10.6 m
Height of opening	10.5 m
Design Head	15.25 m
Embedded parts	9 sets

2.3 STANDARDS

The standards under which work is to be performed or tested are cited throughout the RFP. Where such standards are cited, it shall be understood that the latest issue or revision in effect at time of submission of Bid shall apply. If it is desired to deviate from the cited or approved standards, a statement of the exact nature of the proposed deviation shall be submitted for approval. Name of the standards and abbreviations are given below:

Name	Abbreviation
American Gear Manufacturer's Association	AGMA
American Institute of Steel Construction, Inc.	AISC
American National Standards Institute	ANSI
American Iron and Steel Institute	AISI
American Society of Mechanical Engineers	ASME

Name	Abbreviation
American Society for Testing and Materials	ASTM
American Welding Society	AWS
Federal Specifications Board	U.S.Fed. Spec.
United States Bureau of Reclamation	USBR
Institute of Electrical and Electronics Engineers	IEEE
International Organization for Standardization	ISO
National Bureau of Standards	NBS
National Electrical Code	NEC
Crane Manufacturers Association of America	CMAA
National Electrical Manufacturer's Association	NEMA
Society of Automotive Engineers	SAE
Steel Structures Painting Council	SSPC
Underwriter's Laboratories, Inc.	UL
Antifriction Bearing Manufacturers Association	AFBMA

Or Equal

For convenience certain equipment, articles, materials, or processes are designated by trade name or catalog name and number. Such designation shall be deemed to be followed by the words "or equal".

3. ELECTRICAL, I&C AND SUBSTATION EQUIPMENT

3.1 STANDARDS AND CODES

The equipment shall be manufactured and tested according to the following international standards as per their latest editions.

IEC 60034	Rotating Electrical Machinery
IEC 61869-2	Current Transformers
IEC 61869-3	Voltage Transformers
IEC 60076	Power Transformers
IEC 60076-10	Power Transformers: Determination of sound levels- Application Guide
IEC 60076-11	Dry-type power transformers
IEC 60085	Electrical insulation-Thermal evaluation and designation
IEC 60137	Insulated Bushings for alternating voltages above 1000 V
IEC 60146	Semiconductor converters
IEC 60204	Safety of machinery - Electrical equipment of machines all parts
IEC 60214-2	Tap changers- Application guide
IEC 60255-1	Measuring relays and protection equipment
IEC 60296	Unused mineral Insulating Oil for Transformer and Switchgear
IEC 60269	Low voltage fuses
IEC 60364	Low-voltage electrical installations
IEC 60309	Plugs, socket-outlets and couplers for industrial purposes
IEC 60265-1	Switches for rated voltage above 1 kV and less than 52kV
IEC 60439	Low-voltage switchgear and controlgear assemblies
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60598 – 1	Luminaries – general requirements and tests.
IEC 60616	Terminal and tapping Marking for Power Transformer
IEC 60662	High pressure sodium vapor lamps
IEC 60715	Dimensions of low-voltage switchgear and controlgear
IEC 60801	Electromagnetic compatibility for industrial-process measurement and control equipment
IEC 50(161)	Electromagnetic compatibility
IEC 60896	Stationary lead-acid batteries
IEC 60906	IEC system of plugs, socket-outlets for household and similar purposes
IEC 60947	Standards for Low-voltage switchgear and controlgear
IEC 60999	Connecting devices- Electrical Copper Conductors
IEC 61131	Programmable Logic Controllers
IEC 62271-1	High-voltage switchgear and controlgear-Common specifications
IEC 62271-100	High Voltage AC Circuit Breakers

IEC 62271-200	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
ANSI C29.1	Test Methods for Electrical Power Insulators
ANSI C37.20	Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
ANSI C37.24	Guide for Evaluating the Effect of Solar Radiation on Outdoor Metal-Clad Switchgear
ANSI C29.10	Wet-Process Porcelain Insulators Indoor type
ANSI Z55.1	Gray finishes of Industrial Apparatus and Equipment
NEMA SG5	Power Switchgear Assemblies
ASTM A36	Specification for Carbon Structural Steel
AWS D1.1	Structural Welding Code Steel
IEEE 115	Guide for Test Procedures for Synchronous Machines
IEEE Std. C37.013	AC High-Voltage Generator Circuit Breakers
IEEE 80	Guide for Safety in AC Substation Grounding.
IEEE 665-1995	Guide for Generating Station Grounding

3.2 GENERATORS

Main characteristics of each generator are to be as under:

Item	Unit	Unit No. 1 to 9
Rated Output	MVA	**19.125**
Nominal Speed	rpm	**73.2**
Runaway Speed	rpm	**244**
Generator Efficiency	%	**98.4**
No. of poles		**82**
Power Factor (Lagging)		**0.8**
Short Circuit Ratio		**1.07**
Insulation Class (Stator / Rotor)		F/F
Temperature Rise		B
Cooling		Air/Water

The generator shall be designed, constructed and tested in accordance with IEC Publication No. 60034 and other relevant parts dealing with rotating electrical machines.

The three phase synchronous generators shall be of the horizontal shaft type, bulb turbine of direct driven construction, with a combined thrust and guide bearing, and a guide bearing installed at the downstream side of the turbine shaft. A vertical access-shaft shall be attached to the top of the bulb to facilitate inspection, maintenance and outlet for cables, generator neutral connection, cooling water pipes for the generator coolers, turbine blades adjusting oil piping etc. Generator terminals shall be connected by XLPE cables which shall also pass through the vertical access shaft.
Each generator shall be capable of continuously maintaining constant output for system frequency changes within the range of 50.5 to 49.5 Hz. Each generator shall be connected to MV Circuit Breaker suitable for generator switching applications.

The generators shall be designed to withstand all fault situations which can be experienced during operation without any displacement of its windings or mechanical damage to any of its parts or to the generator foundations, such as short circuit between two or three phases at its terminals, faulty synchronization, magnetic imbalance due to pole winding failure and runaway conditions.

The neutral point of the generator shall be equipped with a distribution transformer meant for grounding of the generator connected between the neutral of the generator and the earth. Current transformers of appropriate ratings are also to be provided in the neutral of the generator for connecting the intended system protective equipment.

The generator shall be designed that all repair works, maintenance and inspection of the generator and turbine parts may be done with a minimum of disassembly work.

The power generated shall be dispersed through 132 kV transmission lines to the national grid.

A state-of-the art generator condition monitoring system, comprising the following features shall be supplied:

- On-line Vibration Monitoring System
- On-line Partial Discharge (PD) Monitoring System
- Generator Air Gap Monitoring System

The system shall be complete with proximity probes, PD sensors and associated accessories. Detailed analysis of the data acquired from the above systems shall be possible utilizing software to be provided as part of the generator condition monitoring package.

3.3 EXCITATION AND VOLTAGE REGULATION SYSTEM

Static Excitation System controlled by Digital Automatic Voltage Regulator (DAVR) shall be used for generators. Excitation power shall be taken from the generator itself and supplied to the excitation rectifier via AN cooled, dry Class B insulated excitation transformer.

The redundant excitation rectifier shall be of solid-state type with controlled silicon power thyristors for both polarities. It shall be capable of reversing its output voltage to obtain fast response in case of load rejection and unit over speed.

The rated continuous output of the excitation rectifier shall correspond to not less than the excitation power required for continuous operation of the generator at rated output and power factor and 105% of rated voltage.

The D.C field circuit breaker shall be able to break the field current under the most unfavourable fault conditions.

De-excitation during normal shutdown of the unit shall be performed by opening of the field circuit breaker. Simultaneously, the AVR shall trigger all thyristors simultaneously to fully open state, thereby providing a "free-wheeling" circuit for the field current.

An over voltage protection against induced over voltages in the field circuit shall be included.

The AVR shall be equipped with fully redundant controllers with automatic and manual channels with auto-followers to track position of the digital controller that is in control to provide bump-less, two-way transfers between controllers and manual-auto control. Part of the redundancy scheme requires redundant voltage transformers for the generator. Over- and under-excitation limiters & Volts per Hertz limiter are included.

The excitation system shall be equipped with a power swing stabilizer unit with adjustable parameters.

The excitation system shall have built-in protection and supervision equipment. External power is supplied in the form of DC control voltage, field flashing source, and power supply for cubicle lighting and power sockets. The digital AVR shall interface directly to the digital control system for the station. High-speed fuses will protect thyristors. All other power and control circuits shall be equipped with circuit breakers or mini-circuit breakers for protection and disconnection means.

The rotor shall be equipped with slip ring arrangement for excitation.

3.4 GENERATOR MAIN TRANSFORMER

The Power Transformer should comply with the IEC-60076 Standard Specifications.

Two Generating Units – One Generator Main Transformer Scheme shall be used for eight generating units (i.e units # 1-4 & 6-9), whereas One Generating Unit – One Generator Main Transformer Scheme shall be used for one generating unit (i.e unit # 5) as shown in Single line diagram (Figure 10).

All generator main transformers including one spare transformer shall be three phase oil-immersed, with ONAN/ONAF cooling,

The transformer shall be equipped with an off-load tap changer which shall be operated by means of a hand wheel with a tap position indicator.

All bushings shall comply with IEC 60137 and shall be of concealed construction.

Each transformer 132 kV bushing shall be provided with current transformers rated as shown in the single line diagram.

Oil purification unit shall be provided consisting of all oil and vacuum pumps, oil tanks, filter, vacuum instrumentation, monitoring equipment, flexible oil and vacuum hoses, electrical supply cables, and portable test equipment.

Fire protection shall be by water deluge system.

Main Data

Item	Unit	Generator Main Transformer
Function		Step-up
Type		**Oil filled**
Rated output	MVA	**31.5/40**
Rated voltage primary secondary	 kV kV	 **11** **138***
Frequency	Hz	50
Temperature rise of winding	^{0}C	55
Power Factor		0.8
Impedance	%	**12**
Tap changer		**NLTC**
Vector group		**YNd11**
Tap range		**±4 X 2.5%**
Cooling		**ONAN/ONAF**
Rated BIL HV LV	 kVp kVp	 **650** **75**
Neutral Earthing, HV		Solidly Earthed

Note: *The transformer ratio to be finalized during detailed design by carrying out study as recommended in IEEE C57.116.

3.5. STATION AUXILIARY TRANSFORMERS

The Station Auxiliary Transformers shall be dry type three-phase units with neutral point of 400 V winding solidly grounded.

The auxiliary transformers shall be mounted in enclosures with suitable damp proof heating arrangement, integral with their associated 400V switchboard. Transformers HV connection shall be by single phase XLPE cable connections. Temperature indicators should be provided for monitoring and signaling the winding temperature. The thermal classification shall be according to IEC 60085.

Main Data

Station Auxiliary Transformers

Parameters	**Unit**	**Value**
No. of Station Auxiliary Transformers	Qty	2
Type		Dry Type
Rating at IEC Conditions	kVA	*1250
Rated Voltage Ratio	kV / kV	11 / 0.4
Vector Group	-	DYn11
Tap Changer	-	NLTC
Voltage Adjustment Range	±%	5
No. of Steps x Step Size	%	±2 x 2.5%
Impedance Voltage	%	5.75
Frequency	Hz	50

Note: * The ratings indicated are the minimum required. The final ratings shall be determined during detailed design.

3.6 UNIT AND STATION AUXILIARY POWER SUPPLY SYSTEM

The station auxiliary loads shall be derived by 400 VAC distribution board supplied from two (2) sets of 11 kV generator switchgear through two (2) 11/0.4 kV dry type Station Auxiliary Transformers (SATs) each of 1250 kVA.

An emergency diesel generator rated '500 kW' shall be connected to the 400V Essential Bus of (ESB) which shall supply power to the plant in blackout and black start conditions.

The system shall be made of non-essential bus and essential bus connected by a bus tie breaker. The main 400 VAC distribution boards shall be installed indoor in the powerhouse.

3.6.1 MV SWITCHGEARS

The equipment shall be in accordance with IEC 62271-1, 62271-100 and 62271-200.
The switchgear assemblies shall consist of circuit breakers on mobile draw-out carriages, a single bus bar, main circuit components, CTs & VTs, control and protection relays and indicating instruments.

The main circuit breakers shall be 3-phase single-throw, trip free vacuum type mounted on the removable elements of the switchgear units.

The MV circuit breakers connected with generators shall be suitable for generator switching applications.

"Local – Remote" control switch device shall be furnished for each breaker to transfer control from the switchgear to a remote location.

Main Data

	11 kV Switchgear	
Parameters	**Unit**	**Value**
Nominal system Voltage	kV	11
Rated Voltage	kV	12
Rated Short Time Withstand Current	kA	40
Rated Continuous Current	A	2000
Insulation Medium	-	Vacuum / SF_6
Aux. and / or Control Voltage (DC)	V	220
Frequency	Hz	50

3.6.2 LV SWITCHGEAR

The Equipment shall be in accordance with IEC-60439.

The equipment in the switchgear assemblies consist of low voltage power air circuit breakers, moulded case circuit breakers, buses, current transformers, potential transformers, indicating instruments, relays and control devices.
The circuit breakers shall be of 3-pole electrically and mechanically trip-free draw out type air circuit breakers and shall be complete with manual and electrical stored-energy operating mechanism, mechanical position indicator, and mounted on a draw out mechanism in the breaker compartment.

All moulded case circuit breakers are manually operated, fixed type and have thermal and magnetic tripping devices. The electrically operated circuit breakers shall be equipped with push buttons for local control, and a "LOCAL – REMOTE" selector switch.

All distribution boards shall be of the weatherproof enclosure type to IP54.

Switch fuse units or disconnectors connected on the incoming side of a distribution board shall be mechanically attached to the board with solid copper electrical connections between the units.

The neutral connection for each circuit is to be direct to the neutral busbar.

The distribution boards shall be either single pole and neutral; or triple pole and neutral type and shall be equipped with means to provide overcurrent protection to each circuit.

Main Data

	0.4 kV Switchgear	
Parameters	**Unit**	**Value**
Nominal system Voltage	kV	0.4
Rated Voltage	kV	1
Rated Short Time Withstand Current	kA	40
Rated Continuous Current	A	1200, 630
Insulation Medium	-	Air
Aux. and / or Control Voltage (DC)	V	220
Frequency	Hz	50

3.7 CABLES

The following main types of cables shall be provided for the powerhouse and Substation:

- 132kV power cables;
- 11 kV power cables;
- 230 V/400 V power cables;
- Multi-core protection and control cables;
- Multi-core communication cables;
- co-axial high frequency cables;
- Fibre optic cables; and
- Communication cables (special cable)

To the extent possible, cables shall be routed using ladder type cable trays.

Cables and Raceway shall meet IEC standards requirements. Wherever possible, medium voltage power cables are to be copper foil shielded and terminated with proper stress relief devices, outer jackets are to be thermosetting type. Steel conduit or other armouring shall be used on cables laid outside the powerhouse and for cables close to the mechanical plants requiring higher mechanical strength. Special cables shall be in accordance with the particular requirements of the media for which they are being used.

Steel conduit or other armouring shall be used on cables laid outside the powerhouse and for cables close to the mechanical plants requiring higher mechanical strength. Co-axial and other special cables shall be in accordance with the particular requirements of the media for which they are being used.

3.8 PROTECTION AND RELAY SYSTEM

The electrical protection system for the generators, transformers and the MV/LV switchgears shall be state of the art numerical protective relays.

Generator protections includes the following:

- Differential Protection
- Generator Phase Fault Backup Protection
- Reverse Power Protection
- Unbalanced Loading / Negative Phase Sequence Protection
- Loss of Excitation Protection
- Over / Under Frequency Protection
- Stator and Rotor Earth Fault
- Generator Over fluxing Protection
- Over-Voltage Protection
- Out of Step Protection
- Impedance Backup Protection

Generator Main Transformer protections includes the following:

- Differential Protection
- Overcurrent Protection

- Ground Protection at Low Voltage Side
- Overload Protection
- Back-up Earth Fault Protection
- Over fluxing Protection
- Generator Main Transformer Gas Detection, Thermal and other Protections

Station Auxiliary Transformer protections includes the following:

- Overcurrent & Earth Fault Protection
- Thermal and other Protections

All parts of the installation shall be covered by high speed protection schemes which are independent to avoid common-mode failures. The protection equipment shall be complete with all relay panels, instruments, meters, interposing and auxiliary relays, control switches, interposing current and voltage transformers, transducers and all auxiliary equipment. All protections, as far as possible, are connected to separate current transformers, have separately protected voltage circuit.

Relays shall be in accordance with IEC 60255 and shall be suitable for use with 1 A secondary current transformer and 110/63.5 V secondary voltage transformers.

3.9 SYNCHRONIZATION SYSTEM

One (1) digital type synchronization apparatus (Auto synchronizer) shall be provided as part of respective Local Control Unit (LCU).

The synchronization of the generating units shall be automatic and be carried out from the power plant's operator's Control Console in the CCR.

The following equipment shall be provided, for generating units for synchronization purpose:

One (1) set of synchronizing instruments including synchronoscope, double voltmeter and double frequency meter for synchronization, common for all the generating units.

One (1) digital system (Auto Synchronizer to be provided as part of respective unit LCU) for automatic connection of two voltage systems, with raise / lower outputs for the generator voltage (DAVR) and for the speed of the turbine (governor) for each generating unit.

One (1) synchrocheck relay for each generating unit.

All necessary equipment for the synchronization by the 132 kV circuit breaker(s).

3.10 DC AND ESSENTIAL AC POWER SUPPLY SYSTEM

The DC System comprises two 220 VDC batteries. Each DC Battery is fed from redundant battery chargers working in parallel and equally sharing the load.

The two DC Distribution Boards shall be supplied from two Battery chargers and one 220 V Battery Bank.

The single phase (230 VAC) UPS shall be supplied from the 220 VDC Distribution boards.

A dedicated single phase UPS with its own battery and battery charger supplied from 400 V non-essential bus shall be provided for power plant emergency lighting.

Lead Acid batteries having design life of 25 years with guarantee period of 10 years shall be used. The batteries shall be sized for 10 hours discharge.

Over / under voltage protection of DC distribution board and earth fault protection of each outgoing DC feeder shall be provided.

The static switch is used to select between normal AC supply and UPS source. The UPS system shall be used for supply of essential AC power to the communication and plant control system.

3.11 LIGHTING AND SMALL POWER SERVICES

Lighting equipment has a minimum degree of protection of IP54 where required.

The horizontal illumination levels in the area around transformers, and buildings, shall not be less than 5 Lux.

Fittings shall be designed for halogen lamps with built-in ballast. Poles have built-in fuse-boxes. All lighting poles are connected to the main earth grid.

Main roads and access roads within 25 meters of buildings and transformers are provided with street light fittings at 6 m high poles.

The control room, relay room are provided with emergency hand lamps.

3.12 EARTHING

The design of the earthing system shall generally follow the main requirements outlined in the IEEE publication No.80 "Guide for Safety in Substation Grounding".
A station earth ring shall be routed around the station to connect all the installed electrical equipment to earth buses and to bond principal pieces of exposed steel to the earthing network. A system of ground plates which can be connected to by bolting shall be used for connection of principal components to the main grid system.

The main switchyard earth shall be formed by a buried copper mat interconnected to earth rod groups as required. All the switchyard equipment shall be connected to the earth mat, which shall be interconnected to the powerhouse earth.

Lightning protection systems shall be connected to separate earth rod groups.

The minimum conductor size and the quantity of earth rods shall be to obtain the required station ground resistance of 0.5 ohms.

3.13 Emergency Diesel Generating Unit (EDG)

One Emergency Diesel Generating Unit (EDG) rated for continuous 500 kW, 0.4 kV three phase 50 Hz, Yn connection, 0.85 Power Factor, indoor installation, insulation class H shall be provided to meet with the Black Start conditions in case of power failure.

The 500 kW EDG unit shall have an incorporated tank of ample capacity and a storage tank of 7500 litters.

The internal combustion engines shall comply with ISO standard 3046 (1981) and BS 5514 (1982) or approved equivalent.

The electrical parts of generator shall comply with IEC 60034-1 recommendations. EDG unit shall have 1 (one) control panel with AVR, protection including minimum of phase over current and ground over current relays, negative phase sequence relay, thermal relay, supervision equipment and indicating instruments. Fuel system shall consist of an oil-day tank with a capacity of fuel sufficient for full load running of the generator for 12 hours. The noise level shall be as per standard recommendations.

The EDG unit shall be protected by fire detectors for alarm and handsets and portable extinguishers to be placed nearby the locations of the unit together with sets of heat and fire resistant clothing including helmets, gloves and boots.

3.14 FIRE ALARM AND DETECTION SYSTEM

A fire alarm system complying with the requirements of the relevant NFPA Codes shall be provided to cover the entire power plant area. Fire protection system shall consist of smoke and thermal detectors, polling device, light indication and broadcasting system. The system shall be interlocked with the station ventilation system.

3.15 CONTROL & INSTRUMENTATION SYSTEM

The Power Plant and related facilities shall be controlled and monitored through a modern state-of-the art PLC based Control System (PCS). The PCS control philosophy as shown in Figure 11 is based on a structure with the following hierarchical levels:

1. Supervisory Control Level
2. Central Control Level
3. Unit Control Level
4. Local Control Level

The supervisory control & monitoring level shall be limited exclusively to the control of the substation 132 kV circuit breakers and automatic load frequency control of generating units; and for limited monitoring of the units from the National Power Control Centre (NPCC), Islamabad via SCADA.

The second highest level in the control hierarchy shall be the control and monitoring of the entire powerhouse from a central control room (CCR).

The next lower level shall be the unit control. This level shall deal with the control of individual units, which include the generating units, electrical distribution and other auxiliary systems. The individual LCUs shall be designed for Remote, Local and Manual control.

The bottom of the hierarchy shall be the local control. This shall comprise hardwired instrumentation and control through the local control panels e.g. local panels of circuit breakers, generators etc.

The main man-machine interface point is the CCR where three (3) Operator Workstations shall be located.

The PCS shall monitor both analogue and digital instrumentation to provide the operators with the required information to safely and efficiently operate the power station. The primary means for interaction between the station operators and the PCS shall be the LCD monitors based operator workstations. Each operator workstation shall be capable of controlling up to two LCD monitors.

The general overview of the power plant and its auxiliaries, overall status of the powerplant equipment shall be provided in the CCR on a Large Screen Display.

The PCS design shall incorporate functional redundancy and as far as practicable component redundancy to ensure maximum reliability during system operation. Critical trip functions, which are developed within a particular processor and used by another processor, shall be hard-wired between the processors in addition to the signal being transmitted over the communication cables.

