

**DESIGN, MANUFACTURE, SUPPLY, INSTALLATION,
, TESTING & COMMISSIONING OF STATCOM FOR
GRID/NETWORK STABILITY ENHANCEMENT AT 132KV
GRID STATION PASNI IN THE MEKRAN REGION**

**SINGLE STAGE-TWO ENVELOPE
(SSTE) BIDDING PROCEDURE**

EMPLOYER



QUETTA ELECTRIC SUPPLY COMPANY

CONSULTANT CONSORTIUM



**INVITATION
FOR BIDS**

Date: [Insert Date]

Credit No: [Insert No.]

Bid Reference No: [Insert Ref No.]

The Quetta Electric Supply Company (QESCO) (the “Employer”) has received a loan/credit from the Government of Pakistan towards the cost of STATCOM Installation for Grid/Network Stability Enhancement at 132kV Grid Station PASNI in the Mekran Region. It is intended that part of the proceeds of this loan/credit will be applied to eligible payments under the Contract for the Design, Manufacture, Supply, Installation, Testing, and Commissioning of the STATCOM systems on an EPC/Turnkey basis.

1. **Scope of Work:** The Works further include the construction of a dedicated infrastructure (to accommodate STATCOM Panels, Control, Engineering, Battery, DG rooms etc.) and allied civil infrastructure as per the General Layout Plan (GLO). The Contractor shall also be responsible for **Operation & Maintenance (O&M)** post-energization and a structured **Handover** including training and documentation.
2. **Procurement Method:** Bidding will be conducted through the **Single-Stage Two-Envelope** procurement procedure in accordance with **PPRA Rules** and is open to all eligible bidders as defined in the Bidding Documents.
3. **EPADS Requirement:** All procurement processes, including the purchase of bidding documents, clarifications, and submission of bids, shall be conducted exclusively through the **EPAD Portal (www.eprocure.gov.pk)**. Bidders must be registered on the EPAD system to participate.
4. **Eligibility:** Bidders must hold a valid **Pakistan Engineering Council (PEC)** license in Category **C-A (No Limit)** or **C-B** with specialization code **EE-05**. Foreign Bidders must form a **Joint Venture (JV)** with a Pakistani constructor as per PEC bye-laws.
5. **Bid Security:** A **Bid Security** in the fixed amount of 55 million PKR must be provided in the form of **Bank Draft / Pay Order / Call Deposit Receipt (CDR)** from a reputable schedule bank of Pakistan in the favour of **Finance Director QESCO**.
 - a. A high-resolution scanned copy of the Bid Security must be uploaded to the Technical Section of the EPAD Portal.
 - b. The original physical instrument must be delivered to the office of the **Project Director (GSC) QESCO, Airport Road, Quetta**, before the bid submission deadline.
6. **Submission & Opening:** Bids must be submitted electronically via the EPAD Portal on or **before 11:00 hours on [Date], 2026**. The system will automatically close the link at the stipulated time. Technical Bids will be opened electronically at **11:30 hours** on the same day. Financial Bids of technically responsive bidders will be opened at a later date after technical evaluation.
7. **Contact Information:** **Project Director (GSC) QESCO** Project Directorate, WAPDA Colony, Sheikh Manda, Airport Road, Quetta. **Telephone:** 081-2881092 | **Facsimile:** 081-2307054 **EPADS Support:** Any technical queries regarding the portal should be addressed through the EPADS Helpdesk.

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INSTRUCTIONS TO BIDDERS

- Bidders failing to meet mandatory requirements uploaded on the EPAD portal shall be disqualified. No offline bid documents shall be accepted, except the original bid security instrument, which must be delivered physically as specified.
- All points of the mandatory criteria must be fulfilled and electronically verified for qualification.
- The bidder shall furnish a Bid Security in the fixed amount of 55 million PKR. A scanned copy of the Bank Draft / Pay Order / Call Deposit Receipt (CDR) must be uploaded on PPRA EPAD, while the original physical instrument must be submitted to the Project Director (GSC) QESCO office address as indicated in IB 6.1 of bidding document before the bid opening deadline.
- Bids must remain valid for 180 days from the date of technical bid opening through the EPAD system.
- All required documentary proof must be digitally attached/uploaded in the designated sections of the EPAD technical envelope.
- If any documentation is missing in the EPAD submission, the bid shall be evaluated "as-is.". Under EPAD transparency rules, bidders may be asked for clarifications, but no new material documents can be added post-opening.
- Bidders/Service Providers scoring less than 70% (70 marks) in the Technical Evaluation conducted through the EPAD module shall be disqualified.
- All uploaded proofs must be properly indexed and cross-referenced to the specific clause numbers within the EPAD mandatory section.

NAME OF Bidder/Vendor/Service Provider: _____

ADDRESS: _____

Tel No. _____ Email _____

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LIST OF ABBREVIATIONS

Category	Abbreviation	Full Description
Technology & Engineering	MMC	Modular Multi-level Converter
	STATCOM	Static Synchronous Compensator
	VSC	Voltage Source Converter
	IGBT	Insulated Gate Bipolar Transistor
	MVAR	Mega Volt Ampere Reactive
	SCR	Short Circuit Ratio
	POC / POC	Point of Connection / Point of Common Coupling
	LVRT	Low Voltage Ride Through
	AIS / GIS	Air Insulated Switchgear / Gas Insulated Switchgear
	HMI	Human Machine Interface
Procurement & Legal	BoP	Balance of Plant
	TIF	Telephone Influence Factor
	BIL	Basic Insulation Level
	EPADS	E-Procurement and Auction System
	PPRA	Public Procurement Regulatory Authority
	PEC	Pakistan Engineering Council
	NCB	National Competitive Bidding
	SSTE	Single Stage-Two Envelope
	QCBS	Quality and Cost Based Selection
	JV	Joint Venture
Financial & Commercial	FIDIC	International Federation of Consulting Engineers
	GCC / PCC	General / Particular Conditions of Contract
	ITB / IB	Instructions to Bidders
	SRO	Statutory Regulatory Order
	EDB	Engineering Development Board
	PKR	Pakistani Rupee
	LCC / FCC	Local Currency / Foreign Currency Component
	DDP	Delivered Duty Paid
	CIF	Cost, Insurance, and Freight
	FBR / ATL	Federal Board of Revenue / Active Taxpayers List
Project Management	CDR / DD	Call Deposit Receipt / Demand Draft
	EPC	Engineering, Procurement, and Construction
	O&M	Operation and Maintenance
	CPM / PERT	Critical Path Method / Project Evaluation & Review Technique
	TOC / FAC	Taking-Over / Final Acceptance Certificate
Regulatory & Utility	FAT / SAT	Factory Acceptance / Site Acceptance Test
	HIL	Hardware-in-the-Loop
	GLO	General Layout Plan
	HSE	Health, Safety, and Environment
NEPRA	National Electric Power Regulatory Authority	

LIST OF ABBREVIATIONS

Category	Abbreviation	Full Description
	QESCO	Quetta Electric Supply Company
	ISMO	Independent System and Market Operator
	NTDC	National Transmission & Dispatch Company

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INSTRUCTIONS TO BIDDERS AND APPRNDICES

(A) GENERAL

IB.1 Scope of Bid and Source of Funds

1.1 Scope of Bid

Quetta Electric Supply Company (QESCO) (hereinafter called the “Employer”) wishes to receive Bids on an **EPC/Turnkey basis** for the scope of work which includes, but shall not be limited to:

1.1.1 Primary Scope of Works

The Works to be executed under this assignment comprise the **Design, Manufacture, Supply, Installation, Testing, and Commissioning** of STATCOM for Grid/Network Stability Enhancement at 132kV Grid Stations in the Mekran Region on a complete EPC/Turnkey basis. The scope further includes:

- a. **Integrated Housing Solution (Containerized or Indoor):** The Contractor shall design and provide the most technically and economically viable housing solution for the STATCOM and sensitive power electronics infrastructure. This may include either:
 - i. **Modular Containerized Solutions:** Factory-assembled, climate-controlled, and EMI-shielded containers; or
 - ii. **Permanent Civil Structures:** Design and construction of a dedicated infrastructure to house the Containerized STATCOM and Ancillary equipment and cooling interfaces.
- b. **Essential Control & Support Infrastructure:** Notwithstanding the choice of technology housing, the Contractor shall be responsible for the design and construction of all necessary infrastructure required to accommodate:
 - i. 132kV STATCOM Control and Protection Panels;
 - ii. Engineering Workstations and HMI;
 - iii. A dedicated Battery Room for STATCOM as per applicable international standards.
 - iv. A Diesel Generator (DG) Room (with acoustic treatment and fuel storage).
- c. **Allied Civil Infrastructure:** Construction of all specialized foundations (for transformers, cooling units, and gantry structures), cable trenches, drainage systems, and site development works required to accommodate the electrical plant within the spatial constraints indicated in the As-Built **General Layout Plan (GLO)** of the respective Grid Station at Pasni as Annexure D2.
- d. **Lifecycle Services:** Provision of a comprehensive capacity-building mandate covering the Installation, Operation, and Maintenance (O&M) of the STATCOM system for the Employer’s and Consultant engineers. This training shall be carried out continuously to ensure technical self-sufficiency until the formal Handover of a fully functional and stabilized system to the Employer.

1.1.2 Extended Technical and Operational Requirements

In addition to the physical implementation and specialized housing solutions, the scope of work shall further include:

- a. **Intensive Capacity Building:** Provision of an accelerated technical training program for QESCO personnel and Consultant engineers. This shall be completed within the first six (6) months of the O&M period to ensure the Employer's staff can independently manage basic field diagnostics and routine system switching by the end of the two-year tenure. The Contractor shall act as a "Master Trainer" as defined in IB.1.1.3.
- b. **Integrated Operation & Maintenance (O&M) and Tail End Warranty:** The Contractor shall assume full responsibility for the specialized operation and maintenance of the STATCOM unit(s) for a period of at least two (2) years commencing from the date of issuance of the Taking-Over Certificate (TOC). Upon completion of the O&M period, the Defects Liability Period (DLP) shall extend and shall remain valid for a period of one (1) year. The Contractor shall maintain the guaranteed performance metrics and system availability benchmarks as specified in Schedule A throughout the O&M and applicable DLP periods.
- c. **Fault Response and Service Level Obligations:** In accordance with international best practice for STATCOM O&M service agreements; the Contractor shall maintain the following tiered response times. Failure to meet these timelines shall trigger the Employer Step-in Rights under PCC 30.15:
 - i. **Severity I – Full System Outage (Category A):** Where a fault renders the STATCOM wholly unable to provide reactive power output, the Contractor shall acknowledge the alarm remotely within fifteen (15) minutes of fault detection, commence remote diagnostics immediately, and mobilise specialised on-site personnel to commence physical remediation within four (4) hours of fault detection. This obligation shall apply on a 24/7 basis throughout the O&M tenure without exception.
 - ii. **Severity II – Derated Operation (corresponding to Category B components):** Where a fault allows continued STATCOM operation at reduced rating but with risk of full outage upon further failure, the Contractor shall acknowledge within Thirty (30) minutes, initiate remote diagnostics within two (2) hours, and ensure on-site specialist attendance within eight (8) hours of fault detection. Remediation shall be completed within forty-eight (48) hours or the fault shall be escalated to Severity-I treatment.
 - iii. **Severity III – Emergency Operation (corresponding to Category C components):** Where a fault allows continued operation on an emergency basis with a critical function lost or bypassed, the Contractor shall acknowledge within one (1) hours and ensure on-site attendance within twenty-four (24) hours. A temporary remediation or safe-state plan shall be implemented within seventy-two (72) hours.
 - iv. **Severity IV – Non-Critical (corresponding to Category D components):** Where a fault does not impair operation but affects ancillary services, the Contractor shall address the fault within the next scheduled maintenance window, and in no case later than seven (7) days from detection.

- d. **Handover and Knowledge Transfer:** A formal transition process concluded at the end of the two-year period. Issuance of the Final Acceptance Certificate (FAC) is strictly contingent upon meeting five conditions:
 - i. Expiry of O&M tenure
 - ii. Rectification of all DLP defects
 - iii. Demonstrated technical self-sufficiency of QESCO staff
 - iv. Final delivery of all "As-Built" docs and permanent licenses
 - v. Verified replenishment of mandatory spares.

- e. **Failure to meet Availability Benchmark:** The Contractor guarantees an annual equivalent availability of $\geq 99.7\%$ for forced outages and $\geq 99.0\%$ for scheduled outages. Underperformance shall constitute a default, triggering:
 - i. Availability Liquidated Damages as per Clause 27.1.
 - ii. A one (1) year extension of the O&M and Availability Guarantee period at no additional cost to the Employer. The total cumulative extension shall not exceed three (3) years.
 - iii. DLP Extension: Mandatory extension of the Defects Liability Period for the affected subsystem as per the "Recurring Fault" logic in PCC 30.14.

1.1.3 Project Timelines and Lifecycle Phases

- a) **EPC Completion (365 Days):** All design, manufacturing, civil construction, and installation works at the 132kV Pasni Grid Station must be completed, culminating in successful Site Acceptance Testing (SAT) and **Energization** within **365 Days** from the Commencement Date.
- b) **Initial Taking Over (TOC)& Reliability Run:** Following successful commissioning, the STATCOM shall enter a **Trial Operation** period of a minimum of three (3) months. Within this period, the Contractor must demonstrate a **continuous 720-hour (30-day) Reliability Run**.
 - i. The 720-hour clock shall **restart to zero** upon any forced outage or material performance non-compliance.
 - ii. The Trial Operation may be extended by a further three (3) months at the Employer's discretion if benchmarks are not met.
 - iii. Successful completion of the 720-hour run triggers the issuance of the **Taking-Over Certificate (TOC)**, marking the formal end of the EPC phase and the simultaneous start of the two-year O&M/Warranty tenure and the two-year Availability and Reliability Guarantee.
- c) **Mandatory Two-Year O&M Tenure:** For a period of at least **two (2) years** immediately following the TOC, the Contractor shall manage the facility on a 24/7 basis. This tenure constitutes the Availability and Reliability Guarantee. The Contractor shall maintain:
 - i. **Forced Outage Availability:** $\geq 99.7\%$ (Max 1 forced outage/year).
 - ii. **Scheduled Outage Availability:** $\geq 99.0\%$ (Max 5 scheduled outages/year).
 - iii. The Contractor shall actively monitor, tune, and submit periodic performance verification reports to ensure the MMC valves are optimized for Pasni's specific grid conditions.

- d) **Technical Mentorship:** The Contractor shall act as **Master Trainer**, executing a structured "Shadow-Operator" capacity-building program for QESCO's designated staff and Consultant Engineers: intensive diagnostics and switching training to be completed within the first six (6) months, demonstrated first-level fault competency by month nine (9), and certified technical self-sufficiency by the end of the tenure. All training materials and O&M manuals to be provided in English.
- e) **Final Acceptance & Handover:** Upon expiration of the two-years O&M tenure and successful rectification of all Defects Liability Period (DLP) items, the **Final Acceptance Certificate (FAC)** shall be issued provided:
 - i. QESCO staff have achieved the certified technical self-sufficiency milestones.
 - ii. All "As-Built" documentation and permanent software licenses are transferred.
 - iii. The mandatory spare parts inventory is fully replenished.
 - iv. Failure to meet availability benchmarks during any year of the Availability and Reliability Guarantee period shall trigger Availability Liquidated Damages (as per Clause 27.1) and an automatic one (1) year extension of the Availability and Reliability Guarantee at no cost to the Employer. The total cumulative extension shall not less than three (3) years.

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1.2 Source of Funds

The Employer has received funds from the Government of Pakistan, and it is intended that part of the proceeds of the funds will be applied to eligible payments under the Contract for which these Bidding Documents are issued.

IB.2 Eligible Bidders

2.1 Bidding is open to all firms and persons from eligible countries as per Appendix 'A' to Instructions to Bidders, meeting the following requirements:

- a) Eligibility is strictly contingent upon the Contractor/Manufacturer/Specialized subcontractor (or the Lead Partner in case of a JV) holding a PEC license in Category C-A (No Limit) or C-B with specialization code EE-05.
- b) Foreign Bidders are eligible to participate only by forming a Joint Venture (JV) with a Pakistani Constructor. Pursuant to PEC Bye-laws, the Joint Venture must be led by a Partner possessing a valid PEC Category registration appropriate to the project's financial magnitude To satisfy local participation and technology transfer requirements:
 - i. The Joint Venture must include a **"Pakistani Constructor"** (an enterprise with minimum 51% shares owned by Pakistani nationals).
 - ii. The Foreign JV partner shall ensure that at least **70% of the engineering staff** for the project are Pakistani nationals to facilitate on-the-job training and local support. Bidders must be prequalified if such an exercise has been conducted for this specific project.

IB.3 Eligible Goods and Services

- 3.1 Country of Origin Compliance:** All Goods and ancillary Services to be supplied under this Contract shall have their origin in eligible source countries as defined in **Appendix 'A'** to the Instructions to Bidders. All expenditures made under the Contract shall be strictly limited to such authorized Goods and Services.
- 3.2 Technology Responsibility:** Given the specialized and high-fidelity nature of Modular Multi-level Converter (MMC) STATCOM technology, the ultimate technical responsibility for the execution and stabilization of the facility—including but not limited to Detailed Engineering Design, PSSE/PSCAD Simulation Modeling, System Integration, Grid Code Compliance, the achievement of Performance/Availability Guarantee etc., shall rest solely and collectively with the Joint Venture (JV).
- 3.3 Operational Training & Warranty Origin:** Subsequent to the initial training modules defined in **Schedule A**, the following protocols shall govern the two-year stabilization tenure. For the purpose of the **two-year Operational Training and O&M phase**, 'origin' shall refer to the domicile of the specialized technical expertise and training modules mobilized for the Works:
- a. **Shadow-Operator Execution:** While the primary technical leadership and 'Master Trainers' shall be provided by the **Foreign JV Partner** (Technology Provider), the facility must be operated in a **'Shadow-Operator'** mode. In this mode, the Contractor maintains full responsibility for the plant while systematically involving QESCO personnel in all control and switching sequences to build operational confidence.
 - b. **Local Support Mandate:** The Foreign JV Partner must be supported by specialized local personnel (provided by the **Pakistani JV Partner**) to ensure continuous 24/7 system availability and to facilitate the intensive, on-site transfer of technical knowledge to QESCO/Employer-designated staff.
 - c. **Verification of Knowledge Transfer:** The mobilization of training expertise shall be documented through quarterly performance audits. Successful 'origin' of expertise is evidenced by the ability of QESCO staff to perform Severity III and IV troubleshooting (as defined in the SLA) under Contractor supervision by the end of the ninth (9th) month of the tenure.
 - d. **Accountability for Availability:** The reliance on local personnel for support does not dilute the Foreign Technology Provider's obligation to meet the **99.7% forced availability benchmark** throughout the duration of the two-year tenure and the subsequent guarantee period
- 3.4 Definition of Origin:** The origin of Goods and Services is defined as the place where the Goods were mined, grown, or produced, or from which the ancillary Services are supplied. This definition is distinct and independent from the nationality of the Bidder or the individual members of the Joint Venture.
- 3.5 Software & Control Logic:** All control software, diagnostic tools, and simulation modules provided under the Contract must originate from the Technology Provider and include a permanent, non-expiring license for the Employer, effective from the date of the Final Handover.

IB.4 Cost of Bidding

- 4.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid and the Employer will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the Bidding process.

(B) BIDDING DOCUMENTS

IB.5 Contents of Bidding Documents

- 5.1 In addition to Invitation for Bids, the Bidding Documents are those stated below, and should be read in conjunction with any Addenda issued in accordance with Clause IB.7. The Bidding Documents are available on the EPAD Portal, and any submission must be made through the same.

1. Instructions to Bidders (ITB) with Appendices to ITB
2. Letter of Technical Bid & Schedules to Bid
Schedules to Bid are the following:
 - (i) Schedule A: Specific Works data
 - (ii) Schedule B: Proposed Organization for the Project
 - (iii) Schedule C: Method of Performing Works
 - (iv) Schedule D: Proposed Programme of Works
 - (v) Schedule E: Work to be Performed by Subcontractors
 - (vi) Schedule F: Deviations from Technical & Contractual Provisions
 - (vii) Schedule G: Specific Operation/Plant and Equipment Details
 - (viii) Schedule H: Specimen JV Agreement
 - (ix) Schedule I: Past Performance and Present Commitments
3. Letter of Price Bid & Schedules to Bid
Schedules to Bid are the following:
 - (i) Schedule J: Integrity Pact
 - (ii) Schedule K: Estimated Progress Payments
 - (iii) Schedule L: Lump Sum Cost Breakup for Major Cost Items (To separate EPC from 2-year O&M)
4. Schedule of Prices
5. Preamble to Conditions of Contract
6. General Conditions of Contract (GCC)
7. Particular Conditions of Contract (PCC)
8. Standard Forms
Forms include the following:
 - (i) Form of Bid Security
 - (ii) Form of Contract Agreement
 - (iii) Form of Performance Security

- (iv) Form of Bank Guarantee for Advance Payment
- (v) Indemnity Bond for Secured Advance

- 9. Specifications - Special & Technical Provisions
- 10. Drawings
- 11. Annexures

5.2 The Bidders are expected to examine carefully the contents of all the above documents. Bidders must ensure they are registered on the EPAD system to access and submit bids. Failure to comply with the requirements of Bid submission will be at the Bidders own risk.

IB.6 Clarification of Bidding Documents

A prospective Bidder requiring any clarification(s) in respect of the Bidding Documents may notify the Employer through the EPAD Portal. The Employer will examine the request for clarification received not later than twenty-eight (28) days prior to the deadline for submission. Responses to clarifications and any issued amendments will be uploaded directly to the EPAD Portal for all registered bidders to access simultaneously.

6.1 Contact Information: Project Director (GSC) QESCO Project Directorate, WAPDA Colony, Sheikh Manda, Airport Road, Quetta. Telephone: 081-2881092 | Facsimile: 081-2307054

EPADS Support: Any technical queries regarding the portal should be addressed through the EPADS Helpdesk.

IB.7 Amendment of Bidding Documents

- 7.1 At any time prior to the deadline for submission of bids, the Employer may modify the Bidding Documents by issuing addendum through the EPAD Portal
- 7.2 Any addendum thus issued shall be part of the Bidding Documents. Notification of such addenda will be generated automatically by the EPAD system to all registered bidders. The Bidder shall acknowledge and incorporate such addenda through the system's interface.
- 7.3 To afford prospective Bidders reasonable time, the Employer may extend the deadline for submission of Bids on the EPAD Portal in accordance with Clause IB.19.

(C) PREPARATION OF BIDS

IB.8 Language of Bid

8.1 The Bid prepared by the Bidder and all correspondence and documents relating to the Bid, exchanged by the Bidder and the Project Manager/Engineer shall be written in the English language., All uploaded electronic documents must be legible and in the prescribed file formats (e.g., PDF, Excel) as supported by the EPAD system. Provided that any printed literature furnished by the Bidder may be written in another language so long as accompanied by an English translation of its pertinent passages in which case, for purposes of interpretation of the Bid, the English translation shall govern.

IB.9 Documents Comprising the Bid

- 9.1 The Bid prepared by the Bidder shall comprise the following components, to be uploaded on the EPAD Portal in their respective technical and financial sections:
 - a. Covering Letter
 - b. Letters of Bids duly filled and digitally signed/scanned, signed and sealed, in

- accordance with Clause IB.17.
- c. Schedules (A to L) to Bid duly filled and uploaded. Bid duly filled and signed, in accordance with the instructions contained therein.
 - d. Schedule of Prices completed in accordance with Clauses IB.11 and IB.12 submitted in the designated financial section of the EPAD Portal.
 - e. Bid Security (Original to be submitted physically to the Employer, with a scanned copy uploaded on EPAD before the submission deadline) furnished in accordance with Clause IB.15.
 - f. Power of Attorney. in accordance with Clause IB 17.5.
 - g. Joint Venture Agreement (if applicable). A foreign Bidder is entitled to bid only in a joint venture with a Pakistani constructor in accordance with the provisions of relevant PEC bye-laws.
 - h. Documentary evidence of eligibility and qualification. Documentary evidence established in accordance with Clause IB.13 that the Bidder is eligible to Bid and is qualified to perform the Contract if its Bid is accepted (past performance and present commitments to be filled in as per schedule I to Bid).
 - i. Documentary evidence of Plant and Services conformity. Documentary evidence established in accordance with Clause IB.14 that the Plant and ancillary Services to be supplied by the Bidder are eligible Plant and Services and conform to the Bidding Documents.
 - j. Domestic preference information/evidence (if applicable). Bidders applying for eligibility for domestic preference in bid evaluation shall supply all information & evidence to establish the claim for domestic preference required to satisfy the criteria for eligibility as described in Clause IB.27. The particulars for domestic Goods prescribed in Appendix C to these Instructions shall also be filled in to substantiate claim for domestic preference.
 - k. Any other documents prescribed in Particular Conditions of Contract or Technical Provisions to be submitted with the Bid.

9.2 Price Bid (Financial Envelope in EPADS)

- a. **Letter of Price Bid:** Duly filled and signed.
- b. **Schedule of Prices:** Completed in accordance with **Clauses IB.11 and IB.12**, comprising:
 - i. Schedule No. 1 to 5: Detailed cost breakdown (Civil, Foundations, Supply, Installation/O&M, Design).
 - ii. Schedule No. 6: Grand Summary.
- c. **Milestone Payment Table:** Duly initiated **Schedule K**, acknowledging the link between payments and the **720-hour Reliability Run** and **99.7% Availability** benchmarks.
- d. **Schedules (K to L):** Including the **Lump Sum Cost Breakup** required to separate the EPC cost from the at least two-year O&M tenure cost.

IB.10 Letters of Bids and Schedules

- 10.1 The Bidder shall complete, sign and seal the Letters of Bids, Schedules (A to L, or as modified) to Bid and Schedule of Prices furnished in the Bidding Documents and shall also enclose other information as detailed in Clause IB.9.
- 10.2 For the purpose of granting a margin of domestic preference pursuant to Clause IB.27, The Engineering Development Board (EDB) guidelines and SROs shall be the primary reference for verifying the domestic content. The Employer reserves the right to request a verification certificate from the EDB or a third-party auditor to substantiate the value addition claimed in Appendix C.

IB.11 Bid Prices

- 11.1 The Bidder shall fill up the Schedule of Prices attached to these documents indicating the unit rates and prices of the Works to be performed under the Contract. Prices on the Schedule of Prices shall be entered keeping in view the instructions contained in the Preamble to the Schedule of Prices.
- 11.2 The Bidder shall fill in rates and prices for all items of the Works described in the Schedule of Prices. The Bidder's attention is particularly drawn to the following:
 - a. Deemed Covered: Items against which no rate or price is entered by a Bidder shall not be paid for by the Employer when executed and shall be deemed covered by the rates and prices for other items in the Schedule of Prices. This specifically includes the cost of the detailed Geotechnical and Soil Investigation required under Sub-Clause (e) below.
 - b. Mandatory Scope: Notwithstanding Sub-Clause (a) above, the Bidder must quote for the complete scope of work. If a Bidder fails to quote for a major technical component (e.g., the STATCOM MMC Valves, Cooling System, or the Mandatory at least two-year Operational Training), the Bid shall be considered non-responsive and shall be rejected pursuant to Clause IB.24.
 - c. Material Deviation: Any omission in the Schedule of Prices that represents a 'Material Deviation' (as defined in IB.24.3) or prevents a fair price comparison with other Bidders shall result in the Bid being declared non-responsive.
 - d. EPADS Submission: All prices must be entered in the designated fields of the EPAD Portal. Any discrepancy between the uploaded scanned Schedule of Prices and the digital entries on the EPAD system shall be resolved in favor of the digital entry, provided it does not constitute a material omission of scope.
 - e. Geotechnical Verification Responsibility: The soil investigation data provided in Annexure-G is indicative only and based on random borehole samples. The successful Bidder/Contractor shall be responsible for:
 - i. Carrying out a comprehensive and detailed Soil Investigation at its own cost, specifically tailored to the proposed plant footprint and technical solution.
 - ii. Performing all tests at a reputable, ISO-accredited laboratory approved by the Employer.
 - iii. Vetting and validating the investigation program and subsequent test reports with the Employer and Consultant Engineer (BARQAAB) prior to foundation design.
 - iv. No adjustment to the Contract Price shall be permitted based on variations between the indicative data and the actual site conditions discovered during the Contractor's detailed investigation.

- 11.3 The Bidder's breakup of price components in accordance with Sub-Clause 11.1 above will be solely for the purpose of facilitating the comparison of Bids by the Employer and will not in any way limit its right to contract on any of the terms offered.
- 11.4 Unless otherwise stipulated in the Conditions of Contract, prices quoted by the Bidder shall remain fixed during the Bidder's performance of the Contract and not subject to variation on any account. When the Bidders are required to quote only fixed price(s), a Bid submitted with an adjustable price quotation will be treated as non-responsive, pursuant to Clause IB.24.
- 11.5 Any discount offered shall be valid for at least the period of validity of the Bid. A discount valid for lesser period shall be considered null and void.

IB.12 Currencies of Bid

- 12.1 Prices shall be quoted in the following currencies:
- (a) For Plant/Goods and Services which the Bidder will supply from within Pakistan, the prices shall be quoted in the Pak. Rupees.
 - (b) Not applicable for this NCB; all evaluation and payments shall be indexed in PKR
- 12.3 As stated in the PCC, payment shall be in PKR.

IB.13 Documents Establishing Bidder's Eligibility and Qualifications

CLAUSE	CATEGORY	REQUIREMENT DESCRIPTION
13.1	General	Bidders must furnish documents establishing eligibility and technical/financial qualifications as part of the Bid.
13.2	Source Eligibility	Documentary evidence must establish that the Bidder is from an eligible source country as defined under Clause IB.2.
13.3	Agency & Authorization	(a) Manufacturer's Authorization: Required if the Bidder is not the manufacturer. (b) Capability: Must prove financial, technical, and production capacity. (c) Local Representation: Foreign Bidders must have a local agent equipped for maintenance, repair, and spare parts.
13.4(a)	Primary Experience PKR	(i) Turnkey EPC: Minimum one (1) project valued at Rs. 500 Million within the last 10 years (PEC aligned). (ii) Similar Facility: Designed/installed at least two similar facility valued at Rs. 500 Million in the last 5 years. (iii) Equipment Ownership: Must own specific tools/machinery required for specialized performance.

CLAUSE	CATEGORY	REQUIREMENT DESCRIPTION
13.4(b)	Financial Capability	Average Annual Turnover: \geq Rs. 500 Million (last 5 years).OR Specific Project: Completed a single project \geq Rs. 1,500 Million in the last 5 years.
13.4(c)	Specific Technical	Must provide evidence of ≥ 2 completed projects involving greater than equal to ± 50 MVar STATCOM systems.
13.5	Joint Venture (JV)	(a) Qualification: At least one partner must meet criteria in 13.4(a) and 13.4(c). (b) Constitution: All firms must be legally constituted. (c) Liability: Partners are jointly and severally liable for the entire Contract. (d) Binding: Form of Bid/Agreement must be legally binding on all partners. (e) Lead Partner: One partner must be nominated as "Partner-in-Charge" via Power of Attorney. (f) Authority: Lead partner authorized to incur liabilities and receive payments/instructions. (g) JV Agreement: Copy of agreement must be submitted (Schedule-H) and cannot be modified without Employer consent.
13.6	Equipment Sourcing	a. Mandatory Engineer Approval: Formal written approval required <i>before</i> shipment. Must comply with IEC 62927 and match PSCAD/PSS/E models. b. Compliance with International Standards: Final approval is contingent upon the Contractor providing verified documentary evidence (including Type Test Reports from STL-accredited laboratories) demonstrating the equipment's full compliance with IEC 62927 (for VSC valves), IEEE 1052, and other relevant international power quality standards. c. Technical Consistency: The approved Manufacturer's hardware must be identical in performance characteristics to the digital simulation models (PSSE/PSCAD) verified during the Design Review stage to ensure the achievement of the 99.7% availability benchmark.

IB.14 Documents Establishing Plant's Eligibility and Conformity to Bidding Documents

- 14.1 Pursuant to Clause IB.9, the Bidder shall furnish, as part of its Bid, documents establishing the eligibility and conformity to the Bidding Documents of all Plant and Services which Bidder proposes to perform under the Contract.
- 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 IB.3. A certificate of origin issued at the time of shipment will satisfy the requirements of the said Clause.

- 14.3 The documentary evidence of the Plant and Services' conformity to the Bidding Documents may be in the form of literature, drawings and data and shall furnish:
- (a) A detailed description of the Plant, essential technical and performance characteristics.
 - (b) Complete set of technical information, description data, literature and drawings as required in accordance with Schedule A to Bid, Specific Works Data. Drawings and data submitted must be in sufficient detail and clarity to permit the Employer to verify compliance with the provisions of the Bidding Documents. This will include but not be limited to the following:
 - (i) A sufficient number of drawings, diagrams, photographs, catalogues, illustrations and such other information as are necessary to illustrate clearly the significant characteristics such as general construction dimensions and other relevant information about the Plant to be furnished.
 - (ii) The approximate weight and dimension of the main components, a brief description of the principal materials and fabrication processes to be used and recommended methods of assembly.
 - (iii) Any other information which is required for evaluation purposes.
 - (c) A clause-by-clause commentary on Technical Provisions, provided with the Bidding Documents, demonstrating the Plant's and Service's substantial responsiveness to those Specifications or a statement of deviations and exceptions to the provisions of the Technical Provisions as required in Schedule F to Bid.
- 14.4 For purpose of the commentary to be furnished pursuant to Sub-Clause 14.3(c) above, the Bidder shall note that standards for workmanship, material and equipment, and references to brand names or catalogue numbers, designated by the Project Manager/Engineer in the Technical Provisions are intended to be descriptive only and not restrictive. The Bidder may substitute alternative standards, brand names and/or catalogue numbers in its Bid, provided that it demonstrates to the Project Manager/Engineer's satisfaction that the substitutions are substantially equivalent or superior to those designated in the Technical Provisions. Copies of the standards proposed by the Bidder other than those specified in the Bidding Documents shall be furnished.

IB.14.5 Site Integration & Layout Compliance

As part of the Technical Proposal, the Bidder shall submit a detailed, dimensioned Integrated General Layout Plan (IGLO) based on the indicated GLO provided in the Bidding Documents (Annexure D-2). The submission must strictly adhere to the following:

- a. The Bidder shall precisely indicate the proposed location of the containerized STATCOM, Heat Exchangers/Cooling Units, Transformers etc.
- b. The layout must show the orientation and dimensions of all allied infrastructure, including but not limited to the Control House Building (CHB), Battery Room, Diesel Generator (DG) Room, etc.
- c. The proposed layout must include all necessary topographical dimensions (Length, Width, and Height) and verify that all mandatory safety clearances (Phase-to-Phase and Phase-to-Earth) are maintained relative to existing 132kV structures.
- d. The Bidder must clearly mark the Point of Common Coupling (PCC), the routing of 132kV power cables/bus-extensions, and the connection points between the new facility's grounding grid and the existing Substation Earth Mat.

- e. Failure to provide a detailed integration plan with verified dimensions, or proposing a layout that violates the spatial constraints of the 132kV Pasni Grid Station, shall be considered a Material Deviation and may result in the Bid being declared non-responsive.

IB.15 Bid Security

- 15.1 A Bid Security in the fixed amount of PKR 55 million in the form of Bank Draft / Pay Order / Call Deposit Receipt (CDR) from a reputable schedule bank of Pakistan in the favor of Finance Director QESCO .
- 15.2 The Bid Security shall be, at the option of the Bidder, in the form of a Deposit at Call or a Bank Guarantee issued by a Scheduled Bank in Pakistan, or from a foreign bank duly counter-guaranteed by a Scheduled Bank in Pakistan, in favor of the Quetta Electric Supply Company (QESCO). The Bid Security shall remain valid for a period of twenty-eight (28) days beyond the original Bid Validity period (i.e., 180 + 28 = 208 days total), or beyond any period of extension subsequently requested under Sub-Clause 16.2.
- 15.3 The Bid Security is required to protect the Employer against the risk of Bidder's conduct which would warrant the security's forfeiture, pursuant to Sub-Clause 15.7 hereof.
- 15.4 Any Bid not accompanied by an acceptable Bid Security, or where the physical instrument is not received by the Employer within the stipulated timeframe, shall be rejected by the Employer as non-responsive, pursuant to Clause IB.24
- 15.5 The Bid securities of unsuccessful Bidders will be returned upon award of contract to the successful Bidder or on the expiry of validity of Bid Security whichever is earlier.
- 15.6 The Bid Security of the successful Bidder will be returned when the Bidder has furnished the required Performance Security, pursuant to Clause IB.34 and signed the Contract Agreement, pursuant to Clause IB.35.
- 15.7 The Bid Security may be forfeited:
 - (a) if a Bidder withdraws his Bid during the period of Bid validity;
 - (b) if a Bidder does not accept the correction of his Bid Price, pursuant to Sub-Clause 24.2 hereof; or
 - (c) in the case of a successful Bidder, if he fails to:
 - (i) furnish the required Performance Security in accordance with Clause IB.34, or
 - (ii) sign the Contract Agreement, in accordance with Clause IB.35.
- 15.8 EPADS Submission Requirement:
 - A high-resolution scanned copy of the Bid Security instrument must be uploaded to the Technical Section of the EPAD Portal before the bid closing time.
 - Bidders shall submit bid security electronically via EPADS E-Payment or upload a digital instrument, with the physical original provided only for verification post-opening.

IB.16 Validity of Bids

- 16.1 Bids shall remain valid for 180 days after the date of Bid opening as prescribed in Clause IB.19.

16.2 In exceptional circumstances prior to expiry of original Bid validity period, the Employer may request the Bidders to extend the period of validity for a specified additional period which shall in no case be more than the original Bid validity period. The request and the responses thereto shall be made in writing. A Bidder may refuse the request without forfeiture of his Bid Security. A Bidder agreeing to the request will be required to extend the validity of his Bid Security for the period of the extension, and in compliance with Clause IB.15 in all respects in which case, the Employer will be obligated to compensate the Bidders, upon substantiation for their increase in costs (if it is a fixed price bid).

IB.17 Format and Signing of Bid

- 17.1 Bidders are particularly directed that the amount entered on the Electronic Form of Bid within the EPAD Portal shall be for performing the Contract strictly in accordance with the Bidding Documents.
- 17.2 All Schedules to Bid (A to L) must be properly completed, duly sign& stamp, scanned, and uploaded to their respective technical or financial sections as prescribed. Failure to upload a mandatory schedule may result in the bid being declared non-responsive.
- 17.3 No alteration is to be made in the Form of Bid or the Schedules thereto except in filling up the blanks as directed. Any unauthorized modification to the template documents provided by the Employer may lead to the rejection of the Bid.
- 17.4 Bidders shall submit their bids strictly in electronic format through the EPAD Portal. Manual or physical submission of Bids (except for the original Bid Security instrument) shall not be entertained and will result in automatic rejection. The system-generated time stamp shall serve as the primary record of submission.
- 17.5 The Bid shall be digitally signed (where supported) or contain high-resolution scans of documents signed by a person duly authorized via a written Power of Attorney.
- i. The Power of Attorney must be uploaded as part of the Technical Bid.
 - ii. All uploaded pages of the Schedules to Bid shall be sign and stamped physically before scanning, or digitally signed in accordance with the Electronic Transactions Ordinance.
- 17.6 The electronic Bid shall contain no alterations or additions, except those necessary to correct errors made by the Bidder. In such cases, the corrected document must be re-signed and re-uploaded prior to the submission deadline.
- 17.7 Bidders shall provide in the EPAD registration and the Form of Bid their full and proper physical and email addresses. All legal notices and correspondence served through the EPAD Correspondence Module or sent to these addresses shall be deemed validly served.
- 17.8 Bidders are advised to retain a complete digital copy of the submitted Bid and the system-generated Submission Receipt for their records.

(D) SUBMISSION OF BIDS

IB.18 Sealing and Marking of Bids

18.1 Electronic Submission Procedure: Each Bidder shall submit their Bid through the EPAD Portal (Version 2.0) as follows:

- a. **Electronic Bid Box:** Bids shall be uploaded into the system-defined "**Technical**" and "**Financial**" envelopes separately. The EPAD system's encryption protocols ensure that the Financial Bid remains locked and inaccessible until the successful completion of the Technical Evaluation.
- b. **Bid Security Instrument:** Notwithstanding the electronic submission, the **original physical Bid Security** instrument must be delivered to the Employer's physical address (as per IB 6.1) in a sealed envelope before the bid closing time. A high-resolution scanned copy of this instrument must be uploaded to the **Technical Section** of the EPAD Portal as a mandatory requirement for responsiveness.

18.2 Marking of Physical Bid Security Envelope: The envelope containing the physical Bid Security instrument shall:

- a. Be addressed to the Employer at the address provided in **Sub-Clause 6.1**.
- b. Bear the Project Name (**DESIGN, MANUFACTURE, SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF STATCOM FOR GRID/NETWORK STABILITY ENHANCEMENT AT 132KV GRID STATION PASNI IN THE MEKRAN REGION**), Contract Reference Number, and the Date of Bid Opening.
- c. Bear a clear warning: "**DO NOT OPEN BEFORE THE TIME AND DATE FOR BID OPENING.**"

18.3 Digital Marking of Electronic Files: Bidders shall ensure that all uploaded files are clearly named to reflect their contents (e.g., "Technical_Proposal_Schedule_A.pdf"). The EPAD system will automatically associate these files with the Bidder's digital identity and the specific tender reference.

18.4 Delivery of Physical Instrument: The physical Bid Security shall be delivered in person or sent by registered mail/courier to the address specified in the Invitation for Bids. It is the Bidder's sole responsibility to ensure that the physical instrument reaches the Employer's office before the deadline.

18.5 Non-Compliance:

- a. If the electronic files are uploaded to the incorrect section (e.g., Financial data included in the Technical envelope), the Bid may be rejected as non-responsive.
- b. If the physical Bid Security envelope is not sealed and marked as required, the Employer assumes no responsibility for its misplacement.
- c. Failure to upload the scanned copy of the Bid Security to the EPAD portal before the closing time shall result in the Bid being blocked or rejected by the system.

IB.19 Deadline for Submission of Bids

- 19.1 Bids must be submitted electronically through the EPAD Portal no later than the date and time specified in the Invitation for Bids (IFB). The system will automatically close the bid submission link at the exact time stipulated, and no further uploads will be permitted.
- 19.2 Bidders shall bear all costs associated with the preparation and electronic submission of their Bids. The Employer shall not be responsible for any delays in submission due to internet connectivity issues, local power failures, or the Bidder's failure to complete the upload process within the designated time.
- 19.3 Bids submitted through any means other than the EPAD Portal—including but not limited to telegraph, telex, fax, e-mail, or physical courier—shall not be entertained and will be considered non-responsive.
- 19.4 The Employer may, at his discretion, extend the deadline for submission of Bids by issuing an addendum in accordance with Clause IB.7, in which case all rights and obligations of the Employer and the Bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

IB.20 Late Bids

- 20.1 The EPAD System is configured to reject any attempt to submit a bid after the deadline prescribed in Clause IB.19. Consequently, no late bids can be received or considered by the Employer.
- 20.2 Bidders are strongly advised to initiate the uploading process well in advance of the deadline to avoid technical complications. A Bid is only considered "Received" once the system generates a digital submission acknowledgment.

IB.21 Modification, Substitution and Withdrawal of Bids

- 21.1 A Bidder may modify, substitute, or withdraw its Bid after it has been submitted, provided that such action is performed through the available functionality of the EPAD Portal prior to the deadline for submission of Bids.
- 21.2 To modify a bid, the Bidder must withdraw the existing submission and re-submit a revised version through the portal before the closing time. All previous versions of the bid will be automatically purged by the system upon withdrawal.
- 21.3 No Bid may be modified, substituted, or withdrawn after the deadline for submission.
- 21.4 Withdrawal of a Bid between the deadline for submission and the expiration of the period of Bid validity specified in the Form of Bid may result in the forfeiture of the Bid Security pursuant to Clause IB.15 and potential administrative action via the EPAD platform.

(E) BID OPENING AND EVALUATION

IB.22 Bid Opening

- 22.1 The Employer's designated Bid Opening Committee shall perform the Electronic Bid Opening through the EPAD Portal at the date and time stipulated in the Invitation for Bids. The "Electronic Bid Box" will remain encrypted until the specified time. Technical Bids shall be opened first. The EPAD system automatically records the date and time of the opening and the members present digitally. Financial Bids will remain encrypted and inaccessible within the system until the completion of the Technical Evaluation.

22.2 In the EPAD environment, any "MODIFICATION", "SUBSTITUTION", or "WITHDRAWAL" performed by the Bidder pursuant to Clause IB.21 is managed by the system. Only the final, validly submitted version of the Bid existing in the system at the deadline shall be opened.

22.3 The Bidder's name, presence of a scanned Bid Security, and any other such details as the Employer may consider appropriate shall be announced and recorded in the system-generated Minutes of Bid Opening.

Any discount offered by the Bidder must be clearly indicated in the designated "Discount" field or the Price Schedule within the EPAD Portal.

In case of any discrepancy between discounts mentioned in the Letter of Price Bid and the Summary Page of the Priced BOQ within the system, the discount shown on the Priced BOQ shall prevail. Discounts submitted via separate offline letters or external emails shall be considered null and void.

22.4 Discounts offered for lesser period than the Bid validity shall not be considered in evaluation.

IB.23 Clarification of Bids

23.1 To assist in the examination and evaluation of Bids, the Employer/Project Manager may request clarifications via the "Correspondence" or "Clarification" module of the EPAD Portal.

The Bidder's response must be submitted through the portal. No change in the price or substance of the Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered during evaluation.

IB.24 Preliminary Examination & Determination of Responsiveness of Bids

Prior to detailed evaluation, the Project Manager/Engineer will determine the responsiveness of Bids. The system-uploaded documents must be legible and complete.

A Bid shall be rejected if:

- a. It is not accompanied by a scanned copy of the Bid Security (with the original to follow physically).
- b. Its validity is less than the 180 days specified.
- c. It is submitted for an incomplete scope of work.
- d. It indicates a completion period beyond the 365-day limit.
- e. It is submitted by a Bidder who has participated in more than one Bid for the same project.

24.2 Arithmetical errors will be rectified on the following basis:

The EPAD system may perform automatic calculations; however, the Project Manager/Engineer will manually verify and rectify errors on the following basis:

- If there is a discrepancy between the unit price and the total price (unit price × quantity), the unit price shall prevail.
- If the Bidder does not accept the corrected amount, the Bid will be rejected and the Bid Security forfeited.

24.3 A substantially responsive Bid is one which conforms to all terms, conditions, and specifications without Material Deviation. A material deviation is one which:

- Affects the scope, quality, or performance of the STATCOM systems.
- Inconsistently limits the Employer’s rights or the Bidder’s obligations.

IB.25 Cost of Bid in Single Currency

25.1 To facilitate the comparison and evaluation of Bids, the Employer (or the Project Manager) will convert all Bid Prices—including those portions quoted in foreign currencies for imported Plant and Equipment—to Pak Rupees (PKR). The following protocols shall apply:

- a) Determination for NCB: For the purpose of this National Competitive Bidding, the PKR shall be the functional currency for evaluation. If the date of Technical Bid opening falls on a public holiday or a day when the SBP does not publish rates, the exchange rate of the last preceding working day shall be utilized.
- b) EPADS Integration: The converted rates will be utilized by the EPAD system to generate the final Financial Ranking (S_f) as per the methodology defined in Clause IB.26

IB.26 Detailed Evaluation of Bids

26.1 Technical Evaluation (Qualified/Disqualified & Scoring)

The Technical Bids will be evaluated based on the criteria specified in the Table under Sub-Clause IB24.

A: Qualified: Bidders securing an aggregate score of 70% or higher.

B: Disqualified: Bidders securing an aggregate score of less than 70%. Only Bids that pass the Technical Evaluation and meet the following Mandatory Requirements will be considered for Financial Opening:

1. Valid registration in Category C-A (No Limit) or C-B with specialization code EE-05.
2. Registered with FBR and appearing on the Active Taxpayers List (ATL).
3. Affidavit confirming the firm is not blacklisted/debarred internationally or by any Public Sector organization in Pakistan.
4. Affidavit confirming no pending litigation that could impact contract execution.

26.2 Evaluation and Comparison of Bids

Combined Score Methodology (QCBS)

The evaluation will utilize a weighted combined score of Technical (S_t) and Financial (S_f) performance.

- **Technical Weightage:** 80%
- **Financial Weightage:** 20%

The **Financial Score (Sf)** shall be calculated as:

$$S_f = \frac{F_m}{F} \times 100$$

Where:

- F_m = Lowest Evaluated Bid Price among responsive bids.
- F = Evaluated Bid Price of the Bidder under consideration.

The **Combined Score (S_c)** shall be calculated as:

$$S_c = (S_t \times 0.80) + (S_f \times 0.20)$$

(ii) The criteria for evaluation of technical bid shall be as per following details:

Criteria Category	Max Marks	Sub-Criteria & Scoring Basis
1. Experience	20	<p>1.1 Specific STATCOM Experience (12 Marks): 6 marks per project for successfully completed ± 50 MVAR (or higher) STATCOM projects on an EPC turnkey basis within the last 15 years. (Max 2 projects).</p> <p>1.2 Industry Tenure (8 Marks): 2 marks for every 3 years of experience in 132kV (or above) AIS/GIS EPC works beyond the mandatory 10-year threshold.</p>
2. Design & Tech Compliance	25	<p>2.1 Performance Guarantees (10 Marks): Full marks for meeting ± 70 MVAR at the POC with 20% transient overload capability. Pro-rata deduction for deviations.</p> <p>2.2 Studies & HIL Testing (10 Marks): 5 marks for commitment to provide PSSE/RTDS software models and 5 marks for a documented "Hardware-in-the-Loop" (HIL) factory testing plan.</p> <p>2.3 Architecture (5 Marks): Evaluation of the Modular Multi-level Converter (MMC) efficiency and N-1 redundancy in cooling/control.</p>
3. Performance Record	20	<p>3.1 Operational Success (10 Marks): 5 marks per project for notarized certificates confirming ≥ 2 years of trouble-free operation for the specific model offered.</p> <p>3.2 Availability Benchmarks (10 Marks): 5 marks per project for verified historical data demonstrating $\geq 99.7\%$ annual equivalent availability.</p>
4. Financial Strength	15	<p>4.1 Annual Turnover (10 Marks): Average annual turnover (last 5 years) \geq Rs. 500 Million. Bidders exceeding Rs. 750 Million (50% over) receive full marks.</p> <p>4.2 Liquidity & Health (5 Marks): Current Ratio ≥ 1.5 (3 Marks) and consistent positive Net Worth for last 5 years (2 Marks).</p>
5. Methodology & HR	20	(Detailed Breakdown Below)
Total Marks	100	Minimum Qualifying Threshold: 70% Aggregate Score

DETAILED REPRODUCTION: SECTION 5 – METHODOLOGY & HUMAN RESOURCES (20 MARKS)

This section evaluates the Bidder's ability to execute the project within the 365-day window while ensuring the intensive one-year technology transfer to QESCO personnel.

Ref	Sub-Category	Max Marks	Scoring Basis
5.1	Implementation Schedule (CPM/PERT)	5	<p>4 Marks: Logical Critical Path Method (CPM) showing parallel tracks for Civil CHB works and STATCOM manufacturing to meet the 365-day deadline.</p> <p>1 Mark: Identification of "Long-Lead Items" (IGBTs/Transformers) and specific mitigation plans for shipping to the Mekran Region.</p>
5.2	Site Logistics & Civil Strategy	5	3 Marks: Robust mobilization plan for Pasni/Mekran, including independent security, residential arrangements, and equipment transport.

Ref	Sub-Category	Max Marks	Scoring Basis
			2 Marks: Detailed strategy for Flood-Resilient Control House Building (CHB) construction as per Option B (Elevation/Drainage logic).
5.3	Human Resource (HR) Capability	5	3 Marks: Compliance with PEC bye-laws ensuring $\geq 70\%$ of the engineering staff are Pakistani nationals. 2 Marks: Qualification of the "Master Trainer" (Foreign Partner) and the Project Manager (Must be a PEC-registered Professional Engineer with 15+ years experience).
5.4	Operational Training Methodology	5	3 Marks: Detailed plan for the O&M phase (at least Two Year) and one year extended DLP, including on-the-job training modules for QESCO staff. 2 Marks: Comprehensive schedule for Overseas Factory Training (15 Engineers) and Site-based diagnostics training.

Only Bidders securing an aggregate Technical Score (St) of 70% (70 Marks) or higher shall be qualified for the opening of Financial Bids. The final contract award shall be determined using the Weighted Combined Score (80% Technical / 20% Financial) pursuant to PPRA guidelines for complex EPC works.

26.3 Evaluation Methods for Price Adjustments

Pursuant to Sub-Clause 26.2, the following price adjustments will be applied to the Bid Price for **comparison purposes only** to reach the **Evaluated Bid Price (F)**:

(i) Completion Schedule

- **Advance Completion:** No credit given.
- **Delayed Completion:** A factor of **0.1%** of the Bid Price per day will be added for any period exceeding the 365-day stipulated timeline.
- **Rejection Threshold:** Bids indicating completion beyond **60 days** after the stipulated period shall be rejected.

26.4 If the successful Bidder's price is significantly lower than the Engineer's Estimate (seriously unbalanced), QESCO may require a detailed price analysis and an increase in the Performance Security (up to 15% or 20% total) to mitigate the risk of default.

IB.27. Domestic Preference

- 27.1 In the comparison of evaluated Bids, the Goods manufactured in Pakistan, will be granted a margin of preference in accordance with the following procedures, provided the Bidder shall have established to the satisfaction of Employer that the manufacturing cost of such Goods includes a domestic value addition equal to at least 20% of the ex-factory Bid price of such Goods. Bidders applying for domestic preference shall fill in Appendix C and supporting evidence to the EPAD Portal.
- 27.2 The Employer/Project Manager/Engineer will first review the Bids to determine, the Bid group classification in accordance with Sub-Clause 10.2 hereof.
- 27.3 The comparison shall be ex-factory price of the Goods to be offered from within Pakistan (such prices to include all costs as well as custom duties and taxes paid or payable on raw

materials and components incorporated or to be incorporated in the Goods) and the DDP (CIF + Customs duty, sales tax and other import charges) Pakistan seaport price of the Goods to be offered from outside Pakistan.

- 27.4 The Engineering Development Board (EDB) guidelines and SROs shall be the primary reference for verifying the domestic content. The Employer reserves the right to request a verification certificate from the EDB or a third-party auditor to substantiate the value addition claimed in Appendix C.
- 27.5 The lowest evaluated Bid of each Group shall first be determined by comparing all evaluated Bids in each Group among themselves taking into account:
- a. In the case of Goods manufactured in Pakistan, sales tax, local body charges and other similar taxes which will be payable on the furnished Goods in Pakistan.
 - b. In the case of Goods of foreign origin offered from abroad, customs duties, sales tax and other import charges which will be payable on furnished Goods in Pakistan.
 - c. In the case of Goods of foreign origin already located in Pakistan, customs duty, sales tax and import charges on CIF price as applicable for Sub-Clause 27.5(b) here

IB.28 Process to be Confidential

- 28.1 Information relating to the examination, clarification, evaluation, and comparison of Bids, and recommendations for the award of a contract, shall not be disclosed to Bidders or any other persons not officially concerned with such process until the Final Evaluation Report is published on the EPAD Portal.
- 28.2 Subject to Clause IB.23, no Bidder shall contact the Employer or the Project Manager/Engineer on any matter relating to its Bid from the time of the Electronic Bid Opening to the time the evaluation result is announced. Any communication regarding the bid must be conducted strictly through the "Correspondence/Clarification" module within the EPAD Portal.
- 28.3 In accordance with PPRA Rule 35, the Employer shall ensure full transparency in the evaluation process through the following publication protocols on the EPAD Portal and the PPRA website:
- a. Technical Evaluation Announcement: Upon completion of the technical scrutiny, the Employer shall upload the Technical Evaluation Report. This report shall remain available for public viewing for a mandatory period of at least fifteen (15) days. Financial Bids of only the technically responsive Bidders shall be opened electronically after the expiration of this period and the resolution of any technical grievances.
 - b. Final Evaluation & Award Notification: Following the financial opening and combined scoring (QCBS 80/20), the Employer shall upload the Final Evaluation Report. This report shall include:
 - i. A comprehensive evaluation summary.
 - ii. Technical scores (S_t) and Evaluated Read-out Prices.
 - iii. Financial scores (S_f) and the Final Combined Ranking of all Bidders.
 - c. Standstill Period: The Final Evaluation Report shall remain available for at least fifteen (15) days prior to the formal issuance of the Letter of Acceptance (LoA). This period serves as a window for any aggrieved Bidder to lodge a protest via the EPADS Grievance Redressal Module in accordance with PPRA Rule 48
- 28.4 Any effort by a Bidder to influence the Employer or the Project Manager/Engineer in the Bid evaluation, Bid comparison, or Contract Award decisions—whether through offline

communication or unauthorized system access—shall result in the automatic rejection of their Bid and potential debarment via the EPAD platform.

- 28.5 Grievance Redressal (Rule 48): Any Bidder feeling aggrieved by the evaluation result may lodge a formal complaint through the "Grievance Redressal" module on EPADS or in writing to the Grievance Redressal Committee (GRC) of QESCO.
- Such complaint must be lodged not later than fifteen (15) days after the announcement of the bid evaluation report.
 - While the lodging of a complaint does not automatically suspend the procurement process, the Employer/GRC shall decide upon the complaint within fifteen (15) days of its receipt before the final award of the contract.

(F) AWARD OF CONTRACT

IB.29. Post-Qualification

- 29.1 The Employer may, at any stage of the evaluation, require a Bidder to provide further information concerning their professional, technical, financial, or managerial competence. This applies whether the Bidder was pre-qualified or not, provided that the reasons for such a request are recorded in writing and included in the Bid Evaluation Report uploaded to the EPAD Portal.
- 29.2 The determination will examine documentary evidence of the Bidder's capabilities (Appendix B) and verify the authenticity of specialized experience in STATCOM technology.
- 29.3 An affirmative determination is a pre-requisite for the award. If a Bidder is determined to be unqualified, the Employer will proceed to a similar determination for the next lowest evaluated Bidder.

IB.30 Award Criteria

- 30.1 Subject to Clause IB.32, the Employer will award the Contract to the Bidder whose Bid has been determined to be substantially responsive to the Bidding Documents and who has offered the lowest evaluated Bid Price, provided that such Bidder has been determined to be qualified to satisfactorily perform the Contract in accordance with the provisions of Clause IB.29.

IB.31 Employer's Right to Vary Quantities

- 31.1 Employer reserves the right at the time of award of Contract to increase or decrease by up to 15 % the quantity of Plant and Services contained in the Schedule of Prices without any change in the unit price or other terms and conditions.

IB.32 Employer's Right to Accept any Bid and to Reject any or all Bids

- 32.1 Notwithstanding Clause IB.30, the Employer reserves the right to accept or reject any Bid, and to annul the bidding process and reject all Bids, at any time prior to award of Contract, without thereby incurring any liability to the affected Bidders or any obligation to inform the affected Bidders of the grounds for the Employer's action except that the grounds for its rejection shall upon request be communicated, to any Bidder who submitted a Bid, without justification of grounds. Rejection of any or all Bids shall be notified to any or all Bidders promptly through EPAD.
- 32.2 No negotiation with the Bidder having been evaluated as lowest responsive or any other Bidder shall be permitted. However, the Employer may have clarification meeting(s) to get clarified any item(s) in the Bid evaluation report.

IB.33 Notification of Award

- 33.1 Prior to expiration of the period of Bid validity, the successful Bidder will be notified with a Letter of Acceptance issued through the EPAD Portal and physical mail. This letter shall name the sum which the Employer will pay the Contractor in consideration of the design, execution and completion of the Works/facility by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called the "Contract Price").

- 33.2 The Letter of Acceptance and its acceptance by the Bidder will constitute the formation of the Contract, binding the Employer and the Bidder till signing of the formal Contract Agreement.
- 33.3 Upon furnishing by the successful Bidder of a Performance Security, the Employer will promptly notify the other Bidders that their Bids have been unsuccessful and return their Bid securities.

IB.34 Performance Security

- 34.1 The successful Bidder shall furnish a Performance Security 10% of the Contract Price, within twenty-eight (28) days of receipt of the Letter of Acceptance.
- 34.2 Failure of the successful Bidder to comply with the requirements of Sub-Clauses IB.34.1, IB.35 or Clause IB.44 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security.

IB.35 Signing of Contract Agreement

- 35.1 Within fourteen (14) days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Employer will send to the successful Bidder the Form of Contract Agreement provided in the Bidding Documents, duly filled in and incorporating all agreements between the parties for signing and return it to the Employer.
- 35.2 The formal Agreement between the Employer and the successful Bidder shall be executed within fourteen (14) days of the receipt of such Form of Contract Agreement by the successful Bidder from the Employer.

(G) ADDITIONAL INSTRUCTIONS

IB.36 Instructions not Part of Contract

- 36.1 Bids shall be prepared and submitted in accordance with the above Instructions to Bidders including Additional Instructions which are provided to assist Bidders in preparing their Bids, and do not constitute part of the Bid or the Contract Documents.

IB.37 Contract Documents

- 37.1 The Documents which will be included in the Contract are listed in the Form of Contract Agreement set out in these Bidding Documents.

IB.38 Sufficiency of Bid

- 38.1 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. Except insofar as it is otherwise expressly provided in the Contract, the rates and prices entered in the Schedule of Price shall cover all his obligations under the Contract and all matters and things necessary for the proper completion of the Works/facility.

IB.39 One Bid per Bidder

- 39.1 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.

IB.40 Bidder to inform himself

- 40.1 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 a Contract for execution of the Works/facility. This shall include but not be limited to the following:

- (a) inquiries on Pakistani Income Tax to the Commissioner of the Income Tax and Sales Tax,
- (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.

IB.41 Alternate Proposals by Bidder (Not Applicable)

- 41.1 Should any Bidder consider that he can offer any advantage to the Employer by a modification to the designs, specifications or other conditions, he may, in addition to his Bid to be submitted in strict compliance with the Bidding Documents, submit any Alternate Proposal(s) containing (a) relevant design calculations; (b) technical specifications; (c) proposed construction methodology; and (d) any other relevant details / conditions, provided always that the total sum entered on the Form of Bid shall be that which represents complete compliance with the Bidding Documents.
- 41.2 Alternate Proposal(s), if any, of the lowest evaluated responsive Bidder only may be considered by the Employer as the basis for the award of Contract to such Bidder.

IB.42 Site Visit and Local Conditions

- 42.1 Bidder must verify and supplement by his own investigations the information about site and local conditions. However, Employer will assist the Bidder wherever practicable and possible.
- 42.2 All Bidders are required to visit the site at their own expense to review the areas allocated for the Plant and the interfacing facilities, if any. Bidders may also wish to study local conditions, available facilities, communications, craft wages, roads and other transport facilities. Bidders shall also acquaint themselves with the relevant laws, rules, and regulations of Pakistan.
- 42.3 The Bidders and any of their personnel or agents will be granted permission by the Employer to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the Bidders, their personnel and agents, will release and indemnify the Employer, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such inspection.
- 42.4 Given the project location is 132kV Grid Station Pasni in the Mekran Region, the Contractor shall be solely responsible for the security of its employees, labor, plant, and materials. All costs associated with private security coordination or specialized logistics shall be deemed included in the Bid Price.

IB.43 Pre-Bid Meeting

- 43.1 The Employer may, at its own initiative or at the request of any prospective Bidder(s), hold a Pre-Bid Meeting to clarify technical specifications, site conditions of 132kV Grid Station Pasni in the Mekran region, and EPADS submission procedures.

- 43.2 The date, time, and link for the Pre-Bid meeting shall be published and communicated strictly through the EPAD Portal. The meeting may be conducted physically at the address indicated in clause IB 6.1, virtually via a secure video-conferencing link, or in a hybrid format. All registered Bidders who have downloaded the documents from EPADS will receive an automated system notification.
- 43.3 Prospective Bidders are encouraged to submit their questions or requests for clarification through the "Clarification" module of the EPAD Portal at least seven (7) days prior to the Pre-Bid meeting to allow for a comprehensive response.
- 43.4 No verbal statement made during the meeting shall modify the Bidding Documents unless it is issued as a formal Addendum.
- The Minutes of the Pre-Bid Meeting, including the text of the questions raised and the responses given (without identifying the source of the inquiry), will be uploaded to the EPAD Portal within five (5) working days.
 - All Bidders are required to acknowledge these minutes/addenda through the EPADS interface, and these shall form an integral part of the Bidding Documents pursuant to Clause IB.7.
- 43.5 If the Pre-Bid meeting includes a scheduled site visit to the 132kV Grid Station Pasni in the Mekran Region, the logistics and security protocols (as per Clause IB.42) will be detailed in the minutes uploaded to EPADS.

IB.44 Integrity Pact

- 44.1 The Bidder shall sign and stamp the Integrity Pact provided in Schedule-J to Bid in the Bidding Documents for all Federal Government procurement contracts exceeding PKR ten million. Failure to provide such Integrity Pact shall make the Bid non-responsive.

IB.45 General Performance of the Bidders

- 45.1 The Employer reserves the right to obtain information regarding performance of the Bidders on their previously awarded contracts/works (Schedule-I to bid). The Employer may in case of consistent poor performance of any Bidder as reported by the employers of the previously awarded contracts, inter alia, reject his bid and/or refer the case to the Pakistan Engineering Council. Upon such reference, PEC in accordance with its rules, procedures and relevant laws of the land take such action as may be deemed appropriate under the circumstances of the case including black listing of such Bidder and debarring him from participation in future bidding for similar works.

(H) APPENDICES

The Appendices to ITB are as given below:

- Appendix-A: Name of Eligible Countries
- Appendix-B: Evidence of Bidder's Capabilities
- Appendix-C: Domestic Goods (value added in Pakistan)

Appendices are given here below:

Appendix A to Instructions to Bidders

NAME OF ELIGIBLE COUNTRIES

All countries of the World except Israel and India, with whom Islamic Republic of Pakistan has commercial relations.

Appendix B to Instructions to Bidders

EVIDENCE OF BIDDER'S CAPABILITY

Note: Bidders to provide the following information with the Bid separately and indicate herein its references where this information is available.

SR. NO.	INFORMATION TO BE SUPPLIED	BID REFERENCES
1	Name of Bidder, business address, country of incorporation, and valid PEC Registration (Category C-A (No Limit) or C-B with specialization code EE-05).	
2	Type of firm (Individually owned, Partnership, Corporation, or Joint Venture) and names of owners/partners. Provide a notarized JV Agreement explicitly stating Joint and Several Liability.	
3	Financial Strength (Last 5 Years):(a) Authenticated Annual Reports: Balance sheets, P&L statements, and Turnover.(b) Audited Balance Sheets for the preceding five (5) years.(c) Total value of works in hand as of the bid opening date.(d) Total value of works completed in the last three (3) years.	
4	Technical Experience (As per IB 13.4):(a) Evidence of completing at least one (1) EPC/Turnkey Contract with a minimum value of Rs. 500 Million during the last ten (10) years.(b) Evidence of having designed, supplied, and installed at least two similar facility (High Voltage Substation/STATCOM) ≥ Rs. 1,500 Million during the last five (5) years.	
5	Location and address of manufacturing facilities for the STATCOM units and primary power electronics.	
6	Full description of owned factories and annual manufacturing capacities for Modular Multi-level Converters (MMC) and control panels.	

SR. NO.	INFORMATION TO BE SUPPLIED	BID REFERENCES
7	Details of testing facilities, manufacturing processes, and quality standards. Provide names and experience records of specialized sub-suppliers for IGBT modules and cooling systems.	
8	Quality Assurance: Copy of License Agreement (if manufactured under license), ISO certifications, and a project-specific Quality Control/Quality Assurance (QC/QA) Plan.	
9	Human Resources:(a) Resumes and qualifications of key technical personnel (Project Manager, Design Engineer, Site Engineer).(b) Total permanent staff on roll and total number of qualified engineers (showing compliance with PEC's 70% local engineering staff rule).	
10	Verification of the manufacturer's tenure in the high-voltage power electronics business.	
11	Proof of "In-Service" history for the offered STATCOM model (Manufacturer must show compliance with IB 13.4(c) regarding ± 50 MVar project experience).	
12	Reference List: (a) Detailed list of similar works (Domestic & International) including customer name, capacity (\pm MVar), year of supply, and performance certificates. (b) Detailed list of Telecommunication & SCADA Integration works (Domestic & International) including customer name, year of supply, and performance certificates.	
13	Details of current contractual commitments and projects under execution for each JV partner.	

SR. NO.	INFORMATION TO BE SUPPLIED	BID REFERENCES
14	Banking References:(a) Authority to make inquiries with the Bidder's bankers regarding financial status.(b) Details of Overdraft (OD) limits and available credit lines to ensure cash flow for a project of this magnitude.	
15	Project Risk Management: Health, Safety, and Environment (HSE) plan and a specific Security Risk Management Plan for the 132kV Grid Station Pasni in the Mekran Region.	
16	Methodology: Detailed integrated work plan (CPM/PERT) and methodology for EPC, commissioning, and the 24-year O&M phase.	
17	Capacity Building Plan: Detailed plan for training QESCO and Consultant personnel. Note: The Contractor must allocate a minimum budget of *Rs. [Insert Amount] ** for trainings, O&M manuals, and software simulation tools (Not Reimbursable).	
18	Litigation History: Information on any litigation or arbitration over the last ten (10) years for each JV partner. Provide an affidavit of Non-Blacklisting.	