A high-speed data communication system with fibre optic data communication cables shall be used for communication between the hardware components of the Power Plant Control System (PCS). All PCS equipment power supplies shall be redundant with automatic switchover for uninterrupted operation in the event of power supply failure.

The internal clocks of the PCS shall be time synchronized with the GPS Clock. The PCS shall include logging capability as well as historical data storage and retrieval capability.

3.15.1 GENERATING UNIT CONTROL

Each generating unit shall be provided with a PLC located at the LCU which shall contain all the start and stop logic required for all modes of operation. The controller shall also provide the required signals or information to the governor and excitation controllers. The local control system shall be with an operator interface comprising colour digital touch screen only.

3.15.2 AUXILIARY POWER

LCU(s), covering the MV/ LV Switchgears shall be interfaced with PCS. The control of the MV and LV switchgear shall be carried out through PCS via operator workstations in the CCR and from local points at the switchboards.

3.15.3 STATION COMMON AUXILIARIES

One LCU shall be dedicated to the emergency diesel generator, SATs, Compressors, Dewatering and Drainage system and others.

3.15.4 132 KV SUBSTATION

Monitoring and limited control of the 132 kV switchgear shall be possible through the CCR operator stations. The PCS shall be interfaced with the 132 kV Substation Automation System (SAS) through a protocol converter.

3.16 GRID SUBSTATION AND ITS MAJOR EQUIPMENT

The grid sub-station shall be 132 kV, Gas Insulated Switch gear (GIS) type with the following interconnection.

- 132kV D/C transmission line, approx. 1 km long on Lynx conductor for in/out of existing 132kV Taunsa – 132kV Shadlund at Taunsa HPP.
- 132kV D/C transmission line, approx. 1 km long on Lynx conductor for in/out of existing 132kV N.A. Wali – 132kV Kot-Addu at Taunsa HPP.
- 132kV S/C transmission line, approx. 36 km long on Lynx conductor from 132kV Taunsa HPP – 132 kV Taunsa.

The interconnection system should conform to NTDC conducted load flow study and the requirements of single line diagram (Figure 12) should be complied within the power house GIS Substation.

To accommodate five (05) Transformer feeders coming from powerhouse side and five (05) line feeders for dispersal of power from Taunsa HPP as well as interconnection with the system network, the following bays shall be used in the switchyard:

Transmission Line Bay	:	5
Transformer Bay	:	5
Coupler Bay	:	1
Bus VT Bay	:	2

Double bus single breaker arrangement scheme shall be employed for the switchyard.

The connection between the GIS and the transformers as well as between GIS and line terminal equipment shall be achieved through XLPE cables.

3.16.1 Design Parameters of GIS & Line Terminal Equipments

The GIS and line terminal equipment shall be designed in accordance with the applicable international standards as per their latest editions. Main design parameters would be as hereunder:

Nominal voltage:	132kV
Rated voltage:	145kV
Rated short time current (1 sec)	40kA
Rated continuous current of busbar:	3150A
Rated continuous current of line/transformer bays:	2000A
Rated continuous current of bus-coupler bay:	3150A
Rated lightning impulse withstand voltage:	650kV
Rated short duration (1 min) power frequency withstand voltage:	275kV

3.16.2 GIS Equipment

GIS equipment shall be modular design so that failure of one equipment shall not affect other equipment in the adjacent GIS compartments. Earthing switches shall be motor operated and controlled remotely from the bay local control panels. The system shall be completely interlocked to prevent improper, unsafe operation causing damage to the equipment. Line feeders shall be normally provided with high speed, ground switches.

Voltage transformers (VT) and current transformers (CT) shall be insulated by gas and supplied in modular form. Multi ratio design shall be provided with 1 amp secondary windings. VTs shall be 3 winding instrument transformers of the specified turns ratio. Outdoor wave traps and CVTs and surge arrester shall be provided for power line carrier (PLC) systems. Communications offsite shall be by optical fibers inside the transmission line ground wire (OPGW)/PLC.

3.16.3 Power Supplies

Two 400V feeders shall be brought from powerhouse to feed AC distribution boards for 132kV GIS substation. Separate 110V DC distribution system including batteries, battery chargers and inverted system shall be provided for 132kV GIS substation.

3.16.4 Protection System

Modern state of art numerical relays shall be used for protection system. Each 132kV line shall be protected with one distance, over current and directional over current protection.

Details of protection shall be as under:

1) Distance Protection
2) Over current/Directional over current Protection
3) Breaker Failure Protection

Synchro check protection and busbar protection shall also be a part of protection system.

3.16.5 Substation Control and Monitoring

The 132 kV GIS substation shall be controlled and monitored through a modern state-of-the art Substation Automation System (SAS) based on IEC 61850 for the safe and reliable operation of the substation.

The SAS shall interface with the NPCC SCADA system through duplicated SCADA Gateways for communication of duplicated IEC 101 and IEC 104 data between Taunsa HPP and NPCC. The gateway equipment shall be equipped with redundant IEC 101 and IEC 104 ports.

The SAS shall interface with PCS through protocol converters.

GPS shall be provided at switchyard for time synchronization between SAS and the existing SCADA system at NPCC. Necessary augmentation in GPS system at NPCC shall be considered.

The control philosophy is based on a structure as shown in Figure 13:

The supervisory control level shall be limited exclusively to the control of the substation 132kV circuit breakers and for automatic generation control whereas monitoring shall be for all substation equipment and for some generating units parameters.

The overall control and monitoring of the substation shall be carried out from Substation central control room.

The substation shall also be monitored at the PCS Operator Console in the Powerhouse Central Control Room.

The next control shall be from Bay control level.

Control shall also be provided from Local Control Cubicle (LCC) installed in front of each bay in the GIS Hall.

The equipment local control shall comprise hardwired instrumentation and control of the local control panel e.g. local panels of circuit breakers.

3.17 METERING SYSTEM

A Revenue/ Tariff Metering facility shall be provided at the high voltage side of each Generator Main Transformer for energy and active & reactive power measurement.

The facility shall include main and backup metering system conforming to NEPRA Grid Code (Protection & Metering).

Separate dedicated revenue class current (CT) and Potential (PT) transformers with accuracy class 0.2S for CT and 0.2 for PT shall be provided.
In addition to the Revenue/Tariff Metering, a normal metering shall also be provided for each transmission line.

The Bidder shall be obligated to provide AGC control when the NPCC / NTDC requires its operation and control.

3.18 TELECOM AND SCADA SYSTEMS

3.18.1 General

The Telecom and SCADA systems for the Project shall be provided for interconnection with the NTDC network and integration of Taunsa HPP with the SCADA system installed at NPCC. The equipment shall be field-proven and shall be type tested according to IEC standards.

Self-contained subsystems shall be provided within the power plant for voice communication, paging personnel, computer networking and security.

3.18.2 Communication System for Interconnection with Grid and NPCC

New overhead transmission lines emanating from Taunsa HPP to the national grid shall be equipped with OPGW. The interconnection shall be achieved through optical fiber (SDH) and digital power line carrier (DPLC) links to the nearest existing SDH node to cater to the data, voice and teleprotection requirements for Taunsa HPP.

For voice communication of Taunsa HPP with NPCC and adjacent stations, a state-of-the-art digital PAX for operational purposes and fully compatible with the existing PAXs installed in NTDC integrated telephone network shall be provided. The PAX shall integrate with the nearest PAX(s).

The data communication shall require the establishment of redundant data links between Taunsa HPP and NPCC through the new/existing telecommunication media over physically separate paths.

3.18.3 SCADA System for Integration with NPCC

The integration of Taunsa HPP with NPCC shall permit remote control and monitoring of the switchyard from NPCC. The interfacing shall be achieved through the duplicated SCADA Gateways and associated Interfaces in Substation Automation System (SAS) at Taunsa HPP switchyard and the SCADA equipment at NPCC. Necessary augmentation in hardware/software and the development of database/displays shall be included at NPCC. The signals to be exchanged with NPCC shall be determined from the teleinformaton plan for power plants defined by NPCC.

3.18.4 Administrative PABX System

A digital PABX shall be provided for speech communication with a capacity of at least 256 lines. Subscriber connections from the exchange shall be provided within the powerhouse and switchyard. External communication of the power station shall be achieved via PSTN trunk lines which shall connect to the public telecommunication network. Video conferencing facilities and facsimile machines shall also be included.

3.18.5 Video Surveillance System (CCTV)

A Video surveillance system shall be provided for the power plant enabling key areas in the powerhouse and switchyard to be monitored remotely from the CCR. The system shall comprise CCTV cameras, video recording equipment (with video archives for past fifteen days) and power supplies.

3.18.6 Other Systems

In addition to the above systems, the following systems shall be provided for operation and maintenance of the power plant:

- Public Address System (PAS) for paging personnel within the powerhouse and in the switchyard.
- Omnibus Telephone System (OTS) comprising a number of 2-wire subscriber circuits within the power house for communication during commissioning and maintenance.
- Direct Wire Telephone System (DWTS) at the switchyard for communication with the control room operator.
- Access Control System for the powerhouse to restrict the entry of personnel in sensitive areas.
- Computer Network within the power plant.

3.18.7 Power Supply Systems

The power for the equipment shall be fed through fully redundant 48V DC UPS and 230V AC UPS systems to be provided at both switchyard and powerhouse.

The DC battery chargers shall be SMPS type with a lifetime of at least 25 years and the batteries Plante type having a guaranteed life of min. 15 years.

Figure 1: Hydropower Layout Plan at El. 150.00

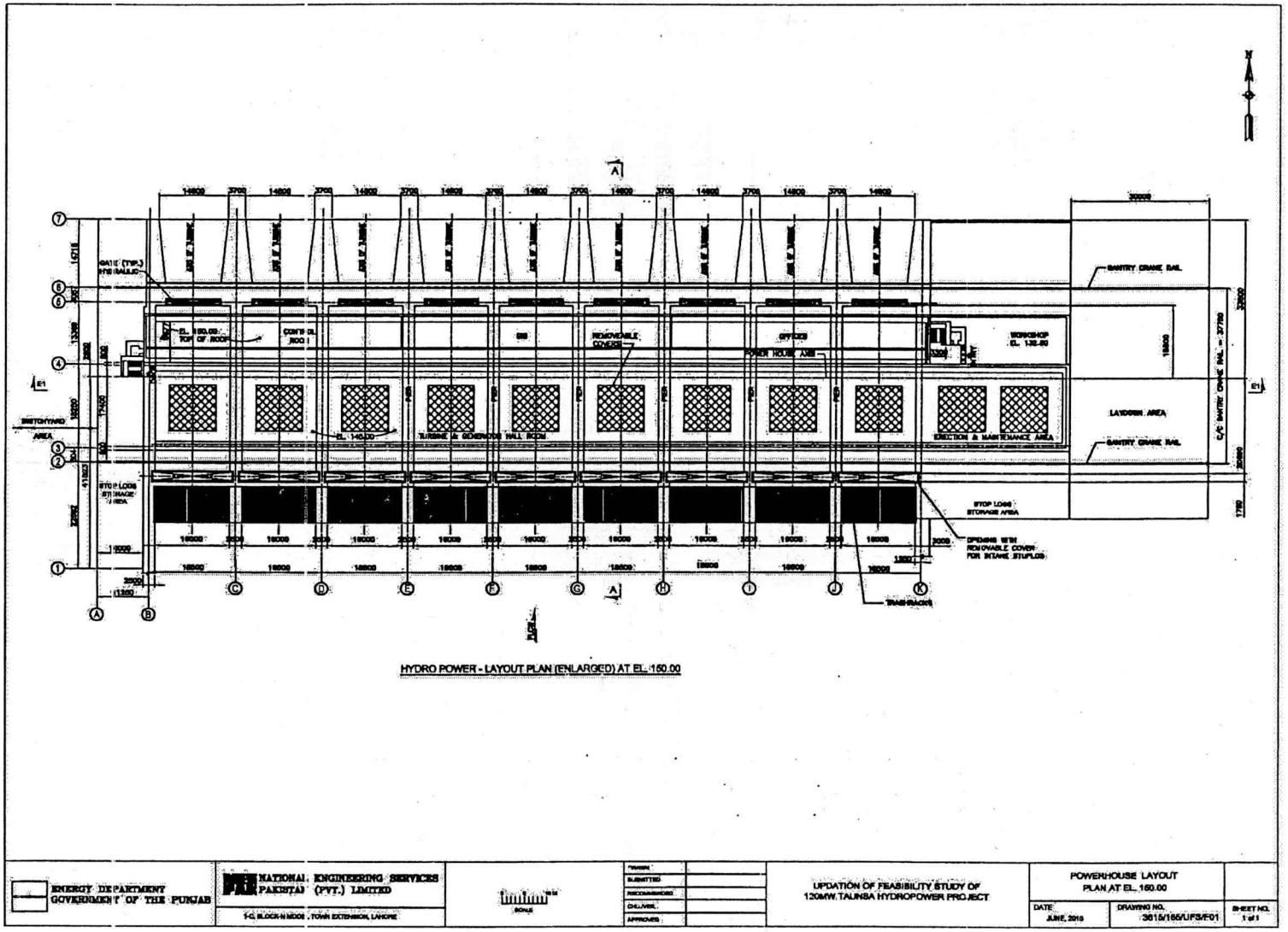

Figure 2: Hydropower Layout Plan at El. 142.00

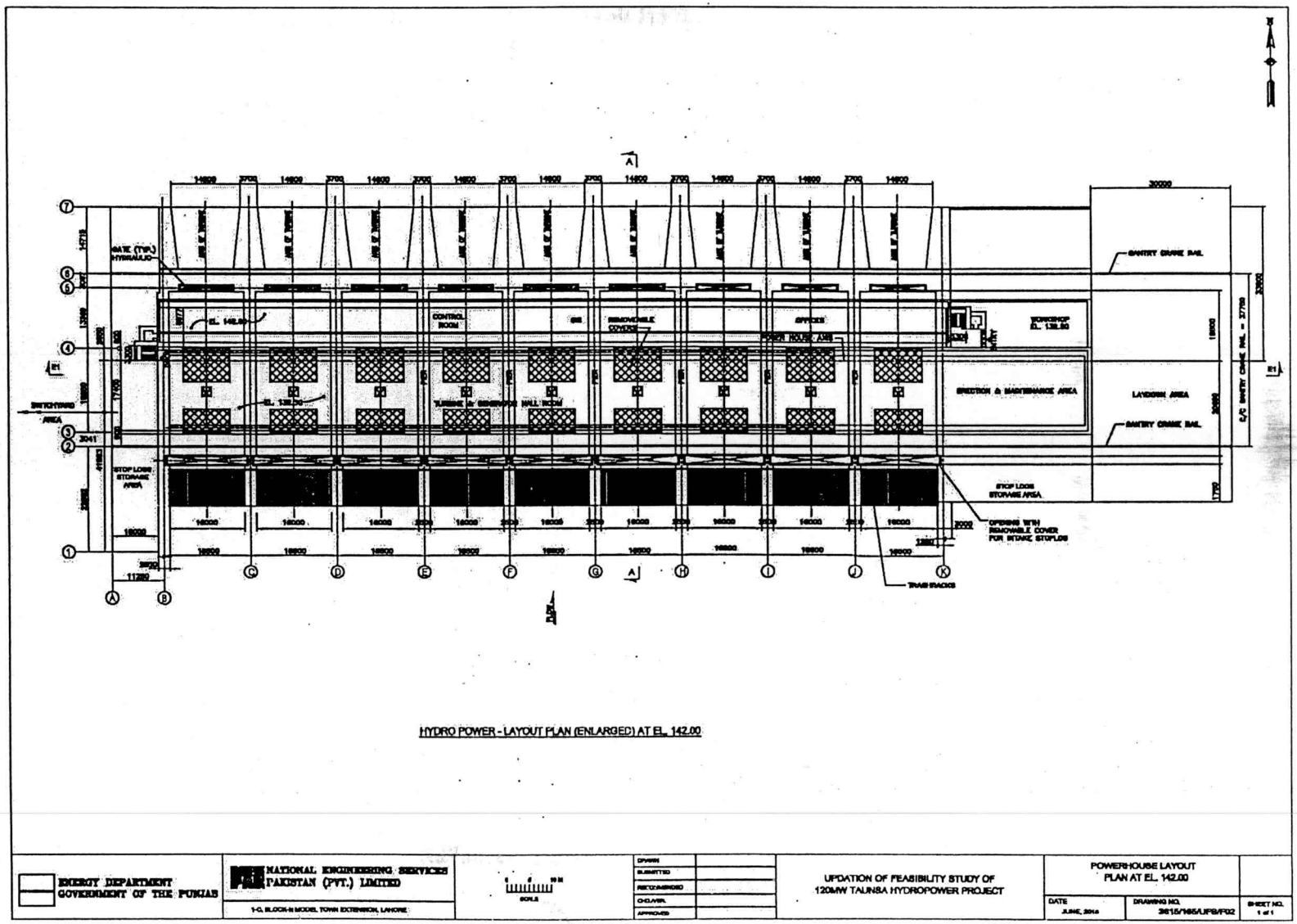

Figure 3: Hydropower Layout Plan at El. 132.50

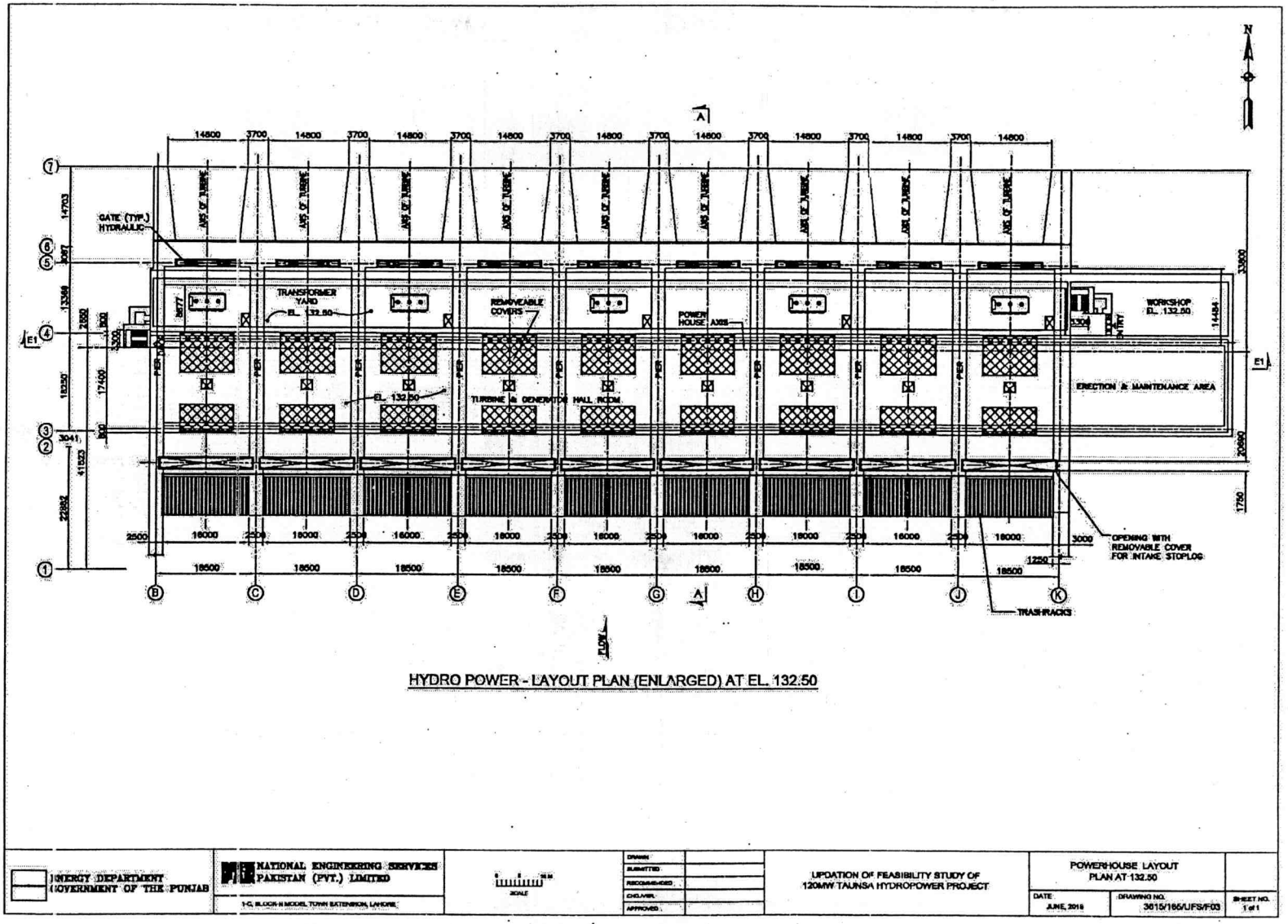

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Figure 4: Hydropower Layout Plan at El. 121.00