Appendix C to Instructions to Bidders

Domestic Goods (Value added in Pakistan)

[Bidders claiming eligibility for domestic preference should fill in for supply items only, all columns hereunder and provide necessary documentation to substantiate their claim].

Sr. No.	Description of Indigenous Goods	Unit	Qty	Total Price of Goods Ex-Factory (Pak Rs.)	Domestic value added in the manufacturing cost as percentage of Ex-Factory Price	Amount of value addition (Pak Rs.)
1	2	3	4	5	6	7
Total in columns 5 & 7						

Computations:

- A. Total amount of Value Addition (from Col.7) Rs _____
- B. Total Ex-Factory Price of Indigenous Goods (from Col.5) Rs _____
- C. Total DDP/CIF Price of imported supply items Eqv.Rs _____
- D. Total Price of supply items [B+C] Eqv.Rs _____

1. Verification of Eligibility (Minimum 20% Threshold):

Percentage of Value Addition = $[A / D] \times 100 =$ _____%

(Note: If this value is less than 20%, the Bidder is ineligible for Domestic Preference).

2. Determination of Preference Margin (As per SRO 827 EDB):

- If Value Addition is **20% to 30%**: Preference = **15% of [B]**
- If Value Addition is **over 30% to 40%**: Preference = **20% of [B]**
- If Value Addition is **over 40%**: Preference = **25% of [B]**

3. Calculated Amount of Domestic Preference:

Rs. _____ *(This amount shall be deducted from the Bidder's Evaluated Price for financial ranking purposes only).*

**LETTER OF TECHNICAL BID
AND
SCHEDULES TO BID**

**LETTER OF TECHNICAL BID
AND
SCHEDULES TO BID**

Letter of Technical Bid

Schedules to Bid

- Schedule A to Bid: Specific Works Data
- Schedule B to Bid: Proposed Organization for the Project
- Schedule C to Bid: Method of Performing Works
- Schedule D to Bid: Proposed Programme of Works
- Schedule E to Bid: Works to be Performed by Subcontractors
- Schedule F-1 to Bid: Deviations from Technical Provisions
- Schedule F-2 to Bid: Deviations from Contractual Conditions
- Schedule G to Bid: Specific Operation/Plant and Equipment Detail
- Schedule H To Bid: Specimen JV Agreement
- Schedule I To Bid: Past Performance and Present Commitments

LETTER OF TECHNICAL BID

Bid Reference No.:

Package No.:

.....
.....
[Name of Works]

To:

.....
.....
.....

Gentlemen,

1. Having examined the Bidding Documents including Instructions to Bidders, Conditions of Contract, Specifications, Drawings, Schedules to Bid, Schedule of Prices and Addenda Nos. for the execution of the above-named Works, we, the undersigned, being a company doing business under the name of and address and being duly incorporated under the laws of hereby offer to execute and complete such Works and remedy any defects therein in conformity with the said documents including Addenda thereto.
2. We understand that all the Schedules attached hereto form part of this Bid.
3. As security for due performance of the undertakings and obligations of this Bid, we submit herewith a Bid Security in the amount of drawn in the favor of, or made payable to the Employer, and valid for a period days beyond the period of validity of Bid.
4. We undertake, if our Bid is accepted, to commence the Works and to deliver and complete the whole of the Works comprised in the Contract within the time(s) stated in Preamble to the Conditions of Contract.
5. We agree to abide by this Bid for the period of days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
6. Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.
7. We undertake, if our Bid is accepted to execute the Performance Security referred to in Clause 10 of Conditions of Contract for the due performance of the Contract.
8. We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other person or persons making a Bid for the Works.
9. We do hereby declare that our firm, including any subcontractors or suppliers for any part of the Contract, have nationalities from eligible countries *[insert the nationality of the Bidder, including that of all parties that comprise the Bidder if the Bidder is a consortium or association, and the nationality of each Subcontractor and Supplier]*.
10. We, including any subcontractors or suppliers for any part of the Contract, do not have any conflict of interest.

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11. We are not participating, as a Bidder or as a subcontractor, in more than one bid in this bidding process.
12. We confirm, if our Bid is accepted, that all partners of the joint venture shall be liable jointly and severally for the execution of the Contract and the composition or the constitution of the joint venture shall not be altered without the prior consent of the Employer. (Please delete in case of Bid from a single firm).

Dated this day of 200...

Signature in the capacity of duly authorized to sign
 the Bid for and on behalf of
 (Name of Bidder in Block Capitals)
 (Seal of Bidder)

Bidder's Address

Witness:

Signature:
 Name:

Address:

Occupation

SCHEDULE – A TO BID

SPECIFIC WORKS DATA

The main technical data is prescribed in the relevant sections of the Technical Provisions. However, the Bidder may supplement the main technical data by providing hereunder other salient parameters including main plant make, capacity and suitability for the works under consideration to enable the Employer/Project Manager/Engineer to assess technical conformance of the proposed process and the means available with the contractor to do it.

Initials of Signatory to Bid:.....

SCHEDULE – A TO BID

1. INTRODUCTION & PURPOSE

1.1. Background

- 1.1.1. QESCO continues to face several operational challenges, including voltage stability issues due to long transmission lines and limited grid infrastructure in Mekran Region.
- 1.1.2. The Mekran Region power system exhibits pronounced weak-grid characteristics, including low short-circuit strength, long radial transmission corridors, and heavy reliance on remote generation, resulting in high sensitivity to voltage disturbances and delayed post-fault voltage recovery. Comprehensive steady-state and time-domain dynamic stability studies, performed in accordance with NEPRA Grid Code 2023 (TCPS Article 4.6), have identified an optimum node at a critical electrically weak location requiring fast and continuous dynamic reactive power support. The final reactive power requirement has been dynamically sized at ± 70 MVar. The STATCOM installation is therefore required to be designed using a modular and expandable architecture, such that the plant can be commissioned in phases while being fully configured for ultimate operation at ± 70 MVar without requiring major redesign, replacement of primary equipment, or extended system outages. The EPC Contractor shall take due cognizance of this dynamic sizing basis, weak-grid operating environment, and modular expansion requirement when developing the detailed design, equipment ratings, layout, control philosophy, and protection schemes for the project.

1.2. STATCOM Project Description

- 1.2.1. For STATCOM site and system descriptions, please refer to Annexure-A.
- 1.2.2. The design of STATCOM shall meet the operational and system dynamic requirements specified in this specification using power electronic based Voltage Source Converter allowing symmetrical operation in the leading & lagging MVAR region. Temporary overload of specific components shall also be considered.
The harmonic filter requirements have to be fulfilled over the whole reactive power range for harmonic emission from the grid as well as STATCOM system.
- 1.2.3. Each bidder shall provide a detailed design of the STATCOM being offered, showing all the equipments in the Contractor's scope of supply, control & protection schemes, cooling system arrangement, reliability, SCADA Integration & Remote control architecture, telecommunication architecture and availability calculations etc. with adequate redundancy.
- 1.2.4. The bidder shall declare safety hazards including hazardous materials associated with equipments being supplied and the design shall include suitable protection measures complying with the international standards.

2. Reference Standards

2.1. Documentation, Language & Units

- 2.1.1. All documents, drawings, instructions, manuals, technical information and test certificates shall use SI units and shall be in English.

2.2. Standards/Specifications

- 2.2.1. All work connected with the supply of the STATCOM system shall be in accordance with the requirements of appropriate latest International/Company standards and regulations such as IEC & IEEE. Where no International/Company standard exists, the STATCOM system shall comply with recognised standards and design practices. If the requirements of this specification conflict with any of the reference standards or practices, the Company's specification(s) shall prevail in particular to those items/requirements. The bidder shall state and furnish a list of all standards used for the specific type of equipment/material with the bid.
- 2.2.2. For the major STATCOM components, the latest version of the standards mentioned in Table-1 shall apply:

Table-1

SCHEDULE – A TO BID

Standard	Description
ISO 1000	Metric Standards
ISO 9001	Quality Assurance
ISO 1459, 1461	Hot-dip Galvanisation
IEC 60060	High Voltage Testing Techniques
IEC 60071	Insulation Co-ordination
IEEE 1052	IEEE Guide for Specification of Transmission Static Synchronous Compensator (STATCOM) System
IEEE 1031	IEEE Guide for the Functional Specification of Transmission Static Var Compensators
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use of polluted conditions
IEC 61000-3-6	Electromagnetic Compatibility (EMC) – Part3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems
IEC 60146	Semiconductor Converters
IEC 60147	Essential Ratings and characteristics of Semiconductor Devices and General Principles of Measuring Methods
IEC 60747-1	Semiconductor Devices - Discrete Devices - Part 1: General
IEC 60747-2	Semiconductor Devices - Discrete Devices - Part 2: Rectifier Diodes
IEC 60747-6	Semiconductor Devices - Discrete Devices - Part 6: Thyristors
IEC 61954	Testing of Thyristor Valves for Static VAR Compensators
IEEE 1303	Guide for Static VAR Compensation Field Tests
IEC 62927	Voltage Sourced Converter (VSC) valves for static synchronous compensator (STATCOM) – Electrical Testing
IEC 61070-11, IEC/TR 600871-1;-4	Shunt Power Capacitors
IEC 61071	Capacitors for power electronics
IEEE Std 18™	IEEE Standard for Shunt Power Capacitors
IEEE Std 519™	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
IEC 62001	High-voltage direct current (HVDC) systems - Guidance to the specification and design evaluation of AC filters
IEEE Std 1267™	Guide for Development of Specification for Turnkey Substation Projects
IEEE Std 1303™	Guide for Static Var Compensator Field Tests
IEEE Std 1313.2™	IEEE Guide for the Application of Insulation Coordination
IEEE Std C37.90.1™	IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE Std C57.123™	Guide for Transformer Loss Measurement
IEC 60076, P-46	Transformers
IEC 60289	Reactors
IEC 60099, P-181	Surge Arrestors
IEC 62271-100, P-193	Circuit breakers
IEC 62271-102, P-128	Disconnectors and Earthing Switches
IEC 60137	Bushings above 1000V
IEC 60168	Insulators of Ceramic or Glass
IEC 60044-1, P-90	Current Transformers
IEC 60044-2, P-129	Voltage Transformers

SCHEDULE – A TO BID

Standard	Description
IEC 60694	Common clauses for HV Switchgear and Control gears
IEC 62271	High-voltage switchgear & control gear
IEC PAS 62001	Specification and Design Evaluation of AC Filters for HVDC Systems
IEC 60688	Transducer for Electrical measurements
IEC 60794	Optical fibre cables
IEC 60255	Electrical Protective Relays

2.2.3. The above stated list does not claim to be complete. Some additional standards are also referred under specific clauses. Additionally, all general laws and regulations must be followed regarding Health and Safety.

2.3. Definitions

2.3.1. For the purposes of this specification, the following technical terms and definitions shall apply. IEC 60050 & IEEE International Electro technical Vocabulary shall be referred for terms not defined in this clause.

- i. **Taking Over Certificate (TOC)**
The certificate issued by the Client upon successful completion of the 720-hour Reliability Run post-energization, marking the start of the at least two-year Warranty and O&M period.
- ii. **Contract Start**
The date a contract to supply a static synchronous compensator (STATCOM) becomes effective, and the user has given notice to proceed
- iii. **Control Range**
The total inductive plus capacitive range of reactive current or megavar variation of the static synchronous compensator (STATCOM) at the point of connection during normal voltage ($\pm 5\%$ of the nominal value) and contingency voltage ($\pm 10\%$ of the nominal value) range.
- iv. **Hybrid STATCOM**
A combination of both STATCOM and Thyristor switched devices whose outputs are coordinated
- v. **Point of common coupling (PCC)**
The connection point between the STATCOM and power system at which performance requirements are defined
- vi. **Point of connection (POC)**
For a STATCOM with a dedicated transformer, the high voltage (HV) bus to which the whole is connected. For a STATCOM connected to an existing transformer, or direct connected, the busbar to which the STATCOM is connected
- vii. **Reference voltage**
The point on the voltage/current (V/I) characteristic where the static synchronous compensator (STATCOM) is at zero output (i.e., where no vars are absorbed from, or supplied to, the transmission system at the point of connection).
- viii. **Response time**
The duration from a step change in control signal input until the voltage changes by 90% of its final change, before any overshoot.

SCHEDULE – A TO BID

- ix. Settling time**
The duration from a step change in control signal input until the STATCOM output settles to within $\pm 5\%$ of the required control output.
- x. Slope**
The ratio of the voltage change to the current change over the defined controlled range of STATCOM, normally the full (inductive plus capacitive) range at nominal voltage, expressed as a percentage.
- xi. STATCOM (Static Synchronous Compensator)**
A static synchronous generator operated as a shunt connected compensator, whose capacitive or inductive output current can be controlled independent of the ac system voltage
- xii. STATCOM Valve**
Electrically and mechanically combined assembly comprised of forced commutated devices (e.g. IGBT) assembled in levels, complete with all connections, auxiliary components, and mechanical structures, which can be connected in series with each phase of reactor of a STATCOM.
- xiii. Submodule**
Part of a STATCOM valve comprising controllable switches and diodes connected in a half bridge or full bridge arrangement, together with their immediate auxiliaries, and storage capacitor, if any; where each controllable switch consists of one or more switched valve device(s) connected in series.
- xiv. Voltage/current (V/I) characteristic**
The relationship between the current of the STATCOM and the voltage at its point of connection.
- xv. VSC (Voltage Sourced Converter)**
A forced commutated device (e.g. IGBT) based self commutated converter that is capable of generating ac voltage from dc capacitor voltage

2.4. Acronyms & Abbreviations

BoP	Balance of Plant
BIL	Basic Insulation Level
EMI	Electromagnetic Interference
ETT	Electrically Triggered Thyristors
EMC	Electromagnetic Capability
FAT	Factory Acceptance Test
FACTS	Flexible AC Transmission System
HV	High Voltage
HVDC	High Voltage Direct Current
PCC	Point of Common Coupling
POC	Point of Connection
RI	Radio Interference
RMS	Root Means Square
STATCOM	Static Synchronous Compensator
SWC	Surge Withstand Capability

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TIF	Telephone Influence Factor
TNA	Transient Network Analyzers
IGBT	Insulated Gate Bipolar Transistor
LTT	Light Triggered Thyristor
LV	Low Voltage
LVRT	Low Voltage Ride Through
TVI	Television Interference
V/I	Voltage/Current
CT	Current Transformer
PT	Potential Transformer
HMI	Human Machine Interface
DFR	Digital Fault Recorder
DSM	Dynamic System Monitor
VQR	Voltage Quality Recorder
SOE	Sequence of Event Recorder
VSC	Voltage Source Converter

3. ENVIRONMENTAL DATA

3.1. Ambient Conditions

3.1.1. The STATCOM shall be designed to meet all ratings and performance requirements specified in this document while operating in the following environmental conditions:

Maximum temperature (under the Sun)	55°C
Maximum mean over any 24 hours	45°C
Mean temperature in any year	30°C
Minimum temperature	-10°C

3.2. Relative Humidity

3.2.1. The relative humidity may range up to 100%. The maximum values of the ambient temperature and humidity, however, do not occur simultaneously. During monsoons high humidity may persist for many days at a time with temperature ranging from 30°C to 40°C.

3.3. Altitude

3.3.1. Installations may be upto 1000 m above sea level.

3.4. Atmospheric Conditions

3.4.1. It may be assumed that the air is not, normally, heavily polluted by dust, smoke, aggressive gases, vapours or salt spray. However, at certain times of the year severe dust storms may be experienced.

3.4.2. Certain areas are subject to heavily polluted atmosphere and insulation or bushings for installation in such areas shall have an extended creepage distance from line to earthed parts.

4. SCOPE OF WORK

4.1. General Requirements

4.1.1. The Contractor shall be responsible for all the specified studies, design, engineering, furnishing of all equipments, delivery, civil works, , installation, testing, commissioning, warranty, training, field verification and placement into commercial operation of the STATCOM system. The Contractor may also be required to provide all information for independent design verification and system modelling.

4.1.2. The Contractor shall be responsible for design, construction, site improvements and determining the final dimensions based on detailed design study.

4.1.3. All equipment shall be designed as needed to meet the requirements in this specification. Any equipment and/or function of the STATCOM not specifically mentioned herein shall be

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designed as required by the overall design of the STATCOM system in order to ensure the satisfactory operation of the system even after installation and operation of STATCOM.

- 4.1.4. The scope shall include Remote Terminal Units (RTUs) in the STATCOM control room and substation control room, all necessary intra-site cables for interfacing, and a complete telecommunication link between the STATCOM SCADA system and the Company's existing SCADA infrastructure. The interfaces shall be compatible with the existing RTUs at the Company's SCADA Control Centre. The STATCOM shall be remotely controllable through the SCADA interface by the Company's Control Centre. The EPC Contractor shall be fully responsible for the provision and commissioning of all telecommunication equipment and links as specified in the Clause 7.11

4.2. Equipment Material

- 4.2.1. The Contractor's scope of works also includes but not limited to the followings. For additional/special requirements, refer Annexure - D.

- i. All engineering, fabrication, supply, installation, testing and commissioning of the STATCOM components, their assemblies and accessories.
- ii. 132 kV/MV transformer, ONAN/ONAF cooling, 3 phase Single unit, oil immersed, outdoor type with HV & MV insulated bushings, control & auxiliary cubicles and all other allied accessories. One single-phase unit shall be supplied as spare in addition.
- iii. VSC or other devices for reactive power control with their protection, control, monitoring and cooling system.
- iv. Harmonic filters as required by the specified harmonic performance levels.
- v. All transformer bay equipment on the primary side of the step-down transformer including circuit breakers, disconnect switches, instrument transformers, surge arresters, a motor-driven earthing switch, etc.
- vi. All bus work on secondary side of the transformer including tubular bus bars, steel support structures, insulators, circuit breakers, disconnectors, earth switches, surge arresters, connectors, joints, fittings etc.
- vii. Bushings to the STATCOM valve building or termination to STATCOM Container
- viii. STATCOM MV Auxiliary transformer.
- ix. Control and Protection equipment of the STATCOM, including measurement, monitoring, indication etc.
- x. STATCOM MV Surge capacitors and STATCOM Control HMI.
- xi. MV Current and Voltage transformers.
- xii. Separate STATCOM auxiliary supplies (AC and DC) complete with automatic changeover, cable laying, protection, batteries and battery chargers with charger coupler arrangement.
- xiii. Ring main unit (RMU) arrangement for the AC supplies shall be applied to ensure uninterruptible supply.
- xiv. Surge protection and overhead lightning protection of the STATCOM yard and supporting structure.
- xv. STATCOM yard lighting.
- xvi. All equipment's support structures, foundations and trenches.
- xvii. STATCOM control and power cabling.
- xviii. 132kV air insulated Surge Arresters mounted in close proximity to the STATCOM HV transformer bushings. Numbers of Surge Arresters required shall be identified through Insulation Coordination Study
- xix. MV Transformer mounted Surge Arresters. Numbers of Surge Arresters required shall be identified through Insulation Coordination Study
- xx. The Contractor shall be fully responsible for the design, engineering, supply, construction, installation, testing, and commissioning of a complete STATCOM solution, which will be implemented as a prefabricated containerized system, as deemed appropriate by the Contactor. The selected solution shall include, as a minimum, all STATCOM valves, control, relay, and protection systems, together with

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foundations, plumbing, lighting, fire detection and fire protection systems, electrical outlets, and facilities for maintaining the required ambient temperature and humidity. The proposed design shall comply with the performance requirements of this specification document and with the applicable Company standards. Approval of the proposed configuration by the Company shall not relieve the Contractor of full responsibility for the adequacy, completeness, safety, and fitness for purpose of the STATCOM installation.

- xxi. The Contractor shall design and construct one maintenance room for the local repair/maintenance of the STATCOM equipment/parts.
- xxii. All delivered equipment shall be adequately protected and anti-corrosive in nature.
- xxiii. Any other equipment and engineering required for the proper functioning, operation and maintenance of the STATCOM.
- xxiv. Single Line and Layout Drawings of the substation where STATCOM is to be installed, are presented in Annexure-C.

4.3. Services

4.3.1. The following services shall be part of the Contractor's scope of work

- i. Site civil works including site preparation
- ii. Installation of RO plant with pumping and water storage system keeping in view the STATCOM requirement for cooling system as per section 4.4.4.4.2 in case STATCOM system requires water-based cooling.
- iii. STATCOM yard and associated substation civil work i.e. sub-soil investigation, site development, clearing, grading, access roads, site fences, gates, surface treatment, drainage, drainage materials, filling, footings, foundations, trenches, ducts, site security during construction etc as per site requirements.
- iv. Delivery, receiving and handling at the site of all materials and equipment under scope of work.
- v. Supply, installation, testing, and termination of all interconnecting power cables, control cables, and fibre-optic links between STATCOM equipment, STATCOM control building or containerized units, and the existing or new substation control building, including all associated accessories.
- vi. The Contractor's responsibility includes the provision of potential-free contacts at the SCADA terminal box at each site for data exchange. Additionally, the Contractor shall supply, install, commission, and integrate all telecommunication equipment and links required to interface the STATCOM SCADA system with the Company's existing SCADA infrastructure. No telecommunication infrastructure exists at site. The Contractor shall design, supply, install, commission, and integrate a complete end-to-end telecommunication system. The technology shall be selected from microwave point-to-point link, satellite communication, or GSM/LTE-based communication, subject to approval by the Company. Full details are specified in Clause 7.11.
 - The Contractor shall provide automatic link health monitoring for all telecommunication links. In the event of a primary link failure at site, the system shall automatically switch to a backup channel (where provided) or enter a defined safe freeze state as specified. The Contractor shall incorporate link quality indicators and RSSI/signal strength monitoring into the SCADA HMI at the STATCOM control room.
- vii. Assembly, Installation and installation of all equipment on site. Wiring and connection of all equipment, apparatus, components, and equipment frames, racks and switchboard panels, etc. at site

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- viii. Supervision and performance of field verification, final checkout, start up and commissioning tests of all STATCOM apparatus and controls connected to the grid including all interfaces, and verification of proper operation and functioning of the same.
 - ix. Training of the Company’s personnel, which will enable them to operate and maintain the STATCOM and modify its control parameters if so required. Training requirements can be found in sub-clause 8.17
 - x. Arrangement of testing facilities and witnessing of routine/type tests, trainings etc. to the Company engineers, as required.
 - xi. Provision of Diesel Generator (DG) Backup: The Contractor shall provide a Diesel Generator set of adequate capacity to provide a complete backup supply for the SVC/STATCOM, including its auxiliary supply and control systems. This shall include the provision of backup fuel sufficient for at least one (1) full day (24 hours) of continuous operation at complete supply load.
 - xii. Based on historical data from the 2005 flood event, where water levels reached a minimum of 4 feet above the Finished Floor Level (FFL) within the Control House Building (CHB)—specifically impacting the 11kV Switchgear Room, CP/RP Room, and Battery Room—the following technical mandates apply to the proposed works:
 - Option A: Modification of Existing CHB If the contractor elects to utilize the existing CHB, comprehensive civil structural alterations are required to elevate the FFL. The contractor must ensure that all elevated equipment maintains mandatory vertical clearances to the roof, strictly adhering to NGC/WAPDA standards.
 - Option B: Construction of New CHB Prospective bidders may propose the construction of a new CHB. This facility must be designed to house existing equipment relocated from the current CHB while meeting updated flood-resiliency elevations.
 - xiii. Redundant Power House Integration The Prospective bidders may propose the utilization of already constructed building of thermal power plant subject to:
 - Decommissioning & Site Preparation: The contractor shall be responsible for the complete dismantling and removal of all existing redundant machinery and legacy infrastructure currently housed within the building.
 - FFL Elevation & Structural Modification: Based on the 2005 hydrological data, which recorded flood levels at a minimum of 4 feet above the existing Finished Floor Level (FFL), the contractor must execute a floor-uplifting program.
 - Clearance Compliance: The final elevated floor height must provide sufficient vertical clearance for the SVC/STATCOM equipment. All installations must remain compliant with NGC/WAPDA safety clearances and structural load-bearing requirements.
 - xiv. Any other services and engineering required for the proper functioning of the STATCOM.
- 4.4. Interfaces
- 4.4.1. Connection to the substation
 - 4.4.1.1. The existing 132 kV outdoor switchgear in single bus single breaker configuration which shall be expanded by a complete 132 kV bay for making interconnection to the STATCOM.

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- 4.4.1.2. The STATCOM shall be connected to the specified bus bar at the substation through a coupling transformer and outdoor bay. The bay shall comprise of circuit breakers, disconnectors, earthing switches, arresters, current and voltage transformers etc. as per STATCOM overall operation and design requirements.
- 4.4.1.3. 132kV tubular bus bar arrangement and its connections from the STATCOM 132 kV bay in the existing 132kV switchyard to the STATCOM transformer air insulated outdoor bushing.
- 4.4.2. Earthing Grounding Mat
 - 4.4.2.1. The grounding mat is to be connected to the existing grounding system in the substation. The Contractor shall perform earth measurements and care shall be taken when providing new grounding system that it shall not form closed loops to ensure that induced current is not circulated in the grounding loops.
- 4.4.3. SCADA & Communication System Interfacing
 - 4.4.3.1. Interface to the Company's communication and SCADA system shall be provided including RTUs in STATCOM control room, substation control room etc. and all necessary cables for interfacing. The interfaces shall match with the existing RTUs. The STATCOM shall also be remotely controlled through SCADA interface by the Company's control centre.
 - 4.4.3.2. The 132 kV connection bay shall be included in the remote control system of substation.
 - 4.4.3.3. Alarms shall be grouped locally in a rational way and be exchanged with the remote control centre.
 - 4.4.3.4. The Contractor's responsibility includes the provision of potential free contacts at the SCADA terminal box at the site for exchanging the data but excludes the communication links.
- 4.4.4. Water Supply Sewage and Drainage
 - 4.4.4.1. In the substation, the water supply has to be arranged by the Contractor. The connection for the STATCOM cooling system has to be investigated by the Contractor. The connection for the drainage of the STATCOM and the rainwater is also included in the Contractor's scope of work.
 - 4.4.4.2. RO plant needs to be installed by Contractor to meet cooling and other auxiliary water requirements
- 4.5. Documents
 - 4.5.1. Supply of the following documentation shall be made by the successful bidder:
 - i. All drawings/data, instructions/service/trouble shooting manuals necessary to operate and maintain the STATCOM and associated equipments with complete drawings in triplicate. The drawings shall include the complete set of plans, elevations, sections, wiring, schematics, piping, etc. of the whole STATCOM system. The scope of spare parts and special tools must be co-ordinated with the requirements/guarantees of reliability and availability requirements mentioned in sub-clause 7.9.
- 4.6. Spare Parts & Special Tools
 - 4.6.1. The bidder shall furnish recommended spare parts for the STATCOM system as well as all special tools needed for the maintenance/operation of the STATCOM. A detailed list of the spare parts/special tools including all necessary information regarding manufacture, supplier, equipment specification, calibration intervals, etc. shall be furnished with the bid. Refer to sub-clause 8.15 of this specification as well.

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4.7. Equipment, Material & Services Furnished by the Employer

- 4.7.1. A dedicated piece of land where the STATCOM system shall be installed.
- 4.7.2. Water, one or two (independent) auxiliary AC feeders (230/400V) for temporary use, as required for installation of the equipment and to facilitate reasonable working conditions for the Contractor's personnel.
- 4.7.3. Available as-built reference data and drawings for the Contractor's use for design and interconnection of the STATCOM system.

5. Power System Characteristics

- 5.1. The power system AC characteristics at the point of connection prior to STATCOM installation are mentioned in Annexure - A & B. STATCOM operation is required within the specified parameter values and durations.

6. STATCOM Characteristics and Performance Requirements

6.1. STATCOM Performance Requirements

- 6.1.1. The performances and rating requirements of the STATCOM shall be demonstrated by the Contractor, depending on the specific requirement and equipment or system involved, by at the following activities:
 - i. At Bidding stage, through preliminary performance studies
 - ii. At Engineering Stage, through dedicated detailed studies
 - iii. At Manufacturing Stage, through dedicated inspection and test plans for the different equipment and systems (covering the overall process, from checking the received materials to routine and type tests)
 - iv. At Commissioning Stage, through sub-systems and system tests and acceptance tests for the overall converter station.

6.2. STATCOM Configuration

- 6.2.1. The STATCOM shall have minimum one VSC branch, but two or more VSC branches are allowed. VSC branches shall be connected to a common MV bus. In case of two or more VSC branches, each branch shall be possible to disconnect from the common bus separately.
- 6.2.2. Auxiliary power shall be taken from the MV bus, alternatively from a third winding on the STATCOM power transformer. Also, a provision of the feeder from the existing/ new 11 kV switchgear room of the substation should be Provided in addition to the preferred supply. A margin of 10% shall be added to the on MVA rating for each one of the two independent supplies from the power system.
- 6.2.3. Harmonic filters shall be provided (if necessary), to meet the harmonic performance requirements. Provision for small converter filters shall be included in case there is no filter in the original design. A converter filter is seen as an integral part of a VSC branch and consequently there shall be an identical filter in each VSC branch.

6.3. STATCOM Rating

6.3.1. Continuous Rating

- 6.3.1.1. All values, definitions and references are referred to: IEEE Std 1052-2018, and clause 8. The VI diagram specified stipulates the minimum requirements. All requirements are defined for a symmetrical power system except where otherwise stated. In case the chosen technology provides an extended V-I diagram compared with the specified, the same shall be provided by the Bidder based on 100MVA base. Bidder shall fill the following Table 2 and provide in the design document at bidding stage.

Table – 2: STATCOM Operating Points and Reactive Power Generation

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Sr. No	Operating Points	Voltage (PU)	Duration	Reactive Power (MVAR)
1	A	1.00	Continuous	
2	B	1.00	Continuous	
3	C	0.3	10 Seconds	
4	D	0.7	2.5 Minutes	
5	E	0.9	Continuous	
6	F	1.06	Continuous	
7	G	0.95	Continuous	
8	H	1.07	Continuous	
9	I	0.96	Continuous	
10	J	1.12	Continuous	
11	K	1.20	60 Seconds	
12	L	1.30	3 Seconds	
13	M	1.50	1 Seconds	
14	N	1.80	1 Cycle	

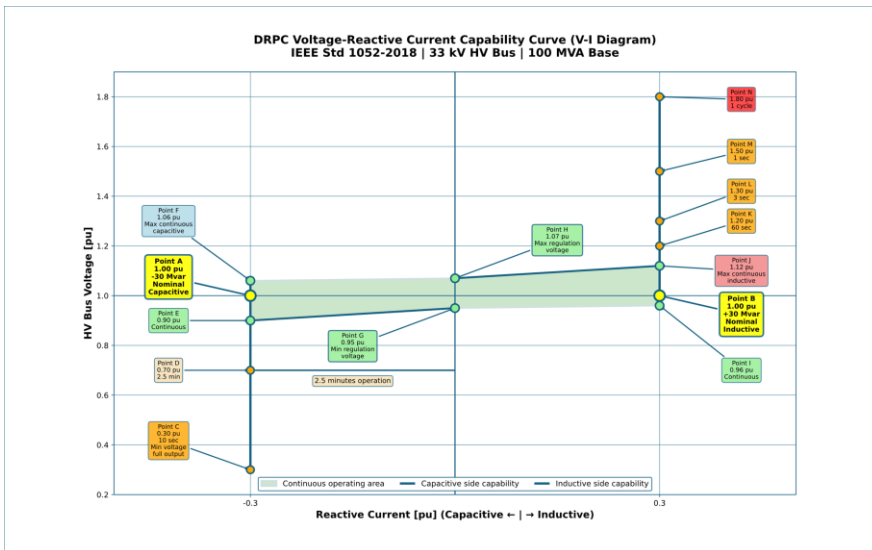


Figure 1: Conceptual STATCOM V/I Diagram

- i. The STATCOM should regulate the HV bus voltage to a reference voltage of Base Voltage (1.0 P.U.), continuously adjustable between 0.95 P.U. (point G) and 1.07 P.U. (point H).
- ii. The nominal capacitive reactive power output of the STATCOM at point A shall not be less than the value specified in Annexure-A on 100 MVA base at 1.0 P.U. HV bus voltage and at nominal system frequency.
- iii. The nominal inductive reactive power output of the STATCOM at point A shall not be less than the value specified in Annexure-A on 100 MVA base at 1.0 P.U. HV bus voltage and at nominal system frequency.
- iv. The maximum continuous capacitive reactive power output of the STATCOM is denoted by point F and is obtained when the STATCOM is operated with minimum droop and maximum reference voltage.