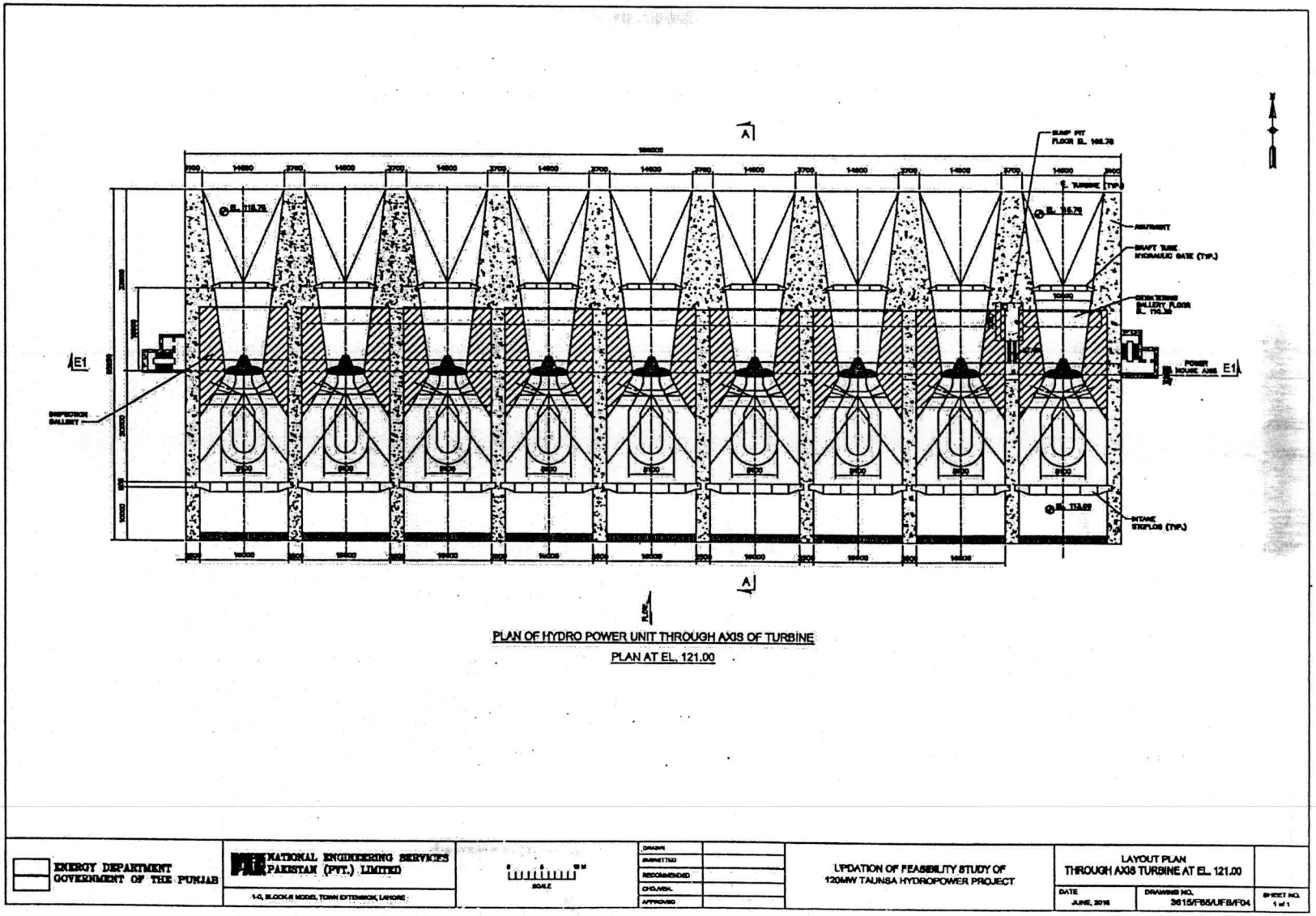

Figure 5: Hydropower L-Section

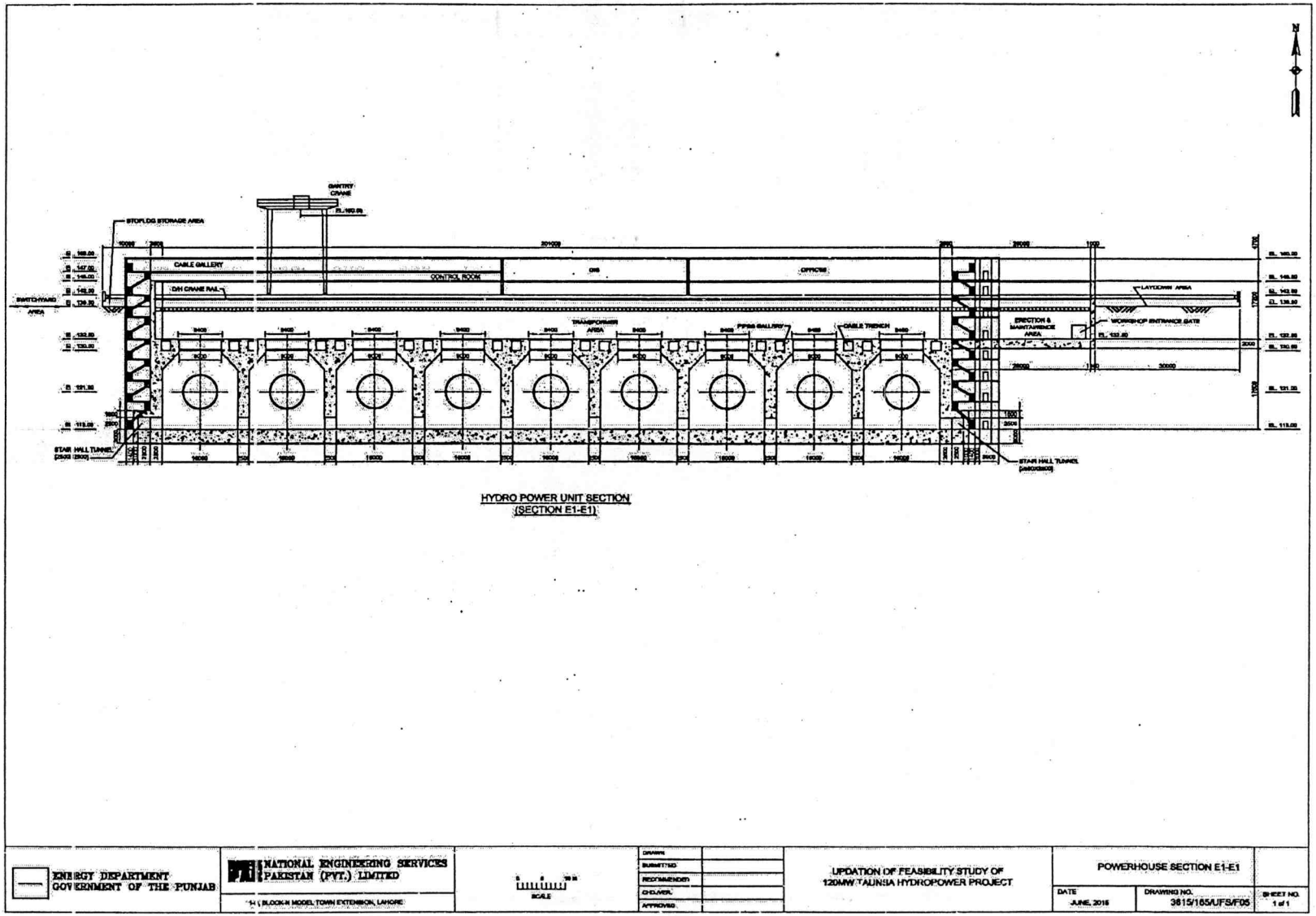

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Figure 6: Hydropower X-Section

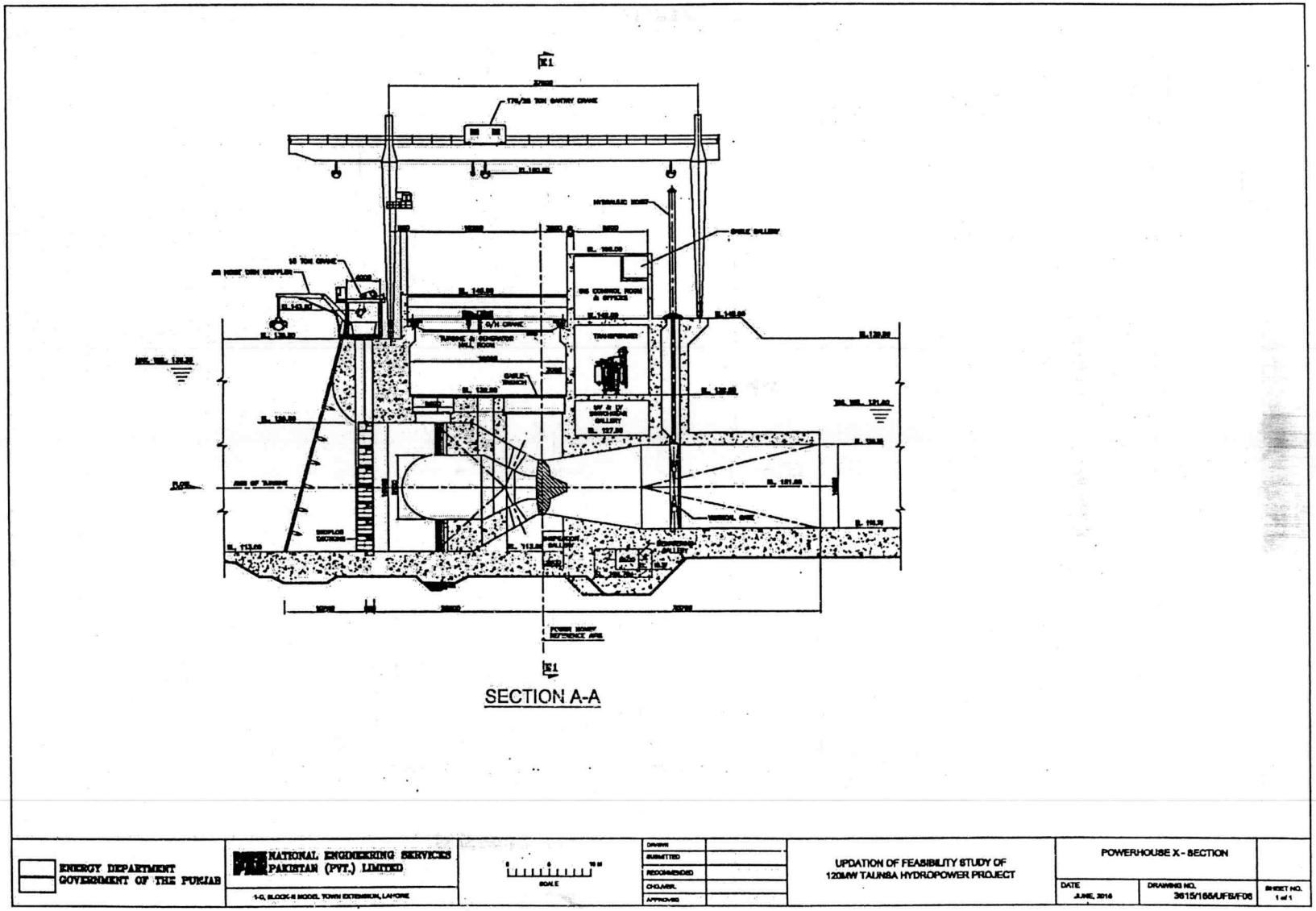

Figure 7: Gate Details

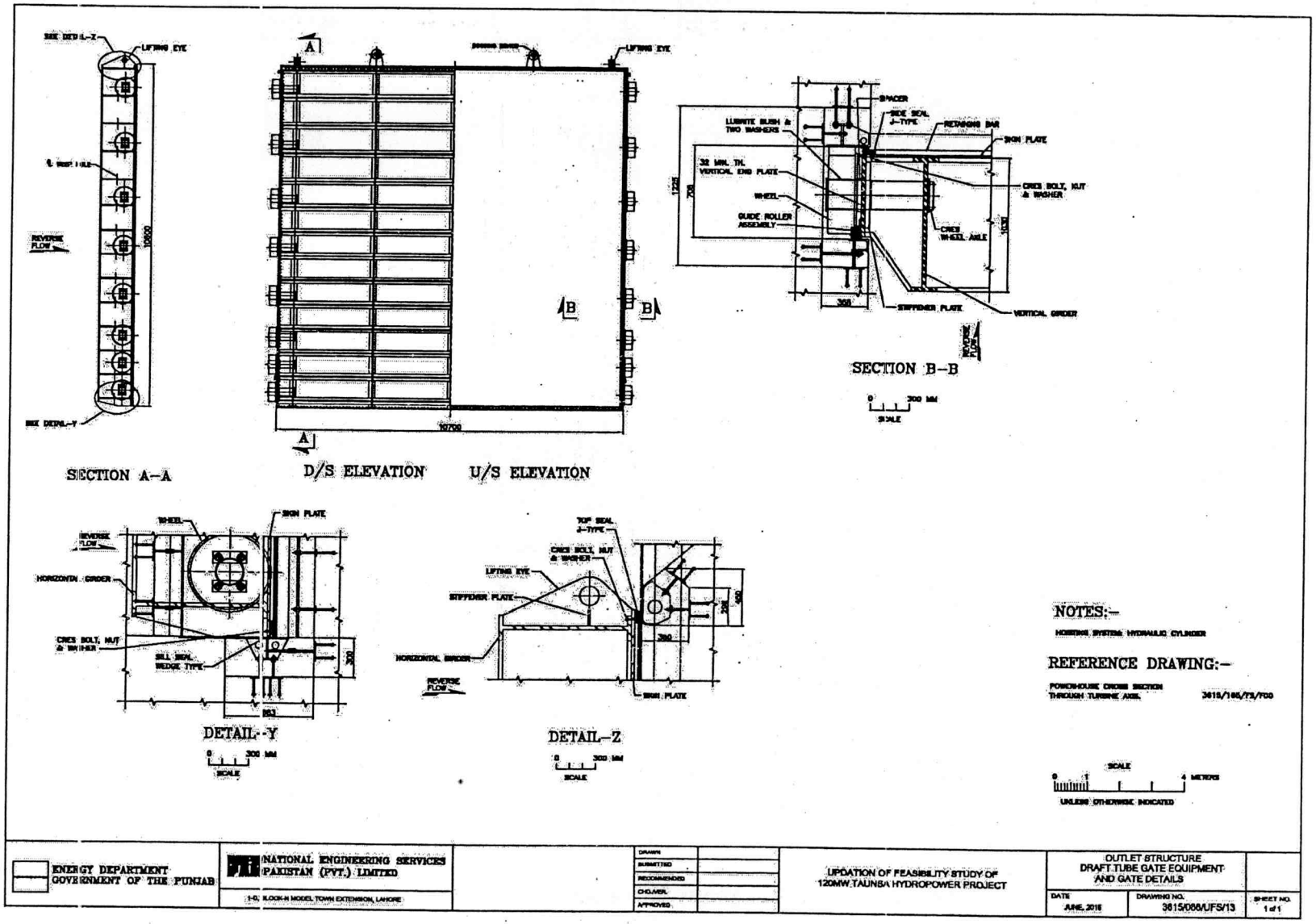

Figure 8: Stoplog Details

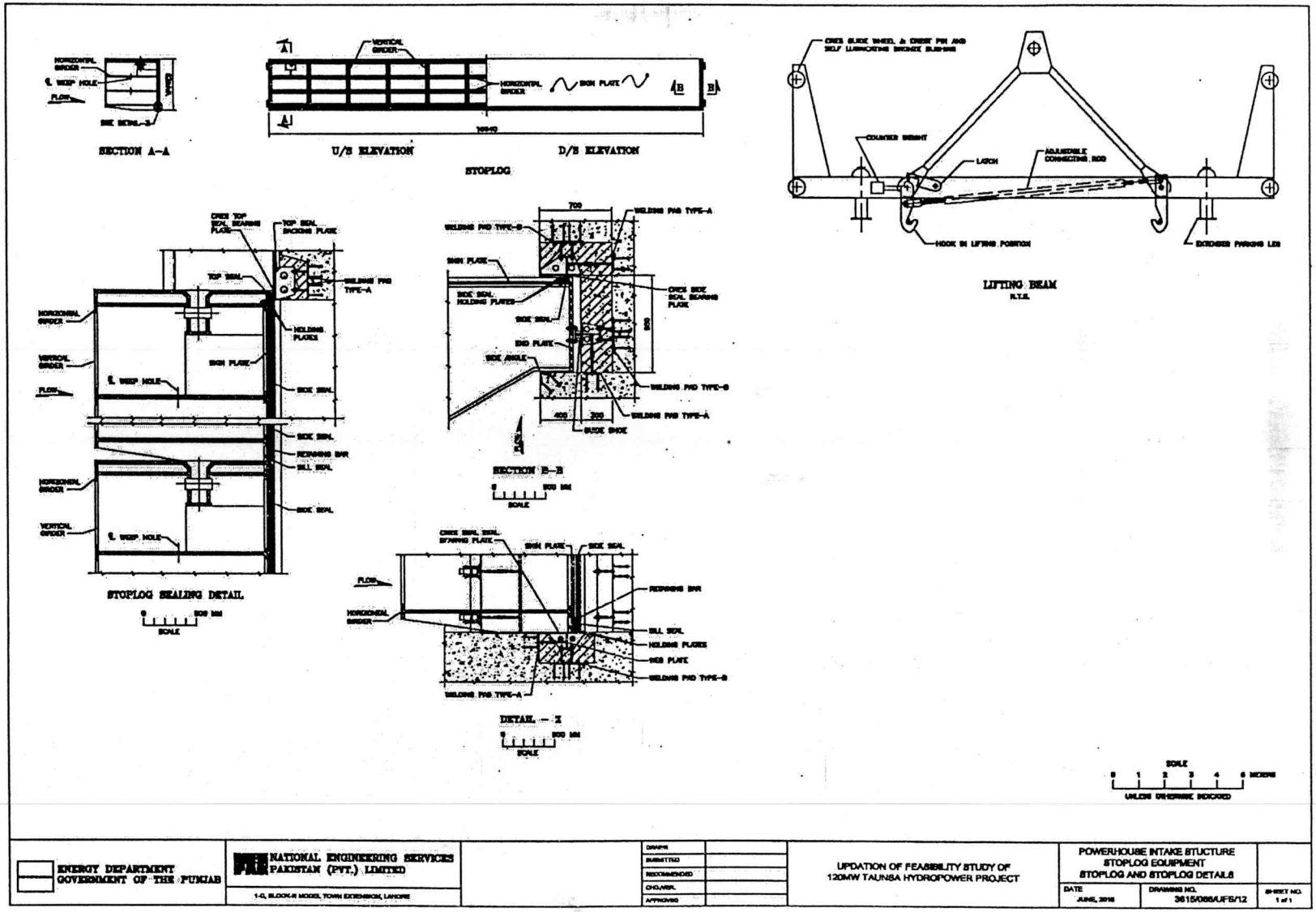

Figure 9: General Arrangement of Gates

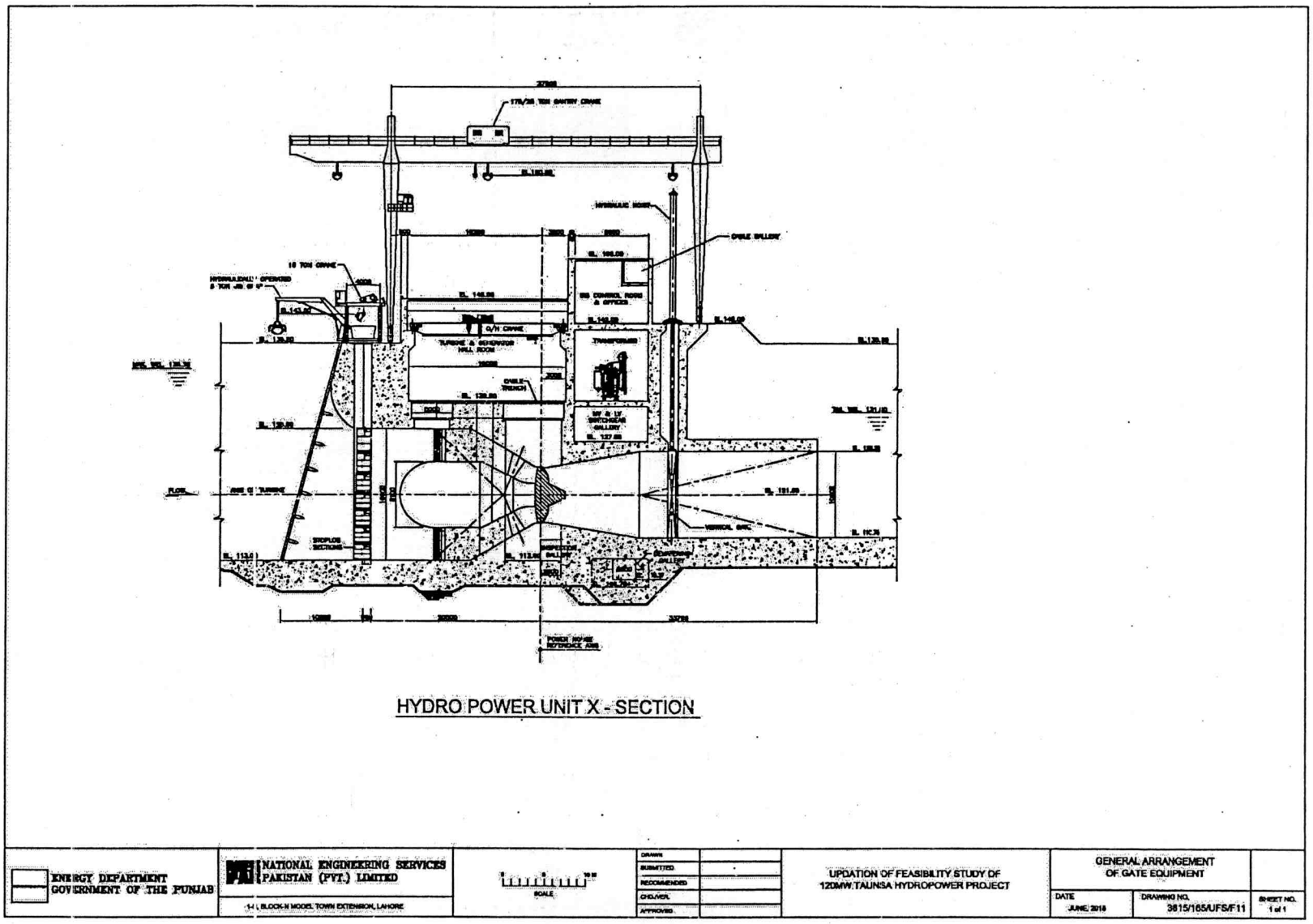

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Figure 10: Units & Station Auxiliary Supply System

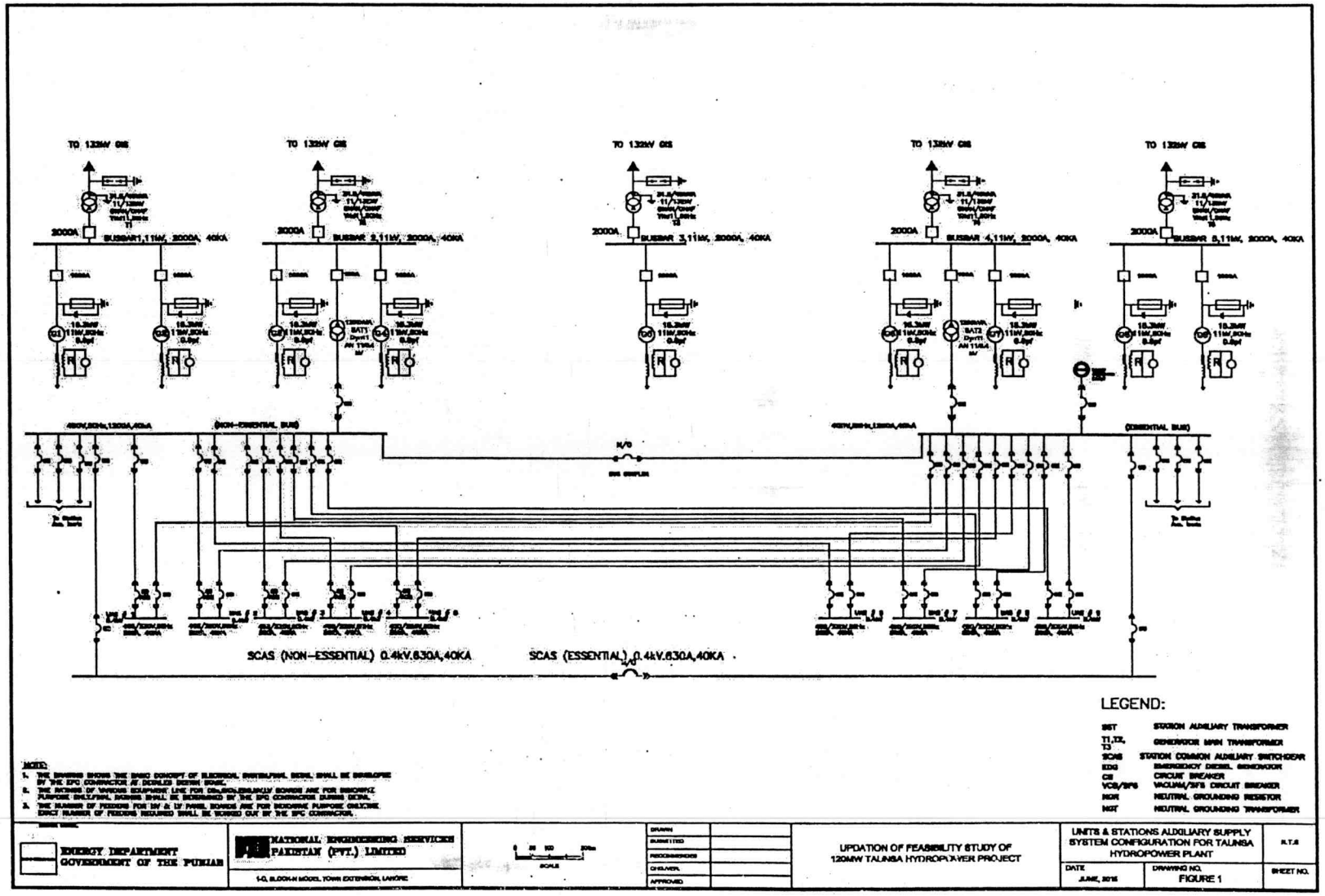


Figure 11: Conceptual DCS Configuration

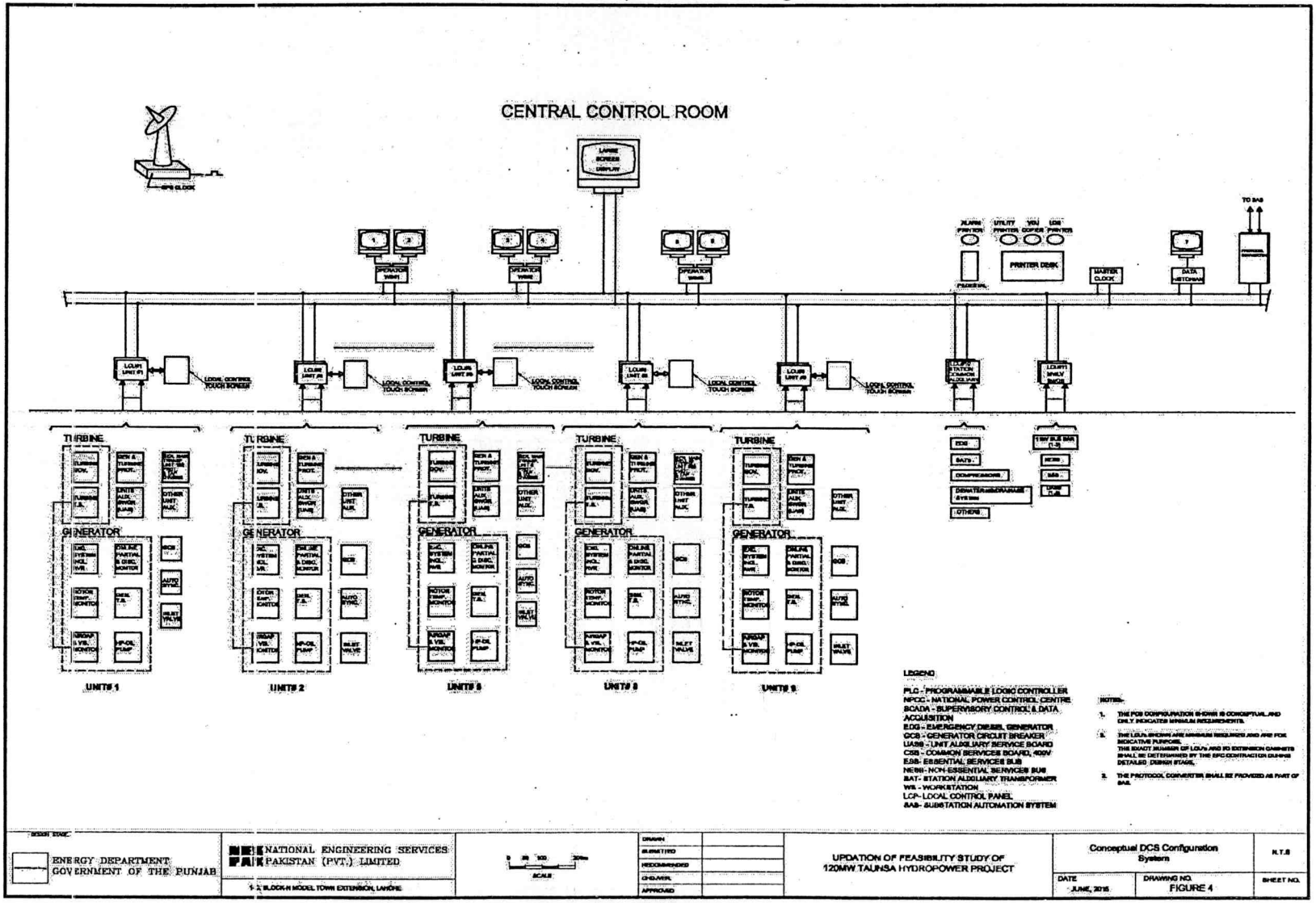
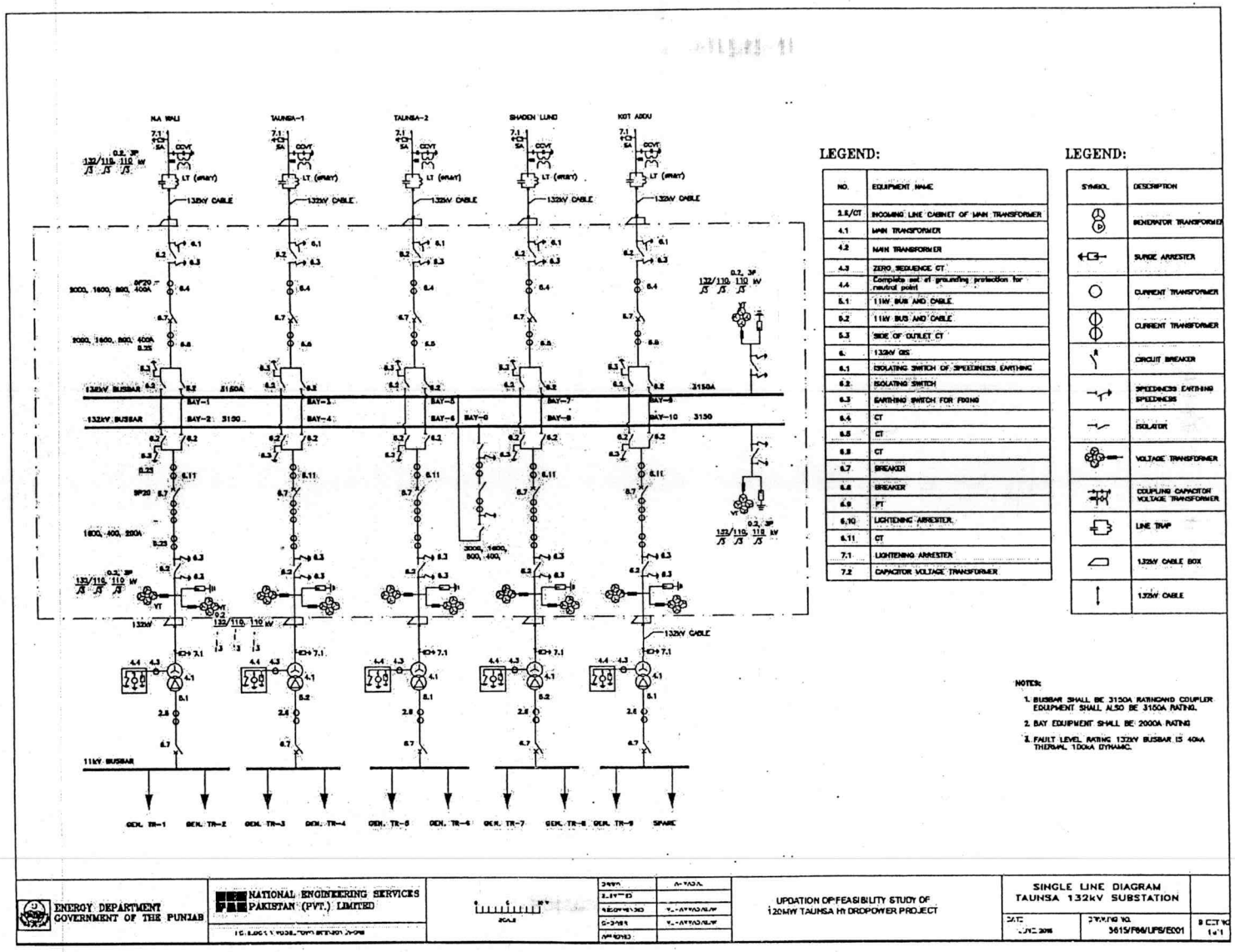


Figure 12: Single Line Diagram 132 KV Substation



NO.	EQUIPMENT NAME
2.8/CT	INCOMING LINE CABINET OF MAIN TRANSFORMER
4.1	MAIN TRANSFORMER
4.2	MAIN TRANSFORMER
4.3	ZERO SEQUENCE CT
4.4	Complete set of grounding protection for neutral point
5.1	11kV BUS AND CABLE
5.2	11kV BUS AND CABLE
5.3	SIDE OF OUTLET CT
6.	132kV GIS
6.1	ISOLATING SWITCH OF SPEEDNESS EARTHING
6.2	ISOLATING SWITCH
6.3	EARTHING SWITCH FOR FEDING
6.4	CT
6.5	CT
6.6	CT
6.7	BREAKER
6.8	BREAKER
6.9	PT
6.10	LIGHTENING ARRESTER
6.11	CT
7.1	LIGHTENING ARRESTER
7.2	CAPACITOR VOLTAGE TRANSFORMER

SYMBOL	DESCRIPTION
	GENERATOR TRANSFORMER
	SURGE ARRESTER
	CURRENT TRANSFORMER
	CURRENT TRANSFORMER
	CIRCUIT BREAKER
	SPEEDNESS EARTHING SPEEDNESS
	ISOLATOR
	VOLTAGE TRANSFORMER
	COUPLING CAPACITOR VOLTAGE TRANSFORMER
	LINE TRAP
	132kV CABLE BOX
	132kV CABLE

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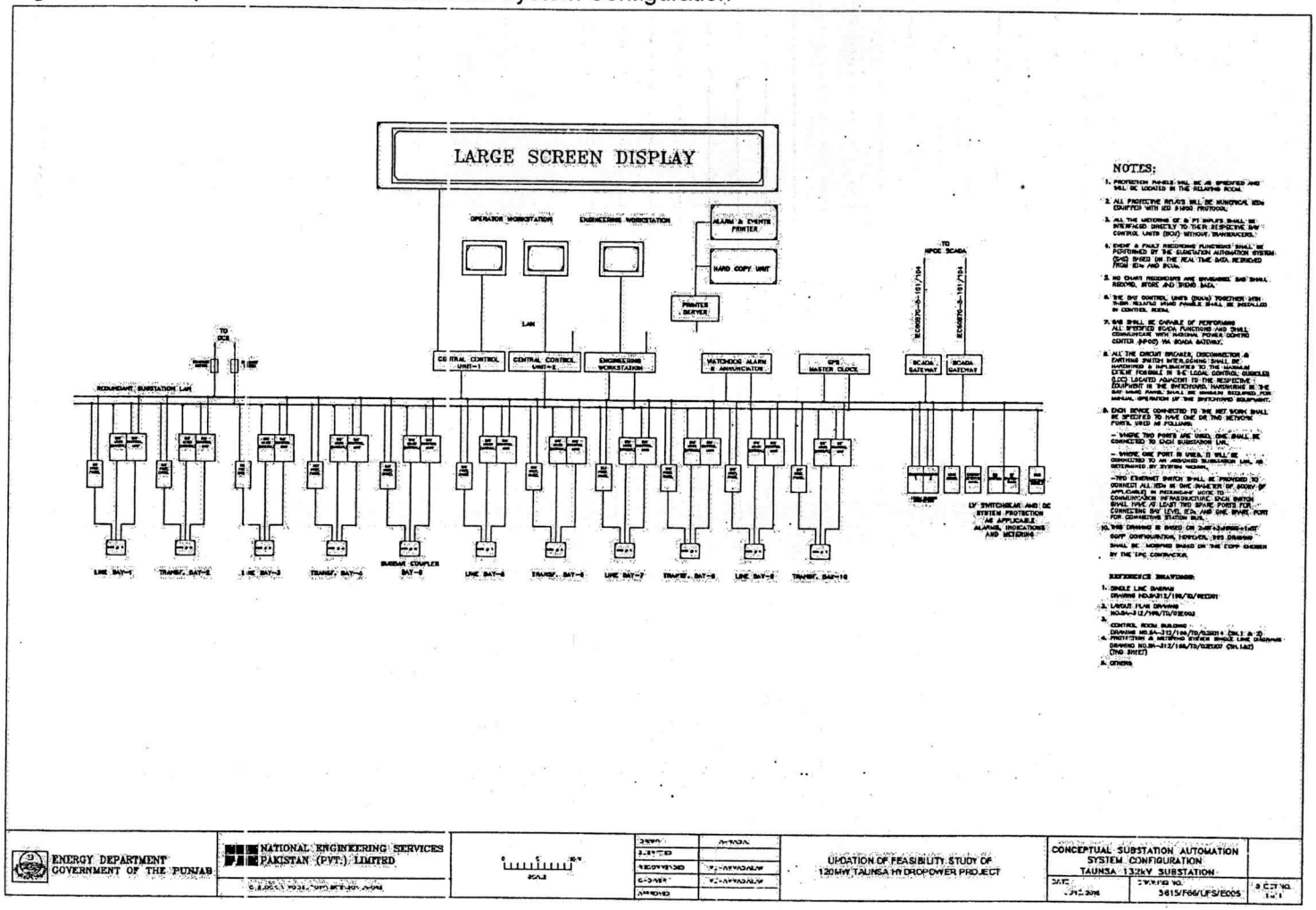
Figure 13: Conceptual Substation Automation System Configuration



SCHEDULE OF TECHNICAL DATA

132 kV GAS INSULATED SUBSTATION (GIS)

A	**General**	
1	Manufacturer's name and country of manufacturer	
2	Manufacturer's address & fax number	
3	Type designation of the equipment	
4	Year of manufacturing of the equipment	
5	Standard to which manufactured	
6	Type Test Certificates:	
	a) Issuing Authority	
	b) No. and date	
	c) Standard to which tested	
7	Whether designed for indoor or outdoor installation	
8	Permissible ambient conditions at site:	
	i) Max. temperature	deg. C
	ii) Min. temperature	deg. C
	iii) Max. humidity	%
	iv) Max. attitude	
	v) Earthquake intensity	
9	Supply system for which equipment has been designed:	
	i) Rated system voltage	kV
	ii) Max. system voltage	kV
	iii) Number of phases	
	iv) Frequency	Hz
	v) System neutral grounded/underground	
B.	**Switchgear**	
1	Rated voltage	kV
2	Rated normal (continuous) current at site conditions specified	
	i) Busbars	A
	ii) Equipment/circuits:	
	- line circuit	A
	- Transformer circuit	A
3	Rated short-time withstand current	
	i) Main circuits	kA
	ii) Earthing circuits	kA
4	Rated peak withstand current	kA
5	Rated duration of short circuit	Second
6	Rated insulation levels at minimum operating SF6 gas pressure	
	i) Lightning impulse withstand voltage (peak value)	
	- to earth and between poles	kV
	- across isolating distance (break)	kV
	ii) Power frequency (one min.) withstand voltage (rms value)	
	- to earth and between poles	kV
	- across isolating distance (break)	kV
7	Insulation level with SF6 gas at atmospheric pressure	
	i) Lightning impulse withstand voltage	
	- to earth and between poles	kV
	- across isolating distance (break)	kV
	ii) Power frequency (one min.) withstand voltage (rms value)	

		- to earth and between poles	kV
		- across isolating distance (break)	kV
	iii)	Power frequency voltage which can be applied continuously	kV
8	Single phase or three-phase (common encapsulation		
	i)	Busbar	
	ii)	Equipment/components	
9	Material:		
	i)	Enclosure	
	ii)	Busbars	
	iii)	Other current carrying parts e.g. C.Bs, Isolators etc.	
10	Busbar system, single or double		
11	a)	Design pressure of enclosure	bar (g)
	b)	Type test presure of enclosure	bar (g)
	c)	Routine test pressure enclosure	bar (g)
12	Design temperature of enclosure		deg C
13	Is enclosure cast or welded		
14	Thickness of enclosure		mm
15	Thickness of control cubicle sheet		mm
16	SF-6 gas system:		
	i)	Pressure operating range at 20°C circuit breaker chamber	
		- Rated pressure	bar (g)
		- Max. pressure	bar (g)
		- Min. pressure	bar (g)
		Busbar compartment:	
		- Rated pressure	bar (g)
		- Max. pressure	bar (g)
		- Min. pressure	bar (g)
		Other compartment (if different from busbar compartment	
		- at rated pressure	bar (g)
		- at max. pressure	bar (g)
		- at min. pressure	bar (g)
	ii)	Density at 20°C circuit breaker chamber:	
		- at rated pressure	kg/cm^3
		- at max. pressure	kg/cm^3
		- at min. pressure	kg/cm^3
		Busbar compartment	
		- at rated pressure	kg/cm^3
		- at max. pressure	kg/cm^3
		- at min. pressure	kg/cm^3
	iii)	Quantity of SF6 gas in various compartments by volume:	
			l
			l
			l
			l
			l
		Total	l
	iv)	Quantity of SF6 gas in various compartments by weight at 20°C and rated pressure:	
			kg
			kg
			kg

v)	Operating temperature range	kg
vi)	Permissible	deg C
	a) Moisture content	
	b) Air content	ppm
vii)	Gas leakage per annum max.	%
	- each compartment/partition	
	- while switchgear	%
viii)	Is pressure relief device provided for each gas compartment	%
ix)	Type of pressure relief device, safety valve or requiring diagram	
x)	Method for personnel safety	
xi)	Setting pressure for operation	bar (g)
xii)	Is two stage contact pressure gauge provided for each gas compartment	
xiii)	Details of contact pressure gauge:	
	- Type	
	- indicating range	
	- contact setting range	
xiv)	Critical temperature (liquification)	deg C
xv)	Critical density	kg/cm3
xvi)	Critical pressure	bar (g)
xvii)	Sealing system:	
	- type of sealing, double seal, O ring, gaskets	
	- method of compression	
	- material of gaskets	
	- temperature range of gaskets	deg. C
	- life expectancy/under specified service conditions	years
xviii)	Filer:	
	a) type	
	b) service life	years
xix)	Total power consumption of gas	bar (g)
17	Auxiliary supply voltage:	
	AC supply	
	- voltage	V
	- frequency range	Hz
	- No. of phases	
	- voltage tolerance (+)	%
	(-)	%
	- voltage	V
	- tolerance	
	a) control circuits max	V
	min	V
	b) trip circuits max	V
	min	V
18	Temperature rise at rated current and frequency:	
-	busbars	deg C
-	busbar contacts/joints	deg C
-	enclosures	deg C
19	Whether all equipment and accessories designed for continuous operation at specified ratings under specified service condition	
20	Is air-conditioning heating or any other special process required in the switchgear building for satisfactory operation	
21	Is switchgear of modular design	
22	Can future alterations and extensions be carried out without disturbance to and modification of existing bays	
23	Do switchgear components offer necessary flexibility to be	

	arranged in different configurations according to any single line diagram	
24	Can inspection and maintenance of any section be carried out without disturbance to other parts and without switching off the switchgear	
25	Whether the switchgear bays will be shipped completely assembled and tested at manufacturer's works. If not, give details of separately transported assemblies	
26	Dimensions of largest shipping package:	
	- Width	mm
	- Length	mm
	- Height	mm
	- Weight	kg
27	Type of joints i.e. sliding (tulip), plug-in or others, at various connections and their materials:	
	- Busbars	
	- Circuits breakers	
	- Isolators	
	- Earthing switches	
	- Current transformers	
	- Voltage transformers	
28	Measures taken to compensate for:	
	i) thermal expansion and contraction	
	ii) vibrations/movements	
	iii) mis-alignments	
	iv) minimum expansion/contraction cycles for which designed	
29	Degree of protection of control and auxiliary circuits	IP
30	Noise level	
	- normal	
	- during operation of CB	
31	Maintenance	
	i) Minor inspection of switchgear components, after	Years
	ii) Major inspection/overhauls after:	
	- intervals of	Years
	- No. of operations at rated current	
	- No. of operations at rated short circuit current	
	iii) gas refilling	Years
	iv) gas treatment (give details)	Years
32	Number of gas compartments in:	
	- line bay	
	- transformer bay	
33	Details of different gas compartments	
	- line bay	
	- transformer bay	
34	Whether earthing, HV testing and fault location of connected cables can be carried out easily	
35	Whether the components of same rating and construction are interchangeable	
36	Insulators:	
	i) Manufacturer	
	ii) Type	
	iii) Dimensions	
37	Partitions (gas barriers)	
	i) Bursting pressure	bar (g)
	ii) Routine test pressure	bar (g)

	iii) Internal arc withstand at rated short circuit current	sec
38	Methods of connections to switchgear	
	i) for line bay	
	ii) for transformer bay	
39	SF6 to air bushings:	
	i) Manufacturer	
	ii) Type	
	iii) Impulse withstand voltage	kV peak
	iv) Power frequency withstand voltage:	
	- dry	kV rms
	- wet	kV rms
	v) Creepage distance	mm
	vi) Flashover distance	mm
40	Expansion joints:	
	- Type	
	- Locations	
41	Local control cabinet:	
	i) Whether provided for each bay	
	ii) Dimensions HXLXW	
	iii) Material and thickness (give other details separately)	
	Circuit Breakers	
1	Manufacturer's name and country of manufacturer	
2	Type designation	
3	Standard to which manufactured/tested	
4	Test certificates:	
	- Issuing Institute/Authority	
	- No. and date (attach reports)	
5	No. of poles	
6	Suitability for three phase-single phase operation and rapid auto-reclosing	
7	Rated voltage	kV
8	Rated Insulation level:	
	i) Voltage	kV peak
	ii) Power frequency withstand voltage:	
	- One min.	kV rms
	- 10 Sec	kV rms
9	Rated continuous current under site conditions	A
10	Rated short circuit breaking current:	
	- symmetrical	kA
	- asymmetrical	kA
	- DC component	%
11	i) First pole-to-clear factor	
	ii) Amplitude factor	
12	Rated short time withstand current for 1 Sec	kA
13	Rated short circuit making capacity	kA peak
14	Rated operating sequence	
	Rated out-of-phase breaking current	kA
	Line charging breaking current	
	- Rated current	A
	- Over voltage	A
	Cable charging breaking capacity	
	- Rated current	A
	- Over voltage factor	A
	Small inductive breaking capacity	
	- Rated current	A
	- Over voltage factor	A
	Single capacitor breaking capacity	