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- v. The maximum continuous inductive reactive power output of the STATCOM is denoted by point J and is obtained when the STATCOM is operated with maximum droop and maximum reference voltage.
 - vi. The reactive power range required is the minimum requirement at the STATCOM HV bus after allowing for the combined effect of all component and control tolerances including that of the transformer. These tolerances shall be stated in bid and shall be guaranteed. The reactive range is defined at fundamental frequency.
 - vii. The nominal slope of the characteristic should be adjustable in steps of not greater than 0.1% between 1.0% and 5.0%, on a basis of STATCOM nominal capacitive power rating.
 - viii. The STATCOM shall be capable of continuous operation over the voltage range as indicated in the V/I characteristics drawing.
 - ix. The STATCOM shall continue to generate reactive current during a temporary undervoltage in accordance with the VI diagram down to a HV voltage of 0.7 P.U. For the duration of 2.5 minutes and down to a HV voltage of 0.3 P.U. for 10 s (point C). At operation outside the limits set by the VI diagram, the STATCOM is allowed to block. STATCOM shall remain connected to the system, ready for immediate voltage control as soon as the HV voltage is above 0.3 P.U. The STATCOM is allowed to trip 10 seconds after it has blocked.
 - x. The STATCOM shall continue to generate reactive current during a temporary overvoltage in accordance with the VI diagram up to the value of 1.2 P.U. for the duration of 60 seconds (point K), 1.3 P.U. for the duration of 3 seconds (point L) up to 1.5 P.U. for the duration of 1 second (point M) and up to 1.8 p.u. for 1 cycle (point N). At operation outside the limits set by the VI diagram, the STATCOM shall preferably block but it is allowed to trip if needed. It shall (if possible) remain connected to the system, ready for immediate voltage control as soon as the STATCOM design allows. The STATCOM is allowed to trip 10 seconds after it has blocked. This is the minimum requirement, and the Bidder/Contractor shall determine the maximum overload and overvoltage requirement based on the network data provided in the specification. The STATCOM shall be rated and designed to withstand these over-voltages.
 - xi. The STATCOM shall remain in service (with full current capability) during a single line to ground fault, resulting in zero voltage on one HV phase, or a line to line fault resulting in 0.5 P.U. remaining HV voltage between the faulted phases.
 - xii. The STATCOM transformer and all bus equipment shall be rated to withstand the specified continuous and short-term operation, and to withstand or be protected against voltage and current stresses that exceed these conditions. No components of the STATCOM are allowed to trip during the overload period.
 - xiii. Taken with its normally connected transformer, all STATCOM equipment should sustain, without damage, any internal fault in the STATCOM MV side. The disconnectors (if provided) for the VSC branches must be able to withstand the maximum through fault current until the STATCOM HV breaker has cleared the fault. Fault level on HV bus shall be limited to 40 kA as per WAPDA/NGC applicable standards. Fault current shall be calculated using a voltage source of 1.1 P.U. behind the source impedance.
 - xiv. The STATCOM reactive current output shall not be limited while within the specified rating range setting and operating modes. The STATCOM controller shall be capable of controlling (switching and blocking) the VSC at any time during a transient disturbance.
- 6.3.1.2. Component and Control Tolerance

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- i. The STATCOM shall not, in steady state operation, increase the voltage unbalance at its HV terminals by more than 0.2% due to component, measurement and control system and power electronic valve firing unbalance tolerances.
- 6.3.1.3. Reactive Power Rating Tolerance
- i. The reactive power range required is the minimum requirement after allowing for the combined effect of all component and control tolerances including that of the transformer. These tolerances shall be stated by the Bidder and shall be guaranteed.
- 6.3.2. Short Term Rating & Overload Behaviour
- 6.3.2.1. See V-I Characteristic as supplied in V/I characteristics diagram Figure 2: Conceptual STATCOM V/I Diagram. The components of the STATCOM shall be designed for operation consistent with the V-I characteristic defined in the presence of power frequency surges and dips at the STATCOM HV bus corresponding to the overload cycles specified. The STATCOM shall not be tripped or prevented from operation during these network conditions.
- 6.3.2.2. The STATCOM and in particular its transformer and HV connection overloading capability shall be designed with the requirement that the transformer operation mode should not limit the above capability at any time. At an ambient temperature of 55° C, or less, there shall be a 20% overload capacity for 2 seconds. This capacity will be called upon at major loss of generation or single line to ground faults. At these occasions there may shortly be a severe lack of capacitive power. The system voltage will be restored by switching line reactors. Until these reactors are in correct operation mode, the STATCOM shall, to its best, maintain the system voltage. Major disturbances calling for the overload capacity is expected to occur only a few times per year. It is expected to be minimum 1 minute between two events.
- 6.3.2.3. The STATCOM must be able to sustain the specified overload cycle as a result of a single line to ground phase fault on Company's HV or MV system for the fault duration (minimum to maximum) as defined in Annexure-E section E.4.2.2 Fault Cases, followed by either delayed voltage recovery or an overvoltage of 1.3 P.U. for 3 seconds or 1.5 P.U. for 1 second. It can be assumed that there is minimum 1 minute between two independent system faults.
- 6.3.3. Undervoltage V-I characteristics for Auxiliary Power
- 6.3.3.1. Contractor shall design an auxiliary power system that allows the requirement for operation stated in the VI diagram (level and time) to be met. The effect on the auxiliary power by the variation on the HV grid must be considered. No single point failure of equipment is allowed to limit STATCOM operation.
- 6.3.3.2. Automatic switch-over between systems shall be initiated when the active system becomes faulty.
- 6.3.3.3. At HV voltages below 0.95 P.U. the STATCOM can be assumed to run at full capacitive current (except when it is blocked).
- 6.3.3.4. At HV voltages above 1.12 P.U. the STATCOM can be assumed to run at full inductive current (except when it is blocked).
- 6.3.3.5. The requirements on the STATCOM when taking its auxiliary power from internal & external sources as mentioned below:
- i. Internal Source
CONTRACTOR shall account for the voltage drop/rise across the STATCOM power transformer and auxiliary transformer. Voltage unbalance on the STATCOM MV bus shall be considered. Equipment needed (such as voltage stabilizers, UPS, UMD etc.) to meet the requirements shall be provided.

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- ii. External Source
The second source should be from the existing 11 kV switchgear.

6.4. Control Objectives

- 6.4.1. Control of three-phase average or positive sequence of the fundamental voltage in steady state, during and after faults, over the full slope range. The STATCOM voltage controller shall be optimized to rapidly control the HV voltage during and after single phase, phase to phase or three phase faults on the Company transmission system.
- 6.4.2. Balancing of asymmetries during system faults. During single line to ground faults the voltages on healthy phases may become excessively high if the STATCOM runs fully capacitive on all phases. The STATCOM shall run unsymmetrical in such a way that all line to line voltages at PCC are kept below 1.3 P.U. (or another set value) during system faults, if within STATCOM power capability.
- 6.4.3. The STATCOM should not trip during the overvoltage conditions as defined.
- 6.4.4. The STATCOM should not trip during the undervoltage conditions as defined. The STATCOM controller shall:
 - i. Prevent harmonic instability due to network resonances,
 - ii. Not limit the dynamic performance of the STATCOM
 - iii. Not limit the voltage and reactive power control range.

6.5. Control System Response & Stability

Refer to IEEE Std 1052™-2018 for definitions of response time, maximum overshoot and settling time.

- 6.5.1. The change of measured system voltage, for a voltage change of less than 20% (Small Signal Response), should reach 90% of the desired total change within two cycles (40 ms) of the initiating control signal. The maximum overshoot should not exceed 10% of the final change and the settling time should not exceed 100 ms, after which the voltage should be within 5% of the final value.
- 6.5.2. The change of measured system voltage, for a voltage change of larger than 20% (Large Signal Response), should reach the STATCOM reactive power range limit within one cycle (20 ms) of the initiating control signal.
This response is required when the system three-phase fault MVA is between the normal minimum and maximum value defined in this specification.
- 6.5.3. The response of the STATCOM controller shall be valid over the total STATCOM range. This shall be demonstrated by the Bidders and the Contractor during the bid stage, basic design stage and factory control performance testing.
- 6.5.4. A Thevenin network equivalent is sufficient for this validation which is provided in Annexure-A.
- 6.5.5. The rapid voltage STATCOM controller shall be designed to ensure stable dynamic behaviour of the STATCOM over the entire short-circuit range and system network impedance as specified. Gain reduction (if applicable) for voltage controller at low fault level shall be automatic. The step response requirements shall be achieved from normal minimum short circuit power to normal maximum short circuit power without any adjustment of the regulator settings. Regulator settings can be optimized if fast (instantaneous) continuous monitoring of short circuit power is provided. Optimization that takes more than 3 cycles is not considered as fast short circuit power monitoring. It is not allowed to fine tune control parameters manually for each fault level in order to fulfil step response requirements during studies.
- 6.5.6. Dynamic performance under very weak network condition: The network is considered very weak when the three-phase short-circuit current at the substation is abnormal (below the specified minimum values) as occurs upon network restoration, for instance. The STATCOM

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control system shall ensure stable behaviour of the STATCOM under these conditions (gain supervision and stability control).

6.5.7. Gain Supervision

- 6.5.7.1. The input signal of the supervisor is the output of the rapid voltage regulator. This signal is filtered so as retain only the oscillating-frequency band specific to instabilities of the compensator voltage regulating loop.
- 6.5.7.2. Instability is detected when the amplitude of the oscillations on the filtered input signal overshoots an adjustable thresh-hold for an adjustable number of times. The response speed of the compensator is gradually reduced until the amplitude is within acceptable limits.
- 6.5.7.3. The values of the voltage regulator parameters governing the response speed of the compensator remain at the new values dictated by the supervisor until an operator from the Company Control Centre or local HMI commands the return to the initial values or until action by the optimizer, as described herein.

6.5.8. Optimization

- 6.5.8.1. The optimizer re-adjusts the rapid voltage regulator parameters altered by the action of the supervisor so as to optimize the dynamic performances of the STATCOM relative to the initial settings.
 - 6.5.8.2. The optimizer evaluates the dynamic performances of the STATCOM by provoking a small disturbance and then analyzing the output of the rapid voltage regulator. It gradually re-adjusts the parameters until the rapid voltage regulator satisfies its performance criterion or the initial values of the parameters are obtained. Optimization must in general take account of other DRPCs, SVC's or generators electrically close nearby. Each Compensator must have its own optimizer circuit.
 - 6.5.8.3. The optimizer must take account of all the DRPCs on the network. To achieve this, gain freeze send and receive signals shall be provided in the controller.
 - 6.5.8.3.1. The small disturbances generated by the optimizers at various substations must be time-coordinated to ensure balance of the values of the rapid voltage regulator parameters for all the DRPCs on the network.
 - 6.5.8.3.2. There must be a certain delay between the action of the supervisor and activation of the optimizer so as to allow permanent network recovery.
 - 6.5.8.4. Contractor shall study how the nearby generators affect the gain optimization and define a workable strategy for gain setting and optimization.
 - 6.5.8.5. When operating near the inductive limit gain optimizer shall perform a test in capacitive direction and when operating near the capacitive limit perform the test in the inductive direction.
- 6.5.9. The bid document shall include an analysis of the behaviour of the automatic rapid voltage regulation supervisor/optimizer during disturbances and / or sudden oscillations in the short-circuit level and / or changes in the number of compensators in service. The operating principle of the automatic devices must be explained, and transfer and logic functions shall be provided.
- ### 6.5.10. Undervoltage Control Strategy
- 6.5.10.1. The purpose of the under-voltage control strategy is to provide voltage support in an optimal manner. It should be noted that the normal STATCOM operation at under-voltages is to support and balance the voltage in an optimal manner defined by system studies.
 - i. An under-voltage condition is detected when the positive phase sequence voltage at the STATCOM HV bus is below an adjustable lower threshold of 0.30 to 0.95 P.U. (Step size of 0.01 P.U.) for an adjustable time of 0 to 5 seconds (step size of 1ms).

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This condition is cleared when the positive phase sequence voltage rises above an adjustable upper threshold of 0.30 to 0.95 P.U. (step size of 0.01P.U.) for an adjustable time of 0 to 200ms (step size of 1ms).

Upon detection of an under-voltage condition, one of the control strategies described below, shall be run. The control strategy to use shall be set at the HMI. The VSC branch(es) must remain in service (deblocked or blocked) during the under-voltage condition, unless it drops below the operational limits.

- a) Strategy #1: No special action is required. The STATCOM reacts to the output of its rapid voltage controller.
- b) Strategy #2: The output of the STATCOM controller is set to a preset value (value I_{ref}). This value is adjustable between maximum inductive to maximum capacitive.
- c) Strategy #3: VSC branches block. This action occurs at the voltage level where the synchronization for firing pulses is no longer guaranteed, i.e. operation outside the limits set by the VI diagram.
At voltage recovery, the STATCOM voltage regulator operation starts from a preset output value B2 (defaulted to 0). The output of the STATCOM controller is from this time the normal function of the voltage error.
- d) Strategy #4: The Contractor shall implement additional under-voltage strategies based on results from the dynamic studies (PSCAD / RTDS). Criteria for detection of under-voltage conditions shall be defined by the Contractor.

6.5.11. Overvoltage Control Strategy

6.5.11.1. The STATCOM shall remain in operation during temporary over-voltages and reduce them. An overvoltage condition is detected when the positive phase sequence voltage measurement, as used by the rapid voltage STATCOM controller, exceeds an adjustable upper threshold of 1.10 to 1.50 P.U. (step size of 0.01P.U.) for an adjustable time of 0.000 to 2.000 seconds (step size of 1 ms). This condition is cleared when the voltage is below an adjustable lower threshold of 1.0 to 1.5 P.U. (Step size of 0.01P.U.) for an adjustable time of 0 to 200ms (step size of 1ms).

Upon detection of an over voltage condition, one of the control strategies described below, shall be run. The control strategy to use shall be set at the HMI.

- a) Strategy #1: No special action is required. The STATCOM reacts to the output of its rapid voltage controller.
- b) Strategy #2: The Contractor shall implement additional under-voltage strategies based on results from the dynamic studies (PSCAD / RTDS). Criteria for detection of under-voltage conditions shall be defined by the Contractor.

6.5.12. Under Frequency

6.5.12.1. In the event, the network frequency drops below the minimum value specified in NEPRA Grid Code, the STATCOM shall not trip and lock out, but block all power electronic valves and remain on standby. As soon as the frequency exceeds the value, the STATCOM shall go back into normal voltage control. The STATCOM is allowed to trip 10 seconds after it has blocked.

6.5.13. Over Frequency

6.5.13.1. In the event, the network frequency exceeds the maximum value stated in specified in NEPRA Grid Code, the STATCOM shall not trip and lock out, but block all power electronic valves and remain on standby. As soon as the frequency drop below the value, the STATCOM shall go back into normal voltage control. The STATCOM is allowed to trip 10 seconds after it has blocked.

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6.6. Major Control Functions

6.6.1. Manual Control – Fixed Reactive Power (Q) Mode

6.6.1.1. The control system shall be provided with facilities for manual Mvar control, which will enable setting of the reactive output by direct control of the valve firing i.e., a fixed Q operating mode, with the automatic voltage controller out of service. The manual control operation shall only be allowed within the limits of the continuous STATCOM rating of the main components and shall not cause automatic under or overvoltage conditions on the network. Under and overvoltage limits shall be selectable.

6.6.1.2. The Manual Control shall:

- i. Be provided with a follow-up device or similar system such that a transfer from automatic control to manual control mode and vice versa at any operating point within the STATCOM range results in a reactive disturbance of less than ± 3.00 Mvar. It shall not provoke voltage kicks or surges. This follow-up device would be disabled when the STATCOM is operating under manual control. The rate of adjustment during transfer from manual to automatic control mode shall be approximately 3.00 Mvar per second.
- ii. Be capable of setting the unit output over its complete range.
- iii. Permit testing of the control system with the STATCOM connected to the Company's transmission system.
- iv. Indicating instruments and appropriate controls shall only be accessible via password controlled access to the HMI that will facilitate the transfer between automatic and manual mode and reference setting. Only remote indication of the control mode (automatic and manual) shall be required. This mode shall be automatically disabled, and the controller is switched to the normal voltage control mode within 10ms of detecting a system under-voltage or overvoltage condition.
- v. All control system protective functions such as current and voltage limitations shall remain in operation while operating in manual mode.

6.6.2. Automatic Energizing – Sequence Control

6.6.2.1. Automatic energizing of the STATCOM shall be provided and must cause minimum disturbance on the network.

- i. Trip and Lock-out shall only occur for serious faults. Loss of AC Auxiliary power shall not prevent a restart. Loss of HV AC and based on a low battery level alarm shall result in the STATCOM switching off (#2 OFF) without any lock out and restart shall be possible.
- ii. No alarms shall prevent restart after a normal shutdown: OFF.
- iii. The STATCOM shall have auto-restart function where the faulty branch is automatically disconnected and the STATCOM re-energized.
- iv. The Contractor shall design the automatic sequence control to take into consideration the fact that the STATCOM connection to the HV bus will be via a single bus single breaker substation arrangement. The Contractor shall develop the "ON", and "OFF" sequence according to best international practice for such an arrangement. The Contractor shall take note of the location of the HV voltage measuring point.
- v. During energizing of the STATCOM (ON), the STATCOM shall not cause a large transient change in the voltage. The limit of the transient voltage variation with reference to the existing voltage is 5% for a network strength between normal min and max. The Contractor shall specify the guaranteed transient voltage variation and duration as well as the energization time, including transformer inrush, etc. The Contractor shall describe the sequence of energizing of the STATCOM
- vi. Within the control and protection system, facilities shall be included for the local and remote initiation of each of the following three functions: on, off and trip.

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Sequence control plant and material shall be provided to cause these initiations to perform the following functions:

- a. #1 ON: The voltage reference shall be adjusted by the sequence control plant and material such that, when the STATCOM is automatically connected to the power system, the output of the STATCOM does not exceed 3 Mvar capacitive or inductive. Following the energizing of the STATCOM by the closing of its HV circuit breaker, and after a suitable time interval, the voltage reference shall be adjusted to the set point, the rate of adjustment being such that the reactive output ramps at 3.00 Mvar per second. If the system voltage exceeds an overvoltage threshold, the Mvar adjustment shall be ignored and the rapid voltage STATCOM controller enabled without any delay.
The STATCOM shall control the filter branches/capacitor bank by selective energization of each branch after the STATCOM has been switched ON.
- b. #2 OFF: The voltage reference shall be adjusted by the sequence control plant and material to cause the reactive output of the STATCOM to become zero and the STATCOM subsequently disconnected from the power system by the opening of the STATCOM HV circuit breaker.
The rate of adjustment shall be such that the reactive output ramps at a rate of approximately 3.00 Mvar per second. If the system voltage should drop below or exceed the adjustable voltage threshold levels $1.00P.U. \leq U_{max} \leq 1.10P.U.$ and $0.95P.U. \leq U_{min} \leq 1.00P.U.$ (step size of 0.01P.U.), the OFF program shall be stopped and the STATCOM Controller shall continue as before. Local and remote indication of this condition shall be provided.
- c. #3 TRIP: The unit shall immediately be disconnected from the system with no delay to initially zero the reactive output. The valves shall be set to reduce the reactive output to zero simultaneously with the trip output signal to the STATCOM HV breaker.
A trip signal shall always have an immediate effect and shall override both the ON and OFF functions.
This signal must be wired into the protection and control systems from the main substation control room and a local trip switch.

6.6.3. Slow Regulation of Reactive Power or Constant MVAR Control

- 6.6.3.1. The STATCOM shall have a selectable "auto runback" option where the STATCOM shall reduce (ramp) its Mvar output to a pre-set operating point after an adjustable preset time delay dependent upon required STATCOM output. Supplementary VSC current control.
 - i. This automatic device is designed to restrict the controlled reactive power range in the steady state condition. It shall ensure a sufficient reserve of reactive power for voltage control during major disturbances.
 - ii. This device regulates the operating point (Q: Mvar) of the STATCOM to a value defined by a reference that can be continuously adjusted over the entire controlled STATCOM range. The setting must be within 1% of the rated current or STATCOM MVA rating (step size tolerance of 1MVAR and step size of 1 to 5 Mvar). The reference can also be adjusted by the operator. This adjustment shall be from local and remote (raise and lower signals).
 - iii. The Constant Mvar controller shall operate slowly so as not to interfere with the rapid voltage regulation and shall not cause under - or overvoltage conditions. The

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- response time of the slow STATCOM controller shall be continuously adjustable from 1.0 to 600.0 seconds (step size of 1 seconds).
- iv. The STATCOM shall return to a voltage control mode if the busbar voltage drops below a preset value or exceeds a pre-set value. The output of the slow reactive power STATCOM controller is limited by independent positive and negative ceilings that are continuously adjustable between 0 and 0.1 P.U. (step size of 0.01P.U.) of the reference voltage. These limits shall be of the dynamic type (non wind-up), i.e., once the output of the slow STATCOM controller has peaked, it must drop off as soon as the input signal changes polarity. The reference voltage signal (Vref) shall be reset to value given on HMI.
 - v. A voltage disturbance prompts (initiates) one of two actions:
 - a. The output of the slow reactive power STATCOM controller is reset and maintained at zero.
 - b. The output of the slow reactive power STATCOM controller is maintained at the value prior to the voltage disturbances.

A voltage disturbance is detected upon the occurrence of an under-voltage below an adjustable threshold of 0.9 P.U. to 1.0 P.U. (step size of 0.01P.U.) or an over-voltage above an adjustable threshold of 1.0 P.U. to 1.1 P.U. (step size of 0.01P.U.). The choice of action and adjustment of the voltage thresholds shall be selected by authorized personnel. Drop-out of the slow STATCOM controller during a voltage disturbance must be indicated (local and remote).
 - vi. The effect of either action described above is maintained for an adjustable period of 1 sec to 50 minutes. In the event of the output of the slow STATCOM controller being held at the value prior to the voltage disturbance, the drift of the output value must be negligible throughout that period. Operator re-activation of the slow STATCOM controller must be possible, even if the timer-controlled period has not fully elapsed.
 - vii. Manual deactivation of the slow STATCOM controller shall not cause voltage steps. Nor shall such voltage steps occur upon manual activation or manual or automatic re-activation of the slow regulation.
 - viii. This automatic device must be compatible with the shared control of the STATCOMs at the substation, or generators / DRPCs / HVDC / converter-based resources (renewable) at any substation electrically close.
 - ix. The STATCOM controller shall allow enabling or disabling of this function from local or remote, including status indication and raise and lower of this signal from local and remote.
 - x. In case this reactive power control function is disabled and the measured reactive current output of the STATCOM remains within adjustable capacitive and inductive limits for adjustable periods, a status alarm indicator is made locally and remote.

6.6.4. Positive Sequence Control

- 6.6.4.1. This section describes two tentative designs for the symmetrical and unsymmetrical control. The Contractor may suggest his own standard design.

6.6.4.1.1. Closed Loop Voltage Control

- 6.6.4.1.1.1. The voltage at the STATCOM HV bus in this substation shall be measured and controlled. The range of the STATCOM that can be used for unsymmetrical control shall be limited only by the available VSC branches range and necessary control restrictions. The STATCOM shall be able to run phase wise unsymmetrically.

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- 6.6.4.1.1.2. The controller shall remain stable for transient and other dynamic operation of the network and the STATCOM.
- 6.6.4.1.1.3. The STATCOM shall be designed for unsymmetrical operation of its full range during system faults. Unbalanced operation of VSC is required. Control strategy during power system short circuits shall be determined and verified by studies.
- 6.6.4.1.1.4. Company aims for maximum voltage support for induction motor loads from the STATCOM. Unsymmetrical voltage control shall be used in order not to violate line to line voltage limits (1.3 P.U.) at PCC during and after grid short circuits if within STATCOM power capability. The limit shall be settable between 1.1 and 1.3 P.U.
- 6.6.4.1.1.5. To ensure maximum voltage support, the voltage reference shall be increased at fault initiation. On fault clearing the voltage reference shall be set to a new lower value. At a settable time (typically less than 2 s) after fault clearing the voltage reference shall be ramped back to its initial value during a settable time (typically less than 5 s).
- 6.6.4.1.1.6. The details of this function shall be determined during the design studies. Fault initiation can be detected by a sudden drop in positive phase voltage and/or rise in negative phase sequence voltage. Manufacturer shall suggest a scheme for detecting fault initiation and clearing.

i. Phase Sequence Components Control

The measured voltage shall be separated in phase sequence components and DQ transformed.

A positive phase sequence current giving the wanted positive phase sequence voltage shall be generated in the STATCOM. A PI (proportional - integrating) regulator shall be used for the Q component of the measured positive phase sequence voltage to determine the needed phase wise identical STATCOM current.

The phase sequence wise calculated currents shall be summed together.

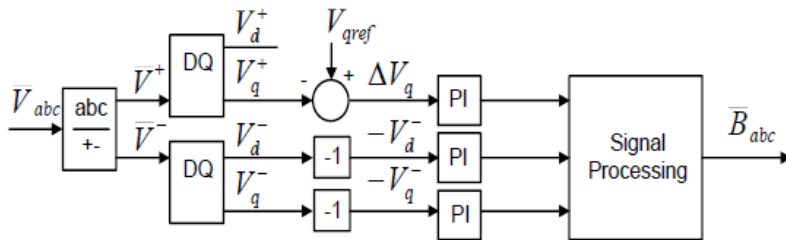


Figure-2: Phase Control Sequence

The STATCOM shall be able to use one half of its full power for unbalanced voltage control.

The range of the STATCOM that can be used for unsymmetrical control shall be limited only by the available VSC and TSC range. The STATCOM shall be able to run phase wise unsymmetrically during faults and directly post fault recovery.

Optimal strategies shall be developed to determine the controller operation when one or several of the STATCOM phases legs hit their maxima/minima.

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ii. Positive Phase Sequence Component and Individual Line to Line Voltage Control

A positive phase sequence current giving the wanted positive phase sequence voltage shall be generated in the STATCOM. A PI (proportional - integrating) regulator shall be used for the Q component of the measured positive phase sequence voltage to determine the needed phase wise identical STATCOM current.

The difference between the line to line voltages shall in addition to the symmetrical voltage be used for unsymmetrical control.

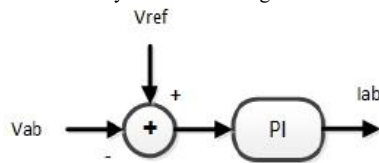


Figure-4: Unsymmetrical Control (example phase ab)

With this controller it is easy to make sure that individual line to line voltages does not become excessive during unsymmetrical grid faults.

Each one of the control functions described above i.e. closed loop positive phase sequence voltage control shall be made available for enabling/disabling on the HMI.

The controller shall be able to run with any combination of the control functions enabled.

Company aims for maximum voltage support for induction motor loads from the STATCOM. Unsymmetrical voltage control shall be used in order not to violate voltage limits (line to line voltages or line to ground voltages) at PCC during and after grid short circuits.

6.7. STATCOM Control & Monitoring

6.7.1. The STATCOM monitoring bus would be HV Bus as specified in Annexure-A. The STATCOM shall regulate the monitored bus voltage to the reference voltage (p.u.) specified by the operator.

6.8. Self-Checking & Availability of Components

6.8.1. The STATCOM control system shall automatically self-check the availability of all components. Self-checking of power electronic valve branches shall not violate harmonic distortion limits nor shall there be changes in the STATCOM output. There shall be provision for the operator to manually initiate self-checking.

6.9. Shared Control or Parallel Operation

6.9.1. The STATCOM shall be capable of operating in parallel with existing DRPCs, generators and converter-based resources (renewables) and SVC/STATCOMs without reducing or influencing the efficiency or range of the STATCOM during any of the abovementioned functions. The parallel DRPCs, generators and converter-based resources (renewables) and SVC/STATCOMs may be located at the same substation or at any substation electrically close. The parallel DRPCs, generators and converter-based resources (renewables) and SVC/STATCOMs may even be at a different voltage.

6.9.2. The Contractor shall make sure before STATCOM energization that the transformer taps are set to manual and not OLTC.

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6.10. Suppression of Harmonic & Filter Performance

6.10.1. Harmonic Performance Limits

6.10.1.1. The maximum voltage distortion generated by the STATCOM shall not exceed the maximum voltage harmonic limits. The harmonic limits shall be met for symmetrical as well as for unsymmetrical STATCOM operation. The limits (of each individual harmonic as well as the THD) shall be 50% of that remaining after the ambient harmonics is subtracted geometrically from the limits stated in Table 1 of IEEE Std 519-2022. This shall be limited to harmonic number n=2 to 50. Each individual background harmonic voltage (VBACKGROUND) shall for the calculations be considered.

$$VLimit = \left(\sqrt{IEEE2LIMIT - V^2BACKGROUND} \right) \times 0.5$$

6.10.1.2. In case calculation of the harmonic voltage limit (VLIMIT) results in values lower than 0.3% then VLIMIT can anyway be considered as 0.3%.

6.10.1.3. The maximum current distortion generated by the STATCOM should not cause the values shown in Table 3 and 4 (as applicable) of IEEE Std 519-2014 to be exceeded.

6.10.1.4. These requirements should be met for the continuous range of system and environmental conditions stated in this specification and the parameters detailed in this section such as:

- i. Continuous range of the STATCOM
- ii. Variation in tolerance of total filter capacitance, including permissible fuse failures.
- iii. Variation in tolerance for STATCOM parameters, such as transformer winding unbalances, system unbalance, valve firing variations, and unequal reactor reactance between phases.

6.10.1.5. All harmonic performance and rating calculations shall be performed with a capacitance variation due to temperature that can be supported by tests.

6.10.1.6. The conditions for the calculations shall be energized capacitors at a minimum ambient temperature of -5 degrees C to a maximum ambient temperature of +55 degrees C. If no relevant tests are available, new test have to be carried out before approval of filter design.

6.10.1.7. In case of one filter branch out of service (degraded mode operation) the harmonic voltage distortion limits (VLIMIT) are increased by 100% but they shall not exceed the limits stipulated in The NEPRA Grid Code.

6.10.1.8. The ratings of all the equipment shall be designed to withstand continuously the distortion during all permissible degraded modes such as one filter branch out, etc. These performance requirements may be exceeded for system conditions outside the continuous normal envelope specified in this specification.

6.10.1.9. For rating purposes, the IEEE limits shall be used as background harmonic source voltage; the individual harmonic contributions shall be limited such that the specified THD limit is not exceeded. This is done such that a different set of individual harmonics may be selected for each STATCOM component, depending on which harmonics give the highest stresses for that particular component.

6.10.1.10. As a first step the raw calculated harmonic stresses for the given component are sorted in descending order, then using this order, harmonics stresses are added up starting with the largest harmonic contribution and adding successively smaller harmonic contributions, also adding the individual source voltages until the chosen THD limit for the harmonic source is reached. The following limits on the maximum contribution limits for individual groups of harmonics shall also be respected while performing these additions, as follows:

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- i. Contribution of 3rd, 5th and 7th harmonic is max. 70% of THD limit
 - ii. Contribution of harmonics >15 is max. 50% of THD limit
The above individual harmonic contribution limits in (i) & (ii) shall be waived for specific harmonic order if the value of the background harmonic contribution for a specific harmonic order is exceeding this limit already and hence the measured values for that harmonic order shall be used.
 - iii. THD of the corresponding source voltage is limited to the specified THD limit.
- 6.10.1.11. Limiting the total THD of the corresponding source voltage to the specified THD limit cuts off the remaining harmonic contributions and reduce them proportionally, conditioned that the remaining harmonic values shall not be below the background harmonic values. i.e., all subsequent harmonic contributions are then used equal to the background harmonic values.
- 6.10.2. Filter Design requirements
- 6.10.2.1. Harmonic filters shall be designed in such a way that the total harmonic currents from the power system and the STATCOM do not overload the filter reactors, resistors and capacitors. The rated current of the filter components (including load break switches and circuit breakers) shall be based upon the calculation of the generated harmonic currents added quadratically (RSS), and adding a 0.1 P.U. margin in total rated current (including fundamental, and harmonic loading) in consideration of background harmonics.
 - 6.10.2.2. The rated voltage of capacitors should be not less than the arithmetic sum of the maximum continuous power-frequency voltage and each of the individual harmonic voltages (from $n = 2$ to 50), A margin of 0.1 P.U. in total voltage shall be added.
 - 6.10.2.3. The rated current of reactors should be not less than the geometric sum of the maximum continuous power-frequency voltage and each of the individual harmonic voltages (from $n = 2$ to 50), A margin of 0.1 P.U. in total current shall be added.
 - 6.10.2.4. The components of harmonic filters shall be sized upon the following factors:
 - i. Filter detuning and maximum expected frequency deviation
 - ii. Requirements and contingencies described in herein,
 - iii. Operation of STATCOM with all redundant filters out of service, if applicable
 - iv. Maximum current amplification
 - 6.10.2.5. The small VSC filters are allowed to be installed without designated relay protection and associated current measurement. In such a case an overrating in both current and voltage of not less than 1.2 p.u based on the requirements in sub clause 7.10.2.1, 7.10.2.2, 7.10.2.3 and 7.10.2.4 above shall be applied.
 - 6.10.2.6. De-tuned capacitor banks shall be rated as per sub clause 7.10.2.1, 7.10.2.2, 7.10.2.3 and 7.10.2.4 above. The fundamental frequency current rating shall be derived from the point giving highest continuous voltage on the medium voltage bus in the VI diagram.
- 6.10.3. STATCOM Power Transformer Requirements
- 6.10.3.1. The voltage and current stress from ambient harmonics shall be calculated by using a harmonic voltage source on the STATCOM HV terminals. The transformer current rating shall be the geometric sum of the maximum fundamental current, the background harmonic currents and the STATCOM generated harmonics.
- 6.11. Harmonic Current Amplification
- 6.11.1. Second harmonic resonance (large current/voltage amplification) seen from the STATCOM medium voltage bus shall be avoided to the maximum extent practical.
 - 6.11.2. Power transformer impedance or VSC tuning shall be optimized for low second harmonic amplification.

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- 6.11.3. Studies to be performed during base design shall demonstrate low second harmonic current or voltage amplifications.
- 6.11.4. Sensitivity of VSC tuning and/or power transformer impedance shall be investigated.
- 6.11.5. Power transformer impedance shall be changed if high second amplification exists. An amplification factor below 20 is acceptable.

6.12. Audible Noise

- 6.12.1. The Contractor shall design and construct the STATCOM to limit the audible noise interior and exterior to the facilities.
- 6.12.2. The level of the audible noise inside the STATCOM building shall not exceed 80 dB (A) in areas where personnel are permitted during STATCOM operation. Audible sound shall be further limited not to exceed 50 dB (A) in the control room.
- 6.12.3. The Contractor shall also be responsible for establishing existing audible noise levels prior to the construction of the facilities and for preparation of a report. The final report shall record audible noise levels prior to and after construction to verify the compliance with the specified requirements. Post-commissioning audible test be carried out to ensure requirements of noise level limits.

6.13. Loss Evaluation

6.13.1. General

- 6.13.1.1. The Bidder shall provide a graph and a table for the total operating active power losses over the complete steady state operating range for the STATCOM. The losses shown on the graph (and in the table) shall be based on calculation of the losses for each of the components comprising the STATCOM according to the method outlined in IEEE STD 1052.
- 6.13.1.2. Guaranteed losses shall be stated. Losses in the table shall be shown in steps of 3.00 MVAR STATCOM output. An Excel file with the tabular data shall be provided.
- 6.13.1.3. The Bidder shall also supply calculated and guaranteed losses on a per component basis.
- 6.13.1.4. In evaluating bids, the capitalized cost of losses for the complete STATCOM will be added to the bid price.

6.13.2. Assumptions

6.13.2.1. The following assumptions shall be made for calculation of the STATCOM:

Sr. No.	Parameter	Value to be Assumed
1	Ambient Temperature	55°C for outdoor equipment
2	Voltage on HV bus	1.0 P.U.
3	Slope Setting	2%

6.13.3. Calculation of Losses

- 6.13.3.1. Losses in switchgear, bus bars, cables, clamps, connectors, etc., are excluded. The applicable tolerance, if any, shall be stated clearly for all the equipments.
- 6.13.3.2. A weighted average active power loss figure shall be calculated for the STATCOM. The STATCOM shall for the calculation be expected to run in different operating ranges. The ranges and their relative duration of total operation time are shown in the table below:
 - i. Total system losses (excluding transformer no-load loss), P1 (kW), at 100% inductive output at 10% of the system total operating time, T1.
 - ii. Total system losses (excluding transformer no-load loss), P2 (kW), at 50% inductive output at 15% of the system operating time, T2.
 - iii. Total system losses (excluding transformer no-load loss), P3 (kW), at 0 Mvar output at 10% of the system operating time, T3.
 - iv. iv) Total system losses (excluding transformer no-load loss), P4(kW), at 50% capacitive output at 45% of the system operating time, T4.