	- Rated current	A
	- Over voltage factor	A
	Performance Data	
1	Maximum ambient temperature range	°C
2	Temperature rise at normal rated current and max. ambient temperature specified	
	i) Contacts	°C
	ii) Terminals	°C
	iii) Other metal parts	°C
	iv) Auxiliary circuits at max. operating voltage:	
	- trip coils	
	- close coils	
	- auxiliary contacts	
3	i) Rated voltage of:	
	a. closing coil	VDC
	b. tripping coil	VDC
	ii) Rated power consumption of:	
	a. closing coil	W
	b. tripping coil	W
4	i) Heater voltage	V
	ii) Heater power	Watts
5	Range of rated control and auxiliary supply viz:	
	i) Control – maximum/minimum	VDC
	ii) Operating mechanism – maximum/minimum	VDC-VAC
	iii) Tripping voltage – maximum/minimum	VDC
6	Tolerance in operating time	%
7	Rated opening time	ms
8	Rated closing time	ms
9	Rated breaking time	ms
10	Rated making time	ms
11	Rated dead time:	
	i) Minimum open-close dead time	ms
	ii) Minimum close-open dead time	ms
12	Rated reclosing time	
13	No. of permissible switching operations without maintenance at:	
	i) 100% short circuit breaking capacity	No.
	ii) Normal rated current:	No.
14	Recommended maintenance after above mentioned switching operation	
	CONSTRUCTION	
1	No. of breaks in series per pole	
2	Length of breaking	
3	No. of operating mechanism 3-phase circuit breaker	
4	Length of contact travel	
5	Rate of contact travel:	
	i) at tripping	m/s
	ii) at closing	m/s
6	Whether trip free or fixed trip	
7	Provision of anti-pumping device	
8	Type of operating mechanism:	
	i) opening mechanism	
	ii) closing mechanism	
9	i) Rated voltage of the charging motor in the operating mechanism	V
	ii) Total power consumption of motor	Watts
	iii) Speed	RPM
10	No. of close-open operations possible with the stored energy	No.

11	Pneumatic mechanism:	
	i) Compressor	
	a) Type	
	b) Max. discharge pressure	bar (g)
	c) Speed	rpm
	d) Auxiliary power	km
	e) Start/stop pressure	bar (g)
	f) Number	
	g) Output	
	ii) Rated pressure of compressed air for operation:	
	a) Minimum	bar (g)
	b) Maximum	bar (g)
	c) Nominal	bar (g)
	iii) Time required for the motor compressor unit to charge the air tank pressure from:	
	a) Minimum operating pressure to maximum operating pressure	Sec
	b) Atmospheric pressure to maximum operating pressure	Sec
	iv) Quantity of _____	
	a) Closing (C)	Lit.
	b) Opening (O)	Lit.
	c) Closing – Opening (CO)	Lit.
	v) Opening pressure of safety valve	Lit.
	vi) Leakage per month	Lit.
	vii) No. of description of alarms provided and corresponding pressure:	
	a) Alarm I) details to be given	bar (g)
	b) Alarm II)	bar (g)
	c) Lockout	bar (g)
	viii) Air reservoir	
	a) Number	
	b) Capacity	Lit.
	c) Rated current _____	bar (g)
	d) Operating _____	
13	Hydraulic mechanism	
	i) Rated pressure of oil for operation	
	a) Minimum	Bars
	b) Maximum	Bars
	c) Nominal	Bars
	d) Closing and spring charging mechanism normal pressure (if applicable)	Bars
	ii) Time required for the motor hydraulic pump to charge the pressure from:	
	a) Minimum to _____ pressure	Sec.
	b) Zero to maximum hydraulic pressure	Sec.
	iii) Operating mechanism pressure monitoring:	
	a) Pressure relief valve operation	Bars
	b) Oil pump 'ON' indication	Bars
	c) Auto-reclosing lockout	Bars
	d) Tripping lockout	Bars
	iv) No. of description of alarms provided and corresponding pressure:	
	a) Alarm I) details to be given	
	b) Alarm II)	
	c) Lockout	
14	Spring charge mechanism	
	i) Time required for the motor to recharge the closing	Sec.

		spring	
	ii)	No. and description of safety alarms provided	
		a) _____	
		b) _____	
		c) _____	
15	SF6 gas pressure at 20°C		
	i)	Normal SF6 pressure	Bars
	ii)	Maximum SF6 pressure	Bars
	iii)	Minimum SF6 pressure	Bars
	iv)	SF6 pressure alarm Stage-I	Bars
	v)	SF6 pressure alarm Stage-II	Bars
	vi)	Total volume of SF6 gas per pole	Lit.
	vii)	Leakage of SF6 gas per year	ml
	viii)	Max. pressure developed during quenching at rated short circuit breaking capacity	
16	Type of contacts:		Main Arcing
	i)	Material	
	ii)	Type of plating	
	iii)	Thickness of plating material	
	iv)	Contact pressure	
	v)	Total No. of auxiliary contacts:	
		a) N.O.	
		b) N.C	
		c) Reversible	
	vi)	No. of spare auxiliary contacts:	
		a) N.O.	
		b) N.C	
		c) Reversible	
17	Minimum clearance between moving and stationary parts when the circuit breaker in the open position		mm
18	Type of devices, if any, used to limit the rate of rise of recovery voltage		mm
19	Horizontal loading of operating mechanism		kg
20	Impact vertical loading of operating mechanism		kg
21	Enclosures:		
	i)	Material	mm
	ii)	Dimension _____	mm
	iii)	Thickness:	
		a) Bottom	mm
		b) Cover	mm
22	Is manual trip device provided		
23	Is slow closing device provided		
24	Is operation counter provided		
25	Weight per pole of circuit breaker		kg
26	Total weight of complete breaker		kg
D	**Isolators and Earthing Switches**		
1	Manufacturer's name		
2	Type designation		
3	Standard to which manufactured		
4	Type test certificates:		
	a)	Issuing Authority	
	b)	No. & date	
5	Rated voltage		
6	Rated lightning impulse withstand voltage:		
	a)	Across isolating distance	kV peak
	b)	To earth and between poles	kV peak
7	Rated power frequency withstand voltage:		

	a) Across isolating distance	kV rms
	b) To earth and between poles	kV rms
8	Rated normal current for isolators	A
9	Rated short-time withstand current	kA
10	Rated duration of short current	Sec.
11	Rated peak withstand current	kA
12	Rated short circuit making current (for high speed earthing switches only)	
13	Are the poles mechanically coupled	
14	Minimum clearances	
	i) Between poles	mm
	ii) To earth	mm
	iii) For isolating distance	mm
15	Type of operating mechanism	
	a) For isolator	
	b) For earthing switch	
	i) Ordinary type	
	ii) High speed type	
16	Rated supply voltage of the operating mechanism	V
17	Current required at rated supply voltage to operation the isolator	
	a) Isolator	A
	b) High speed earthing switches	A
18	Material and facing of contacts:	
	a) isolator	
	b) earthing switch	
	i) Ordinary	
	ii) High speed type	
19	Capacity to interrupt	
	i) magnetising current of transformer	A
	ii) charging current of lines and cables	A
20	Type of interlocks (details to be given separately)	
21	Number and type (NO/NC etc.) of auxiliary switches:	
	a) For the disconnected	
	b) For the earthing switch	
22	Auxiliary contacts rating	VDC – A
23	Type of position indicator	
24	Is motor operated _____ with hard operation _____	
25	Operating time	
	i) Isolator (close/open)	Sec.
	ii) High speed earthing switch:	
	a) Close/open	Sec.
	b) Spring charging	
26	Mass of complete	
	i) Isolator	kg
	ii) Earthing switch	
	a) Ordinary	kg
	b) High speed	kg
E	**Current Transformers**	Line bay T/F bay
1	Manufacturer's name	
2	Type designation	
3	Standard to which manufactured/tested	
4	Type test certificates:	
	a) Issuing Authority	
	b) No. & date	
5	Rated voltage	
6	Rated normal primary currents	A
7	Rated secondary current	
8	Rated secondary output	

	i) Measuring	VA
	ii) Protective core ( )	VA
	iii) Protective core ( )	VA
	iv) Protective core ( )	VA
9	Accuracy class:	
	i) Measuring core	
	ii) Protective core	
10	Instrument securing factor	
11	Accuracy limit factor	
12	Continuous thermal current ratings	A
13	Short-time current rating	
	i) Thermal (Ith)	kA
	ii) Dynamic (Idyn)	kA
14	Impulse withstand voltage	kV peak
F	**Voltage Transformers**	
1	Manufacturer's name & country of manufacture	
2	Type designation	
3	Standard to which manufactured/tested	
4	Type test certificates:	
	a) Issuing Authority	
	b) No. & date	
5	Rated primary voltage	kV
6	Rated secondary voltage	V
7	Rated secondary output:	
	i) for measuring accuracy	VA
	ii) for protective accuracy	VA
	iii) Total	
8	Accuracy class	
	i) for measuring	
	ii) for protective	
9	Voltage factor at rated voltage	
	i) Continuous	
	ii) 30 Sec.	
10	Thermal limit burden	VA
11	Type of insulation	

Sr. No.	Description	Particulars/Values
	Gas Insulated Surge Arresters	
	Type and designation number	
	BIL of equipment to be protected	
	System Neutral grounding at Arrester Point Of Installation (Effectively, Non-Effectively grounded)	
	Rated Voltage (Vrms) MCOV (kVrms) Line Discharge Class	
	Nominal Discharge Current (Lightning Impulse Classifying Current) with 8/20 microsecond Waveform (kApeak)	
	Temporary overvoltage capability with/without Prior discharge (kVrms) for 1 sec, 10 sec	
	Discharge Counter provided?	
	Leakage current through Arrester MCOV (mA)	

Sr. No.	Description	Unit	Particulars
	XLPE Cables		
0	Rated Voltage (Uo/U/Um)	kV	
1	Conductor		
	- Nominal Cross Section Area	Mm2	
	- Shape		
	- Diameter (approx.)	Mm	
3	Overall Diameter (approx.)	Mm	
4	Weight (approx.)	Kg/m	
5	DC conductor resistence (20°C)	Ohm/km	
6	Capacitence (nom.)	µF/km	

TECHNICAL SCHEDULES FOR TAUNSA HPP POWERHOUSE GATE EQUIPMENT

Sr. No.	Description	Unit	Origin	Particulars
A	**Power House Gate Equipment**			
a.	**Gantry Crane**			
1	Manufacturer			
2	Main Hook Hoisting Capacity	Tons		
3	Auxiliary Hook Hoisting Capacity	Tons		
4	Main Hook Maximum Travel	M		
5	Auxiliary Hook Maximum Travel	M		
6	Hook Height	M		
7	Wheel Load			
8	Crane Span			
9	Crane Width			
10	Main Trolley Maximum Lifting Speed	m/ min		
11	Crane Travel Speed	m/ min		
12	Span between Crane Rails	M		
13	Cantilevers (Left, Right)			
b.	**Fixed Wheel Gate Equipment**			
2.1	**Draft tube Hydraulic Gate**			
2.1.1	**General**			
1	Gate Manufacturer			
2	Size			
3	Design Head			
4	Material of Gate Leaf Assembly			
5	Total Weight of Gate Leaf Assembly	Tons		
6	Rubber Seals Manufacturers & Materials			
7	Local Gate Position Indicator Type			
8	Material Specifications of Embedded Parts (Side, Bottom, Lintel)			
9	Painting Specifications (Manufacturer, Type, Thickness)			
2.1.2	**Gate Hoist Hydraulically Operated**			
1	Hoisting Capacity			
2	Total Weight of Hoisting System			
3	Manufacturer			
4	Type			
5	Cylinder Materials			
6	Power Unit (Type, Manufacturer, Arrangement)			
7	Pump Type, Manufacturer			
8	Flow Directing Valves - Type, Manufacturer			
9	Flow Regulating Valves - Type, Manufacturer			
10	Pressure Relief Valves - Type, Manufacturer			
11	Pressure Switches - Type, Manufacturer			
12	Pressure Gauges - Type, Manufacturer			

13	Piping materials			
14	Filters - Type, Manufacturer			
15	Motor RPM			
16	Motor Type			
17	Motor Manufacturer			
18	Motor Capacity			
19	Brake Type and Manufacturer			
20	Oil Pumping System (Manufacturer, Arrangement)			
21	Gate Speeds (Max., Min.)	m/ min		
c.	**Stoplog**			
3.1	**Intake Stoplog**			
3.1.1	**General**			
1	Manufacturer			
2	Type of Stoplog			
3	Materials			
4	Size			
5	Design Head			
6	Height of each Section			
7	Number of Sections per Set	Nos.		
8	Weight of each Section of Stoplog			
9	Lifting Beam Type			
10	Lifting Beam Weight	Tons		
11	No. of Lifting Beams	Nos.		
12	Painting Specifications (Manufacturer, Type, Thickness)			
d.	**Trashracks**			
4.1	**Trashracks for Power House Intake**			
4.1.1	**General**			
1	Manufacturer			
2	Material			
3	Height of each Section of Trashrack			
4	Weight of each Section of Trashrack			
5	Clear space between vertical trash bars	M		
6	Number of Sections per Set	Nos.		
7	Differential Head	M		
8	Type of Lifting Beam			
9	Lifting Beam Weight	Tons		
10	No. of Lifting Beams	Nos.		
11	Painting Specifications (Manufacturer, Type, Thickness)			
4.1.2	**Trashrack Cleaning Machine**			
1	Manufacturer			
2	Width of rake	M		
3	Weight of rake			

4	Lifting Capacity of rake			
5	Rake Lifting speed	m/min		
6	Rake lowering speed	m/ min		
7	Cleaning machine travelling speed	m/ min		
8	Travelling rails span approx.	M		
9	Weight of Trashrack Cleaning Machine			
10	Wheel Load			
11	Trash Collecting Bucket (Size, Material)			
4.1.3	**Jib Grab**			
1	Type			
2	Capacity			
3	Angle of Rotation			
4	Make			
5	Mode of Operation			

1.2. TECHNICAL SCHEDULES FOR HYDROMECHANICAL EQUIPMENT

DESCRIPTION	UNIT	ORIGIN	PARTICULARS
BULB TURBINES			
Turbine Efficiency, Maximum Power and Cavitation			
- Manufacturer			
- Type			
- Model No.			
- Efficiency Hill Diagram.	Attachment Nos.		
- Efficiency Curve.	Attachment Nos.		
- Turbine Output at rated head	MW		
- Max. Turbine Efficiency	%		
- Power output at maximum efficiency	MW		
- Efficiency at maximum discharge	%		
- Efficiency at minimum discharge	%		
- Maximum/minimum discharge	m^3/s		
- Prototype and/or Model Test data for demonstrating the cavitation guarantee .	Attachment nos.		
- Maximum allowable continuous load verses gross heads between 6.92 m and 5.28 m,	Attachment nos.		
Runner			
- Manufacturer			
- Type			
- No. of Blades			
- Runner blade material			
- Maximum outer diameter	mm		
- Outlet diameter, D3	mm		
Guide Vanes and Servomotors			
- Manufacturer			
- Number of Guide Vanes	-		
- Material specifications	-		
- Necessary servomotor pressure, closed guide vanes	bar		
- Minimum required servomotor pressure for operation	bar		
- Number of servomotors	-		
- Curve showing Guide vane hydraulic torque as a function of relative opening. Appendix no.	-		
Shaft, shaft seal (if applicable)			
- Main shaft diameter	mm		
- Material specification	-		
Bearing			
- Manufacturer			
- Type			
- Model No.			
Weights			
- Runner	tonne		
- Heaviest part to be transported	-		
- Weight of heaviest part to be transported	tonne		
- Total weight of the turbine	tonne		

DESCRIPTION	UNIT	ORIGIN	PARTICULARS
GOVERNORS (PID)			
Type of Governor being offered, Attachment no			
- Manufacturer			
- Type			
- Model No.			
Governor Parameters			
- Integral time constant, TD. Adjustable between (max. / min.)	s		
- Derivative time constant, TN. Adjustable between (max. / min.)	s		
- Temporary speed droop, bt. Adjustable between (max. / min.)	-		
- Permanent speed droop, bp. Adjustable between (max. / min.)	-		
- Load setting time, full load range. Adjustable between (max. / min.)	s		
- Preliminary setting TD	s		
- Preliminary setting TN	s		
- Preliminary setting bt	-		
- Governor Dead Band	%		
Governor Main Characteristics			
- Oil Sump capacity	m^3		
- Pressure vessel(s) total volume	m^3		
- Type of pumps	-		
- Pump power consumption (each)	kW		
- Capacity of each pump	l/s		
Compressor Unit			
- Manufacturer			
- Type			
- Model No.			
- Capacity, each	Nm^3/h		
- Attach technical specification, brochures and dimensional sketches	-		
CRANES			
Powerhouse Bridge Cranes			
- Manufacturer	-		
- Type	-		
- Model No.	-		
- No of trolleys	-		
- No of hooks	-		
- Max lifting capacity	kN		
- Max lifting height	m		

DESCRIPTION	UNIT	ORIGIN	PARTICULARS
GIS Monorail			
- Manufacturer	-		
- Type	-		
- Model No.	-		
- Max lifting capacity	kN		
- Max lifting height	m		
Workshop Monorail			
- Manufacturer	-		
- Type	-		
- Model No.	-		
- Max lifting capacity	kN		
- Max lifting height	m		
COOLING AND FIRE WATER EQUIPMENT			
Pumps, Generator Cooling Circuit			
- Manufacturer			
- Type			
- Model No.			
- Material of pump casing	-		
- Material of impeller	-		
- Length			
- Width			
- Weight incl. frame, motor			
Pumps, Cooling Water Tank Supply			
- Manufacturer			
- Type			
- Model No.			
- Material			
- Speed	rpm		
- Design head (geodetic)	mWC		
- Material of pump casing	-		
- Material of impeller	-		
Fire Water Pumps			
- Manufacturer			
- Type			
- Model No.			
- Speed	rpm		
- Design head (geodetic)	mWC		
- Material of pump casing	-		
- Material of impeller	-		
- Pressure tank Weight, empty	tonne		
Dewatering Pumps			
- Manufacturer			
- Type			
- Model No.			
- Speed	rpm		

DESCRIPTION	UNIT	ORIGIN	PARTICULARS
- Design head (geodetic)	mWC		
- Material of pump casing	-		
- Material of impeller	-		
Drainage Pumps			
- Manufacturer			
- Type			
- Model No.			
- Speed	rpm		
- Design head (geodetic)	mWC		
- Material of pump casing	-		
- Material of impeller	-		
WORKSHOP EQUIPMENT			
Brochures and Catalogs:			
Special equipment			
- Vertical milling/drilling/boring/grinding machine			
Attachment no	-		
- Horizontal turntable. Attachment no.	-		
- Horizontal precision lathe. Attachment no.	-		
- Horizontal lathe with equipment for welding, coating. Attachment no.			
- Equipment for sandblasting etc. Attachment no.	-		
- Air compressors and tanks. Attachment no.	-		
General equipment			
- Column Type Drilling Machine. Attachment no	-		
- Bench Lathe.Attachment no.	-		
- Arc Welding Machine, Heavy duty. Attachment no.	-		
- Arc Welding Machine, Medium Duty. Attachment no.	-		
- Gas Welding Equipment. Attachment no.	-		
GENERAL INFORMATION			
General experience and suggestions regarding surface protection of the equipment against abrasion for use in sediment loaded water. Attachment no.	-		

GENERATORS AND EXCITATION SYSTEM

1.1 Technical Guarantees

Description	Unit	Value
Main Data:		
Applicable Design Standard		
Rated Output, S_N	MVA	
Rated Power Factor, PF (lagging & leading)		
Rated Voltage, U_N	kV	
Voltage Limits	± %	
Rated Current, I_N	A	
Rated Frequency, f_N	Hz	
Rated Speed, n_N	rpm	
Design Runaway Speed	rpm	
Critical Speed	rpm	
Rotor, Moment of Inertia, J	tm^2	
Permissible Turbine Hydraulic Load	kN	
Direction of Rotation when viewed from top		
Losses: At rated output and 75 °C winding temperature. Bearing losses caused by turbine runner weight and hydraulic load shall not be included.		
No-Load Losses	kW	
Load Losses, incl. excitation losses	kW	
Losses		
Iron losses	kW	
Ventilation losses	kW	
Bearing losses	kW	
Excitation no-load losses	kW	
Stator I^2R-losses	kW	
Additional load losses	kW	
Excitation and field circuit losses	kW	
Additional thrust bearing losses caused by max. hydraulic load	kW	
Total Losses		
Efficiencies: At rated output and 75 °C winding temperature. Bearing losses caused by turbine runner		