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- v. Total system losses (excluding transformer no-load loss), P5(kW), at 100% capacitive output at 20% of the system operating time, T5.
- 6.13.3.3. In addition to above, the bidder shall submit a description of the calculation methodology for total system losses with break-up details. As-built STATCOM losses shall be based both on factory measurements and calculations and shall be furnished with the bid.
- 6.13.3.4. Sleep mode is acceptable (if available), i.e. the output of the STATCOM is set to zero and valve switching is halted (the charge of the capacitors must be maintained by other means) when its output is smaller than +/- 3.00 Mvar. Bidder shall propose conditions for entering and leaving the sleep mode. Leaving the sleep mode shall not take more than half a cycle. Loss figures with and without the sleep model shall be provided.
- 6.13.3.5. In case of hysteresis areas with two different loss figures for a given Q, the average value of the two shall be used for the calculation. This applies for hysteresis areas where contiguous operations on the higher loss curve remains for more than 60s. In case active switching brings the operation to the lower loss curve, in shorter time than 60s, the calculation shall be based on the lower loss curve.

6.13.4. Calculation of Losses

- 6.13.4.1. The STATCOM bid prices shall, as part of the bid evaluation process, be adjusted to take into account the present value of the total STATCOM losses over a 25 year period in order to determine comparable prices between proposed systems. The tolerance in component losses, if any, shall clearly be stated in the bid by the bidder.

- 6.13.4.2. For the purposes of loss capitalization of the complete plant the following figures shall be used

$$\text{Capital Cost of No Load Loss} = \text{USD } 5200/\text{kW}$$

- 6.13.4.3. The losses will be verified/measured during STATCOM factory testing in the presence of engineers and in case the measured values exceed the guaranteed values, a penalty at twice the rate of the capital cost stated above shall be payable by the Contractor in excess of guaranteed values.

- 6.13.4.4. The total cost for losses used in the evaluation will be calculated by the Company using the following formulas:

$$\text{Total evaluated loss,} = [P1 \times T1 + P2 \times T2 + P3 \times T3 + P4 \times T4 + P5 \times T5]$$

- 6.13.4.5. The total evaluated cost of the complete STATCOM system losses in USD is given by:

$$Ceq = \left(\sum P \times Co \right) \times \left[\frac{1 - (1 + t)^{-n}}{t} \right]$$

Where

Co = Cost per year per kW of losses

i = Interest Rate = 14%

Note: The operating life of the plant is considered as 25 years.

6.14. STATCOM Availability & Reliability

6.14.1. Required Availability & Reliability

- 6.14.1.1. The STATCOM is being installed to provide steady state and transient voltage support, in order to improve the stability margins of the transmission system to avoid voltage sags leading to voltage collapse under disturbed condition thus enhancing the reliability and quality of power delivery. The entire STATCOM system shall be designed for a life time of at least 25 years.

- 6.14.1.2. Refer to IEEE STD 1052 for the definitions on STATCOM Availability and Reliability.

- 6.14.1.3. Unavailability period starts immediately after a plant trip and continues until the plant is energized and in unrestricted operation again.

- 6.14.1.4. The annual equivalent availability for forced outages for a STATCOM shall be at least 99.7%.

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- 6.14.1.5. The annual availability for scheduled outages for a STATCOM shall be at least 99.0%.
 - 6.14.1.6. The maximum number of forced outages shall not exceed 1 outage per year.
 - 6.14.1.7. The maximum number of scheduled outages shall not exceed 5 outages per year. (Multiple outages during one and the same maintenance event are counted as one outage). All plant items which require regular inspection shall be listed in the bid together with the recommended service intervals to achieve the required service life of 25 years. The bidder shall list in full details, all those components which have a life of less than 25 years and shall provide detailed proposals for overcoming this deficiency.
 - 6.14.1.8. If partial STATCOM output is available i.e. multiple VSC converters are used, the duration of equivalent outage should be calculated as the product of the de-rated condition duration and the proportion of the output range that cannot be achieved during this period.
 - 6.14.1.9. The Bidder should state the expected or guaranteed average number and duration of scheduled outages per year.
 - 6.14.2. Availability & Reliability Guarantee for Forced Outages
 - 6.14.2.1. The Bidder shall guarantee the quoted availability performance for 2 years from the date of Taking Over Certificate (TOC). The Contactor will be notified of major outages. During the guarantee period, the Company will maintain records of the number and duration of forced and scheduled outages, hours of operation and any other relevant data, and will make those records available to the Contractor upon request.
 - 6.14.2.2. If the actual performance is below the values stated above, the Contactor should provide corrections and modifications (make fine) to meet the availability guarantees at no extra cost to the Company. Required spare parts shall be at no cost to the Company. The availability guarantee should then continue two year more of operation. The O&M agreement shall apply at no cost for the Company during this third year. The total cumulative period is three (3) years.
 - 6.14.3. Conditions
 - 6.14.3.1. Maintenance intervals should occur regularly (according to the maintenance plan) for inspection and where necessary repair. The Bidder should suggest the maintenance interval suitable for his equipment and should describe any condition monitoring offered.
 - 6.14.3.2. STATCOM substation is manned; however, spares are kept at the different location, the time to travel to site as well as to collect spares shall be accounted for in the outage duration.
 - 6.14.3.3. Due to the high maximum ambient temperature at the site, running air-conditioning may be a must for STATCOM operation at some periods. The availability of the air conditioning system together with the thermal characteristics of the STATCOM building shall be accounted for in calculating the availability for the complete STATCOM.
7. STATCOM Main Components & Required Functions
- 7.1. General
 - 7.1.1. The specification clauses regarding VSC valves and other main components are intended to be general, i.e., not prescribing the precise form, rating, or quantity of the components, but allowing the bidder to propose an optimum solution. All the offered equipments shall be type tested in accordance with the latest issue of the relevant IEC/Company standards. In case Company standards are not available IEEE/IEC shall take precedence.
 - 7.1.2. As a minimum requirement, all equipment shall be designed and rated to withstand the full rated requirement of the STATCOM. All STATCOM equipment ratings shall be adequately sized to carry the maximum steady-state current that can flow in it (square root of the sum of

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the squares of the fundamental and harmonic current) and the maximum short circuit and momentary current due to faults that can flow in it. In addition, equipment shall be rated to withstand the maximum steady-state, harmonic and short term voltages that can appear across it.

7.2. STATCOM Step Down Transformer

7.2.1. General Requirements

- 7.2.1.1. The transformer winding configuration shall be determined by the Contractor, as required by the proposed STATCOM design and Company network requirements.
- 7.2.1.2. The design of the transformer shall be three-phase and single unit shall be provided with the bank. The installation shall be designed to facilitate the connection of the spare transformer into the system and isolation of the failed unit. The spare unit shall normally be energized from the primary side. The transformers shall not be equipped with OLTC. The protection schemes shall also be arranged to facilitate rapid reconnection to the spare transformer CTs. This reconnection shall not require rewiring or reconnection of CT wires.

7.2.2. Rating

- 7.2.2.1. The transformer shall be designed to comply with the continuous and short-time MVAR requirements mentioned in sub-clause 7.1. The capacity of the transformer (MVA) must be designed to meet these requirements without exceeding normal loss of life or increase in the level of internal partial discharges.
- 7.2.2.2. The offered transformers shall be ONAN/ONAF cooled. Sufficient reserve capacity shall be provided, so that STATCOM capacity is not reduced upon loss of a cooling pump, fan, etc.

7.2.3. Impedance

- 7.2.3.1. The transformer impedance shall be determined by the Bidder as required by the STATCOM design and shall be chosen so that the transformer will withstand all fault currents at the maximum fault level current specified in Annexure-B.

7.2.4. Voltage Ratings & BIL

- 7.2.4.1. The transformers voltage rating shall be as required by the STATCOM design. The BIL rating shall be determined by the bidder as required by the STATCOM design and in accordance with the IEC standards and requirements mentioned under Annexure-B.

7.2.5. Audible Noise

- 7.2.5.1. Audible noise levels from the step-down transformer shall be coordinated to meet the requirements for the STATCOM installation in sub-clause 7.12 and applicable IEC standards.

7.2.6. Direct Current Capability

- 7.2.6.1. The flux density shall be appropriate for the excitation conditions under the voltage range specified.
- 7.2.6.2. The transformer shall be designed to carry direct current consistent with the STATCOM design or suitable means shall be incorporated within the STATCOM to limit this current to a level satisfactory for the transformer. To ensure minimum harmonic generation, the saturation flux density of the transformer shall be higher than the maximum flux density reached during normal operation, and the bidder shall state the margin by which it is exceeded. This maximum flux density is obtained at the highest secondary voltage during any reactive power generation, highest reference voltage, minimum slope, and minimum continuous frequency.
- 7.2.6.3. The bidder shall clearly indicate the Harmonic content (HV and MV) that the transformer shall be subjected to under the worst case conditions.

7.2.7. Other Requirements

- 7.2.7.1. As per Company specification P-46.

7.2.8. Standards & Testing Requirements

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- 7.2.8.1. As per IEC & Company Standards. If company standards are not available IEC standards shall take precedence.
- 7.2.9. Information to be supplied with the Bid
- 7.2.9.1. Complete data/drawings, ratings, dimensions, test reports etc as per relevant Company/IEC standards including the following:
- i. Type, make & designation
 - ii. Continuous and short-time MVA and voltage ratings.
 - iii. Insulation levels.
 - iv. Number, accuracy and ratio of all bushing current transformers.
 - v. Type of cooling.
 - vi. Audible sound level
 - vii. Direct current capability
 - viii. Weights and physical dimensions
- 7.3. VSC Power Electronic Valves
- 7.3.1. General Description
- 7.3.1.1. The valves shall be designed to ensure satisfactory operation according to the overall performance requirements and include all necessary auxiliary equipment.
- 7.3.1.2. The valves shall be indoor air-insulated and of a water cooled type.
- 7.3.1.3. The valves shall be of modular or sectional design and have removable components for ease of maintenance. The semiconductor switches and valves shall be mounted to allow easy access for visual inspection, routine maintenance, and replacement, or facilities shall be provided to enable easy access.
- 7.3.1.4. The valves shall use DC capacitors of dry type.
- 7.3.1.5. The valves shall be designed to meet overall availability and reliability performance requirements for the STATCOM. All rating, performance and protection requirements shall be met with all redundant semiconductors short-circuited.
- 7.3.2. General Design Requirements
- 7.3.2.1. The VSC valves shall comply with the requirements of Standards/specifications mentioned under clause 3.2.
- 7.3.2.2. The valve shall be designed with semiconductor switches applied in a conservative manner with regard to their basic design parameters. The semiconductor valves shall comply with the requirements of IEC and IEEE Standards. The Bidder/Contractor shall provide a standard data sheet of ratings for the semiconductor switches offered. The semiconductor switches shall be designed to withstand all stresses expected under steady state, transient and temporary overvoltage conditions as specified in this specification including, but not limited to the following:
- i. Transient overvoltages due to AC system fault application and fault clearing.
 - ii. Temporary overvoltages originating in the AC system (e.g. such as load rejection), or caused by AC system faults (such faults normally result in combined overcurrent and overvoltage stresses).
 - iii. Resonant voltage oscillations on the medium voltage side of the STATCOM transformer excited by system disturbances such as fault application, fault clearing, line switching and transformer energisation.
 - iv. Fast surges transferred from the AC system.
 - v. Overvoltages due to control malfunction such as false firing of the valve, loss of firing signal, maloperation of the voltage control loop and loss of synchronisation.
 - vi. Transient overvoltages due to partial blocking caused by, for example, improper firing, forward recovery protection or VBO/EOP (electronic overvoltage protective) firing.
 - vii. The Bidder shall provide proof that the valves including stack assembly, cooling pipes and valve electronics can operate at 50°C ambient (outdoor) temperature at

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- maximum current continuously. If insufficient proof is provided the Contractor shall perform relevant tests during project execution.
- 7.3.2.3. Redundant levels are levels which may become short circuited during service without impairing the ability of the VSC phase unit to meet its performance requirements. A minimum of 10% redundant levels (but not less than one) are required in each single phase valve, the redundant levels shall assume random fault locations. The actual number will be determined based on the stated requirements for availability and reliability for the STATCOM. Measures shall be implemented where necessary to ensure that the voltage across the healthy semiconductor switch is within the capability of the semiconductor switch in the event of failure of a level. The voltage rating of the semiconductor shall be such that no cascading failure shall result in the event of failure of all redundant levels + 1.
- 7.3.2.4. The valves shall be designed to allow easy replacement of failed semiconductor switch and other electrical components in the valve. It shall be possible to replace faulty semiconductor switches without significant leakage of the cooling circuit and with minimum disturbance to other plant and material. Any special tools required for replacement of these parts shall be provided under the contract.
- 7.3.2.5. The firing control signals from circuits at ground potential shall be transmitted by optical coupling via light guides. The firing system shall be designed to tolerate electromagnetic interference present in the valve. The firing pulses shall be sufficiently coherent not to impose excessive overvoltage stresses on the last levels to turn on.
- 7.3.2.6. Monitoring of semiconductor switch status while the STATCOM is in operation shall be provided and the number of failed semiconductor switches and their location shall be indicated. Monitoring of repetitive firing by voltage break-over (VBO) action, (if present) shall also be provided. The monitoring system shall be designed to prevent false indication due to electromagnetic interference present in the valve.
- 7.3.2.7. The valve shall be designed for the maximum overvoltage and overcurrent stresses due to system faults and switching. The semiconductor valve components which are the main heat-generating components (e.g. semiconductor switch, damping and grading components, valve reactors, gating circuits and current carrying connections within the valve) shall be designed to withstand the thermal stresses which affect their operating characteristics. The semiconductor switch valves shall be capable of withstanding the highest overcurrents expected in service and be capable of blocking corresponding voltages at the highest semiconductor switch junction temperature reached.
- 7.3.2.8. The Contractor shall provide details of the complete valve, including control and protection circuitry, valve cooling facilities, including their means of control, temperature and flow monitoring and alarms, mechanical design, container design, auxiliary wiring and earthing, EMC, etc. This shall be included in the valve design report.
- 7.3.2.9. The cooling medium shall have adequate dielectric withstand capability and an alarm for high conductivity of the cooling liquid. Each valve level shall be provided with a corrosion-resistant identification showing the following minimum information:
- i. Rated Voltage
 - ii. Continuous Operating Voltage
 - iii. The Manufacturer's name or trademark, type and identification.
 - iv. Identification number.
- 7.3.2.10. The heat-sinks for the semiconductor switch shall be treated to ensure good electrical contact if necessary without risk of corrosion. The Contractor shall supply information on the material used and its performance characteristics.
- 7.3.2.11. The semiconductor firing pulse synchronisation and generation systems must be able to operate under the following conditions:

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- i. Maximum steady-state voltage unbalance
 - ii. Variation in three-phase short-circuit levels (existing, future and abnormal) at the STATCOM HV bus
 - iii. Presence of harmonic distortions during transient, dynamic and steady state conditions
 - iv. Single- or multi-phase faults on the AC network
 - v. Transformer, reactor or capacitor switching on the AC network
 - vi. Possible transient and temporary overvoltages on the AC network.
- 7.3.2.12. The semiconductor firing pulse synchronisation and generation systems shall be designed to minimise the generation of non-characteristic harmonics and prevent any harmonic instability.
- 7.3.2.13. The semiconductor firing pulse synchronising and generation systems shall be designed for satisfactory operation of the STATCOM during and after fault clearing on the AC network. Successive misfires shall not occur. Firing pulse strategy shall be implemented to protect them from direct blocking voltage throughout the anticipated conduction period.
- 7.3.2.14. The Bidder/Contractor shall provide all design factors and margins, including calculated design factors and margins, marginal settings and manufacturing margins for Company as part of the bid and base design respective reports.
- 7.3.3. Valve Overvoltage Protection
- 7.3.3.1. Overvoltage protection shall be provided to protect the complete valve or individual semiconductor/semiconductor levels against transient overvoltages. Valve Overvoltage Protection scheme shall be described in detail in the proposal.
- 7.3.4. Valve Overcurrent and Thermal Overload Protection
- 7.3.4.1. The VSC valves shall be protected against currents of excessive amplitude, magnitude and duration. Overcurrent protection shall be provided for the semiconductors to ensure that the highest semiconductor junction temperature reached under the worst-case overcurrent conditions is such that: the semiconductor when blocked will be capable of withstanding the worst-case blocking voltage at the elevated junction temperature, the resulting highest semiconductor junction temperature is below the value above which the semiconductor can be damaged by thermal filamentation.
- 7.3.4.2. Thermal overload protection shall be based not only on the time and magnitude of the fault current, but also on the fault current wave shape to avoid unnecessary tripping. Thermal overload protection in which the semiconductor junction temperature is computed from the thermal model of the semiconductor, its heatsink and cooling medium, using for example a microprocessor, shall be used.
- 7.3.4.3. The overcurrent protection shall be properly coordinated with the overcurrent capability of the valves, taking into account the time, magnitude and wave-shape of the worst overcurrent expected in service.
- 7.3.5. Valve Fire And Electrical Arc Protection
- 7.3.5.1. The semiconductor valves and other valve hall plant and material shall be designed to minimise the risk of fire or an electrical arc being initiated within the valve hall and to limit the consequences of such a fire shall it occur. The use of flammable materials in the valves shall be minimised as far as practicable. Where such materials cannot be avoided, such materials must be demonstrated to exhibit self-extinguishing capability equal to or better than the Underwriters Laboratory UL-94-V0 classification for vertical material, and UL-94 HB for horizontal material.
- 7.3.6. Valve Tests
- 7.3.6.1. Valve tests shall comply requirements of International Standards. The Bidder shall describe the routine and type test (dielectric tests and operational tests) to be carried

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out for the proposed valve design. Type test assessment and previously performed type tests shall be attached to the bid.

7.3.7. Standards & Testing Requirements

7.3.7.1. The design and testing requirements of the VSC valves shall comply with the standards specified in sub-clause 3.2 of the specification.

7.3.8. Information to be Supplied with the Bid

7.3.8.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant standards including the followings:

- i. Continuous and short-time current and voltage ratings of VSC valves.
- ii. Voltage and current capability of Valves.
- iii. Number of Valves in series and number of redundant Valves.
- iv. Insulation level.
- v. Principles of Firing system and Monitoring system
- vi. Weights and physical dimensions.
- vii. Valve overvoltage, overcurrent and misfiring protection scheme.

7.4. VSC (STATCOM) Cooling System

7.4.1. General Requirements

- 7.4.1.1. Cooling System shall be designed to comply with relevant International Standards.
- 7.4.1.2. A complete cooling system with all plant and material shall be supplied.
- 7.4.1.3. The cooling system shall be capable of maintaining the plant, designed by the Contractor, within its allowable operating temperature range under all conditions of loading and weather prevailing at site.
- 7.4.1.4. The cooling system shall have a high degree of reliability and require the minimum of maintenance.
- 7.4.1.5. All materials or components used, whether mechanical, electrical or electronic shall have a proven service history.

7.4.2. For Liquid Cooled System

7.4.2.1. The redundant cooling control and protection system shall provide for the necessary cooling of the STATCOM system valves and shall monitor its own operation and the condition of cooling water. An automatic control system shall regulate and sequence the operation of the cooling equipment to maintain the temperature within the design limits. The control system will allow for a transfer from main to standby pumps without a cooling system or STATCOM system shutdown. Each pump, cooling fan and/or mixing valve shall have both automatic and manual control modes. The cooling system control shall have sufficient indication of status, temperature, pressure and flow to allow for safe manual operation of the cooling system in the event of the automatic cooling system control failure. The control system shall include as a minimum the following alarm signals:

- viii. Pump stopped, failure
- ix. Low cooling medium resistivity
- x. Low expansion tank level
- xi. Abnormal liquid flow
- xii. High coolant temperature
- xiii. High coolant pressure
- xiv. Fan stopped, failure
- xv. Leakage

7.4.2.2. Replacement of certain cooling equipment (e.g. pumps, fan, cooler unit e.t.c.) if defective should be possible while cooling system still operates.

7.4.2.3. The protection system shall include as a minimum the following shutdown signals:

- i. Low expansion tank level.
- ii. Abnormal liquid flow.

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- iii. High coolant temperature.
- 7.4.2.4. All alarms, indications and measured values shall be displayed in the local control system.
- 7.4.2.5. The control and protection of the cooling system shall be supplied from the dc station battery. Loss of the dc supply to the cooling controls shall not result in damage to the cooling equipment or the VSC valves. Pumps and fans shall be supplied from the station service (AC).
- 7.4.3. For Air Cooled System
 - 7.4.3.1. For air-cooled systems, the protection system shall include, as a minimum, the following warning alarms:
 - i. Blower transfer
 - ii. High exhaust air temperature
 - iii. High differential pressure across the filter
 - iv. Low air flow.
 - 7.4.3.2. For air-cooled systems, the protection system shall include, as a minimum, the following shutdown alarms:
 - i. Excessive exhaust Air Temperature
 - ii. Loss of Air Flow
- 7.4.4. Standards & Testing Requirements
 - 7.4.4.1. The design and testing shall comply with the relevant standards specified in sub-clause 3.2 of the specification.
- 7.4.5. Information to be supplied with the Bid
 - 7.4.5.1. Complete data/drawings, ratings, dimensions, test reports, etc as per relevant standards including the followings:
 - i. Overall diagram of the cooling system and its components including gauges.
 - ii. Rated values on flow, temperature, pressure drop and liquid volume.
 - iii. Cooling medium.
 - iv. Ratings of pumps and fans.
 - v. Alarm and trip signals from the control system
- 7.5. Reactors
 - 7.5.1. The reactors are utilized to limit rate of change of current in the VSC Switching Devices. Reactors are also used as tuning elements of the harmonic filters.
 - 7.5.2. Design requirements for TCRs shall include but not limited to the followings:
 - i. The reactors used for Phase Reactors for STATCOM and filter components shall be of single phase, air-cored, self-cooled and suitable for outdoor installation.
 - ii. Each phase reactor may be divided into two reactors, one on each side of the converter valve to limit short circuit currents resulting when one reactor is shorted or ground fault occurs.
 - iii. All structural and fence metalwork, including foundations, shall be designed to avoid metallic loops and parallel circuits in which induced currents can run.
 - iv. The purpose of the filter reactors is to tune the capacitor banks to provide the necessary reduction of harmonics.
 - v. Reactors shall be capable of withstanding short circuit forces based on maximum design fault levels.
 - vi. The reactor voltage rating shall be as required by the STATCOM design. The BIL and BSL rating shall be determined by the Bidder as required by the STATCOM design and the insulation requirements specified in Annexure-B.
 - vii. Audible noise levels from the reactors shall be co-ordinated to meet the requirements for the STATCOM installation in sub-clause 7.12 and the applicable IEC standards.

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- viii. The magnetic field strength at any point where personnel have access during operation shall not exceed 2 mT.
- 7.5.3. Standards & Testing Requirements
 - 7.5.3.1. The design and testing requirement shall comply with the relevant standards specified in sub-clause 3.2 of this specification.
- 7.5.4. Information to be Supplied with the Bid
 - 7.5.4.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant standards including the followings:
 - i. Inductance including manufacturing tolerances
 - ii. Continuous and short-time current and voltage ratings, indicating contribution from the harmonic currents
 - iii. Design criteria for maximum temperature
 - iv. Insulation level
 - v. Weight and physical dimensions
- 7.6. Capacitor Banks
 - 7.6.1. The purpose of the capacitor banks is to provide the required leading var supply and also to provide sufficient reduction of harmonic voltages and currents that may be generated by the STATCOM System.
 - 7.6.2. The capacitor banks shall be designed to avoid resonance with ac power system regardless of the system configuration. Possible resonance phenomena shall be included for in the design.
 - 7.6.3. The capacitor units shall be constructed with materials resulting in minimum losses and maximum reliability. Each unit shall be free of PCB.
 - 7.6.4. The capacitor units shall be identical and interchangeable among all capacitor where possible.
 - 7.6.5. The capacitor voltage rating shall be as required by the STATCOM design. The rated voltage shall be based on an arithmetical addition of individual harmonic voltages that will appear across the capacitors. The harmonic currents generated by STATCOM and pre-existing harmonic voltages (Annexure-B) applied on PCC has to be simultaneously taken into account in STATCOM design. The BIL and BSL rating shall be determined by the Bidder as required by the STATCOM design and the insulation requirements specified in Annexure-B. The bidder shall show how the protection system matches the capability of the capacitors with full regard to the harmonic content of the currents and voltages.
 - 7.6.6. The individual capacitor units shall be individually fused. Anyhow, either internally or externally fused capacitors can be used. For the dimensioning of the capacitor fuses parallel charged elements must be considered.
 - 7.6.7. Audible noise levels from the capacitor banks shall be co-ordinate to meet the requirements for the STATCOM installation and the applicable IEC standards.
 - 7.6.8. All conduction within the capacitor bank shall be insulated and insulating caps shall be provided for all capacitor units bushing terminals or conducting mounting points.
 - 7.6.9. Capacitor dielectric losses shall clearly be stated by the bidder in the bid.
 - 7.6.10. The capacitor units shall reduce the residual voltage by suitable state of the art methods.
 - 7.6.11. The Bidder shall guarantee the filter and AC shunt capacitor unit maximum annual failure rates. The capacitor unit annual failure rate in service shall be calculated based on the actual level of capacitor unit or element failures during the availability guaranteed period mentioned under sub-clause 7.14, commencing after the start of date of Taking Over Certificate (TOC) of the STATCOM system. The above shall apply to each type of capacitor unit supplied individually where type refers to the unit capacitance & voltage, current, and kVAR rating.
 - 7.6.12. The configuration of the individual units shall be determined by Contractor. The kVAR and voltage ratings of the individual capacitor units are not specified herein and shall be determined by the Contractor.

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- 7.6.13. The units shall be identical within each branch vertically or edge mounted, and suitable for mounting in open type structure racks for outdoor use with the service conditions and system ratings given in this Specification.
- 7.6.14. Any capacitor unit found leaking during the warranty period shall be replaced with a new one by the Contractor at its own cost and responsibility. Repair of leaking units will not be accepted.
- 7.6.15. The capacitor racks shall be designed to allow the change-out of any capacitor unit without disassembly of the rack or disturbance of any other capacitor unit.
- 7.6.16. The structural members of the racks shall not be used as electrical buses. To ensure safe earthing of all parts, all structural members of the rack shall be electrical connected together and earthed with a provision of earthing to all structure members during maintenance.
- 7.6.17. Standards & Testing Requirements
- 7.6.17.1. The design and testing requirement shall comply with the relevant standards specified in sub-clause 3.2 of this specification.
- 7.6.17.2. A suitable capacitor bank test device shall be delivered as part of the contract which will facilitate the testing of the bank without removal of any connections.
- 7.6.18. Information to be Supplied with the Bid
- 7.6.18.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant standards including the following:
- i. Capacitance including manufacturing tolerances and redundancy.
 - ii. Rated voltage of capacitor units
 - iii. Insulation level.
 - iv. Description of fuse system.
 - v. Weights and physical dimensions.
 - vi. Losses.
 - vii. Bank configuration, including number of series and parallel units.
- 7.7. Circuit Breakers
- 7.7.1. The circuit breakers shall be of SF6 type. The breaker shall be rated for the switching and current carrying duty imposed upon them in their intended location.
- 7.7.2. The breakers shall be capable of the amount of operations expected, considering the STATCOM application with both inductive and capacitive loads.
- 7.7.3. Interrupting units shall have flags, visible from ground level to indicate open/ closed position.
- 7.7.4. There shall be auxiliary contacts for indication of low gas pressure.
- 7.7.5. Operating mechanism shall have electrically operated trip circuits. There shall be two parallel trip coils.
- 7.7.6. Thermostatically operated heaters shall be supplied for temperature control and prevention of condensation build-up.
- 7.7.7. Mechanically or electrically operated non-resettable operation counters shall be provided.
- 7.7.8. All operating equipment, including auxiliary switches shall be housed in a weather/water/vermin proof cabinet.
- 7.7.9. All other general requirements of Company's specification P-193 shall be compliance with.
- 7.7.10. Standards & Testing Requirements
- 7.7.10.1. The design and testing of the main STATCOM breaker(s) shall comply with relevant latest editions Company specifications and relevant International standards mentioned under sub-clause 3.2 of the specification.
- 7.7.11. Information to be Supplied with the Bid
- 7.7.11.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant Company/International standards including the following:
- i. Continuous current and voltage rating.

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- ii. Making and breaking current capability.
 - iii. Insulation level.
 - iv. Creepage distances.
 - v. Weights and physical dimensions.
- 7.8. Disconnecter & Earthing Switches
- 7.8.1. The switches shall be adequately sized to carry the maximum steady-state and overload currents including fault, inrush, harmonic currents and over-voltages.
- 7.8.2. The switches shall meet the insulation requirements specified in this specification.
- 7.8.3. Thermostatically operated heaters shall be supplied for temperature control and prevention of condensation. All cabinets shall have sufficient ventilation ducts.
- 7.8.4. Disconnectors & earthing switches shall be designed and constructed to operate satisfactorily in the environmental conditions described in this specification.
- 7.8.5. All operating equipment, including auxiliary switches, shall be housed in a weather/water/vermin proof cabinet.
- 7.8.6. Disconnectors shall be both manual and motor operated. Disconnectors shall electrically and mechanically be interlocked. Earth switches shall mechanically be interlocked.
- 7.8.7. Grounding equipment for maintenance and repair shall be supplied with each separate circuit that can be out of service while the remainders are in continuous operation. Grounding equipment for the STATCOM secondary bus system/transformer shall also be supplied.
- 7.8.8. The disconnectors and earth switches shall be positioned to enable maintenance work to be carried out in complete safety on the whole STATCOM and, where appropriate, on its component parts when any depleted mode operation is adopted.
- 7.8.9. For the secondary side of the STATCOM transformer the disconnect switches are required to isolate any apparatus for which maintenance is needed. At a minimum the following major components shall have disconnect and earthing switches:
- i. Each VSC Branch
 - ii. Each Fixed Capacitor Bank
 - iii. Filter Branches
- 7.8.10. The disconnectors shall be used to isolate an affected filter, or VSC branches when a fault is developed. The disconnectors and earth switches shall be fitted with safety interlocks. This isolation shall be carried out through either of the following methods described below:
- i. VSC and Filter: Tripping of the HV circuit breaker either locally or from remote and switching the STATCOM off the system before the disconnector is opened. After successful isolation of the affected branch, the STATCOM shall be available to be immediately switched back on again.
 - ii. Filter branches only: Tripping of the affected filter branch circuit breaker before isolation of this branch, The STATCOM HV circuit breaker shall not operate during this sequence.
 - iii. Auxiliary transformer branch: Tripping of the auxiliary branch circuit breaker before isolation of this branch, the STATCOM HV circuit breaker shall not operate during this sequence.
- 7.8.11. All disconnect and earthing switches shall be indicated on the STATCOM Single Line Diagram provided by the Bidder.
- 7.8.12. Standards & Testing Requirements
- 7.8.12.1. The design and testing of the disconnectors/earthing switches shall comply with relevant latest editions of Company specification P-128 and standards mentioned under sub-clause 3.2 of the specification.
- 7.8.13. Information to be Supplied with the Bid
- 7.8.13.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant Company/International standards including the following:
- i. Insulation level.

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- ii. Creepage distances.
- 7.9. Surge Arrester
- 7.9.1.1. All necessary surge arresters shall be supplied by the Contractor for the protection of the equipment particularly the main STATCOM transformer, VSC valves, reactors and filter banks.
 - 7.9.1.2. The surge arresters shall be properly designed to meet the insulation co-ordination and discharge requirements in accordance with IEC & Company Standards.
 - 7.9.1.3. Only gap-less arresters of the Zinc oxide type shall be accepted. The arrester shall have sufficient pressure relief capability in order to make them explosion free and to sure that personnel and equipment safety is guaranteed. On the primary side of the step-down transformer, it is recommended that the arresters shall be of class 4 or better. On the low voltage side of the transformer the arresters shall be of class 3 or better referring to IEC 60099.
 - 7.9.1.4. All arresters placed on the high voltage side of the transformer shall be equipped with surge counters. Filter energisation shall not activate any surge counter.
 - 7.9.1.5. The activation of a surge arrester on the primary side shall be indicated to remote centre also.
 - 7.9.1.6. The surge arresters supplied for the STATCOM shall comply with the Company Standard selection/sizing taking also into account future shunt capacitors to be located in the nearby substations and over-voltages due to switching, ferro-resonance etc.
- 7.9.2. Standards & Testing Requirements
- 7.9.2.1. The design and testing of the surge arresters shall comply with relevant latest editions of Company specification P-181 and standards mentioned under sub-clause 3.2 of the specification.
 - i. Methodology of the Insulation Coordination Study
 - ii. Type and Rating.
 - iii. Energy discharge capability
 - iv. Insulation level
 - v. Creepage distances
 - vi. Weights and physical dimensions
 - 7.9.2.2. All surge arresters shall be indicated on the STATCOM Single Line Diagram provided by the Bidder.
- 7.10. Instrument Transformers
- 7.10.1. The successful Bidder shall supply all necessary voltage and current transformers on the high voltage as well as on the low voltage side of the step-down transformer. These instrument transformers shall be manufactured and tested according to IEC and Company standards. The quantity of instrument transformers and corresponding current and voltage rating shall be calculated and designed by the bidder. The Bidder shall provide description, rating, performance, dimension and proposed tests for the instrument transformers.
 - 7.10.2. All the insulation, minimum creepage and strike distance and local environmental conditions shall be met.
 - 7.10.3. Current Transformers
 - 7.10.3.1. CTs shall be suitably rated to match the full capabilities of the STATCOM. CT transformation ratios, outputs, and accuracy classes within the STATCOM scheme shall be selected by bidder to meet the requirements of the specific CT application. Full details of all the CTs being offered shall be provided by bidder.
 - 7.10.3.2. All the current transformers for STATCOM component protection, indication, measurement and control purposes shall comply with the latest IEC & Company Standards.
 - 7.10.3.3. The CT secondary's which are used for measurement; indications or control devices shall not be used for protection purposes.