Description	Unit	Value
weight and hydraulic load shall not be included.		
At PF= 0.8 - 168.75 MVA (100% load)	%	
- 126.56 MVA (75% load)	%	
- 84.37 MVA (50% load)	%	
At PF= 1.0 - 168.75 (100% load)	%	
- 126.56 MVA (75% load)	%	
- 84.37 MVA (50% load)	%	
Temperature Rise Maximum temperature rise above cold cooling water (max. 10°C) at rated load and voltage:		
Stator winding, average value measured with ETD	K	
Rotor winding, the entire winding measured by the resistance method	K	
Stator core, average value measured with ETD	K	
Maximum temperature rise above ambient air:		
Slip rings, measured with contact thermometer after machine run-out	K	
Excitation transformer windings, average measured with ETD	K	
Absolute temperatures		
Thrust bearing temperature, measured with ETD in the babbit metal	°C	
Guide bearing temperatures, measured with ETD in the babbit metal	°C	
Outlet cooling water, the inlet temperature not exceeding 25°C	°C	
Generator cold cooling air	°C	
Reactances		
Unsaturated direct axis synchronous reactance, x_d	p.u.	
Unsaturated direct axis transient reactance, x'd	p.u.	
Saturated direct axis subtransient reactances, x''_d	p.u.	
Saturated quadrature axis subtransient reactance, x''_q	p.u.	
Short-Circuit Ratio		
The ratio of excitation currents at no load and rated voltage and at short circuit and rated current, i.e. i_{fo}/i_{fk}	p.u.	
Generator designed mechanically to withstand continuously a turbine output of not less than	MW	
Continuous output , overexcited , at rated speed and voltage when operated as a synchronous condenser , not less than	MVAr	

Description	Unit	Value
Continuous output, under-excited , at rated speed and voltage when charging a transmission line, without	MVAr	
becoming completely self-excited or unstable , not less than,		
Irregularities of Waveform:		
Telephone harmonic factor, THF	%	
3rd harmonic voltage	%	
Deviation factor of wave form , not greater than	%	
Stator winding withstand voltage (rms) at rated frequency, not less than	kV	
Stator winding impulse withstand voltage (BIL, crest), not less than	kV	
Excitation System Response Ratio, not less than		
Rotor and Stator Roundness:		
Max. deviation from stator design diameter (+ or -)	mm	
Max. deviation from rotor design diameter (+ or -)	mm	
-		

1.2 Technical Information

Description	Unit	Value
Manufacturer's Name		
Type		
Flux Densities at Rated Voltage:		
In the stator teeth	T	
In the stator yoke	T	
In the pole core (incl. stray field)	T	
Excitation:		
Excitation at generator rated load and the field winding at steady operating temperature:		
- excitation current	A	
- excitation voltage	V	
Ceiling voltage	%	
Voltage rise above nominal voltage at the generator terminals by throw-off of rated load and constant excitation.		
- at rated power factor	%	
- at PF = 1.0	%	
De-excitation time after tripping from rated load		

Description	Unit	Value
and 1.05 x U_N	S	
Max. slipring voltage after tripping as above	V	
Initial excitation system response	A	
Excitation transformer		
- rated output	kVA	
- rated primary voltage	V	
- rated secondary voltage	V	
- vector group		
- impedance voltage	%	
Thyristor bridge		
- Rated output	kW	
- Rated output voltage	V	
- Rated current	A	
- nos. of parallel paths per phase		
- nos. of thyristors in series per circuit		
- thyristor peak reverse voltage	V	
- thyristor rated average forward current	A	
- type of ventilation (natural conv. or forced)		
- cooling air flow	m^3/s	
Digital Automatic Voltage regulator (DAVR)		
- frequency influence unit, setting range	%/Hz	
- active current compensation, setting range	%	
- react. current compensation, setting range	%	
- field current limiter. free running adj. range	%	
- the minimum generator terminal voltage (in percent of rated value) for which continuous operation is possible	%	
Field suppression system		
- excitation circuit breaker, rated recovery voltage	VDC	
- breaking capacity at rated recovery voltage	ADC	
- estimated peak value of field current at fault conditions	A	
- maximum design voltage across the field discharge		
resistor (peak)	V	
Overvoltage protection trigger voltage	V	
Field flashing:		

Description	Unit	Value
- field flashing current (from battery)	A	
- estimated time for voltage build-up	S	
- required cooling time before repeated starting	S	
Reactances		
x_q (unsaturated)	p.u.	
x'_q (saturated)	p.u.	
x''_q	p.u.	
x_p	p.u.	
x_2	p.u.	
x_o	p.u.	
Electrical Time Constants		
T'_{do}	S	
T'_d	S	
T''_d	S	
Short Circuit Currents		
Stationary 3-phase short circuit current from no load and rated voltage	A	
Stationary 3-phase short circuit current from rated load and constant excitation	A	
Maximum peak phase current by 3-phase short circuit from no load	A	
Unbalanced Load		
Ratio of the negative-sequence current component to the rated current, with none of the phase currents exceeding the rated current	%	
Temperature rise under such operation in - stator winding	°C	
- stator laminations	°C	
- field winding	°C	
Overload Capacity Generator current in excess of rated current at rated voltage, for 15 s	%	
Stator		
Stator core	mm	
Stator laminations, outer diameter	mm	
Stator gross length	mm	
Stator net iron length	mm	

Description	Unit	Value
Loss figure of laminations at 1.0 T	W/kg	
Lamination thickness	mm	
Nos. of slots		
Slot dimensions (width x depth)	mm	
Net weight of laminations	tons	
Stator Winding		
Type of strand transposition		
Nos. of parallel current paths		
Nos. of conductors/slot		
Nos. of strands/conductor		
Coil span		
Conductor cross section	mm^2	
Conductor strand dimensions	mm	
Current density	A/mm^2	
Thickness of ground insulation	mm	
Mica content	%	
Insulation temperature class		
Weight of copper	kg	
AC Resistance per phase at 20°C	ohm	
Rotor		
Air gap (min/max)	mm/mm	
Dimensions of pole shoe (W x L x H)	mm x mm x mm	
Dimensions of pole core (W x L x H)	mm x mm x mm	
Rotor Winding		
Nos. of windings per pole		
Conductor cross section, normal/cooling wind.	mm^2	
Current density	A/mm^2	
Weight of copper	kg	
Rotor resistance at 20°C	ohm	
Thickness of ground insulation laminate	mm	
Damper Winding		
Nos. of bars per pole		

Description	Unit	Value
Bar cross section	mm^2	
Short circuit ring cross section	mm^2	
Current density at 20% negative sequence rotating field	A/mm^2	
Weight of copper	kg	
Air Coolers:		
Nos. of cooling radiators		
Cooling capacity per radiator	kW	
Air flow per radiator	m^3/s	
Cooling water flow per radiator	l/s	
Cooling water temperature rise	K	
Cooling air temperature rise	K	
Maximum test pressure	bar	
Design operating pressure	bar	
Bearing Coolers:		
Bearing cooling water flow	l/s	
Cooling water temperature rise	K	
Maximum test pressure	bar	
Design operating pressure	bar	
Braking System:		
Rot. speed when applying brakes	rpm	
Run-out time	min	
Max. temperature of brake ring	°C	
Nos. of braking cylinders		
Air pressure for braking	bar	
Bearings:		
Main and counter thrust bearing oil volume	l	
Main and counter thrust bearing pressure	N/mm^2	
Radial bearing oil volume	l	
Radial bearing pressure	N/mm^2	
Heat Dissipation of Equipment: (With unit at rated load)		
From the generator	kW	
From the excitation cubicles	kW	
From the excitation transformer	kW	

Description	Unit	Value
Weights and Foundation Forces:		
Stator complete	ton	
Rotor complete	ton	
Thrust bearing	ton	
Guide bearing	ton	
Total weight of generator	ton	
Nos. of stator foundations		
Transport and Erection:		
Dimensions of the largest piece for transportation (W x L x H)	mm	
Heaviest piece for transportation	ton	
Heaviest piece for lifting during erection	ton	
Required lifting height for erection	mm	
Drawing and information references:		
- Transport drawing(s)		
- Erection of generator		
- Generator assembly drawing		
- Excitation cubicle(s) arrangement		
- Excitation transformer weight and dimensions		
- Stator ground insulation		
- Corona suppression		
- Capability diagram with stability limits		
- V-curves and excitation diagram		
- Erection and commissioning time schedule		

2.TRANSFORMERS

2.1 Station Auxiliary Transformers (SAT)
(Fill in the data sheet for each type of transformer used)

Description	Unit	Value
Manufacturer's name		
Type		
Applicable standard		
Number of transformers	No.	
Type of insulation		
Installation (indoor/outdoor)		
Rated frequency	Hz	
Cooling		
Vector group		
Rated power: - Primary (HV) winding - Secondary (LV) winding	MVA MVA	
Temperature rise at full load: - Winding - Other parts	^{o}C ^{o}C	
Noise Level	dB(A)	
Rated voltage: - Primary (HV) winding - Secondary (LV) winding	kV kV	
Tapping on winding: - Number of taps - Tapping range - Type of tap changer		
Highest voltage for equipment: - Primary (HV) winding - Secondary (LV) winding	kV kV	
Power frequency withstand voltage (1 min.): - Primary (HV) winding - Secondary (LV) winding	kV kV	
Lightning impulse withstand voltage (HV)	kV	
short circuit impedance at 100% of rated power at principle tapping	%	
No load losses	kW	
Load losses at principle tapping	kW	
Short circuit current 0.4KV side	KA	
Neutral grounding		
Material of rating and name plate		
Maximum flux density in core at rated voltage and frequency	Tesla	
Protection class of enclosure	IP	
Overall dimension: - Length - Width - Height	mm mm mm	
Total weight	kg	

3. MEDIUM & LOW VOLTAGE SWITCHGEAR

3.1. MV SWITCHGEAR

(All items to be filled in for each type used)

Description	Unit	Value
Cubicles		
Manufacturer		
Type designation		
Rated voltage	kV	
Rated frequency	Hz	
Rated current of the busbars	A	
Material of busbars		
Cross-section of busbars	mm^2	
Temperature rise of busbars at rated current		
Power frequency withstand voltage (1 minute)	kV	
Impulse withstand voltage 1.2/50 µs	kV	
Rated short time withstand current for 3 sec.	kA	
Rated peak withstand current	kA	
Protection Class	IP	
Overall dimensions of the complete cubicle		
- length	mm	
- height	mm	
- width	mm	
Thickness of steel plates	mm	
Weight of complete cubicle less circuit breaker, etc.	kg	
Circuit Breakers		
Manufacturer		
Type designation		
Operating Mechanism (Motorized / Manual Spring Charged)		
Arc quenching medium (Vacuum/SF6)		
Rated voltage	KV	
Rated frequency	Hz	
Rated current	A	
Rated operating sequence		
Rated power frequency withstand voltage (1 min).	kV	
Impulse withstand voltage, 1.2/50 µs	kV	
Rated short circuit breaking current	kA/3s	
Rated short circuit making current	kA	
Circuit breaker operating mechanism		
Rated voltage of auxiliary devices:		
- closing and tripping devices	V DC	
- drive motor	V AC	
Breaking capacity of capacitive current	A	
Rated opening time	ms	
Rated break time	ms	
Rated close time	ms	
Rise of temperature of the contacts with rated current passing	°C	
Weight of circuit breaker, complete	kg	
Auxiliary switches:		
- switching capacity at 110 V DC	W	
- number of free NO contacts		
- number of free NC contracts		
- Power consumption		

Description	Unit	Value
- closing coil	W	
- trip coil	W	
- Motor		
- rated voltage	V	
- max. permissible service voltage	V	
- min. service voltage	V	
- Power consumption	W	
- Running time for spring charging	s	
Earthing Switches		
Manufacturer		
Type designation		
Rated voltage	kA	
Rated short time current 3 sec	kA	
Rated peak withstand current		
Operating mechanism		
Current Transformers		
Manufacturer		
Type designation		
Provided with: 3Ø or single phase for each phase		
Ratio	kV	
Rated voltage	A	
Rated current, primary side	kV	
Power frequency withstand voltage, 1 min	kV	
Impulse voltage withstand voltage, 1.2/50 µs		
Measuring core:	A	
- Rated secondary current	VA	
- Rated burden		
- Accuracy class		
- Instrument security factor		
Protection core:	A	
- Rated secondary current	VA	
- Rated output		
- Protection class		
- Accuracy limit factor		
Voltage Transformer		
Manufacturer		
Type designation		
Provided with: 3Ø or single phase for each phase		
Ratio	kV	
Rated primary voltage	V	
Rated secondary voltage	Hz	
Rated frequency		
Power frequency withstand voltage, 1 min	kV	
- primary terminal	kV	
- secondary terminals	kV	
Primary impulse withstand voltage, 1.2/50 µs		
Secondary measuring winding:	V	
- Rated voltage	VA	
- Rated burden		
- Accuracy class		
Secondary protection winding:	V	
- Rated voltage	VA	
- Rated burden		
- Protection class		

Description	Unit	Value
Surge Arresters		
Manufacturer		
Type designation		
Rated voltage	kV	
Maximum continuous operating voltage	kV	
Rated frequency	Hz	
Nominal discharge current	kA	
Protective Relays		
Type of relay:		
For protection of:		
Manufacturer:		
Measuring input range:		
- Voltage	V	
- Current	A	
- Frequency	Hz	
Output from measuring transformer secondary:		
- Voltage transformer	VA	
- Current transformer	VA	
Operating quantity, rated (100%) value		
Time delayed tripping function:		
- Setting range		
- Time delay setting range	ms	
Instantaneous tripping function:		
- Setting range		
- Tripping time delay	ms	
External power supply:		
- Rated supply voltage	V	
- Permissible voltage variation		
- Power consumption	W	

3.2 LV SWITCHGEAR

(All items to be filled in for each type used)

Description	Unit	Value
Switchgear		
Manufacturer		
Type		
Rated voltage	V	
Rated frequency	Hz	
Rated current of the busbars	A	
Temperature rise of busbar at rated current	°C	
Power frequency withstand voltage, 1 min	kV	
Three phase symmetrical short circuit withstand capacity, 3 sec.	kA	
Heat dissipation at full load conditions	W	
Panels		
Manufacturer		
Type		
Short circuit withstand current	kA	
Power frequency withstand voltage	kV	
Temperature rise above ambient air of busbars at rated current	°C	
Heat dissipation (typical)	kW	
Protection Class	IP	
Overall dimensions of the panel		
- length	mm	
- height	mm	
- width	mm	
Withdrawable Circuit Breakers		
Manufacturer		
Type		
Operation modes (local, remote)		
Rated current	A	
Rated short time withstand current	kA	
Rated breaking current	kA	
Rated making current	kA	
Control voltage	V	
Fixed Circuit Breakers		
Manufacturer		
Type		
Operation modes (local, remote)		
rated current	A	
Rated short time withstand current	kA	
Rated breaking current	kA	
Rated making current	kA	
Current Transformers		
Manufacturer		
Type		
Ratio	A	
Rated secondary current	VA	
Burden		
Accuracy class		
Overcurrent factor		
Rated primary short time current	kA	
Rated primary asymmetrical fault withstand current	kA	
Fuse Switches		

Description	Unit	Value
Manufacturer		
Type		
Rated voltage	V	
Rated current	A	
Fuse breaking capacity	kA	
Protective Relays		
Type of relay:		
For protection of:		
Manufacturer:		
Measuring input range:		
- Voltage	V	
- Current	A	
- Frequency	Hz	
Output from measuring transformer secondary:		
- Voltage transformer	VA	
- Current transformer	VA	
Operating quantity, rated (100%) value		
Time delayed tripping function:		
- Setting range		
- Time delay setting range	ms	
Instantaneous tripping function:		
- Setting range		
- Tripping time delay	ms	
External power supply:		
- Rated supply voltage	V	
- Permissible voltage variation		
- Power consumption	W	

4. PROTECTION RELAY

(All items to be filled in for each type used)

Description	Unit	Value
Type of relay:		
Protection Function:		
Manufacturer:		
Current Input: - Number of CTs - Nominal Current - Nominal Frequency - Burden for each phase	No. A Hz VA	
Voltage circuit input: - Number of VTs - Nominal voltage - Nominal frequency - Burden for each phase	No. V Hz VA	
Time delay tripping function: - Setting range - Operating time range	ms	
Instantaneous tripping function: - Setting range - Operating time range	ms	
Relay contacts: - Number of contacts - Permissible making current at 110VDC	NO/NC A	
Auxiliary power supply - Rated supply voltage - Permissible voltage variation - Power consumption	V % W	
Overall dimension (LxWxH)	mm	
Protection class	IP	

5. CABLES

5.1. MEDIUM VOLTAGE POWER CABLES

Description	Unit	Value
General Design Data: (To be filled in for every type/size of cable)		
Manufacturer:		
Type of cable		
Rated voltage	kV	
Number of cores		
Nominal cross section	mm^2	
Applied standards		
Ampacity at rated air temperature Considering cable configuration Distance between two phases Distance between two system	A	
Rated short time withstand current (1 sec)	kA	
Max. permissible fault duration at 90 °C conductor temperature and at max. fault current	kA/sec	
Conductor material		
Number of strands		
Max. continuous conductor temperature	°C	
Max. conductor temperature under short circuit condition	°C	
Material of insulation		
Material of semi conducting layer		
Material of screen		
Cross section of screen	mm^2	
Material of outer jacket/sheath		
Material of filling sheath		
Material of armoring		
Outer diameter of the cable	mm^2	
Min. bending radius	mm	
Cable length in drum	m	
Dimension of drum		
Weight of drum	kg	

5.2. LOW VOLTAGE POWER CABLES

Description	Unit	Value
Manufacturer		
Type		
Applied standards		
Rated voltage	V	
Number of cores per cable		
Nominal cross section	mm^2	
Ampacity at rated air temperature Considering cable configuration Distance between two phases Distance between two system	A	
Rated short time current (1 sec)	kA	
Max. permissible fault duration at 90 °C conductor temperature and at max. fault current	kA/sec	
Conductor material		
Number of strands		
Max. continuous conductor temperature	°C	
Max. conductor temperature under short circuit condition	°C	
Material of insulation		

Description	Unit	Value
Material of semi conducting layer		
Material of screen	mm	
Cross section of screen		
Material of outer jacket/sheath	°C	
Material of filling sheath	°C	
Material of armoring	m	
Outer diameter of the cable	mm	
Min. bending radius	mm	
Cable length in drum	m	
Dimension of drum		
Weight of drum	kg	

5.3 *Control and Measuring Cables*

Description	Unit	Value
Manufacturer		
Type		
Applied standards		
Rated voltage	V	
Conductor material		
Screen material		
Insulation material		
Max. conductor temperature:		
- at rated current	°C	
- at short circuit conditions	°C	
Cable length in drum	m	
Dimension of drum		
Weight of drum	kg	

5.4 *Fire Alarm Cables*

Description	Unit	Value
Type		
Applied standards		
Rated voltage	V	
Conductor material		
Screen material		
Insulation material		
Max. conductor temperature:		
- at rated current	°C	
- at short circuit conditions	°C	
Cable length in drum	m	
Dimension of drum		
Weight of drum	kg	

5.5 *Cable Trays/Racks*

Description	Unit	Value
Manufacturer		
Type		
Material		
Corrosion protection		
Loading capacity	kg/m	

6. DC SUPPLIES & UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)

(All items to be filled in for each type used)

Description	Unit	Value
BATTERIES		
Manufacturer		
Type		
Rated voltage	V	
Number of cells:		
- In parallel	No.	
- In series	No.	
Type of cells		
Rated Voltage per cell fully charged	V	
Float Charging Voltage	V	
Boost Charging Voltage	V	
End Voltage used for capacity calculation	V	
Float charging current	A	
Nominal charging current	A	
Nominal charging time	Hrs	
Boost charging current	A	
Max. admissible charging current	A	
Internal resistance per cell	Ohm	
Rated discharge capacity/10 hours	Ah	
Total assembly dimensions:		
- Length	mm	
- Width	mm	
- Height	mm	
Heat dissipation at full load	kW	
Material of Battery Rack		
BATTERY CHARGERS		
Manufacturer		
Type:		
Rated ac voltage	V	
Input Parameters: - Voltage - Current - Frequency - p.f	 V A Hz	
Rated dc voltage	V	
Type of cooling		
Rated input at full load	VA	
Rated dc current at ambient temperature	A	
Current limitation	A	
Type of load voltage control		
Range of load voltage control	%	
Adjustable dc voltage for:		
- float charging	V/cell	
- boost charging	V/cell	
Ripple value	%	
Heat dissipation at full load	kW	
Protection class of charger cubicle	IP	
Overall dimensions		
- length	mm	
- width	mm	
- height	mm	

Description	Unit	Value
Weight of complete Charger	kg	
Rated short time withstand current	kA/1sec	
INVERTER		
Manufacturer		
Type		
Rated input voltage	V	
Rated input current	A	
Input voltage variations	%	
Voltage stability from no load to full load with input voltage variations as above	%	
Range of load power factor		
Inductive		
Capacitive		
Over load capacity (1 sec)	%	
Over load capacity (1 min)	%	
Rated output	KVA	
Heat dissipation at full load	kW'	
Overall dimensions		
- length	mm	
- width	mm	
- height	mm	
Weight	Kg	
BATTERY FUSE BOX		
Manufacturer		
Material of box		
Protection class	IP	
Fuse rating	A	
Dimensions		
- Length	mm	
- Width	mm	
- Height	mm	

7. LIGHTING & SMALL POWER SERVICES

Description	Unit	Value
Lighting Distribution Boards		
Manufacturer:		
Type:		
Standard		
Protection class		
Circuit breakers manufacturer / type	IP	
Contactors manufacturer / type		
Fuses manufacturer / type		
Junction Boxes		
Manufacturer		
Type		
Standard		
Protection class		
Indoor Socket Outlets for 230V	IP	
Manufacturer		
Type		
Standard		
Indoor Socket outlets for 400V		
Manufacturer		
Type		
Standard		
Outdoor Socket outlets for 230V		
Manufacturer		
Type		
Standard		
Outdoor Socket outlets for 400V		
Manufacturer		
Type		
Standard		
Indoor Lighting Fixtures Type A		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type B		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type D		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type E		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting fixture type F		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type G		
Manufacturer		
Type/IP Class		