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- 7.10.4. Standards & Testing Requirements
 - 7.10.4.1. The design and testing of the CTs shall comply with relevant latest editions of Company specification P-90 and standards mentioned under clause 3 of the specification.
- 7.10.5. Information to be supplied with Bid
 - 7.10.5.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant Company/International standards shall be furnished with the bid. The numbers of current transformer and corresponding ratings shall be indicated on the Protection Block Diagram to be provided with the bid.
- 7.10.6. Voltage Transformers
 - 7.10.6.1. VT transformation ratios, outputs, and accuracy classes within the STATCOM scheme shall be selected by the bidder to meet the requirements of the specific VT application. Full details of all the VTs being offered shall be provided by the bidder.
 - 7.10.6.2. All the voltage transformers included in the bid for STATCOM component protection, indication, measurement and control purposes shall comply with latest IEC & Company Standards.
 - 7.10.6.3. The voltage transformers shall be designed to avoid saturation at voltages up to at least 1.3 p.u. Further, no ferro-resonance conditions shall occur between voltage transformers and capacitors including stray capacitances.
- 7.10.7. Standards & Testing Requirements
 - 7.10.7.1. The design and testing of the VTs shall comply with relevant latest editions of Company specification P-129 and standards mentioned under sub-clause 3.2 of the specification.
- 7.10.8. Information to be supplied with Bid
 - 7.10.8.1. Complete data/drawings, ratings, dimensions, test reports etc. as per relevant Company/International standards shall be furnished with the bid. The numbers of voltage transformers and corresponding ratings shall be indicated on the Protection Block Diagram to be provided with the bid.
- 7.11. Telecommunication Infrastructure
 - 7.11.1. General Requirements
 - 7.11.1.1. The Contractor shall be responsible for the complete design, supply, installation, testing, commissioning, and integration of all telecommunication equipment required to establish a reliable SCADA data link between STATCOM installation and the Company's SCADA Control Centre.
 - 7.11.1.2. The telecommunication system shall achieve a minimum availability of 99.5% on an annualised basis. The Contractor shall submit availability calculations during the detailed engineering phase.
 - 7.11.1.3. The communication protocol for SCADA data exchange shall be IEC 60870-5-101 (serial) or IEC 60870-5-104 (TCP/IP-based), or DNP3 over TCP/IP, matching the protocol of the Company's existing SCADA Master Station. The Contractor shall confirm the protocol with the Company during the engineering phase.
 - 7.11.1.4. All telecommunication equipment shall be industrial-grade, rated for continuous outdoor/indoor operation in accordance with the environmental conditions specified in Section 4 of this specification (ambient temperature, humidity, altitude, and seismic zone).
 - 7.11.1.5. The telecommunication system shall comply with Pakistan Telecommunication Authority (PTA) regulations. The Contractor shall be responsible for obtaining all necessary frequency allocations, spectrum licences, and regulatory approvals for the chosen communication medium, and shall include the cost of such approvals in the Contract Price.

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- 7.11.1.6. End-to-end SCADA data latency shall not exceed 2 seconds for analogue values and 500 milliseconds for status/alarm points under normal operating conditions.
- 7.11.1.7. The telecommunication link shall support a minimum sustained data throughput of 64 kbps dedicated to SCADA traffic, with provision for future expansion up to 256 kbps.
- 7.11.1.8. All SCADA data transmitted over telecommunication links shall be encrypted using AES-128 or better. The system shall incorporate authentication mechanisms to prevent unauthorised access or injection of false data.
- 7.11.1.9. Power supply to all telecommunication equipment shall be derived from the STATCOM auxiliary DC supply (110V DC or 48V DC as applicable) with an Uninterruptible Power Supply (UPS) backup providing a minimum of 8 hours of autonomy during mains power failure.
- 7.11.1.10. A dedicated Network Management System (NMS) or network monitoring interface shall be provided locally at the STATCOM control room to monitor telecommunication link health, signal quality, and traffic utilisation. Alarms from the NMS shall be integrated into the STATCOM SCADA HMI.
- 7.11.2. Site Specific Requirement – New Telecommunication Infrastructure at Site
- 7.11.2.1. The Contractor shall carry out a detailed site survey at 132kV Pasni Grid Station and the intended remote terminal point to assess the suitability of available communication technologies. The survey shall evaluate line-of-sight conditions for microwave, satellite signal availability, and GSM/LTE network coverage and signal strength at the site.
- 7.11.2.2. Based on the survey findings, the Contractor shall propose a preferred telecommunication technology from the following options and obtain written approval from the Company before proceeding to detailed design:
- Option A — Point-to-Point Microwave Radio Link (preferred where line-of-sight is achievable)
 - Option B — VSAT Satellite Communication Link
 - Option C — GSM/LTE/4G Cellular Communication (as primary or backup link)
- 7.11.2.3. The Contractor shall provide a detailed technical and commercial comparison of all feasible options in the Pre-Engineering Submission, including availability analysis, latency, throughput, regulatory requirements, civil works, and total cost of ownership.
- 7.11.2.4. The selected telecommunication system shall provide a minimum of 10 years of operational life and shall be supported by a local manufacturer/supplier with spare parts availability in Pakistan.
- 7.11.2.5. The Contractor shall be responsible for the civil works associated with the telecommunication system, including tower or antenna mast foundations, equipment shelter or weatherproof enclosures, cable trenching, and earthing of all telecommunication structures.
- 7.11.3. Microwave Point-to-Point Communication — Technical Requirements (Applicable if Option A Selected)
- 7.11.3.1. The microwave link shall operate in a frequency band licensed by PTA. The Contractor shall obtain the necessary frequency licence and include the cost in the Contract Price.
- 7.11.3.2. The system shall achieve a minimum path availability of 99.9% (based on ITU-R P.530 methodology). A detailed link budget and fade margin calculation shall be submitted during detailed engineering.
- 7.11.3.3. Minimum fade margin shall be 30 dB for links up to 20 km and 25 dB for links exceeding 20 km.

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- 7.11.3.4. The microwave terminal equipment shall support Adaptive Modulation with a minimum XPIC capability for frequency re-use where required. Minimum modulation: QPSK to 256-QAM adaptive.
- 7.11.3.5. Antenna structures (towers or masts) shall be designed in accordance with relevant structural standards for the wind speed and seismic zone applicable at Pasni. The Contractor shall submit structural calculations for Company review.
- 7.11.3.6. All outdoor microwave radio units (ODU) shall have an IP65 or better ingress protection rating. Indoor units (IDU) shall be rack-mounted in the STATCOM control room telecommunication cabinet.
- 7.11.3.7. The system shall include an integral 1+1 Hot-Standby protection configuration (redundant ODU or redundant IDU as minimum) to maintain link availability in case of equipment failure.
- 7.11.4. VSAT Satellite Communication — Technical Requirements (Applicable if Option B Selected)
 - 7.11.4.1. The VSAT terminal shall operate on Ku-band or C-band (to be determined based on satellite availability and Pasni coastal interference environment). The Contractor shall verify satellite slot availability and obtain authorisation from PTA/SUPARCO.
 - 7.11.4.2. The VSAT system shall achieve a minimum link availability of 99.5% inclusive of rain fade margin based on ITU-R P.618 methodology for the Pasni location. A link budget shall be submitted during detailed engineering.
 - 7.11.4.3. The round-trip latency of the VSAT link shall not exceed 750 milliseconds. The Contractor shall demonstrate that this latency is compatible with the SCADA protocol polling cycle and shall configure the RTU accordingly.
 - 7.11.4.4. VSAT antenna dish diameter shall be minimum 1.8m. The antenna shall be mounted on a galvanized steel structure with wind load design for 160 km/h sustained wind speed given the coastal location at site.
 - 7.11.4.5. The VSAT modem shall support IP encapsulation and TCP acceleration for SCADA traffic. The system shall include a Quality of Service (QoS) mechanism to prioritise SCADA traffic over any other data.
 - 7.11.4.6. Where VSAT latency is not acceptable to the Company's SCADA Master Station IEC 60870-5-104 implementation, the Contractor shall propose a local data concentrator or protocol adaptation to mitigate latency effects.
- 7.11.5. GSM/LTE/4G Cellular Communication — Technical Requirements (Applicable if Option C Selected or Used as Backup)
 - 7.11.5.1. Where GSM/LTE is proposed as the primary telecommunication medium, the Contractor shall demonstrate by site measurement (drive test or measurement report from the MNO) that the signal strength at 132kV Pasni Grid Station is adequate for reliable operation. Minimum RSSI shall be -90 dBm and minimum SINR shall be 10 dB.
 - 7.11.5.2. The Contractor shall use an industrial-grade cellular router with dual-SIM capability. Two SIM cards from two different mobile network operators shall be installed to provide redundancy. Automatic failover between SIMs shall be configured with a failover time not exceeding 60 seconds.
 - 7.11.5.3. The cellular router shall establish an encrypted IPSec VPN tunnel to the Company's SCADA Control Centre over the public LTE network. No SCADA data shall traverse the public internet without encryption.
 - 7.11.5.4. An external directional or omnidirectional antenna, as required, shall be mounted at optimum height to maximise signal strength. The antenna shall be IP67-rated and suitable for coastal/saline air environment at site.
 - 7.11.5.5. The Contractor shall enter into a data service contract with the selected MNO(s) providing a minimum of a dedicated APN (Access Point Name) for SCADA traffic

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isolation. The cost of the SIM data contract for the duration of the Defects Notification Period shall be included in the Contract Price.

- 7.11.5.6. GSM/LTE shall be the minimum acceptable primary solution and is strongly recommended as the backup channel in combination with microwave or VSAT as primary. The Contractor shall evaluate and propose a hybrid primary+backup topology to maximise availability.
- 7.11.6. Telecommunication System Acceptance, Testing & Documentation
- 7.11.6.1. The Contractor shall prepare and submit a Telecommunication System Design Report (TSDR) for Company approval as part of the preliminary engineering submission. The TSDR shall include: technology selection rationale, link budget calculations, equipment datasheets, network topology diagram, IP addressing scheme, protocol configuration details, security architecture, and regulatory approval status.
- 7.11.6.2. Factory Acceptance Testing (FAT) shall be conducted for all telecommunication equipment prior to shipment. The FAT shall include functional testing of all interfaces, protocol testing, and simulation of communication failure and recovery scenarios.
- 7.11.6.3. Site Acceptance Testing (SAT) for the telecommunication system shall include:
- End-to-end communication path verification from STATCOM RTU to Company SCADA Master Station
 - Data latency measurement for analogue values and status points (verification against specified limits)
 - Throughput and bandwidth utilisation measurement
 - Link failure simulation and automatic recovery verification
 - UPS autonomy test (8-hour minimum under full load)
 - Cybersecurity verification: encryption, VPN tunnel integrity, and access control testing
- 7.11.6.4. The Contractor shall provide As-Built documentation for the telecommunication system including: final network diagrams, equipment manuals, configuration backup files, frequency licence copies, SIM/APN details, and contact details for the network service provider(s).
- 7.11.6.5. Telecommunication system O&M training shall be provided to the Company's nominated personnel covering: equipment operation, routine maintenance, fault diagnosis, configuration backup/restore, and liaison with service providers.
- 7.12. Control & Monitoring System
- 7.12.1. General Requirements
- 7.12.1.1. The Contractor shall provide the necessary systems for the purpose of control, protection, operation, interlocking, indication and alarms for all equipment supplied as part of this contract. The Contractor shall also be responsible for defining and providing the coordination of the controls, protection, interlocking and switching sequences required for equipment during operation, testing and maintenance of the equipment. Reliability of operating equipment, availability of STATCOM system and safety of the personnel shall all be considered in the design.
- 7.12.1.2. The design and testing of all control and protection equipment shall comply with the latest applicable IEC Standards.
- 7.12.1.3. All events and alarms generated by the control system and external input signals (events and alarms) to the control system shall be stored in the control and protection system. It shall also be possible to analyze retrieved events and to print out these messages. All recordings and messages shall be given with a real time stamp. Correct time tagging must be ensured. The accuracy and resolution of the time tagging must at least be 1 ms. The station master clocks of the STATCOM must be synchronized. In

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- case of loss of synchronization, the station master clocks must continue operation with the internal crystal with an accuracy of 1 ppm.
- 7.12.1.4. Software in the control system determines to a great extent the performance of the STATCOM system. Software quality assurance is therefore essential. In this respect the entire life cycle of the software shall be considered:
- i. Experience with comparable system
 - ii. Planning and design of software
 - iii. Implementation of software
 - iv. Testing of software during commissioning
 - v. Maintenance of software after commissioning
 - vi. Possible future extension of software
- 7.12.1.5. The design, quality requirements, testing and documentation of all software for the control system shall comply with the latest revision of relevant IEC standards. The application software shall be written and documented in a high level language, using graphical symbols for functional blocks, logic circuits and numerical elements.
- 7.12.1.6. Dedicated software for debugging of existing software as well as for the maintenance of existing software and development of additional software shall be part of the supplied package.
- i. The software shall be designed if possible for standard hardware. Later upgrades of the hardware shall not necessarily result in major software changes.
 - ii. The software may be benchmarked with the results of RTDS studies performed in the factory before delivering of the STATCOM.
- 7.12.2. STATCOM Control – General Requirements
- 7.12.2.1. The control systems shall achieve the functional objectives given in clause 7. The primary purpose of the control of the STATCOM is to control system voltage in response to measured system variables, auxiliary inputs for supplementary control, or operator inputs. The voltage and current measurements are included in the STATCOM scope of supply in order to ensure that they are compatible for the required response of controls.
- 7.12.2.2. A digital programmable controller shall be supplied to regulate the reactive output from the STATCOM. All necessary equipment for control, protection, monitoring, alarms and indications shall be housed in a relay panel provided by the Contractor. The controller shall have diagnostics and self-checking features for both itself and interface circuits. The control and monitoring equipment shall be used to implement the functional requirements in this specification. Complete redundancy of control system must be ensured to meet the requirements of sub-clause 7.12 – STATCOM Availability and Reliability.
- 7.12.2.3. The accuracy of voltage shall be within $\pm 1\%$ of the reference voltage. The accuracy of linearity of the slope delivered by the STATCOM shall be $\pm 5\%$ of the slope setting of current, expressed as a percentage of nominal current at maximum output.
- 7.12.2.4. The valves and controls shall be designed to avoid any “cross-talk” interference between anti-parallel pairs.
- 7.12.3. Operator Interface
- 7.12.3.1. The control interface shall provide for local and remote control points. Only one control point shall be active at any one time and as determined by a master control point, but it shall be possible to view plant status, control settings, and other STATCOM parameters at all control points.
- 7.12.3.2. The local control point shall be near the STATCOM control Hardware. It shall permit the following control functions to be carried out:
- i. Sensing and regulation of HV bus voltage.

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- ii. Alternate modes of operation, as required, including a manual mode for site testing and emergency shutdown by the operator.
 - iii. Voltage, current and reactive power measurements.
 - iv. STATCOM control by generation of appropriate gating pulses to the switching devices.
 - v. Orderly start-up and shutdown sequencing of the STATCOM to facilitate smooth STATCOM energization and de-energization. Monitoring and protecting the control itself in progress and the components it controls.
 - vi. Coordinating and controlling opening and closing of circuit breakers and disconnect switches.
 - vii. Performing certain protective functions.
 - viii. Change of reference voltage and slope settings.
 - ix. Alarm acceptance and where appropriate reset them.
 - x. The control and monitoring system shall be designed to meet the demands for availability and reliability specified.
- 7.12.3.3. A synchronizing scheme shall be used to produce properly spaced timing pulses synchronized to the AC system. The synchronizing function shall be designed to:
- i. Be immune to severe harmonic distortion of voltage wave form.
 - ii. Be immune to large phase shifts in voltage wave form.
 - iii. Continue to operate during and following large voltage & frequency excursions.
- 7.12.3.4. The controls may also contain one or more of the followings:
- i. Automatic return to manual mode of operation at the most recent voltage setting on the loss of input voltage measurement signal.
 - ii. Automatic voltage control, operative during start-up to prevent unnecessary switching of the reactive elements.
 - iii. Self-check facility at regular intervals which operates equipment to verify its correct operation.
 - iv. Supplementary control modules for damping and var control.
 - v. Control system damping with gain supervisor and gain optimizer. On gain supervision, details shall be given especially in the context of instability. This function shall also include an adjustable emergency gain. The criteria for detection of instability includes:
 - a. Frequency range of the oscillation
 - b. Amplitude of the oscillation
 - c. Number of consecutive oscillations above an adjustable threshold
- 7.12.4. Control System Construction Requirements
- 7.12.4.1. Possible requirements of control system construction are as follows:
- i. The control system components shall be mounted in free-standing, indoor, metal clad cabinets with appropriate rating, where necessary.
 - ii. Control equipment shall be designed to operate properly at the expected maximum allowable ambient indoor air temperature. Supplemental cooling may be provided.
 - iii. Printed circuit cards shall have built-in test points indicating lights to facilitate testing and maintenance. Microprocessor-based systems shall have self-checking and fault diagnosis features to be described by the bidder.
- 7.12.5. Station Control & Monitoring Requirements
- 7.12.5.1. The Contractor shall submit a local digital station control and monitoring system with the following minimum capabilities and features:
- i. The system shall give the operator detailed information regarding the status of the equipment. Functional overview of the STATCOM, displays for the control of the STATCOM, status lists, measured values, indications, alarms etc. shall be present on the screen.

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- ii. Setting/adjustment of certain control parameters/protection settings and command of operating equipment (breakers, disconnectors etc.) shall be given from this system.
 - iii. Interlocking for safety of equipment and personnel shall be included.
 - iv. The control desk shall be equipped with a monitor for the current control of the STATCOM.
 - v. The operator can freely select which information is to be shown on the monitor. All features of the local Station Control and Monitoring system shall be precisely identified to enable proper use by the system operators. The operator interface shall be realised using the standard Windows environment. Different levels (at least three) of access shall be distinguished, using passwords.
 - vi. The Contractor's solution shall use two monitors. One being for local and the second for either local or remote control. In the commissioning phase both monitors are located at the local control location. Both monitors can be used for monitoring functions however only one for controlling the STATCOM.
 - vii. Supervision and recording of events, internal and external. Resolution shall be 1 ms or better. The event information shall be stored on recoverable data media in a standard format, for later access. In case of disturbances of the STATCOM, the system shall handle all the events without losing information.
 - viii. All alarm, event and help texts presented to the operators in the local station shall be in English. All messages must be identified by a unique index. The structure of one event line shall at least include date, time, alarm number, source, text, status.
 - ix. The system shall be equipped with a powerful on-line help function to advise local operators in the actions that have to be taken in any fault situation within the STATCOM.
 - x. There shall be a possibility for a remote dialled up connection to the local control system for maintenance purposes (PC anywhere). Measures to prevent unauthorised system access must be taken. There must be different levels of user access available for a dialled up connection.
- 7.12.5.2. A power quality measurement system shall continuously acquire, store and present information with respect to the quality of the AC voltages and currents. At a minimum the following measured values shall be determined:
- i. True RMS measurement of the phase voltages and currents
 - ii. Reactive and apparent power per phase and total
 - iii. Voltage and current unbalance
 - iv. Voltage sags and swells
 - v. Current sags and swells
 - vi. Individual harmonic distortion in the currents and voltages up to the 40th harmonic
 - vii. Total harmonic distortion
 - viii. Voltage dips ($\Delta U/\Delta t$)
- 7.12.5.3. The device for power quality supervision shall automatically supervise the limits of voltages and currents according to IEC and register any violation of these limits. It must be possible for Company to define their own limitations which shall then be supervised accordingly.
- 7.12.5.4. The monitoring/recording of the AC harmonics shall comply with the latest applicable IEC standard.
- 7.12.5.5. The stored information in the recording equipment shall be accessible for later evaluation. Dedicated software to present all measured values and to allow for additional mathematical processing of the data shall be included.
- 7.12.5.6. The Contractor shall present the proposed system to the Company.

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- 7.12.5.7. SCADA RTU will be required to accommodate all the STATCOM SCADA system requirements including 20% spare capacity without using the existing spare capacity. Communication of STATCOM analogue, status and alarm points to the substation operator via SCS Human Machine Interface in the line terminal substations.
- 7.12.5.8. A state of the art sequence of event recorder will be required. Resolution shall be 1ms or better. To the maximum extent practical, the SOE functionality shall monitor internal variables in the STATCOM Control and Protection System. It will monitor to the maximum extent possible, signals on an individual phase basis and identify each as such.
- 7.12.5.9. A state of the art Transient Fault recorder (TFR)/ DFR (or equivalent) will be included to monitor the status of various STATCOM parameters. The TFR/DFR Device shall have a pre-fault capture and a post-fault capture. The TFR/DFR Device shall have a variable sampling rate for short and long duration power system disturbance events. Disturbance and event recording facilities are required for local monitoring of the STATCOM following a disturbance on the power system or on the STATCOM. STATCOM voltages, currents, thyristors, TSC/TCR and filter currents will be monitored by the Transient Fault Recorder in addition to various other control and protective variables.
- 7.12.5.10. A state of the art Voltage Quality Recorder (VQR) shall be provided which shall monitor the STATCOM HV voltage (three phases) and current (three phases). The VQR shall be set up to measure power quality parameters in accordance with international standards from IEC/IEEE.
- 7.12.5.11. A state of the art DSM shall monitor all the main HV circuits' voltages and currents – incoming and outgoing lines and transformers. It shall include all three phases of each circuit. The DSM shall also monitor the system frequency.
- 7.12.5.12. The integrated STATCOM controller together with the HMI, SOE, TFR, DSM and VQR shall be designed and configured that will allow future connection/interfacing to a network via Ethernet TCP/IP protocol, for remote access, fault diagnostics, data download and viewing. This is inclusive of all the hardware and software requirements for the STATCOM site and remote site but excludes the communication cabling/links.
- 7.12.6. Local/Remote Control
- 7.12.6.1. STATCOM may be controlled either locally or remotely.
- 7.12.6.2. In case of remote control, the control system must spontaneously prepare all signals and changes in analogue values from the STATCOM control system for transmission to the control centre without delay.
- 7.12.6.3. Details of the response time of the signals shall be provided by the bidder in the bid.
- 7.12.6.4. There shall be no limitations in the transmission capacity to the control centre other than the limitations given by the available communication speed and the communication protocol.
- 7.12.6.5. Control Selection
- i. The control system shall be designed to permit a free choice between necessary setting and monitoring of the system from the local control room at the substation or from the control centre. Switching between local and remote control is to be carried out in the local control room.
 - ii. The "Switch" between local and remote control has to be placed locally in the STATCOM control room. It shall only be possible to control the STATCOM either from remote or from local. A key switch will be installed locally in the STATCOM control room.
 - iii. The switch "LOCAL" - "REMOTE" shall have two positions:
 - a. LOCAL: only local control shall be possible. The operator in the STATCOM station can select whether all signals and measurements shall

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- be transmitted to the remote control centre or not. Alarms and measurements shall be registered locally and presented on the HMI.
- b. REMOTE: only remote control shall be possible. All local audible functions shall be blocked. Alarms and measurements shall be registered locally and presented on the HMI.
 - iv. A switch between local and remote control shall neither result in an unintentional jump in the power exchange nor in any electrical disturbances or unintended control actions.
- 7.12.7. Telecommunication Failure
- 7.12.7.1. Any telecommunication failure must not cause any unintentional operation of the control system. If the telecommunication link between STATCOM control system and corresponding remote control centre breaks down during remote operation, the settings shall be frozen at the value at the time of the loss of the telecommunication link or a predefined status should be achieved. Any active control actions shall be terminated in a safe state.
 - 7.12.7.2. When the telecommunication link is re-established, the remote control of STATCOM shall automatically be re-established. All alarms and indications issued in the STATCOM during the failure shall be transmitted in chronological order to the control centre.
- 7.12.8. Indications
- 7.12.8.1. Each control point shall indicate as a minimum:
 - i. Starting or stopping sequence in progress
 - ii. Reference voltage and slope settings
 - iii. The control point selected
 - iv. Any other settings such as supplementary stabilizing signals
 - v. STATCOM “on” indication
 - vi. STATCOM “off” indication
 - vii. Three-phase high-side line currents of the main transformer
 - viii. Total reactive power generated or absorbed by the compensator
 - ix. Primary voltage, single phase
 - x. Secondary voltage, single phase
 - xi. STATCOM (VSC) branches in/out (where applicable)
- 7.12.9. Annunciations/Alarms
- 7.12.9.1. The central control unit shall monitor its own operation and the operations of the various STATCOM components. Two levels of protection i.e. warning and shutdown shall be provided. The first-level alarm (warning) indicates that a problem exists, but the equipment itself or its proper operation is not in immediate danger. The second-level alarm (shutdown) initiates a reduction in output range or a shutdown of the STATCOM due to equipment problems that might cause damage if left unattended.
 - 7.12.9.2. The first-level alarms include the following as a minimum:
 - i. Auxiliary power supply failure; back-up supply in use
 - ii. Cooling system fan or pump failure; back-up pump or fan is available
 - iii. Cooling system problems (e.g., low water resistivity, primary pump stopped)
 - iv. Capacitor failures can exist, but within an acceptable quantity
 - v. Loss of redundant Switching Devices/Valves
 - vi. Branch availability
 - vii. Loss of signal-measuring controlled bus bar voltage, with the control continuing to maintain the last STATCOM operating point unless the regulated bus bar voltage is also the source of synchronizing voltage.
 - 7.12.9.3. The second-level alarms include the following as a minimum:
 - i. Loss of all control power

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- ii. Loss of cooling system rated capabilities
 - iii. Loss of source of synchronizing voltage
 - iv. Excessive number of capacitor failures
 - v. Excessive over-current in a switching devices/ valve
 - vi. Loss of Switching Devices in excess of redundancy margin
- 7.12.9.4. The central control unit shall also have a built-in protective system for self-monitoring.
- 7.12.9.5. It shall be possible to transfer alarms to the remote control centers as individual alarms and as combined alarms. The control system shall contain software that makes it possible to create combined alarms on the basis of detailed alarms of the STATCOM. Combined alarms shall be able to function as detail alarms at the creation of new combined alarms. Both detailed and combined alarms shall be stored in an archive in the local control system. On request from the HMI the alarms can be retrieved, displayed and sorted.
- 7.12.9.6. It shall be easy to block any erroneous detail alarm from being part of a combined alarm. It shall be possible to use logical operators without restrictions in the creation of combined alarms.
- 7.12.9.7. The STATCOM plant indications and alarm system shall register all real changes and shall ensure that the changes are also transferred to the remote control interface. Multiple alarms, for instance due to contact bouncing shall be prevented. False indications and alarms shall be avoided.
- 7.12.9.8. The alarms shall always show the real current status of the STATCOM equipment. Alarms shall not be pulsed. They shall disappear by themselves, once the activation criterion has disappeared, without having to be acknowledged in the station.
- 7.12.9.9. It will be considered as advantage if this selection is made by parameter definition or with graphical tools.
- 7.12.10. Standard & Testing Requirements
- 7.12.10.1. All control plant and material shall be type tested for Surge Withstand Capability according to IEC 1000-4-5, Electrostatic Discharge according to IEC 1000-4-2, Electrical Fast Transient Burst according to IEC 1000-4-4 and Radio Freq. Interference according to IEC 1000-4-3.
- 7.12.11. Information to be Supplied with the Bid
- 7.12.11.1. An overall description of the structure of the control and monitoring system shall be supplied in the bid. Key performance data (e.g. resolution in voltage control, resolution and symmetry in triggering angle, response time in voltage acquisition, intrinsic filtering of voltage harmonics etc.) shall be given and explained.
- 7.13. STATCOM Protection
- 7.13.1.1. Depending on the technical specifications, operational requirements of the STATCOM as well as technical specifications of the existing protection system of the substation, the Contractor will be responsible for providing the appropriate protection solutions. The following solutions, but not limited, shall be provided/performed by the Contractor:
- i. The STATCOM system supplied by Contractor shall be self-protecting.
 - ii. The protection relays and equipment shall be mounted separate from the STATCOM control and interface cabinets.
 - iii. The protection system shall, to the extent applicable, be built on the principle of a main and a back-up protection, for each protected zone/object. The two independent protection schemes, each capable of detecting all faults segregated to the extent that each uses separate secondaries of common current transformers, independently fused supplies from common voltage transformers, separate DC supplies and each tripping a separate circuit breaker trip coil through its own latching tripping relay, are required. The system must enable easy and clear

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identification of fault location and faulted element. The functionality of the protection system shall be given in a protection matrix.

- iv. The functional requirements for the protection system are:
 - a. Protection equipment and personnel from damage and injury
 - b. Determination of the faulted zone
 - c. Protections shall be arranged in overlapping protective zones. A fast main protection shall be available for each fault type. This main protection shall be supported by a back-up protection function, preferably based on a different measuring principle, that may be part of another main protection
 - d. Testing of protections shall be possible on-line without affecting the operation of the STATCOM
- v. The protection relays and equipment shall receive their primary input from CTs, VTs etc., that will be supplied as part of the STATCOM equipments by the Contractor. Redundant protective functions shall be included and demonstrated.
- vi. All protection equipment and systems shall be properly coordinated to prevent incorrect operations of the protection equipment or systems during normal STATCOM operation, including anticipated abnormal conditions on the transmission system of the Company, as specified. Fail-safe principles shall be applied throughout. The protection system shall be selective and the total protection time shall never exceed 100 ms in any case (including circuit-breaker time).
- vii. Single point of failures in the protection system shall be avoided by a complete physical subdivision of the protection system (incl. analogue and digital input signals) in two parts. Both subsystems shall be connected to a separate auxiliary supply. Tripping paths to circuit breakers shall be redundant.
- viii. There must be no possibility that working/programming in the control system can influence the function on the protective devices.
- ix. The Bidder shall provide a report on the protection system and protection coordination with detailed drawings. This report shall provide a description of each type of protection, the co-ordination of the protective devices and the recommended protective settings. The rating and performance of the instrument transformers as well as the co-ordination with the protective relays is also part of this report.
- x. The Contractor shall supply a comprehensive electrical interlocking scheme to permit safe manual or automatic sequential connection and isolation of equipment. The interlocking scheme shall be designed to provide complete safety to personnel, hazard free equipment operation, failsafe operation in the event of component failure and maximum flexibility in operating the equipment.
- xi. During on-line testing of the STATCOM, 100% protection of the STATCOM and the associated AC equipment must be ensured.
- xii. The power supply for the control and protection equipment and the trip paths shall be designed redundant.

7.13.2. Component Protection

7.13.2.1. The following is a list of the possible required protection. Additional protection may be provided if deemed necessary.

- i. Transformer and HV Bus
 - a. Transformer and STATCOM bus differential
 - b. STATCOM primary bus over-current
 - c. Ground Over-current
 - d. Breaker failure function
 - e. Low oil-level

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- f. Sudden pressure relay/Buchholz relay
 - g. Over temperature (oil and windings)
 - h. Cooling circuit supervision
 - ii. STATCOM MV Voltage Bus
 - a. Over-voltage
 - b. Under-voltage
 - c. Residual voltage
 - d. Differential
 - e. Voltage zero-sequence
 - f. Over current
 - g. Overvoltage
 - h. Ground over current
 - iii. VSC Protection
 - a. Instantaneous Over Current
 - b. Overload
 - c. DC overvoltage
 - d. Ground Fault
 - e. Differential
 - iv. Sub Modules (Gating Switching Devices) Protection
 - a. Over Current
 - b. Over Voltage
 - c. Device Failure
 - d. Thermal Overload
 - v. Harmonic Filters
 - a. Neutral voltage shift
 - b. Unbalance
 - c. Overvoltage
 - d. Differential
 - e. Ground Over current
 - f. Three phase over-current
 - g. Overload protection
 - vi. Master Control
 - a. Loss of control power
 - b. Loss of synchronization signal
 - vii. Cooling Media
 - a. Temperature
 - b. Flow
 - c. Resistivity
 - d. Leakage
 - e. Transfer failure or power loss

7.13.3. Accessories

- 7.13.3.1. The term "hardware" is understood to cover both the central processing unit and the directly connected subsystems, e.g. the power supply, I/O-gates, communication equipment and terminal equipment.
- 7.13.3.2. Only components of a high quality shall be used in the equipment. The Contractor shall use standard components. Connecting equipment for the terminal equipment shall be of a standard type.
- 7.13.3.3. The redundancy in the control and protection system shall be so arranged that loss of one auxiliary power source does not result in loss of control, cooling system or protection system. Two independent auxiliary power supplies shall be available. The

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design shall be such that the stand-by control system and cooling system can be tested and maintained during normal operation of the STATCOM.

- 7.13.3.4. Electronic components which are designed to be operated between 0% and 100% of rated voltage, current or power shall not be operated long-term at more than 70% of their rated voltage, current or power. Resistors shall be operated at not more than 50% of their rated power. Integrated digital and analogue circuits and others such as electronic components designed to be operated between a minimum voltage not equal to zero and a maximum voltage shall be operated approx. at the midpoint of their designed voltage range.
- 7.13.3.5. All cables between control cubicles, control desk etc. shall be terminated in terminals in the cubicles etc. The cubicles shall be of IP class 21 or higher. All components in the cubicles which have to be read or adjusted shall be located at a height above the floor of between 70 and 180 cm.
- 7.13.3.6. It is not permitted to fix more than one wire under a terminal. Multithread wires must be terminated with multicore cable ends.
- 7.13.3.7. Binary inputs of protective systems shall not operate on capacitive charge currents caused by earth faults in the DC-auxiliary voltage.
- 7.13.3.8. Design of cubicles has to be according to IEC standards. Terminals and all electrical connections must be of such a type that accidental contact with voltage is impossible.
- 7.13.3.9. The cross section of cables shall be determined according to the requirements of the detailed engineering phase. However the lowest permissible cross section is:
 - i. For secondary circuits of current transformers - 4 mm² (1 A rated current)
 - ii. For secondary circuits of voltage transformers – 2.5 mm²
 - iii. For trip circuits – 2.5 mm²
 - iv. For control circuits – 1.5 mm²
- 7.13.3.10. Current inputs of protective relays have to be designed for 100*I_N for 1 sec.
- 7.13.4. Standard and Testing Requirements
 - 7.13.4.1. The design and testing of the protection equipments shall comply with relevant latest version of IEC standards.
- 7.13.5. Information to be supplied with the Bid
 - 7.13.5.1. A detailed preliminary protection block diagram shall be included in the bid. Details of protection equipment including type, make, rating etc shall also be furnished with the bid.
- 7.14. Auxiliary Power Supplies
 - 7.14.1. The STATCOM equipment shall include all the power supplies necessary for its operation, including step-down transformer, AC distribution boards, batteries, battery chargers, etc. The power supplies shall be sufficient to supply all pumps, fans, valves, valve cooling system and controls, building cooling and heating systems.
 - 7.14.2. The STATCOM auxiliary power distribution shall include both AC & DC distributions. The following principle requirements shall be met:
 - i. Two independent sources (one from STATCOM MV bus bar and other from the existing 11kV panel) shall be installed for the AC auxiliary supply. The power quality of the supply and the required load from the STATCOM shall be specified by the Contractor. The redundant feeders from the existing 400V distribution of the substation will be used for the auxiliary supply of the STATCOM. The connection cables shall be provided and installed including end termination by the Contractor.
 - ii. An automatic switching sequence, for selection of input AC feeder shall be provided. Switching must not cause significant disturbances in the MVAR output of the STATCOM.
 - iii. Auxiliary supplies must provide LVRT (Low Voltage Ride through Capability) and Fault Ride through Capability for at least 10 sec.

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- iv. The STATCOM control and protection equipment shall be supplied from the DC distribution. This is specifically valid for the subsystems being critical for continuous operation of the STATCOM. Certain more peripheral parts of the control system, e.g. subsystems and components related to the operator interfaces, can have AC supply, in these cases a non-interruptible source (type UPS) has to be used.
- v. The DC distribution for the control and protection equipment, concerning batteries, shall be divided into two independent circuits. Each battery shall be rated for the full load in order to assure unrestricted STATCOM operation in case of battery failure. The requirements regarding availability and reliability have to be considered.
- vi. All required rectifiers and inverters shall be supplied by the Contractor.
- vii. The capacity of the batteries shall be chosen for at least 10 hours operation without charging.
- viii. All AC and DC sub-distributions shall be built with at least 20% spare outgoing circuits for possible extension.
- ix. The design and testing of the AC and DC distribution, the batteries, the rectifiers and the inverters shall comply with all relevant NGC/QESCO Specification and IEC standards.
- x. Control & Auxiliary Voltages

Item No.	Parameter	Criteria
a	Type of System	3-phase,4wire,neutral
b	Nominal Voltage	230/400 V
c	Limits of supply voltage which an AC operating device or auxiliary equipment shall be capable of operating correctly within the tolerance	+10% -15%
d	Rated Frequency	50 Hz
e	Frequency Limit	48-51 Hz
f	Initial symmetrical three phase short circuit current	15kA
g	One minute Power frequency withstand voltage for the auxiliary circuits	2kV
h	DC Voltage	
i	Tolerance	+10%, -15%

7.15. Spares

7.15.1. General Requirements

- 7.15.1.1. The basic supply of the STATCOM shall include a full complement of essential spare parts, which are to be furnished at the same time and as part of the STATCOM supply. It is the Contractor's responsibility, based on the particular design for the STATCOM to provide adequate spare parts to meet the specified reliability and availability requirements.
- 7.15.1.2. All spare parts offered must be of the same quality and completely interchangeable with the original parts.
- 7.15.1.3. The Bidder shall submit a complete list of spare parts to be supplied for the STATCOM system including information regarding type, make, rating etc.
- 7.15.1.4. The Contractor shall allow enough room for storage of the recommended spare parts.

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- 7.15.1.5. The Bidder shall guarantee that sufficient spare parts shall be available from the bidder for purchase by the Company after acceptance of the system for a sufficient period of time stated by the bidder.
- 7.15.1.6. If any items which are necessary for safe operation and maintenance fail during the guarantee period, they have to be replaced by the Contractor at his expense and new spare (s) has to be delivered.
- 7.15.2. Spare Strategy
 - 7.15.2.1. A strategy for spare parts shall be developed to demonstrate that the complement of spare parts will be adequate to meet the specified reliability requirements.
 - 7.15.2.2. The spares strategy shall be based on a tabulation of all of the components in the STATCOM, down to the level of the lowest replaceable module i.e. all components suitable for unit replacement at the first level of maintenance shall be included in the tabulation but individual devices that would not be replaced except as part of a shop or bench repair of a replaceable component shall not be in this tabulation.
 - 7.15.2.3. Each component in the tabulation shall be identified for its importance to the operation of the STATCOM, according to the following classification:
 - i. Category A: STATCOM operation is not possible until this component has been repaired or replaced (e.g., main step-down transformer, shunt reactor).
 - ii. Category B: STATCOM operation can continue (or resume) at reduced rating but further failures may lead to STACOM outage (e.g., VSC, Filter Branch).
 - iii. Category C: STATCOM operation can continue on an emergency basis, but a critical function has been lost or bypassed. Some risk of further complications or equipment damage exists until the function is restored (e.g., one of two pumps out of service, protective relaying, UPS, or cooling alarm sensors not in service).
 - iv. Category D: Operation can continue without serious impairment (e.g., building services such as lighting or heating).
 - v. The tabulation shall include the failure rate or the expected replacement rate of the component over a 15 year period.
 - vi. The tabulation shall include the information regarding manufacturer, type, make, ratings and estimated delivery cycle etc.
 - vii. Each device shall either be:
 - a. Included on an inventory list of all site spares. The inventory list shall show the description, quantity, and storage location of each spare, assuming that any time that a spare is used, the item is reordered.
 - b. Provided with a contingency plan to obtain a replacement on short notice, if a spare is not being kept on hand.
- 7.16. Engineering Studies
 - 7.16.1. The Contractor shall perform studies to determine the design ratings and requirements of all plant and material to be supplied under this contract. The CONTRACTOR shall confirm the design ratings and requirements of all plant and material to be supplied under the contract. Engineering studies shall be performed within the scope of supply. Studies are required to demonstrate that the STATCOM meets all specified performance criteria. The bid must contain methodology for the list of engineering studies specified in this specification. Similarly, any additional studies necessary for STATCOM design and operation shall also be identified in the bid.
 - 7.16.2. All simulations software adopted has to be fully specified (e.g. version) in order to allow the Company to use all models in its own simulation environment.
 - 7.16.3. In the study reports, findings that affects the operation of the STATCOM and recommendations how to operate the power grid with the new device(s) shall be given. Highlight any concerns/actions required for satisfactory use of the STATCOM.

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- 7.16.4. For each study item, the Contractor shall submit to the Company, by the specified date, the specified number of copies of the study report. The work shall include, but not limited to the following:
- i. study objective
 - ii. initial conditions, data and assumptions
 - iii. codes, standards and criteria used in the studies
 - iv. description of means and methods used in the studies
 - v. computer models and data used in the studies to represent the Contractor equipment and the Company equipment
 - vi. summary of study results
 - vii. conclusions
 - viii. reference(s)
- 7.16.5. Contractor shall provide simulation files, plots in high definition, results in native software file format and a detailed report. The report shall highlight possible interactions (if any), optimization of the controllers and signals that are required to be exchanged.
- 7.16.6. Prior to manufacture of the STATCOM, the Contractor shall perform simulation studies within agreed time frames for review, comment and participation by the Company. The Company reserves the right to perform parallel verification studies on its own or by a third party. The Contractor shall provide all required information for independent design verification and system modelling. The Contractor will be utilizing the system analysis software of PSS/E and electromagnetic transient simulation package (PSCAD/EMTDC) for verification and require the data to be either in the correct format or available EMTDC data format. The results will be verified by performing studies on Real Time Digital Simulator (RTDS) as well, before delivery of the STATCOM.
- 7.16.7. Transient and stability studies using PSS/E (version 33/35) to verify the STATCOM control system performance, evaluate STATCOM control system function and optimize the control of STATCOM during system disturbances, such as major faults and load rejection in the Company network. The design shall investigate the adequacy of the STATCOM to ensure stability and prevent undervoltages & over-voltages during system transient, dynamic and fault conditions. This is inclusive of degraded modes for the STATCOM system. Refer to Annexure-E for detailed PSSE Study requirements.
- 7.16.8. Detailed harmonic impedance, impact design and measurements to verify the filter design. The detailed filter configuration shall be supplied. This is to verify the adequacy of the STATCOM harmonic filter design through simulation of the Company's equivalent network response to STATCOM harmonics. It shall include evaluating maximum harmonic levels at the STATCOM point of common coupling (PCC). Refer to Annexure-E for detailed Harmonic Study requirements.
- 7.16.9. The Contractor shall provide the following digital models to enable simulation of the STATCOM and its control and protective functions during steady-state operation, dynamic, and transient conditions in different timeframes:
- i. PSCAD/EMTDC (Annexure-E for details) model for time simulations from 1.0 ms up to 10.0s.
 - ii. PSS/E (Annexure-E for details) model for time simulations from 1.0 ms up to 60 s.
- 7.16.10. If the Company's or third party's studies indicate disagreement with the Contractor's results, the Contractor shall be required to work with the Company or his representatives to reach an agreement on the controversial issues and/or to make the required design corrections, in accordance with this specification.
- 7.16.11. The studies made by the Contractor shall result in a report which shall be submitted to the Company for information. The reports shall include but not be limited to:
- i. Main Component Design

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In this report, the analysis for the STATCOM equipment rating required to cover all modes of the STATCOM operation, considering the worst possible combination of manufacturing tolerances and frequency deviations, shall be presented. Power system characteristics shall be clearly stated and a summary of the rating of the STATCOM components shall be given including the calculation of fault currents for thermal and mechanical design.

- ii. Insulation Coordination Study
In this report, analysis for the insulation levels shall be presented.
- iii. VSC Design & Protection Study
In this report, the calculations for the rating of the sub-modules, VSC Valves shall be presented. Coordination of break over device levels and other protective functions shall be described. Control strategies for possible misfirings shall be specified in detail and cooling requirements shall also be stated in this report.
- iv. Control System Strategy
In this report, the control strategies implemented in the control system shall be described in detail. The verification of the main strategies shall be done by running the real control system together with a simulator implementing a network equivalent together with the STATCOM high voltage components. The verification can be done during the factory validation test of the control system
- v. Protective Relay Coordination
In this report, the calculation of relay protection setting levels shall be presented together with the principles for protection coordination. A summarized list of the protection settings shall be given.
- vi. Loss Evaluation
In this report, the total STATCOM losses shall be calculated and compared with guaranteed values. Explanations to discrepancies, if any, shall be given. The Loss Evaluation report shall be based on component loss data obtained from factory tests and from calculations. Refer to sub-clause 7.13 of this specification as well.
- vii. Harmonic Filter Design & Performance Study
In this report, the harmonic filter design shall be described and the resulting maximum harmonic distortion generated by the STATCOM shall be presented. Refer to Annexure-E for details
- viii. Reliability Study
The Contractor shall be required to demonstrate that the STATCOM design will achieve availability specified in sub-clause 7.14. The Contractor shall resubmit during the STATCOM design phase, the Reliability Study updated to reflect the performance of actual components used in the STATCOM.
- ix. Study Noise Level Study
The Contractor shall submit the details/data indicating how the noise limits of sub-clause 7.12 shall be met with. During the STATCOM design phase the Contractor shall perform a detailed site noise level study to confirm compliance with the noise limit specified. This study shall also determine site noise levels at extreme operating points and indicate how STATCOM generated noise varies across the full operating range (MVAR and voltage).

7.16.12. Detailed Study requirements for PSSE, PSCAD are described in Annexure-E

7.16.13. At the bid stage, each Bidder shall submit a set of preliminary STATCOM performance studies demonstrating that the proposed STATCOM design is capable of meeting all performance, stability, and power quality requirements of this specification under the abnormal short-circuit conditions identified in Annexure B. The studies shall be performed using the simulation tools and methodologies specified in Annexure F, and the results shall form part of the Bidder's technical submission. Acceptance of a bid shall not constitute Company approval of the study

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results; final detailed studies shall be performed and submitted by the Contractor during the engineering phase in accordance with Clause 7.16 and Annexure E.

7.17. Documents & Drawings

7.17.1. In addition to the detailed information requested elsewhere in this specification, the Bidder shall submit all technical documentation necessary to give a detailed and clear picture of the proposed delivery. The bid documentation shall further provide ample proof of the Bidder's compliance with all aspects of this specification.

7.17.2. Drawings, technical descriptions, instruction, manuals etc shall be in English.

7.17.3. The following guidelines apply for the presentation of technical documentation being part of the bid:

- i. A descriptive document shall be included, which shall present the proposed STATCOM configuration, and its compliance with the rating and functional requirements. Assumptions and methodology used for calculation of fundamental frequency and harmonic stresses and performance, shall be presented within this document.
- ii. A single-line diagram of the STATCOM shall be included.
- iii. A protection block diagram of the STATCOM shall be included.
- iv. The losses of the proposed STATCOM, as a function of reactive power output, shall be presented as described in sub-clause 7.13.
- v. The audible noise levels, with consideration the Company requirements, and the proposed STATCOM layout shall be presented. This description shall also give the principles of the methodology used for calculation of noise levels.
- vi. The reliability and availability of the proposed STATCOM shall be addressed. Results of availability calculations shall be presented, along with the assumptions taken and methodology used.
- vii. Layout drawing showing the proposed STATCOM site and the location of the main components shall be included. Also, a 3-D plan of the STATCOM installations and building (if applicable) shall be provided.
- viii. Preliminary inspection and test plans shall be provided for the factory tests of VSC valves and STATCOM control system & allied equipment/material along with the commissioning tests, and the field verification tests.

7.17.4. The following documentation is, typically, required to be furnished by the bidder:

- i. Technical reports
- ii. Equipment specifications
- iii. Quality assurance documentation
- iv. Equipment test reports, if any
- v. Control elementary drawings
- vi. Plan and profile drawings, as built
- vii. Civil/mechanical/architecture
- viii. As built drawings

7.17.5. Plant Documentation

7.17.5.1. The Contractor's plant documentation for the delivered STATCOM system shall contain documents, drawings, instructions and manuals necessary to operate and maintain the STATCOM system. As a minimum the following documentation (divided into groups) shall be provided:

- i. System Description
This group shall provide overall system related information such as STATCOM system descriptions, single-line diagrams, function block diagrams and plant circuit diagrams. The design reports in sub-clause 8.15 of this specification shall be provided as part of this group.
- ii. Operation and Maintenance

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This group shall provide information on the operation, fault tracing and maintenance of the plant, such as operation instructions, general maintenance instructions, list of alarms and spare parts, etc.

- iii. Equipment Documentation
This group shall provide information on the equipment included in the STATCOM system. The information shall include circuit diagrams, dimension prints, technical descriptions, assembly drawings etc.
- iv. Plant Construction
This group shall provide information on items such as civil works, Installation and installation, cabling and inter-connection. The information shall include architectural drawings, station layouts, bills of materials, installation manuals and lists of cables.
- v. Factory Testing:
This group shall include Inspection and test plans, and factory test records.
- vi. Commissioning Documentation
This group shall contain field test records created and logged during the testing and commissioning of the STATCOM system.
- vii. Field Verification Test report
The Field Verification Tests shall be documented in a report. This document shall include appropriate references to the performance requirements and to the performed design studies.

7.17.5.2. The All drawings and documentation shall be in accordance with relevant International/IEC Standards.

7.18. Trainings

7.18.1. The Contractor shall arrange following training courses for the Company's Engineers:

7.18.2. Basic Engineering and Studies Regarding STATCOM Technology

- i. The Contractor shall provide courses from operational aspects with respect to hardware and software as well as training of the Engineers who will be responsible for operation, maintenance and repair. Appropriate training documentation shall be included. All the training shall be given in the English language.
- ii. The courses shall also include training in the factory during the testing of the complete STATCOM control system and allied equipments to Fifteen Engineers/Personnels on design, operation maintenance and repair of the system.
- iii. The Contractor shall arrange/provide courses from system analysis, planning and design aspects to verify and modify, if required, some control parameters of the STATCOM.

7.18.3. On-site Training

- i. A comprehensive training programme including complete system design and function, operational aspects and preventive maintenance shall be arranged by the Contractor for Fifteen Engineers/Personnels.

7.18.4. Site Visits

- ii. The Contractor shall arrange at his expense/cost the study tours/visits for five Engineers/Personnels of company on at least two sites of STATCOMs, similar in size and performance as of this project within 3 months after award of contract.

8. Testing Requirements

8.1. General Requirements

8.1.1. The Contractor shall be responsible for organizing and performing all tests in accordance with the applicable standards and any additional requirements in this specification. Where standards are not suitable or applicable, other common industry procedures and mutually acceptable methods shall be used.

8.1.2. All equipment included as part of the STATCOM system shall be tested before being placed in final operation. The bidder shall furnish the test plan/procedures.

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- 8.1.3. The bidder shall submit a list of tests clearly stating the type tests that will be carried out for this project, and stating the type tests where instead a report from a previously performed test shall be considered in lieu of actual test performance. The list of tests shall also include routine tests and factory acceptance tests to be performed for this project.
- 8.1.4. The results obtained from type tests must demonstrate that the equipment conforms to the requirements of this specification and the latest applicable standards.
- 8.1.5. The results obtained from tests must be compiled and organized in writing. All test results must contain the appropriate signature of the Contractor.
- 8.1.6. Company reserves the right for itself and/or its nominated representatives to be present and witness all tests.
- 8.1.7. The Contractor shall furnish all labour, materials, instrumentation, testing facilities and inspection test plan (ITP) for all tests.
- 8.1.8. If any piece of equipment provided as a part of the STATCOM does not pass a test or is damaged, the Contractor must replace or repair the failed or damaged equipment and modify the equipment design, if necessary. The Contractor may be required to repeat the tests previously done on any equipment which is replaced, repaired or modified. All expenses for the material, re-installation and re-testing will be borne by the Contractor.
- 8.1.9. The Contractor, at all times, must obtain permission from Company to perform field verification tests when the STATCOM is connected to the power system.
- 8.2. STATCOM Control System Testing
 - 8.2.1. A Factory Simulator Test shall be performed for the original control and protection system. The Contractor shall thoroughly test all control and protection functions on RTDS in the factory in the presence of Company's Engineers. These tests shall provide an initial verification of performance before the control and protection equipment is shipped to site. These tests shall include but are not limited to:
 - i. Verification of each control function
 - ii. Verification of control linearity
 - iii. Verification of the monitoring system
 - iv. Verification of the protection system
 - v. Verification of overall system performance for minor and major system disturbances
 - vi. Verification of processor loading of all digital controllers
- 8.3. STATCOM Sub-system Testing Before Energization
 - 8.3.1. The STATCOM subsystem tests are those tests to be performed at the site on the fully assembled STATCOM subsystems in the presence of Company's Engineers, without having the STATCOM connected to the power system. The Contractor shall submit a list of these tests. Company reserves the rights to approve the test plan.
- 8.4. STATCOM Commissioning Test & Field Validation
 - 8.4.1. Upon satisfactory completion of the subsystem tests, energization of the STATCOM and field verification tests shall be performed in the presence of Company's Engineers. These tests are performed at the site on the fully assembled STATCOM with the STATCOM operating and connected to the power system. These tests need close co-operation with the responsible remote control centre from the Company. The Contractor shall submit a list of these tests. Company reserves the rights to approve the test plan.
- 8.5. Schedule of Testing
 - 8.5.1. The Contractor shall give the Company an advance notice of type, routine and factory acceptance tests 2 months before the actual testing date.
 - 8.5.2. Inspection and test plans shall be submitted for the Company's information prior to commencement of the test.
 - 8.5.3. Company reserves the right to approve inspection and test plans.
- 8.6. Trial Operation

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- 8.6.1. As soon as commissioning and field verification tests have been completed, the Contractor shall advise Company in writing that the equipment is ready for service.
- 8.6.2. After successful commissioning and field verification tests of the STATCOM itself, the STATCOM will be part of the scope of testing within the grid reinforcement project of the Company.
- 8.6.3. A trial operation shall start according to the time schedule agreed upon. It lasts for a period of 3 months as a minimum extendable to another 3 months in case of maloperation during initial trial period. The Contractor will be responsible for the operation of the plant until it is formally taken over by Company. This applies even if operating periods fall outside normal working hours. During the trial operation Company's operating procedures shall be followed regarding switching, dispatching and access to high voltage areas. The Company will provide the staff necessary for taking care of these safety precaution tasks.
- 8.6.4. During trial operation the Contractor shall provide the agreed number of supervising engineers and service personnel on Site. The supervising engineers shall supervise the equipment on site, instruct the personnel of the Company and at the same time assist during testing etc.

9. Balance of Plant

9.1. General Requirements

- 9.1.1. The Balance of Plant (BoP) shall include all systems, equipment, structures, auxiliaries, and services required for safe, reliable, and continuous operation of the DRPC installation in accordance with the applicable standards, including IEEE 1052-2018, IEC standards, and company requirements.
- 9.1.2. The Contractor shall be fully responsible for the engineering, design, supply, construction, installation, testing, commissioning, and documentation of the complete BoP, for containerized solution
- 9.1.3. The choice of architectural and structural arrangement shall be at the discretion of the Contractor, provided that all functional, environmental, safety, maintainability, and performance requirements specified herein are fully satisfied.

9.2. Scope of Balance of Plant

- 9.2.1. The BoP scope shall include, but not be limited to, the following systems and facilities:
 - i. Civil works and structural systems
 - ii. Enclosures (containerized units)
 - iii. Foundations and equipment supports
 - iv. HVAC and environmental control systems
 - v. Fire detection and fire protection systems
 - vi. Electrical auxiliaries and station services
 - vii. Lighting and small power systems
 - viii. Earthing and lightning protection systems
 - ix. Cable trenches, trays, and routing systems
 - x. Access, handling, and maintenance facilities
 - xi. Drainage, oil containment, and environmental protection systems
 - xii. Control room and auxiliary rooms (if applicable)
- 9.2.2. All BoP systems shall be designed to support the full operational capability of the STATCOM under all specified operating and environmental conditions.

9.3. Enclosure Philosophy

9.3.1. The Contractor may propose either:

- a) A purpose-built building structure, or
- b) Factory-assembled containerized enclosures, or
- c) A hybrid arrangement combining both approaches

9.3.2. The selected enclosure philosophy shall:

- i. Provide adequate protection against environmental conditions at site
- ii. Ensure compliance with equipment operating temperature and humidity limits

SCHEDULE – A TO BID

- iii. Allow safe access for operation, inspection, and maintenance
 - iv. Provide sufficient space for future upgrades or replacements where feasible
 - v. Comply with fire, safety, and occupational health regulations
- 9.3.3. The Contractor shall demonstrate that the selected solution meets or exceeds the performance, safety, and reliability intent of relevant international standards
- 9.4. Civil Works and Structural Design
- 9.4.1. All civil works and structural components shall be designed and executed by the Contractor and shall include:
- i. Foundations suitable for static and dynamic loads of STATCOM equipment
 - ii. Structural design considering seismic, wind, thermal, and operational loads
 - iii. Cable trenches, pits, and routing corridors
 - iv. Equipment plinths and mounting structures
 - v. Access roads, walkways, and maintenance areas
- 9.4.2. For containerized solutions, the Contractor shall ensure that container foundations and anchoring systems provide equivalent structural integrity and seismic performance as permanent buildings.
- 9.5. Environmental Control and HVAC
- 9.5.1. The Contractor shall provide HVAC systems adequate to maintain all equipment within permissible temperature and humidity limits under all operating conditions.
- 9.5.2. The HVAC design shall:
- i. Consider heat dissipation from power electronic equipment
 - ii. Ensure redundancy where required for critical systems
 - iii. Prevent ingress of dust, moisture, and corrosive agents
 - iv. Be suitable for continuous operation and ease of maintenance
- 9.5.3. For containerized solutions, HVAC systems shall be fully integrated and factory-tested.
- 9.6. Fire Detection and Protection
- 9.6.1. Fire detection and fire protection systems shall be provided in accordance with applicable IEEE, IEC, and local fire safety regulations.
- 9.6.2. The system shall include, as minimum:
- i. Smoke and/or heat detection
 - ii. Alarm annunciation locally and to the control system
 - iii. Appropriate fire suppression systems (e.g., clean agent, water mist, or equivalent)
- 9.6.3. The fire protection philosophy shall be applicable to both building and containerized installations.
- 9.7. Electrical Auxiliaries and Station Services
- 9.7.1. The Contractor shall provide all auxiliary electrical systems necessary for STATCOM operation, including:
- i. AC auxiliary power distribution
 - ii. DC systems including batteries and chargers
 - iii. Lighting and emergency lighting
 - iv. Convenience outlets and maintenance power supplies
- 9.7.2. Redundancy and selectivity shall be provided in accordance with international standards.
- 9.8. Earthing and Lightning Protection
- 9.8.1. A complete earthing and lightning protection system shall be designed and installed by the Contractor. The system shall:
- i. Ensure personnel safety under normal and fault conditions
 - ii. Provide effective grounding for power electronic equipment
 - iii. Be integrated with the substation earthing system
 - iv. Comply with IEEE and IEC grounding standards
- 9.8.2. For containerized systems, bonding between containers and grounding grids shall be clearly defined.

SCHEDULE – A TO BID

9.9. Access, Handling, and Maintainability

9.9.1. The BoP design shall facilitate safe and efficient operation and maintenance. This shall include:

- i. Adequate access doors and walkways
- ii. Provision for lifting and handling of major components
- iii. Maintenance clearances as per manufacturer requirements
- iv. Safe escape routes and emergency exits

9.9.2. Maintainability requirements shall be met irrespective of enclosure type.

9.10. Interface and Responsibility Definition

9.10.1. The Contractor shall be responsible for defining and managing all interfaces between the STATCOM equipment and the BoP systems. This shall include:

- i. Mechanical, electrical, and control interfaces
- ii. Civil and structural interfaces
- iii. Environmental and safety interfaces

9.10.2. A clear Interface Responsibility Matrix shall be submitted as part of the detailed engineering documents.

9.11. Testing, Inspection, and Verification

9.11.1. This clause shall be read in conjunction with Main Clause 9 and shall not be interpreted independently of it.

9.11.2. All BoP systems shall be subject to inspection, testing, and verification in accordance with international standards and principles. This shall include:

- i. Factory tests for containerized systems
- ii. Site acceptance tests for all BoP facilities
- iii. Integrated testing with STATCOM equipment

9.11.3. The Contractor shall demonstrate that the BoP design supports the required availability, safety, and performance of the STATCOM installation.

9.12. Documentation and As-Built Records

9.12.1. This clause shall be read in conjunction with sub-Clause 8.16 and shall not be interpreted independently of it.

9.12.2. The Contractor shall submit complete documentation covering the BoP design and installation, including:

- i. Design calculations and drawings
- ii. Layouts and general arrangement drawings
- iii. Equipment datasheets
- iv. As-built drawings and O&M manuals

9.12.3. All documentation shall reflect the final executed design.

SCHEDULE – B TO BID

PROPOSED ORGANIZATION FOR THE PROJECT

The Bidder shall provide in this Schedule Organization chart indicating the key personnel he will employ but not limited for Head office and for Site office involved in management, supervision and Project Manager/Engineering of the Works to be done under the Contract to direct and execute the Works, together with their names, qualifications, experience, positions held and their nationalities.

1. EPC Phase Organization Chart (Project Execution)

This structure covers the Design, Manufacture, Supply, Civil Construction (Control House), and Installation at the Place of Installation.

Level	Name of Person	Position	Minimum Qualification	Experience (Years)
Head Office		Project Director (Lead Partner)	B.Sc. Electrical Engr.	20+
Head Office		Technical Director (Foreign)	M.Sc. Power Electronics	15+
Site Office		Project Manager (Site Rep)	B.Sc. Electrical Engr. (PEC)	15+
Site Office		Lead Design Engineer (Electrical)	B.Sc. Electrical Engr.	10+
Site Office		Construction Manager	B.Sc. Electrical Engr.	10+
Site Office		Installation/Installation Supervisor	B.Tech/Diploma Electrical	10+
Site Office		Commissioning Engineer	B.Sc. Electrical Engr.	10+
Site Office		HSE Officer	Certified Safety Professional	07+
Site Office		Security Officer	Ex-Services Man	10+

2. O&M Phase Organization Chart (2-Year Tenure)

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This structure covers the 24/7 Monitoring, Specialized Maintenance, and Capacity Building.

Level	Name of Person	Position (Qty)	Minimum Qualification	Experience (Years)
Head Office		Plant Manager (01)	B.Sc. Electrical Engr.	15+
Site Office		Lead O&M Engineer (01)	B.Sc. Electrical Engr.	08+
Site Office		Control Room Operators (04)	B.Tech/Diploma (Shift-based)	05+
Site Office		Protection & Control Specialist (02)	B.Sc. Electrical Engr.	10+
Site Office		Electrical Technicians (04)	Diploma Electrical	05+
Site Office		HSE Engineers (02)	B.Sc. / NEBOSH	05+
Site Office		Security Officer	Ex-Services Man	10+
Site Office		Record/Store keeper (01)	Bachelor's Degree	05+

Note to Bidder: As per IB.17, these charts must be accompanied by detailed Resumes (CVs) for all key personnel and must be uploaded exclusively through the EPAD Portal. For the EPC phase, the Lead Member must ensure the Project Manager is a registered Professional Engineer with the Pakistan Engineering Council (PEC).

Initials of Signatory to Bid:.....

METHOD OF PERFORMING THE WORKS

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

- The sequence and methods in which he proposes to carry out the Works, including the number of shifts per day and hours per shift, he expects to work.
- A list of all major items of constructional and Installation 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 Civil Work and Installation, Testing and Commissioning of the Works, in sufficient detail to demonstrate fully that the equipment will meet all the requirements of the Specifications.
- The procedure for installation of equipment and transportation of equipment and materials to the site.
- 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.
- The Contractor shall provide description of his construction camp's facilities and staff housing requirements.
- The Contractor shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the Contractor's construction camp and staff housing facilities. The Bidder shall list or explain his plans for providing these facilities for the service of the Contract as follows:
 1. Site Preparation (clearing, land preparation, etc.).
 2. Provision of Services.
 - a) Power (expected power load, etc.).
 - b) Water (required amount and system proposed).
 - c) Sanitation (sewage disposal system, etc.).

SCHEDULE – C TO BID
Sheet 2 of 2

- 3. Construction of Facilities
 - a) Contractor’s Office, Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).
 - b) Warehouses and Storage Areas (area required, type of construction and layout).
 - c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.)
- 4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity).
- 5. The Bidder shall provide a brief methodology for its proposed detailed soil investigation at the 132kV Pasni site, from a reputable geotechnical testing firm and a commitment to vet all results with as per Clause IB.11.2.
- 6. Other Items Proposed (Security services, etc.).

Initials of Signatory to Bid:.....

SCHEDULE – D TO BID

PROPOSED PROGRAMME OF WORKS

Bidder shall provide a programme in a bar-chart/CPM/PERT form showing the sequence of work items by which he proposes to complete the Work of the entire Contract. The programme should indicate the sequences of work items and the period of time during which he proposes to complete the Works including the activities like designing, schedule of submittal of drawings, ordering/procurement of materials, manufacturing, delivering, design & construction of associated civil works, installation, testing and commissioning of Works to be executed under the Contract.

Initials of Signatory to Bid:.....

SCHEDULE – E TO BID

WORK TO BE PERFORMED BY SUBCONTRACTORS

The Bidder will do the work with his own forces except the part (s) of the Works listed below which he intends to sub-contract.

Items of Works to be Sub-Contracted	Name and address of Sub-Contractor	Statement of similar works previously Executed (attach evidence)
-------------------------------------	------------------------------------	------------------------------------------------------------------

Note:

1. No change of Sub-Contractor shall be made by the Bidder without prior approval of the Employer.
2. The truthfulness and accuracy of the statement as to the experience of Subcontractors is guaranteed by the Bidder. The Employer’s judgment shall be final as to the evaluation of the experience of Subcontractors submitted by the Bidder.
3. Statement of similar works shall include description, location & value of work, year completed and name & address of the clients.
4. This may include manufacturer(s) who are proposed here and their relevant details to be provided accordingly including make, capacity and salient features to make it particularly suitable for the works. The technology used should also be detailed adequately.

Initials of Signatory to Bid:.....

SCHEDULE – F-1 TO BID

**DEVIATIONS
FROM TECHNICAL PROVISIONS**

It is presumed that the Bidder shall not take any deviation. However, if he intends to take deviations to the specified technical provisions, those must be listed in the space provided below:

Sr. No.	Clause No. / Section No.	Deviations/Clarifications
----------------	---------------------------------	----------------------------------

Note: Attach additional sheets, if necessary

Initials of Signatory to Bid:.....

SCHEDULE – F-2 TO BID

**DEVIATIONS
FROM CONTRACTUAL CONDITIONS**

It is presumed that the Bidder shall not take any deviation. However, if he intends to take deviations to the specified Contractual/Commercial Conditions, those must be listed in the space provided below:

Sr. No.	Clause No. / Section No.	Deviations/Clarifications
---------	--------------------------	---------------------------

Note: Attach additional sheets, if necessary

Initials of Signatory to Bid:.....

SCHEDULE – G TO BID

SPECIFIC OPERATION/PLANT AND EQUIPMENT DETAIL

Sr. No.	Technical / Operational Category	Specific Detailed Provision to be Provided by Bidder
1	Core STATCOM System Operational Strategy	Bidder shall provide a detailed 24/7 continuous operational philosophy covering: <ul style="list-style-type: none"> a) Real-time Monitoring: Health status of MMC-VSC branch valve assemblies and IGBTs via Cell Monitoring Units (CMUs). b) Voltage Balancing: DC-link capacitor bank voltage balancing strategy and arm-level deviation thresholds. c) Low SCR Control: Control logic transitions for abnormally low Short Circuit Ratio (SCR \approx 1.0–1.5) at the Site. d) Mode Management: Operation logic for AVC, Fixed Q, Constant MVAR, and Sleep Mode (exit \leq 0.5 cycles). e) Ride-Through: Strategy for ± 70 MVAR full capacitive output during LVRT (0.3 PU for 10s / 0.7 PU for 2.5 min). f) Parallel Operation: Synchronisation and reactive power sharing between multiple VSC branches.
2	Cooling System Management	Comprehensive O&M plan covering: <ul style="list-style-type: none"> a) DI Water Circuit: Monitoring of conductivity, flow rates, and temperature differentials for valve hall containers. b) N-1 Redundancy: Automatic pump changeover and N+1 fan logic; no derating of ± 70 MVAR output under single-component failure. c) Water Quality: Quarterly DI water testing/resin replacement and annual circuit flush. d) Dry Cooler Performance: Mitigation of coastal salt deposition (quarterly pressure wash) and performance at peak ambient 55°C. e) HVAC & Environment: N+1 split-system management for all control and battery rooms.
3	Staffing & Residential Logistics	Contractor's Responsibility: The Contractor shall provide, at its own expense, all residential accommodation, messing, and transport for the O&M and Training staff. No Employer-provided housing is available at Pasni. Compliance: Confirmation that rotation logistics and housing comply with the Factories Act 1934 and ILO core labour standards.
4	Site Security Protocols	Contractor's Responsibility: Given the Mekran Region location, the Contractor shall manage and fund its own Tier-1 Private Security for personnel, plant, and the Control House building. A formal Site Security Plan must be submitted as a mandatory bid document.
5	Preventive Maintenance (PM) Plan	Detailed PM schedule with specific intervals for: <ul style="list-style-type: none"> (i) MMC Valve Assemblies (ii) Harmonic Filter Banks (iii) Coupling Transformers (iv) 132kV AIS Switchgear (v) Protection Relays (Main/Backup) (vi) Systematic Thermal Imaging; and (vii) DC Auxiliary Systems.
6	Corrective Maintenance & SLA	Response/Rectification: Commitment to a Response Time of \leq 2 Hours and a Rectification Time of \leq 24 Hours for critical faults. Availability Guarantee: Forced outage availability \geq 99.7% per annum (max 26.3 hours/year); Scheduled availability \geq 99.0%.