Description	Unit	Value
Standard		
Indoor Lighting Fixtures Type H		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type I		
Manufacturer		
Type/IP Class		
Standard		
Indoor Lighting Fixtures Type OTHERS		
Manufacturer		
Type/IP Class		
Standard		
Outdoor Lighting Fixtures Type OTHERS		
Manufacturer		
Type/IP Class		
Standard		
Installation Cables Indoors		
Manufacturer		
Type		
Standard		
Installation Cables Outdoors		
Manufacturer		
Type		
Standard		
Switches		
Manufacturer		
Type		
Standard		
Lighting Poles		
Manufacturer		
Type		
Height		
Material		

8. EARTHING SYSTEM

Description	Unit	Value
Buried earth Electrode		
Conductor material		
Conductor cross section:		
- buried/embedded conductors	mm^2	
- risers	mm^2	
Joints welding method		
Maximum mesh size	mxm	
Design earthing resistance	ohm	
Earthing rods		
Manufacturer		
Type		
Rod Material		
Length/diameter	m/mm	

9. FIRE DETECTION AND ALARM SYSTEM

Description	Unit	Value
Fire alarm panels To be filled in for each panel with the applicable items of the data below		
Manufacturer:		
Type:		
Adopted standard/code		
Max number of detector loops	No.	
Max number of detectors per loop	No.	
Number of sounder circuits	No.	
Number of sounders	No.	
Adjustable tripping time setting range	s	
Size, W x H x D	mm x mm x mm	
Annunciating panel		
Manufacturer		
Type		
Annunciator system Size, W x H x D	mm x mm x mm	
Power Supply		
Supply (mains) voltage and tolerance	V/±	
Battery capacity	Ah	
Practical operation time without mains	h	
Auxiliary Supply		
Detectors		
Ionized detectors:		
- Manufacturer		
- Type designation		
- Adopted standard/code		
Optical detectors:		
- Manufacturer		
- Type designation		
- Adopted standard/code		
Heat detectors:		
- Manufacturer		
- Type designation		
- Adopted standard/code		
Manual call points		
- Manufacturer		
- Type designation		
- Adopted standard/code		
Alarm sounders		
Bells:		
- Manufacturer		
- Type		
- Sound level/10 m	dBA	
Sirens:		
- Manufacturer		
- Type		
- Sound level/10 m	dBA	

10. CONTROL AND INSTRUMENTATION

10.1. Local Control System

Description	Unit	Value
Local Panel Indicating Instruments (to be filled in for each different instrument)		
Manufacturer		
Type		
Standards adopted		
Location (LCU No/:)		
Local indication and scale range		
For converter / transducer connected instruments: - Converter / transducer output range		
For direct measuring instruments:		
- Ratio of connected voltage transformer		
- Ratio of connected current transformer		
- Resistance of measuring shunt	m ohm	
Instrument accuracy class		
Size of front	mm	
Max. permissible ambient temperature	°C	
Energy meters: (to be filled in for each different type of meter)		
Manufacturer		
Type		
Standards adopted		
Consumption	VA	
Size of front	mm	
Pulse equivalency	kWh	
Max. pulse frequency	s	
Accuracy	%	
Alarm Annunciators:		
Manufacturer		
Type/series		
Signal input/output		
Alarms per card		
Power supply voltage and - tolerance	V/±	

Description	Unit	Value
Max permissible ambient temperature	°C	
Measuring converter / transducers:		
Manufacturer		
Type designation		
Converter / transducer type		
Current input range	A	
- Permissible continuous overload	%	
Voltage input range	V	
- Permissible continuous overload	%	
Output signal for rated input	mA	
Accuracy	%	
Linearity	%	
External power supply:		
- Supply voltage and - tolerance (indicate a.c or d.c.)	V / ±	
- Power consumption	W/VA	
Max. permissible ambient temperature	°C	
Transmitters		
Transmitters for T – Temperature		
Manufacturer		
Type		
Output Signal / max. Load	mA/Ohm	
Adjustability, Zero Point	%	
Adjustability, Measuring Span	%	
Error Limits	%	
Thermal Drift	% per 10 °C	
Power supply/Tolerance	V/%	
Ambient Temperature (min/max)	°C	
Local Indication Provided	Y/N	
Transmitters for P – Pressure		
Manufacturer		
Type		

Description	Unit	Value
Output Signal / max. Load	mA/Ohm	
Adjustability, Zero Point	%	
Adjustability, Measuring Span	%	
Error Limits	%	
Thermal Drift	% per 10 °C	
Power supply/Tolerance	V/%	
Ambient Temperature (min/max)	°C	
Local Indication Provided	Y/N	
Transmitters for F-Flow		
Manufacturer		
Type		
Output Signal / max. Load	mA / Ohm	
Adjustability, Zero Point	%	
Adjustability, Measuring Span	%	
Error Limits	%	
Thermal Drift	% per 10 °C	
Power supply/Tolerance	V/%	
Ambient Temperature (min/max)	°C	
Local Indication Provided	Y/N	
Transmitters for L-Level		
Manufacturer		
Type		
Output Signal / max. Load	mA / Ohm	
Adjustability, Zero Point	%	
Adjustability, Measuring Span	%	
Error Limits	%	
Thermal Drift	% per 10 °C	
Power supply/Tolerance	V/%	

Description	Unit	Value
Ambient Temperature (min/max)	°C	
Local Indication Provided	Y/N	
Transmitters for G-Position		
Manufacturer		
Type		
Output Signal / max. Load	mA / Ohm	
Adjustability, Zero Point	%	
Adjustability, Measuring Span	%	
Error Limits	%	
Thermal Drift	% per 10 °C	
Power supply/Tolerance	V/%	
Ambient Temperature	°C	
Indicators		
(to be filled in for each type)		
Type 1		
for variables (T, P, F, L) installed on local control panels		
Manufacturer		
Type		
Size of Front	mm	
Input Signal	mA	
Error Limits	%	
Ambient Temperature (min/max)	°C	
Type 2		
for position and electric variables installed on local control panels		
Manufacturer		
Type		
Size of Front	mm	
Input Signal	mA	
Error Limits	%	
Ambient Temperature (min/max)	°C	

Description	Unit	Value
Type 3		
for electric variables on switchgears		
Manufacturer		
Type		
Size of Front	mm	
Input Signal	mA	
Error Limits	%	
Ambient Temperature (min/max)	°C	
Type 4		
Double indicators for analogue control stations, (if required)		
Manufacturer		
Type		
Size of Front	mm	
Input Signal	mA	
Error Limits	%	
Ambient Temperature (min/max)	°C	
Control Valves		
(to be filled in for each type)		
Type 1		
Manufacturer		
Type		
Type 2		
Manufacturer		
Type		
Type 3		
Manufacturer		
Type		
LCU General Data:		
Manufacturer		
Scan time per I/O	bit	
Programming system and language		

Description	Unit	Value
LCU Specific Data: (to be filled in for each LCU)		
Number of LCU Cubicles		
Dimensions per cubicle (W x D x H)	mm	
Weight per cubicle	kg	
LC Memory Capacity		
Power consumption per LCU	VA	
Heat dissipation (typical)	kW	
Number of DIs per board		
Number of DI boards		
Number of DOs per board		
Number of DO boards		
Number of AOs per board		
Number of AO boards		
Number of AIs per board		
Number of AI boards		
A/D converting accuracy	%	
Number of PTs per board		
Number of PT boards		
Number of PIs per board		
Number of PI boards		
No. Of free I/O positions as tendered		
Number of measurement converter / transducers:		
- for voltage measurement		
- for current measurement		
- for power measurement (active and reactive)		
- for power factor measurement		
- for temperature (Pt-100) measurement		

10.1.2 Station Control System (SCS)

Description	Unit	Value
Optical disk backup storage system		
Manufacturer		

Description	Unit	Value
Type		
Country of origin		
Memory capacity	Mbyte	
Dimensions (W x D x H)	mm	
Weight	kg	
VDUs/ LCD Monitors:		
Manufacturer		
Type		
Screen:		
- size	in	
- Characters per line		
- Lines per page		
Number of foreground colours		
Number of background colours		
Zoom/planning functions		
Dimensions (W x D x H)	mm	
Functional keyboards:		
Standards adopted		
Number of keys		
Size	mm	
Personal Computer:		
Manufacturer		
Type		
Country of origin		
Memory size	Mbytes	
Disk memory size	Mbytes	
Color Hard Copy Unit:		
Manufacturer		
Type		
Country of origin		
Number of colours		
One VDU picture print of time:	sec	
Dimensions (W x D x H).	mm	

Description	Unit	Value
Printers:		
Manufacturer		
Type		
Country of origin		
International standards adopted		
Noise level	dBA	
Power supply		
- Rated voltage	Vrms	
- Rated power	VA	
Printing method		
Character set		
Printing width	char	
Character buffer capacity	char	
Paper feed		
Paper format		
Dimensions (W x D x H)	mm	
Weight	kg	
Front End Communication Unit:		
Manufacturer		
Type		
Country of origin		
Number of lines		
Hamming-distance		
Critical length of signal cables		
Dimensions (W x D x H)	mm	
Optical-Fibre communication system:		
Manufacturer		
Type		
Country of origin		
Standards adopted		
Modem interface		
Number of lines		
Hamming distance		
Cubicle dimensions (W x D x H)	mm	

Description	Unit	Value
Cubicle weight fully equipped	kg	
Heat dissipation (typical)	kW	
Communication Cables		
Kind of cable		
Transmission rate	Mbaud	
Transmission speed	Mbps	
Communication		
Max. distance without coupler	m	
Max. number of connectable stations	No.	
Hamming-distance	m	
Insensibility against disturbance (acc. to IEC 60255-4)		
Operator Work Station (Central Control Room)		
Max. number of graphics	No.	
Number of graphics prepared by the Contractor	No.	
Number of pre-programmed symbols for graphic presentation	No.	
Number of additional user defined symbols	No.	
Max. number of curves	No.	
Number of curves programmed by the Contractor	No.	
Number of control room plant Monitors:	No.	
per unit	No.	
common	No.	
Number of plant protocols, printers	No.	
unit	No.	
common	No.	
Number of keyboards, alphanumeric type	No.	
Number of keyboards, functional type	No.	
Capacity of external storage device	kB	
Long time archives:		
Number of stored curves/protocols	No.	

Description	Unit	Value
- storage interval	days	
- storage capacity	MB	
Large Screen Display (LSD)		
Type		
Manufacturer		
Resolution		
Diagonal(min 50 Inch)	cm	
Picture frequency	MHz	
Number of colours		
Buffer memory	MB	
Number of characters per line		
Type (kind) of cursor/mouse, Lightpen etc.)		
Power supply limits	V	
Consumption	VA	
Mounting Equipment		
VDU Copier Equipment		
Type		
Manufacturer		
Printing method		
Number of colours		
Paper format		
Kind of paper		
Time necessary for printing A-4 format of average density		
Auto-diagnostic facilities	Y/N	
Number of pictures in the buffer memory		
Capacity of buffer memory	kB	
Consumption	VA	
Power supply limits	V	
CD Read/Write Drive		
Type		
Manufacturer		
Disc-format		

Description	Unit	Value
Disc-capacity	MB	
Transfer rate	kB/s	
Access time	ms	
Hard Disc Unit (as required)		
Type		
Manufacturer		
Disc-format		
Disc-capacity	GB	
Transfer rate	kB/s	
Access time	ms	
Colour Plotter		
Type		
Manufacturer		
Plotting method		
No. of colours		
Kind of paper		
Capacity of Buffer memory		
Power Consumption		
Power Supply limits		
Central Control Room Furniture		
Desk (Unit & Common)		
Manufacturer		
Type		
Dimension per desk/table		
(WxDxH)	mmxmmx mm	
Heat Dissipation		
In CCR	kW	

11. EMERGENCY DIESEL GENERATING UNIT (EDG)

Description	Unit	Value
DIESEL ENGINE		
Manufacturer		
Model/type		
Nominal speed	rpm	
Output	kW	
Number of cylinders		
Displacement	L	
Maximum break pressure	kPa	
Intake air flow	m^3/min	
Radiator Flow	m^3/min	
Exhaust temperature	^0C	
Max. water temperature/ temperature range	^0C	
Coolant capacity	L	
Oil capacity	L	
Fuel consumption at rated output	L/h	
Oil consumption	L/h	
Governor		
- Manufacturer		
- Type		
GENERATOR		
Manufacturer		
Type		
Rated continuous output	kVA	
Phase		
Frequency	Hz	
Rated power factor		
Rated terminal voltage	kV	
Rated speed	rpm	
Temperature rise limits at rated output at a cooling air temperature not exceeding 40°C for		
- stator winding	K	
- rotor winding	K	
Generator efficiency at rated frequency, rated voltage and power factor:		
- rated output	%	
- 75% of rated output	%	
- 50% of rated output	%	
Permissible transient voltage drop	%	
Voltage stabilizing time	sec	
Permissible transient frequency drop	%	
Frequency stabilizing time	sec	
Maximum over speed	rpm	
Neutral grounding		
Audible noise level	dB	
Generator excitation at maximum voltage	%	
Total weight of generator	T	
Max. weight to be lifted	T	
Overall dimensions		
- Length	mm	
- Width	mm	
- Height	mm	
Protection class	IP	

Description	Unit	Value
Batteries		
Manufacturer		
Type		
Rated voltage	V	

11	CONTROL, INDICATIONS, MONITORING AND METERING EQUIPMENT			
11.1	**Substation Automation System (Control, Indications, Monitoring & Metering)**			
	a)	Manufacturer		
	b)	Country of Manufacture.		
	c)	Type.		
	d)	Manufacturing ordering code.		
11.2	**Bay Control Unit & Bay Mimic Panel**			
	a)	Pre-wired.		
	b)	Floor-mounted.		
	c)	Steel sheet thickness.		
	d)	Maximum height.		
	e)	Door material.		
	f)	Paint thickness.		
	g)	Final Colour.		
	h)	Degree of protection - IP class.		
	i)	Anti condensation heater with Adjustable hygrostat thermostat provided.		
	j)	Power supply for heater and cubicle light.		
11.3	**Bay Control Unit (BCU)**			
	a)	Manufacturer		
	b)	Country of Manufacture.		
	c)	Type.		
	d)	Manufacturing ordering code.		
	e)	Dimension		
	f)	Screen Resulation pixels for locl mimic panel.		
	g)	Type of interface.		
	h)	Operating temperature range C°		
	i)	Operating voltage		
	j)	Power Consumption watt.		
	k)	Power supply from station battery VDC.		
	l)	Pre-fault recording time.		
	m)	No. of samples per seconds		
	n)	No. of events storage		
11.4	**COMMUNICATION LINKS:**			
	a)	Data transmission rate Mbit/Sec.		
	b)	Number of buses per processing unit No.		
	c)	Nodes per buses Pcs.		
	d)	Transmission range (with fibre optic cable) meter.		
11.5	**PROGRAMMING AND SERVICES UNIT (personal computer or programming unit):**			
	a)	Main processor type		
	b)	Main memory M byte.		
	c)	Bus speed.		
	d)	Hard disc G byte.		
	e)	Super Drive R/W speed.		
	f)	LCD-Monitor type & size.		
	g)	Interfaces.		
	h)	Operating system.		
	i)	Weight.		
	j)	Ambient temperature:		
		i) Operation °C.		
		ii) Storage °C.		
		iii) Transport °C.		
	k)	Electromagnetic interference tests:		

		(Insulation test, voltage test, individual test).		
		i) Application standards.		
		ii) Test voltage AC kV/Hz		
		iii) Or DC (1 minute).kV.		
		vi) Internal circuit against earth		
		vii) Impulse voltage test, type test:		
		- Test level.		
		- Test voltage.		
11.6	**STATION COMPUTER**			
	a)	Manufacturer / Model.		
	b)	Type.		
	c)	AC Voltage Working Range. Volts		
	d)	Service Conditions (Temperature & RH).		
	e)	Power Consumption. Watt		
	f)	Architecture.		
	g)	Operating system software.		
	h)	VGA controller type		
	i)	Ambient temperature		
	j)	Method of Processor Expansion (e.g. number of free slots when supplied).		
11.7	**Main (Semi Conductor) Memory**			
	a)	Type.		
	b)	Supplied Size.		
	c)	Maximum expandable size.		
	d)	Battery back up system.		
11.8	**Hard Disc Storage.**			
	a)	Type.		
	b)	Supplied Size.		
	c)	Maximum size.		
11.9	**Clock.**			
	a)	Type.		
	b)	Drift per day (when not synchronized to master clock).		
	c)	Method of synchronization with master clock.		
11.10	**Processing system Intercommunications Interface.**			
	a) Number supported.			
	b) Type (e.g. LAN etc.)			
	c) Speed.			
11.11	**Video Display Unit**			
	a) Type & size.			
	b) Number to be supplied at a workstation.			
	c) Screen size.			
	d) Screen pixel resolution.			
	e) Compliance with recognized EMC and safety Standards			
	f) Type of Interface.			
11.12	**Keyboard.**			
	a) Type.			
	b) Number to be supplied.			
	c) Total number of keys			
	d) Alphanumeric character key set.			
	e) Control keys provided.			
	f) Number of special function keys.			
	g) Type of Interface.			
11.13	**Cursor Control Device/Mouse.**			
	a) Number to be supplied.			
	b) Number of buttons.			

	c) Type (e.g. optical).		
	d) Mat		
	e) Type of interface.		
11.22	**LARGE SCREEN DISPLAY**		
	a) Manufacturer/model		
	b) Country of Manufacturer		
	c) Type LCD, LED or Plasma		
	d) Diagonal Display Size (min 103")		
	e) Screen resulation pixels		
	f) Type of interface		
	g) Time between excessive update m sec.		
	h) Operating temperature range °C		
	i) Operating voltage VAC		
	j) Power consumption watt.		
11.23	**Event Log Printer**		
	a) Manufacturer / Model		
	b) Coloured Laser - Type.		
	c) AC Voltage Working Range Volts.		
	d) Power Consumption watt.		
	e) Service Conditions (Temperature & RH).		
	f) Print Speed PPm.		
	g) Print Pitch / Width.		
	h) No. of print pins / jets or resolution.		
	i) No. of fonts / character sets.		
	j) Paper feed proposed / width.		
	k) Self test facility.		
	l) No. of colours.		
	m) Type of interface.		
	n) Stand / Trays.		
	o) Acoustic noise at one meter.		
	p) Alarms local and Remote.		
	q) Configuration / dual network connection.		
11.24	**HARD COPY COLOUR LASER PRINTER.**		
	a) Manufacturer / Model		
	b) Type.		
	c) AC Voltage Working Range Volts.		
	d) Power Consumption watt.		
	e) Service Conditions (Temperature & RH).		
	f) Print Speed for Colour Graphics Printing (PPM).		
	g) No. of colours / toners.		
	h) Resolution.		
	i) Paper Handling.		
	j) Paper Size.		
	k) Type of Interface.		
	l) Stand / Trays.		
	m) Acoustic noise at one meter db.		
	n) Alarms local and remote.		
	o) Configuration / dual network connection.		
11.25	**GPS MASTER CLOCK SYSTEM.**		
	a) Manufacturer / Model.		
	b) Type.		
	c) AC / DC Voltage Working Range.		
	d) Power Consumption.		
	e) Service conditions (temperature & RH).		
	f) Battery Standby capacity.		

	c) Type (e.g. optical).		
	d) Mat		
	e) Type of interface.		
11.14	ENGINEERING WORK STATIONS.		
	a) Manufacturer / Model.		
	b) Type.		
	c) AC Voltage Working Range. Volts		
	d) Service Conditions (Temperature & RH).		
	e) Power Consumption. Watt		
	f) Architecture.		
	g) Operating system software.		
	h) VGA controller type		
	i) Ambient temperature		
	j) Method of Processor Expansion (e.g. number of free slots when supplied).		
11.15	**Main (Semi Conductor) Memory.**		
	a) Type.		
	b) Supplied Size.		
	c) Maximum size.		
	d) Battery back up system.		
11.16	**Hard Disc Storage.**		
	a) Type.		
	b) Supplied Size.		
	c) Maximum size.		
11.17	**Clock.**		
	a) Type.		
	b) Drift per day (when not synchronized to master clock).		
	c) Method of synchronization with master clock.		
11.18	**Processing system Intercommunications Interface.**		
	a) Number supported.		
	b) Type (e.g. LAN etc.)		
	c) Speed.		
11.19	**VIDEO DISPLAY UNIT**		
	a) Type & size.		
	b) Number to be supplied at a workstation.		
	c) Screen size.		
	d) Screen pixel resolution.		
	e) Screen Display Speed		
	f) Compliance with recognized EMC and safety Sandards		
	g) Type of Interface.		
11.20	**Keyboard.**		
	a) Type.		
	b) Number to be supplied.		
	c) Total number of keys.7		
	d) Alphanumeric character key set.		
	e) Control keys provided.		
	f) Number of special function keys.		
	g) Type of Interface.		
11.21	**Cursor Control Device/Mouse.**		
	a) Number to be supplied.		
	b) Number of buttons.		

	g) Type, speed and No: of output interfaces.		
	h) Time and date facility.		
	i) Seasonal changeover / automatic.		
	j) Local display.		
	k) Day – Date: Month: Year		
	l) HH: MM: SS:		
	m) Drift per day (when not synchronized to radio signal)		
	n) Receiver for UT from NAVSTAR satellites.		
	o) Loss of radio synch alarm.		
	p) Other alarms.		
	q) Local alarms and contacts for alarms to SCMS.		
11.26	**IEC61850 ETHERNET SWITCH (LARGE)**		
	a) Manufacturer		
	b) Type		
	c) Network Interfaces		
	d) Simple Network Management Protocol (SNMP)		
	e) Switch Properties		
	f) Input voltage		
	g) Power consumption		
	h) Ambient temperature		
	i) Physical dimension		
11.27	**IEC61850 ETHERNET SWITCH (Small)**		
	b) Type		
	c) Network Interfaces		
	d) Simple Network Management Protocol (SNMP)		
	e) Switch Properties		
	f) Input voltage		
	g) Power consumption		
	h) Ambient temperature		
	i) Physical dimension		
11.28	**UPS**		
	a) Nominal input voltage		
	b) Input voltage range		
	c) Input frequency range		
	d) Nominal output voltage		
	e) Nominal power		
	f) Efficiency at full load		
	g) Dimensions		
11.29	**FURNITURE.**		
	a) Operator desk.		
	b) Engineer desk.		
	c) Material of desk.		
	d) Durable desk top surface.		
	e) Writing area.		
	f) Drawers / shelves.		
	g) Support for VDUs.		
	h) Size.		
	i) Height.		
	j) Operator chair.		
	k) Material.		
	l) Swivel and castor action.		
	m) Arm rests.		
	n) Engineer Chair.		
	o) Material.		
	p) Swivel and castor action.		
	q) High backed design.		
	r) Arm rests.		
	s) Desk lighting.		

	t) Window blinds.		
11.30	**SUBSTATION LAN.**		
	a) Manufacturer / Model.		
	b) Type.		
	c) No. of ports		
	d) Coaxial / Optical Fiber Cable.		
	e) Operating Speed Hz.		
	f) Protocols / Compliance with OSI 7498.		
	g) Media connection.		
	h) Network functionality.		
	i) Network management software.		
	j) Software Packages.		
	k) Dual redundant configuration.		
11.31	**COMMUNICATIONS.**		
	a) Protocol between station computer and BCU:		
	b) Manufacture / Model.		
	c) Complaint with IEC 61850		
	d) Info. Transfer efficiency (data bits / total bits).		
	e) Hamming distance.		
	f) Security of control messages.		
	g) Interface.		
	h) Transmission rate.		
	i) Type and No. of communication cables to BCU.		
	j) Type & No. of communications cables to protection relay.		
	k) The time between selecting display of analog measurements and the actual display on the monitors Sec.		
	l) The time between successive updates of the main database servers with analog measurements shall not exceed.		
	m) MW measurements Sec.		
	n) Other analog measurements Sec.		
	o) The time between successive updates of the main database servers with pulse meter values shall not exceed Min.		
	p) Station computer fail-over time.		
	q) Normal Sec.		
	r) Maximum Sec.		
	s) Control System restarting time to full real-time operation after a power failure Sec.		
11.32	**SYSTEM CAPACITY.**		
	a) CPU: Consumption under Full Load %		
	b) Moderate Load %.		
	c) Worst case Load %.		
	d) Redundant remote control interface based on IEC		
	e) 60870-5-101/104 protoco Yes/No.		
	f) Sequence control of bays Yes/NO.		
	g) Automatic voltage regulation and transformer parallel operation Yes/No.		
	h) Calculation of station internal and external temp. Measurements Yes/No		
	i) Downloading of settings into, and integration of standalone intelligent relay Yes/NO.		
	j) Load shedding and Load management Yes/No.		
	k) On-line monitoring and diagnostic facilities Yes/No.		
11.33	**SYSTEM PERFORMANCE.**		
	a) The time between selection and display of VDU diagram fully		

	updated from the database shall not exceed m sec.		
	b) The time between selection of a control function and check back from field equipment m sec.		
	c) The time between execution of a control function and successful completion displayed at workstation monitors for:		
	- Circuit breaker (operation time less than 100 m Sec.) Sec		
	- Isolator (operating time less than 10 sec) Sec.		
	- Tap changer (operating time about 10 sec.) Sec.		
	d) The time between the occurrence of the first change of state/ alarm in the process and display on the monitor Sec.		
11.34	**IEC 60870-5-T101 Protocol Profile.**		
	a) Functions Supported.		
	- Station initialization Yes/No.		
	- Command transmission. Yes/No.		
	- Cyclic data transmission. Yes/No.		
	- Data acquisition by polling. Yes/No.		
	- Acquisition of events and alarms. Yes/No.		
	- General interrogation scan. Yes/No.		
	- Clock synchronization. Yes/No,		
	- Parameter loading. Yes/No.		
	- Parameter activation. Yes/No.		
	- File transfer. Yes/No.		
	- Transmission of integrated totals. Yes/No.		
	- Test procedure. Yes/No.		
	b) Physical Interface.		
	c) Compliance to Standard.		
	d) V.24/V.28 of ITU-T for unbalance mode. Yes/No.		
	e) X.24/X.27 of ITU-T for balance mode. Yes/No.		
	f) Modern type used.		
	g) 2 wire in half-duplex circuit. Yes/No.		
	h) 4 wire in half-duplex. Yes/No.		
	i) 4 wire in full-diplex. Yes/No.		
	j) Transmission mode:		
	- Unbalanced mode. Yes/No.		
	- Balanced mode. Yes/No.		
	- Modern speed for Unbalanced mode.bps		
	- Modern speed for Balanced mode. Bps		
	K) Transmission Procedures Sported in Control Field:		
	- FCB activated. Yes/No.		
	- FCV activated. Yes/No.		
	- ACD activated. Yes.No.		
	- DFC activated. Yes/No.		
	- List the function codes selected in separate sheets. Yes/No.		
11.35	**Performance / Availability.**		
	Compliance with performance requirements (start and restart).		
	a) Time for redundant station computer to assume online duties.		
	b) Time for full updating of information.		
	c) Confirmation the redundant station computer database is in step with the on line computer.		
	Measurement Accuracy for EHV/HV BAYS (%):		
	Current		
	Voltage		
	Harmonic		
	Active & Reactive Power		
	MV Feeder		
	Availability (Minimum Required 99.98%).		

	Availability calculations included.			
11.36	**Static Switch**			
	a) Manufacturer / Model.			
	b) Type.			
	c) Input voltage range. Volts			
	d) Input frequency range. Hz.			
	e) Output voltage regulation. %			
	f) Service conditions (temperature and RH).			
	g) Rating. Amps.			
	h) Output current overload. Amps.			
	i) Thermal trip. Amps.			
11.37	**Inverter Distribution.**			
	a) Manufacturer / Model.			
	b) Type of switch.			
	c) Type of MCB.			
	d) Distribution circuits (numbers and ratings).			
11.38	**Power Supply Housing.**			
	a) No. of cubicles.			
	b) Forced cooling / alarming.			
	c) Noise limits at one meter.			
	d) Instrumentation.			
	e) Alarms.			
	f) Efficiency & power factor at 25, 50, 75 & 100% outputs.			
	g) Modular design / system extension facilities.			
	h) Provision of maintenance switch.			
	i) Radio frequency interference (production).			
11.39	**AC Mains Power Transient Protector.**			
	a) Manufacturer / model.			
	b) Type.			
	c) Nominal ac voltage and range. Volts			
	d) Input ac frequency and range. Hz			
	e) Service conditions (temperature and RH).			
	f) Power factor.			
	g) Peak discharge current. Amps.			
	h) Leakage current.			
	i) Connection details.			
	j) Dimensions / Housing.			
11.40	**Metering Board**			
	1	Manufacturer's name and country		
	2	Type		
	3	Material and thickness of sheet.		
	4	Dimensions & weight:		
		- Height, mm		
		- Width, mm		
		- Depth, mm		
		- Weight, kg		
11.41	Control Boards:			
	1	Manufacturer's name and country		
	2	Type		
	3	Material and thickness of sheet.		
	4	Dimensions & weight:		
		- Height, mm		
		- Width, mm		
		- Depth, mm		
		- Weight, kg		
11.42	Instruments and Controls:			

		(a) Annunciator:		
		- Manufacturer's name and country		
		- Type designation		
		- Operating voltage		
		- Hardwire connected/programmable		
		- Tolerance in operating voltage, ±, %		
		- Number of windows per unit.		
		- Window size		
		(b) Ammeter:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		- Accuracy		
		(c) Voltmeter:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		- Accuracy		
		(d) Wattmeter:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		- Accuracy		
		(e) Varmeter:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		- Accuracy		
		(f) Synchrono-scope:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		(g) Frequency meter:		
		- Manufacturer's name and country		
		- Type designation		
		- Indication range.		
		- Accuracy		
		(h) Control switches:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(i) Instrument switches:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(j) Current Test blocks:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(k) Voltage test blocks:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(l) Test switches:		

		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(m) Terminal blocks and terminals:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating.		
		- Current rating.		
		(n) Indication lights/alarms:		
		- Manufacturer's name and country		
		- Type designation		
		- Voltage rating, V, rms		
		- Series resistance, ohms		
		(o) Digital clock:		
		- Manufacturer's name and country		
		- Type designation		
		- Dimensions, mm		
		- Operating voltage, V		
		- Tolerance in operating voltage, +, %		
		(p) Voltage transducer:		
		- Manufacturer's name and country		
		- Type designation		
		- Range		
		- Output		
		- Impedance		
		- Accuracy (% of full scale)		
		(q) Current transducer:		
		- Manufacturer's name and country		
		- Type designation		
		- Range		
		- Output		
		- Impedance		
		- Accuracy (% of full scale)		
		(r) Watt transducer:		
		- Manufacturer's name and country		
		- Type designation		
		- Range		
		- Output		
		- Impedance		
		- Accuracy (% of full scale)		
		(s) Var transducer:		
		- Manufacturer's name and country		
		- Type designation		
		- Range		
		- Output		
		- Impedance		
		- Accuracy (% of full scale)		
		(t) Keys for synchronizing and instrument switches:		
		- Manufacturer's name and country		
		- Type designation		
11.43	Energy Meters:			
		(a) Kilowatt Hour Meter:		
		- Type		
		- Manufacturer's name and country		

		- Accuracy class		
		- Number of digits on the display.		
		- Rated power consumption		
		- Current circuit, VA		
		- Voltage circuit, VA		
		- Max. power demand indicator		
		Yes/No.		
		- Protection degree, IP		
		(b) Kilovar Hour Meter:		
		- Type		
		- Manufacturer's name and country		
		- Accuracy class		
		- Number of digits on the display		
		- Rated power consumption		
		- Current circuit, VA		
		- Voltage circuit, VA		
		- Max. var demand indicator		
		Yes/No.		
		- Protection degree, IP		
		(c) Voltage Recorder:		
		- Type		
		- Manufacturer's name and country		
		- Accuracy class		
		- Number of digits on the display		
		- Rated power consumption		
12	**RELAYS AND PROTECTION SYSTEM:**			
12.1	Relay Panel Dimensions:			
	1	Height, mm		
	2	Width, mm		
	3	Depth, mm		
	4	Thickness of sheet, mm		
	5	Weight, kg.		
12.2	Transmission Line Protection:			
12.2.1	Line Distance Protection Set-I			
	1	Type		
	2	Manufacturer's name and country		
	3	Test certificate		
		(a) Issuing Institution		
		(b) Number and date		
	4	Rated voltage, V		
	5	Rated current, A		
	6	Frequency, Hz		
	7	Permissible continuous		
		current, A		
	8	Thermal short time (1 sec.)		
		current rating, A.		
	9	Burden of current circuit, VA		
	10	Burden of voltage circuit, VA		
	11	Auxiliary voltage, (D.C),V		
	12	Tolerance in auxiliary,		
		voltage %, (±).		
	13	Consumption of D.C. auxiliary		
		circuits:		
		(a) During normal conditions, watts.		
		(b) During short circuit, watts		
	14	Settings, range available for		
		starting, unit:		
		(a) Ground faults, ohms/phase		

		(b) Phase faults ohms/phase		
	15	Setting range available for		
		measuring unit:		
		(a) Ground faults, ohms/phase		
		(b) Phase faults ohms/phase		
	16	Directional Sensitivity:		
		(a) For two phase and earth		
		faults, mV		
		(b) For three phase faults when		
		memory has expired, mV		
	17	Time Steps:		
		(a) Number of steps.		
		(b) Basic step (minimum time), msec.		
		(c) Setting ranges:		
		- 2nd step, msec.		
		- 3rd step, msec.		
		- 4th step, msec.		
	18	Contact data, append complete		
		contact data for signalling		
		and tripping.		
	19	Are the following modules		
		included in the scheme offered?		
		(a)Power swing blocking module,(Yes/No)		
		(b) Carrier interface module,yes/No?		
		(c) Any additional module for		
		starting or measuring systems.		
	20	List any module additional to		
		the main scheme offered by the		
		tenderer to provide the		
		characteristics as specified.		
	21	Operating temperature range, deg.C.		
	22	Insulation test voltage and duration.		
	23	Teleprotection:		
		Relay able to work with, and		
		equipment included for following		
		schemes.		
		(a) Permissive under-reach (Yes/No)		
		(b) Permissive over-reach (Yes/No)		
		(c) Permissive transferred		
		acceleration blocking. (Yes/No)		
		(d) Blocking (Yes/No)		
		(e) Unblocking (Yes/No)		
12.2.2	Auto-Reclosing Scheme:			
	1	Manufacturer's name and country		
	2	Type		
	3	Able to Perform:		
		(a) Single pole,reclosing (Yes/No)		
		(b) Three pole, reclosing (Yes/No)		
		(c) Single and three pole (Yes/No)		
		reclosing.		
		(d) Multi shot reclosing (Yes/No)		
	4	Time delay range for dead time:		
		(a) Single pole,reclosing (Yes/No)		
		(b) Three pole, reclosing (Yes/No)		
	5	Reclaim time range, sec.		
	6	Counter included. (Yes/No)		
12.2.3	Fault Locator:			

	1	Type		
	2	Manufacturer's name and country		
	3	Measurement system		
	4	Display		
	5	Printer (Yes/No)		
	6	Recording method		
	7	Accuracy		
	8	Remote Output type.		
12.2.4	Line Distance Protection set II):			
	1	Type		
	2	Manufacturer's name and country		
	3	Test certificate:		
		i) Issuing Institution		
		ii) Number and date		
	4	Rated voltage, V		
	5	Rated current, A		
	6	Frequency, Hz		
	7	Permissible continuous current, A		
	8	Thermal short time (1 sec.) current rating, A.		
	9	Burden of current circuit, VA		
	10	Burden of voltage circuit, VA		
	11	Auxiliary voltage, (D.C),V		
	12	Tolerance in auxiliary, voltage %, (+).		
	13	Consumption of D.C. auxiliary circuits:		
		(a) During normal conditions, watts.		
		(b) During short circuit, watts.		
	14	Settings, range available for starting unit:		
		(a) Ground faults, ohms/phase		
		(b) Phase faults ohms/phase		
	15	Setting range available for measuring unit:		
		(a) Ground fault, ohms/phase		
		(b) Phase fault, ohms/phase		
	16	Directional Sensitivity:		
		(a) For two phase and earth faults, mV		
		(b) For three phase faults when memory has expired, mV		
	17	Time Steps:		
		(a) Number		
		(b) Setting ranges.		
		Basic step (minimum time), msec.		
		2nd step, msec.		
		3rd step, msec.		
		4th step, msec.		
	18	Contact data, append complete contact data for signalling and tripping.		
	19	Are the following modules included in the scheme offered:		
		(a) Power swing blocking module,(Yes/No)		
		(b) Carrier interface module, (Yes/No)		

		(c) Any additional module		
		for starting or measuring systems.		
	20	List any module additional to		
		the main scheme offered by the		
		tenderer to provide the		
		characteristics as specified.		
	21	Operating temperature range,deg.C.		
	22	Insulation test voltage and		
		duration		
	23	Available modes of operation:		
		(a) Directional comparison		
		blocking, (Yes/No)		
		(b) Permissive under-reach		
		transfer tripping, (Yes/No)		
		(c) Permissive over-reach		
		transfer tripping, (Yes/No)		
		(d) Stage acceleration (Yes/No)		
12.2.5	Line Overcurrent Protection:			
	1	Manufacturer's name and country		
	2	Type designation		
	3	DC infeed.		
		. Independent DC/DC converter		
		included. (Yes/No)		
		. Tolerances Idc%.		
		. Rated voltage. V.		
		. Overload protection (Yes/No)		
		. Short circuit Protection (Yes/No)		
		. Power consumption at:		
		(a) Normal operation VA		
		(b) Fault VA		
	4	Relay burden at 3 times		
		minimum operating current, VA		
	5	Operating characteristics		
		. Definite time (Yes/No)		
		. IDMT (Yes/No)		
	6	Instantaneous element (Yes/No)		
		included.		
	7	Current setting range:		
		. Phase elements.		
		. Earth element.		
		. Instantaneous element.		
	8	Operating time:		
		. Minimum operating time sec.		
		. Time setting range.		
	9	Pick-up to drop-off ratio.		
12.2.6	Voltage Relays:			
	(a) Definite time over voltage relays:			
		- Manufacturer's name and country		
		- Type		
		- Setting range, volts		
		- Minimum pick up, time, ms		
		- Maximum reset, time, ms.		
		- pick-up to drop-off ratio %		
	(b) Inverse time over voltage relays:			
		- Manufacturer's name and country		
		- Type		
		- Setting range, volts.		

		- Voltage/time Setting range %		
		- Pickup drop of ratio %		
		2. Type designation		
12.3	High Impedance Busbar			
	Protection Complete:			
	1	Manufacturer's name and country		
	2	Type designation		
12.4	Breaker Failure Protection			
	Complete:			
	1	Manufacturer's name and country		
	2	Type designation		
12.5	Synchronizing Check Scheme			
	Complete:-			
	1	Manufacturer's name and country		
	2	Type designation		
12.6	Lockout Relays:			
	1	Manufacturer's name and country		
	2	Type designation		
12.7	Tripping Relays:			
	1	Manufacturer's name and country		
	2	Type designation		
	3	Pick-up time, m sec		
12.8	Panel Wiring:			
	1	Voltage rating		
	2	Size		
	3	Type of insulation		
12.90	Auxiliary Relays & Contactors:			
	1	Self reset		
		(a) Manufacturer's name and country		
		(b) Type designation		
	2	Manual reset		
		(a) Manufacturer's name and country		
		(b) Type designation		
	3	Time Delay		
		(a) Manufacturer's name and country		
		(b) Type designation		
	4	Tripping		
		(a) Manufacturer's name and country		
		(b) Type designation		
12.10	Other Miscellaneous Relays:			
	(Bidder to provide list)			
13	**CONTROL AND POWER CABLES:**			
13.1	Control cables (600/1000V) for Protection,			
	Control, Measurement and Annunciations:			
	1	Type designation.		
	2	Manufacturer's name and country		
	3	Standard to which manufactured.		
	4	Test certificate.		
		(a) Issuing Institute.		
		(b) Number and date.		
	5	Conductor material.		
	6	Insulation material.		
	7	Shielding material and		
		and thickness.		
	8	Maximum operating temperature,		
		deg C.		
	9	A.C. test withstand voltage		
		level for 5 minutes, kV.		

	10	D.C.test withstand voltage		
		level for 5 minutes, kV.		
	11	Cable identification tag material.		
	12	Wire identification tag		
		type/material.		
13.2	Power Cables		**8.7/15 kV**	
			Power Cables	
	1	Type designation		
	2	Manufacturer's name and country		
	3	Standard to which manufactured		
	4	Test certificates:-		
		(a) Issuing Institute.		
		(b) Number and date.		
	5	Maximum allowable conductor temperature.		
		(a) At continuous operation.		
		(b) Under short-circuit conditions.		
	6	Conductor material.		
	7	Insulation material.		
	8	Sheath material		
	9	Screening material		
	10	Armouring material		
	11	A.C. test withstand voltage		
		level for 5 minutes, kV.		
	12	D.C. test withstand voltage		
		level for 4 minutes, kV.		
	13	Cable identification tag material.		
	14	Wire identification tag		
		type/material.		
14	**GROUNDING AND LIGHTING SYSTEM:**			
14.1	Grounding System:			
	1	Grounding Conductor:		
		(a) Type and specification number.		
		(b) Manufacturer's name and country		
		(c) Size, sq.mm.		
		(d) Dia of conductor, mm.		
		(e) Total length of the conductor used.		
	2	Ground Rods:		
		(a) Type and specification number.		
		(b) Manufacturer's name and country		
		(c) Diameter, mm.		
		(d) Length, m		
	3	Connectors:		
		(a) Type and specification number.		
		(b) Manufacturer's name and country		
		(c) Alloy.		
		(d) Material of bolts.		
14.2	Switchyard Lighting System:			
	1	Lighting Fixtures:		
		(a) Type designation		
		(b) Manufacturer's name and country		
		(c) Standard to which manufactured.		
		(d) Turn angle (Horizontal)		
		(e) Elevation angle (vertical)		
		(f) Finish		

	2	Lamps:		
		(a) Type designation		
		(b) Manufacturer's name and country		
		(c) Standard to which		
		manufactured.		
		(d) Lamp wattage (W)		
		(e) Luminous flux (Lm).		
		(f) Lamp current (I)		
		(g) Power factor correction		
		capacitance (P.f=09)		

SECTION 6 (D)

EMPLOYER'S REQUIREMENT FOR O & M AND DISPATCH REQUIREMENTS OF THE PLANT

1. General

The hydropower plant shall be designed, constructed, tested and commissioned, in accordance with best engineering practices for a plant capacity of 135 MW at Reference Hydrological Conditions and should also fulfill the provisions of this RFP and Power Purchase Agreement (PPA). The plant will be operated prudently in accordance with PPA provisions and best engineering practices for a term of 30 years from COD. The plant shall conform to the provisions of PPA and Grid Code for maintenance and operations, in addition to specific requirements of Irrigation Department, Punjab and Indus River System Authority (IRSA).

2. Dispatch Provisions

The dispatch instructions for operation of the Plant will be provided by NPCC within the plant guaranteed performance values as provided in the PPA and in conformance with the Grid Code. The plant shall be prudently capable of supporting the electrical system, during any electrical disturbance and shall have the black start facility. The plant shall be operated in accordance within its Technical Limits and Reactive Capability Curve.

3. SCADA, Telecommunication and Tele-protection Arrangements

The plant shall have adequate SCADA, Telecommunication and Tele-protection facilities, not limited to those given in the RFP and PPA. The plant should protected by provisions of latest Standard Protection Schemes and equipment, inclusive of tele-protection schemes.

4. Plant operation in conjunction with Irrigation System

The coordinated operation of the plant along with outgoing Canals and Barrage shall be ensured by NPCC, Irrigation Department, Government of the Punjab and IRSA. The safety of the Barrage, Canals and all Irrigation structures and systems shall be ensured during plant operation in normal and flood conditions of the river, also during electrical system faults and abnormal disturbances of the inter-connected electrical networks. In the event of the flood conditions, irrigation department / IRSA instructions shall take precedence for the plant operation, for safety of the irrigation regime. The plant shall be designed, constructed and operated in a way that there will be no additional sedimentation in the barrage, canals and power channel as compared to their previous historic values.

5. Maintenance and Scheduled Outages

The maintenance and scheduled outages shall be allowed by NPCC, Islamabad in coordination with irrigation department / IRSA in accordance with the provisions of the PPA. These outages time should be such that it will suite to the requirement of plant equipment, barrage flows and NTDC system requirements.

6. Visits of Irrigation/IRSA Department and NTDC personnel

During the plant construction, maintenance and operation the Bidder will facilitate the Irrigation/IRSA Departments and NTDC personnel visits in accordance with PPA provisions as well as Irrigation/IRSA Department requirements.