Sr. No.	Technical / Operational Category	Specific Detailed Provision to be Provided by Bidder
7	Spare Parts & Inventory	Capital Spares: Mandatory on-site holding of IGBT modules, gate drivers, DI water pumps, and SF ₆ breaker components. Replenishment: Protocol ensuring any mandatory spare drawn for corrective maintenance is replenished within 60 days.
8	Control & SCADA Interface	Detailed plan for: (a) Integration with Regional Control Centers (RCC) (b) Telecommunication System O&M (c) Cybersecurity management and patch updates (d) Parameter management for MMC control logic.
9	Civil & Allied Maintenance	Planned O&M for the Control House Building, including specialized maintenance for the DG room, Battery room, and ensuring the integrity of flood-resilient structures as per GLO.
10	Emergency & HSE Plan	Specific protocols for fire-fighting system maintenance (N ₂ injection/CO ₂), environmental compliance (oil spill kits), and emergency medical evacuation plans for the Mekran region.

Note: Attach additional sheets, if necessary

Initials of Signatory to Bid:.....

SCHEDULE –H TO BID

JV AGREEMENT

[Employer to provide the standard form of Joint Venture Agreement]

THIS JOINT VENTURE AGREEMENT (hereinafter referred to as the "Agreement") is made and entered into this _____ day of _____, 2026, at Quetta, Pakistan, by and between:

1. **[NAME OF LOCAL FIRM]**, a company organized and existing under the laws of the Islamic Republic of Pakistan, having its principal office at [Address], and holding a valid **Pakistan Engineering Council (PEC) License in Category [Insert Category] with Specialization Code EE 05** (hereinafter referred to as the "**Leading Member**"); and
2. **[NAME OF FOREIGN TECHNOLOGY PROVIDER]**, a company organized and existing under the laws of [Country of Origin], having its principal office at [Address] (hereinafter referred to as the "**Associate Member**").

The Leading Member and Associate Member are collectively referred to as the "Members" and individually as a "Member."

WHEREAS: (a) The Quetta Electric Supply Company (QESCO) (the "Employer") has invited technical and price bids for the project: "**Design, Manufacture, Supply, Installation, Testing & Commissioning of STATCOM Technology for Grid/Network Stability Enhancement at 132kV Grid Station Pasni in the Mekran Region**" (the "Project"); (b) The Members have agreed to combine their technical expertise, financial resources, and management capabilities to bid for and, if successful, execute the Project on an EPC/Turnkey basis followed by at least two-year intensive Operational Training/Warranty phase.

NOW, THEREFORE, THE PARTIES AGREE AS FOLLOWS:

1. CONSTITUTION OF THE JOINT VENTURE

1.1 The Members hereby irrevocably constitute a Joint Venture under the name "**[NAME OF JV]**" (the "Joint Venture") for the sole purpose of participating in the bidding process and executing the Contract for the Project.

1.2 The registered office of the Joint Venture shall be located at the office of the Leading Member.

2. JOINT AND SEVERAL LIABILITY

2.1 In accordance with ITB Sub-Clause 13.5(c), the Members hereby undertake to be **jointly and severally liable** to the Employer for the performance of all obligations under the Contract, including the achievement of all technical performance guarantees and the 365-day completion timeline.

2.2 If any Member fails to fulfill its specific scope of work or financial obligations, the remaining Member(s) shall be responsible for completing such obligations at no additional cost to the Employer.

3. LEADERSHIP AND MANAGEMENT

3.1 [Name of Local Firm] is hereby designated as the **Leading Member** and the Partner-in-Charge.

3.2 The Leading Member is authorized to:

- i. Sign the Bid and the subsequent Contract Agreement
- ii. Incur liabilities, receive instructions, and give valid receipts on behalf of the Joint Venture
- iii. Act as the primary liaison with the Project Manager/Engineer.

3.3 The Associate Member (Foreign Technology Provider) shall be solely responsible for the technical integrity of the STATCOM MMC valves, control logic, and the execution of the master training program.

4. SCOPE OF PARTICIPATION AND RESPONSIBILITIES

4.1 The proportionate participation of the Members in the Project shall be:

- **Leading Member:** _____% (Focus: Civil Works, Flood-Resilient CHB Construction, Local Logistics, 132kV AIS Installation, and PEC Compliance).
- **Associate Member:** _____% (Focus: Design of VSC Valves, High-Fidelity Simulation Studies, HIL Testing, Control System Engineering, and Performance Guarantee Verification). 4.2 Each Member shall provide the resources, plant, and personnel necessary to fulfill its allocated scope as detailed in the Technical Proposal.

5. HUMAN RESOURCE COMPLIANCE

5.1 In accordance with PEC Bye-laws, the Members agree that **at least 70% of the engineering staff** employed for the Project shall be Pakistani nationals. The Associate Member shall provide specialized "Master Trainers" to facilitate technology transfer during the at least two-year Operational Training phase.

6. DURATION AND VALIDITY

6.1 This Agreement shall remain valid until:

- (i) The Bid is rejected by the Employer and the Bid Security is returned; or
- (ii) If successful, the issuance of the **Final Acceptance Certificate (FAC)** following the completion of the at least two-year Warranty and Operational Training phase.

6.2 No changes to the composition of this Joint Venture shall be made without the prior written consent of the Employer.

7. DISPUTE RESOLUTION

7.1 Disputes between Members shall be settled through amicable negotiation. Unresolved disputes shall be referred to arbitration under the **Rules of the Pakistan Arbitration Act, 1940**, with the seat of arbitration in Quetta, Pakistan.

IN WITNESS WHEREOF, the authorized representatives of the Members have executed this Agreement on the day and year first above written.

For and on behalf of the Leading Member: _____ (Signature)

Name: _____ Title: _____ (Seal)

For and on behalf of the Associate Member: _____ (Signature)

Name: _____ Title: _____ (Seal)

WITNESSES:

1. _____ (Name, CNIC, and Address)
2. _____ (Name, CNIC, and Address)

(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.)

SCHEDULE –I TO BID

PAST PERFORMANCE AND PRESENT COMMITMENTS

Past Performance

Sr. No.	Name of project(s)	Name of employer	completed cost	Start date	Planned completion date	Actual completion date	Satisfactory performance certificate from employer / Remarks regarding delays if applicable
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Present Commitments

Sr. No.	Name of ongoing project(s)	Name of employer	Total cost	Start date	Planned completion date	%age of works completed	Award letter / Remarks regarding delays if applicable
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Any Bidder showing projects outside Pakistan, the information provided on the project needs to be substantiated by certification of concerned country’s embassy in Pakistan.

**LETTER OF PRICE BID
AND
SCHEDULES TO BID**

**LETTER OF PRICE BID
AND
SCHEDULES TO BID**

Letter of Price Bid

Schedules to Bid

- Schedule J to Bid: Integrity Pact
- Schedule K to Bid: Estimated Progress Payments
- Schedule L to Bid: Lump Sum Cost Breakdown for Major Cost Items

SCHEDULE OF PRICES

- Preamble to Schedule of Prices
- Schedule of Prices
- Summary of Bid Prices

LETTER OF PRICE BID

Bid Reference No.:

Package No.:

.....

.....

[Name of Works]

To:

.....

.....

.....

Gentlemen,

1. Having examined the Bidding Documents including Instructions to Bidders, Conditions of Contract, Specifications, Drawings, Schedules to Bid, Schedule of Prices and Addenda Nos. for the execution of the above-named Works, we, the undersigned, being a company doing business under the name of and address and being duly incorporated under the laws of hereby offer to execute and complete such Works and remedy any defects therein in conformity with the said Documents including Addenda thereto for the Total Bid Price comprising of Local Currency Component of Pak Rupees (Rs.) or such other sum as may be ascertained in accordance with the said Documents.
2. We understand that all the Schedules attached hereto form part of this Bid.
4. We undertake, if our Bid is accepted, to commence the Works and to deliver and complete the whole of the Works comprised in the Contract within the time(s) stated in Preamble to the Conditions of Contract.
5. We agree to abide by this Bid for the period of days from the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
6. Unless and until a formal Agreement is prepared and executed, this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.
7. We undertake, if our Bid is accepted to execute the Performance Security referred to in Clause 10 of Conditions of Contract for the due performance of the Contract.
8. We understand that you are not bound to accept the lowest or any Bid you may receive.
9. We do hereby declare that the Bid is made without any collusion, comparison of figures or arrangement with any other person or persons making a Bid for the Works.
10. We confirm, if our Bid is accepted, that all partners of the joint venture shall be liable jointly and severally for the execution of the Contract and the composition or the constitution of the joint venture

shall not be altered without the prior consent of the Employer. (Please delete in case of Bid from a single firm).

Dated this day of 202...

Signature in the capacity ofduly authorized to sign the Bid for and on behalf of
(Name of Bidder in Block Capitals)

(Seal of Bidder)

Bidder's Address
.....
.....

Witness:

Signature:
Name:
Address:
.....
Occupation

SCHEDULE – J TO BID

Integrity Pact

[To be filled and signed by the Bidder]

**DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC.
PAYABLE BY THE SUPPLIERS OF GOODS, SERVICES & WORKS IN
CONTRACTS WORTH RS. 10.00 MILLION OR MORE**

Contract No. _____ Dated _____
Contract Value: _____
Contract Title: _____

..... [Name of Supplier] hereby declares that it has not obtained or induced the procurement of any contract, right, interest, privilege or other obligation or benefit from Government of Pakistan (GoP) or any administrative subdivision or agency thereof or any other entity owned or controlled by GoP through any corrupt business practice.

Without limiting the generality of the foregoing, [name of Supplier] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultant, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoP, except that which has been expressly declared pursuant hereto.

[name of Supplier] certifies that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with GoP and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[name of Supplier] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to GoP under any law, contract or other instrument, be voidable at the option of GoP.

Notwithstanding any rights and remedies exercised by GoP in this regard, [name of Supplier] agrees to indemnify GoP for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to GoP in an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by [name of Supplier] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from GoP.

Name of Buyer: Name of Seller/Supplier:
Signature: Signature:
[Seal] [Seal]

SCHEDULE – K TO BID

ESTIMATED PAYMENTS ON MILESTONE

PART A: EPC / EXECUTION MILESTONES (Initial 365 Days):

Milestone Ref.	Milestone Description	Percentage of EPC Cost	Amount PKR
A.1	Mobilization Advance: Against submission of an unconditional and irrevocable Bank Guarantee of equivalent amount.	10%	
A.2	Approval of Design & Studies: Upon approval of Base Design, PSSE/RTDS Simulation Models, and HIL Testing Protocols.	10%	
A.3	Completion of Civil Works: Construction of functional housing (Containerized/Indoor), foundations, and flood-resilient infrastructure.	10%	
A.4	Delivery of Plant at Site: Arrival of Greater than equal to ±70MVAR STATCOM MMC Units, Transformers, and Cooling Plant at 132kV Pasni Grid Station.	50%	
A.5	Installation & Energization: Completion of Installation, Field Acceptance Testing (FAT), and initial Grid Synchronization.	10%	
A.6	Initial Handover (TOC): Issuance of Taking-Over Certificate following a successful 720-hour Reliability Trial Run.	10%	
	SUB-TOTAL EPC PRICE	100%	

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PART B: O&M & TRAINING MILESTONES (2-Yeara Tenure)

Calculated based on the Rates in the Schedule of Prices for O&M services.

Milestone Ref.	Timeline (Post-TOC)	Milestone Description	Percentage of O&M Cost
B.1	Quarter 1	Completion of primary training modules and 3 months of 24/7 supervised "Shadow-Operation".	12.50%
B.2	Quarter 2	Full operationalization of secure remote diagnostic link and 6-month cumulative SLA Compliance audit.	12.50%
B.3	Quarter 3	Advanced software diagnostics training and verification of 9-month Forced Availability $\geq 99.7\%$.	12.50%
B.4	Quarter 4	Completion of 1st Year tenure; successful Year-1 Availability Audit; and hardware health check.	12.50%
B.5	Quarter 5	Transition to hands-on maintenance led by QESCO staff under on-site Contractor supervision.	12.50%
B.6	Quarter 6	Specialized troubleshooting workshop for MMC valve stabilization and Cybersecurity patch verification.	12.50%
B.7	Quarter 7	Demonstrated technical competency of QESCO teams in handling Severity I & II emergency scenarios.	12.50%
B.8	Quarter 8	Operational Hand-over: Final optimization; on-site demobilization; and Verified Replenishment of Spares.	12.50%
B.Final	End of Year 3	Final Acceptance (FAC): Conclusion of the post-O&M warranty year and release of remaining Performance Security.	Security Release
SUB-TOTAL O&M & TRAINING PRICE			100%

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[Note:](#)

C. GRAND SUMMARY OF MILESTONES

Description	AmountPKR
TOTAL PART A: EPC / EXECUTION MILESTONES	
TOTAL PART B: OPERATIONAL TRAINING & WARRANTY	
TOTAL BID PRICE (A + B)	

To be completed by the Employer at the time of Financial Bid Opening in accordance with Clause IB.25.

GRAND TOTAL PROJECT EVALUATED COST IN PKR: _____

Important Notes for the Bidder

1. **JV Payment Authority:** For Joint Ventures, the **Lead Partner** is specifically authorized to receive all payments and instructions for and on behalf of all partners.
2. **Taking-Over Certificate (TOC):** The issuance of the TOC marks the formal end of the EPC phase and the **start of the at least two-year Warranty and O&M period**. It is only issued once the system successfully completes a continuous 720-hour reliability run post-energization.
3. **SLA Compliance (Milestone B.2):** Payment is contingent upon the Contractor's digital fault logs proving that all **Severity I (Critical)** faults were acknowledged within 15 minutes and resolved within the 4-hour window.
4. **O&M Performance Metrics:** During the at two-year O&M phase, the contractor must maintain a system availability benchmark of **≥99.7%**. Failure to meet this will trigger separate Liquidated Damages (LDs).
5. **Staff Certification (Milestone B.3):** The Project Manager/Engineer must certify that QESCO staff have achieved "first-level fault competency" before the 3rd quarter payment is released.
6. **FAC Trigger (Milestone B.5):** This final payment is only released upon the countersigning of the FAC Form by the Employer and the Consultant , confirming that the Year-2 Availability Guarantee is secured and all spare parts are physically present at the Pasni site.
7. **Payment of IPCs:** All the payments shall be made in Pak Rupees.

Initials of Signatory to Bid:

SCHEDULE -L TO BID

LUMP SUM COST BREAKUP FOR MAJOR COST ITEMS

The Bidder is to provide a detailed breakup of his Lump sum costs in a manner that the overall picture for the quoted price can be understood. It should include major heading wise cost breakup including rate analyses for at least 6 major cost items as required to analyze it.

SCHEDULE OF PRICES

SCHEDULE OF PRICES

Description

1. Preamble to Schedule of Prices

Summary of Bid Prices

- Schedule No.1 - External Works (BOQ measurement basis)
- Schedule No.2 - Foundation Works (BOQ measurement basis)
- Schedule No. 3 - Supply of Plant (Pre Engineered Structures)
including Fixtures and other materials & goods
and spare parts (if any) (Schedule of Price basis)
- Schedule No. 4 - Installation and other Services (Schedule of Price basis)
- Schedule No. 5 - Design Services (Schedule of Price basis)
- Schedule No. 6 - Grand Summary of Bid Price

1. PREAMBLE TO SCHEDULE OF PRICES

1. General

- 1.1 The Schedule of Prices shall be read in conjunction with the Conditions of Contract together with the Specifications and Bid Drawings.
- 1.2 The Bidder shall quote for all items of the Works executed on EPC/Turnkey basis and the prices shall be quoted for the complete scope of Work as described or implied from these Bidding Documents in schedule-L to bid.

2. Description & Quantities

- 2.1 Price given in the Schedule of Prices against each item shall be for the scope covered by that item as detailed in the Specifications, Bid Drawings or elsewhere in the Bidding Documents. The general directions and descriptions of work and materials are not necessarily repeated nor summarized in the Schedule of Prices and do not generally give a full description of the Plant and equipment to be supplied and the services to be performed under each item. References to the relevant sections of the Bidding Documents shall be made to ascertain the full scope of the requirements included in each item prior to filling in the rates and prices against each item in Schedule of Prices.

The Schedule of Prices only identifies major components of the structure and it does not restrict the responsibility of the Contractor to furnish all equipments, materials and services as deemed necessary by the Employer/Project Manager/Engineer for making the structure operationally complete and satisfactory as specified and/or implied in the Bidding Documents and subsequent revisions thereto.

- 2.2 The quantities as shown in the Schedule of Prices are estimated quantities and provisional only being given as an indication of the Scope of Work to enable the Bidder to bid for different items of the Works in accordance with his estimate of costs. The estimated quantities shall be used for comparing the Bids. It is, however, be noted that the basis of payment will be the actual quantities of work executed and measured by the Contractor and verified by the Project Manager/Engineer.
- 2.3 The sizes & dimensions mentioned and/or specified in the various technical descriptions and specifications including Bid Drawings are tentative and not final as the responsibility for detailed design rests with the Contractor under the Contract. If, in the opinion of the Project Manager/Engineer, at the time of review of Contractor's drawings/designs for approval, certain sizes & dimensions of some items have to be increased for proper completion and/or operation of the Works, then revised sizes & dimensions shall be supplied by the Contractor at no extra cost to the Employer.

3. Units & Abbreviations

- 3.1 Units of measurement, symbols and abbreviations expressed in the Bidding Documents shall comply both with FPS & MKS System.

The following abbreviations shall be used in the Schedule of Prices:

	<u>Abbreviation</u>
Local Currency Component	LCC
Pakistani Rupees	PKR/Pak Rs.
Ex Works	EXW
Quantity	Qty
Square Feet	Sft.
Running Feet	Rft.

4. Rates and Prices

- 4.1 Except as otherwise expressly provided under the Conditions of Contract, the unit rates and lump sum amounts entered in the Schedule of Prices will be the rates at which the Contractor will be paid, and shall be deemed to include for the full scope and all costs incurred by the Contractor in the performance of the Works, the provision of services including his overheads, income tax, super tax, other indirect costs, customs & other duties, profits and costs of accepting the general risks, liabilities and obligations set forth or implied in the Contract, except for such costs which are specified as reimbursable under the Contract.

The unit rates shall be extended to show the total amount for each item. The total of the Schedule of Prices is the Total Bid Price and shall be entered in Paragraph 1 of the Form of Price Bid. Where a discrepancy exists between the unit rate and the extended total amount, the unit rate shall be taken as correct and the total amount adjusted accordingly.

- 4.2 Unless otherwise stipulated in the Conditions of Contract, the rates and prices entered by the Bidder shall be fixed and firm and shall not be subject to adjustment during the performance of the Contract.
- 4.3 All duties, taxes and other levies payable by the Contractor under the Contract, or for any other cause, as on the date twenty eight (28) days prior to the deadline for submission of Bids shall be included in the rates and prices and the total Bid Price submitted by a Bidder.

Additional/reduced duties, taxes and levies due to subsequent additions or changes in legislation shall be reimbursed/deducted as per provisions of the Conditions of Contract.

- 4.4 The whole cost of complying with the provisions of the Contract shall be included in the items provided in the priced Schedule of Prices, and where no items are provided in the Schedule of Prices for any work required to be executed by the Contractor on EPC/Turnkey basis under single responsibility for the completion of the Works and to make the structure operationally complete, the cost of such item(s) shall be deemed to be distributed among the rates and prices entered for the related items of the Works and no separate payment will be made by the Employer for those items executed by the Contractor.

The rates, prices and amounts shall be entered against each item in the Schedule of Prices. Where a Bidder fails to quote a price of any item of the Schedule of Prices, the Employer will consider that the price of that item is included among other items and the Contractor will be obligated to furnish that item at no extra cost to the Employer, if awarded the Contract.

- 4.5 The Bidder shall be deemed to have obtained all information as to port clearance facilities and charges, loading and unloading facilities and charges, storage facilities and charges,

transportation facilities and charges, congestion and/or other conditions to be expected at Karachi Port and or any other seaport of Pakistan and all requirements related thereto.

The Contractor shall be responsible to make complete arrangements for the transportation of the Plant to the Site. The Bidder shall be deemed to have included all clearing, forwarding and other incidental costs in this regard in his Bid. The Contractor will have the option to use either Karachi Port or any other seaport of Pakistan.

- 4.6 The Contractor shall provide all parts of the Works to be completed in every respect for commercial operation. Notwithstanding that any details, accessories, etc. required for the complete installation and satisfactory operation of the Plant, are not specifically mentioned in the Schedule of Prices, Specifications including Bid Drawings, such details shall be considered as included in the Contract Price. All charges for the supply of goods, materials, accessories or work not specifically mentioned herein but necessary for the completion and operation of the Works shall be deemed to have been included in the quoted prices.
- 4.7 All costs in connection with inspection and witnessing of Factory Acceptance Tests within and out side Pakistan as per provisions of Sub-Clause 20.6 of Particular Conditions of Contract shall be borne by the Contractor and shall be deemed to have been included in the quoted prices.

All costs in connection with the holding of meetings shall be borne by the Contractor.

The rates in the Schedule of Prices shall also include Contractor's cost for providing Performance Security and other Bank Guarantees required for performance of the Contract.

5. Bid Prices

5.1 Break-up of Bid Prices

The various elements of Bid Prices shall be quoted as detailed below:

a) Shipping & Insurance

i) Shipping

The Bidder shall quote prices for shipping from port of shipment to the port of entry in Pakistan (Pakistan seaport) for the sub-totals of the Plant, Installation Equipment, Spare Parts, Workshop Equipment and other materials to be imported in Pakistan for the Contract. Such prices shall include all marine transportation costs including ocean freight, heavy lift charges, fees and other charges, etc.

The prices for shipping/marine transportation shall be quoted for shipment through any reputed shipping lines acceptable to the Employer including Pakistan National Shipping Corporation (PNSC).

Cost of shipment(s) affected by the Contractor at his option by aircraft shall be deemed to be included in the Total Bid Price.

ii) Insurance

The Bidder shall quote prices for insurance cover from ex-factory/ex-works to the Site (warehouse to warehouse) for the sub-totals of the Plant, Installation Equipment, Spare Parts, Workshop Equipment and other materials to be imported in Pakistan for

the Contract. Such prices shall include all insurance costs covering the responsibility for all loss or damages while loading, unloading, storing and trimming on board the vessel at the port of shipment or on inland carrier and transportation to Site.

The prices for transportation/marine insurance cover shall be quoted on the basis of insurance through insurers from any country(ies) of the world acceptable to the Employer.

b) Unit Price for Supply of Goods

The Bidder shall quote prices for Local Goods, materials (other than materials required for civil works such as concrete and reinforcement etc. cost of which will be included in the price of civil works) and equipment in the relevant column of Ex-Factory of "Schedule of Prices". Such prices shall include:

- i) Design documentation, drawings, drafting, planning services, manufacturing, testing and packing of finished goods ready for delivery to Site including loading, unloading, transportation, storing and insurance costs,
- ii) All custom duties, sales tax and other taxes already paid or payable on the components and raw materials used in the manufacture or assembly of Local Goods, materials and equipments.

c) Local Transport

Inland transportation for the Plant, Installation Equipment, Spare Parts and Workshop Equipment shall be the Contractor's responsibility in respect of:

- i) the Plant, Installation Equipment, Spare Parts, Workshop Equipment and other materials offered from outside Pakistan; from the port of entry in Pakistan to the storage area at the Site, and
- ii) indigenous Plant, Installation Equipment, Spare Parts, Workshop Equipment and other materials if any, offered from within Pakistan; from the factory in Pakistan to the storage area at the Site. The cost shall also include all insurance costs of Local Goods and other materials from factory to Site covering the responsibility of all losses or damages, while loading, unloading, storing, trimming on the carrier and transporting to Site. The cost of insurance of Local Goods shall be quoted on the basis of insurance through any insurance company listed in Clause 5.1 a) ii) here above, acceptable to the Employer.

All charges occurring therefrom including octroi, zila tax, fees etc. and charges for loading, forwarding and unloading expenses shall be borne by the Contractor. Unloading at the Site, handling of the Plant, Installation Equipment, Spare Parts, Workshop Equipment and other materials to the designated point of Site storage, checking and verifying all shipments received against shipping documents, issue of all receiving reports and issues of damage reports (when applicable) shall be the Contractor's responsibility.

The Bidder shall recognize such elements of the costs which he expects to incur in the performance of the Works and shall include all such costs in the rates and amounts entered in the Schedule of Prices.

d) Installation & Other Work

The Bidder shall quote prices for Installation & Other Work for the sub-totals of the Plant at the Site. Such prices shall include the costs of handling of the Plant and other materials from Site storage to point of final installation, Installation, installation, testing, commissioning including all inspection, performance tests, reliability tests and responsibility for operation & maintenance of the Plant until issuance of the Taking-Over Certificate, the cost of foreign and local Installation staff and labour, tools and equipment etc. It shall also cover the services of qualified representative(s) of the supplier(s) of Plant or adviser(s) to assure proper Installation and commissioning of the Plant.

The price shall also include cost of arranging insurances in respect of Contractor's operations in Pakistan which insurances shall be effected by the Contractor with any insurance company listed in Clause 5.1 a) ii) hereabove, acceptable to the Employer.

e) Civil Works

The Bidder shall quote prices for Civil Works separately. Such prices shall include all costs of materials used for civil building and other construction works, construction for civil works, supervision including all costs of construction staff and labour, Contractor's Equipment, tools and equipment, etc.

f) Other Services

In the Schedule of Prices, under the relevant items, the Bidders shall quote prices for all costs to be incurred in connection with inspections and witnessing of tests at manufacturers' works within or outside Pakistan by the Employer/Project Manager/Engineer's staff.

5.2 Total Bid Price

The total of Bid prices in the Schedule of Prices shall be entered in the Summary of Bid Prices.

6. Installation & Testing Equipment and Maintenance Tools

6.1 The Bidder shall be responsible to provide all Installation and Testing Equipment & Maintenance Tools at the Site, at his own expenses.

7. Provisional Sums

7.1 Provisional Sums included and so designated in the Schedule of Prices if any, shall be expended in whole or in part at the direction and discretion of the Employer/Project Manager/Engineer. The Contractor will only receive payment in respect of Provisional Sums if he has been instructed by the Employer/Project Manager/Engineer to utilize such sums.

Provisional Sums shall be expended for reimbursement of Contractor's invoices for any

additional site protection works, relocation of services or any other work / payments as instructed by the Employer/Project Manager/Engineer through Variation Order .

SCHEDULE OF PRICES

Description

Schedule of Prices

- Schedule No.1 - Civil Works (BOQ measurement basis)
- Schedule No.2 - Foundation Works (BOQ measurement basis)
- Schedule No. 3 - Supply of Plant (Pre Engineered Structures)
including Fixtures and other materials & goods
and spare parts (if any) (Schedule of Price basis)
- Schedule No. 4 - Installation and other Services (Schedule of Price basis)
- Schedule No. 5 - Design Services (Schedule of Price basis)
- Schedule No. 6 - Grand Summary of Bid Prices

Schedule No.1 - Civil Works (BOQ measurement basis)

Item No.	Description	Unit	Qty	Rate (PKR)	Amount (PKR)
1.1	Site Clearing, leveling, and compaction at 132kV Pasni Grid Station site.	Job	1		
1.2	Boundary wall/fencing for STATCOM yard (if required as per GLO).	Job	1		
1.3	Internal roads, walkways, and gravel surfacing in the yard.	Lot	1		
1.4	Cable trenches, ducts, allied civil work, and drainage system for the housing of STATCOM and its allied connected equipment.	Lot	1		

Schedule No.2: Foundation Works

Item No.	Description	Unit	Qty	Rate (PKR)	Amount (PKR)
2.1	Construction of flood resilient STATCOM infrastructure.	Job	1		
2.2	Reinforced Concrete Foundations for STATCOM cooling units and transformers.	Job	1		
2.3	Foundations for Outdoor Gantry and associated 132kV structures.	Job	1		
2.4	Earth Mat / Grounding Grid for the new facility.	Job	1		

Schedule No. 3: Supply of Plant (Pre Engineered Structures) including Fixtures and other materials & goods and spare parts (if any) (Schedule of Price basis)

Item No.	Description	Unit	Qty	Unit Price (Local)
3.1	STATCOM System: MMC Converters, IGBT Modules, and Control Panels.	Set	1	
3.2	Power Transformers: coupling transformers.	Set	1	
3.3	Pre-Engineered Structure (PEB): Specialized housing components.	Job	1	
3.4	Auxiliary Power: Diesel Generator (DG) set and Battery Bank/UPS.	Set	1	
3.5	Mandatory Spares: List as per Technical Specifications.	Lot	1	

Schedule No. 4 : Installation and other Services (Schedule of Price basis)

Item No.	Description	Unit	Qty	Rate	Amount
4.1	Installation at 132 kV Pasni Grid Station: Unloading, positioning, and assembly.	Job	1		
4.2	Testing & Commissioning: Site Acceptance Tests (SAT) and Reliability Trials.	Job	1		
4.3	O&M Services 2 year: Specialized staff, O&M tools, and maintenance.	Year	1		
4.4	Training: Capacity building for Employer and consultant personnel (Off-site and On-site).	Job	1		

Schedule No. 5 : Design Services (Schedule of Price basis)

Item No.	Description	Unit	Qty	Rate	Amount
5.1	System Design, Detailed Engineering Studies.	Job	1		
5.2	Provision of Software Modules and Simulation Models.	Job	1		
5.3	As-Built Documentation and O&M Manuals (Hard & Soft copies).	Job	1		

Schedule No. 6 :Grand Summary of Bid Prices

Schedule No.	Description	Total Currency (PKR)
1	External Works (Civil & Allied Infrastructure)	
2	Foundation Works (Equipment & Building)	
3	Supply of Plant (STATCOM, PEB Structures, Spares)	
4	Installation, O&M (2 Years), and Other Services	
5	Design & Engineering Services	
6	GRAND SUMMARY (Total Bid Price)	[Sum of 1-5]

DAYWORK SCHEDULE
(As per requirement of job)

PREAMBLE TO CONDITIONS OF CONTRACT

PREAMBLE TO CONDITIONS OF CONTRACT

Subject	Clause Reference / Provisions
Commencement Date	Sub-Clause 1.1.1.(i): The date of issuance of the Project Manager/Engineer's Written Order to Commence, to be issued within 14 days of signing the Contract Agreement and delivery of site possession.
Defect Liability Period (DLP)	Sub-Clause 1.1.11: Extended 365 Days (1 Year) after the Finalization of at least two years of O&M. This period is subject to mandatory extension or "reset" for recurring faults as provided under Sub-Clause 30.4 of the PCC.
The Employer	Sub-Clause 1.1.12: Quetta Electric Supply Company (QESCO).
The Project Manager / Engineer	Sub-Clause 1.1.15: The Project Manager and the Engineer are to be appointed by the Employer and notified to the Contractor via the EPAD Portal.
Time for Completion	Sub-Clause 1.1.35: 365 Days reckoned from the Commencement Date for the whole of the Project (EPC Phase).
Warranty & Training Period	Sub-Clause 1.1.40: At least Two Years for all Plant/Equipment and two (2) Years for Operational Training/O&M Services, running concurrently from the date of TOC. The Contractor guarantees the efficacy of the training and technical self-sufficiency of QESCO staff for this duration.
Engineer's Authority	Sub-Clause 2.1: The duties and authorities of the Project Manager/Engineer are specified in the Particular Conditions of Contract (PCC).
Confirmation in Writing	Sub-Clause 2.6: (i) Contractor shall notify the Engineer within 10 days if confirmation is required. (ii) Engineer shall confirm within 10 days.
Ruling Language	Sub-Clause 5.1: English (The version in English shall prevail).
Communication Language	Sub-Clause 5.2: The language for day-to-day communication is English.
As-Built Drawings	Sub-Clause 6.10: High-resolution digital and hard copies to be provided within 30 days from the date of issue of the TOC.
Work Programme	Sub-Clause 12.1: Must be submitted in Bar-Chart (CPM) format with critical path activities for individual activities and the overall Project.
Employer's Equipment	Sub-Clause 14.4: None available; Contractor to mobilize all specialized testing and HIL equipment.

Working Hours	Sub-Clause 18.3: To conform to applicable labour laws of Pakistan and the specialized 24/7 O&M requirements for the Pasni Site.
Completion Period	Sub-Clause 25.1: As stated under Sub-Clause 1.1.35 hereof.
Bonus for Early Completion	Sub-Clause 26.3: N/A (Not Applicable).
Liquidated Damages	Sub-Clause 27.1: Failure to meet Time for Completion entitles the Employer to deduct 0.1% of the Contract Price per day of delay, up to a maximum limit of 10%.
Availability Liquidated Damages	Sub-Clause 27.1(a): As per Schedule G; triggered if forced availability falls below 99.7% during the Warranty/O&M year.
Prolonged Delay	Sub-Clause 27.2: Maximum amount recoverable from the Contractor by the Employer shall be 10% of the Contract Price (excluding Provisional Sums).
Terms of Payment	Sub-Clause 33.1: Milestone-based as per Schedule K (Part A & Part B) of the Bidding Documents.
Payment Currency	Sub-Clause 35.1: Local Currency (PKR) as the functional currency for evaluation and payment.
Insurance of Works	Sub-Clause 43.1: For full replacement value plus 30%. The Contractor shall indemnify the Employer for all deductibles.
Additional Risks	Sub-Clause 43.1(a): Including risks associated with the Mekran Region as stated in the PCC.
Third Party Liability	Sub-Clause 43.3: N/A (Covered under general liability).
Termination Payment	Sub-Clause 46.3: Limited to the actual cost of work executed up to the date of termination.
Price Adjustment	Sub-Clause 47.1: Applicable as per PEC "Standard Guidelines and Formula for Price Adjustment."
Notice Addresses	Sub-Clause 49.2: As per Sub-Clauses 1.1.12 (Employer) and 1.1.15 (Engineer).
Applicable Law	Sub-Clause 51.1: Laws of the Islamic Republic of Pakistan.
Procedural Law	Sub-Clause 51.2: Pakistan Arbitration Act 1940, as amended.
Arbitration Details	Sub-Clause 51.3: Language: English; Place of Arbitration: Quetta, Pakistan.

GENERAL CONDITIONS OF CONTRACT

[Notes on the Conditions of Contract]

The Conditions of Contract comprise two parts:

- (a) **General Conditions of Contract**
- (b) **Particular Conditions of Contract**

Over the years, a number of “model” General Conditions of Contract have evolved. The one used in these Standard Bidding Documents was prepared by the International Federation of Consulting Engineers (Federation Internationale des Ingenieurs-Conseils, or FIDIC), and is commonly known as the FIDIC Conditions of Contract. (The used version is the 1987 edition, reprinted in 1988 with editorial amendments.)

The FIDIC Conditions of Contract have been prepared for an ad measurement (unit price or unit rate) type of contract, and cannot be used without major modifications for other types of contract, such as lump sum, turnkey, or target cost contracts.

The standard text of the General Conditions of Contract chosen must be retained intact to facilitate its reading and interpretation by Bidders and its review by the Employer. Any amendments and additions to the General Conditions, specific to the contract in hand, should be introduced in the Particular Conditions of Contract.

The use of standard conditions of contract for all electrical/mechanical Works will ensure comprehensiveness of coverage, better balance of rights or obligations between Employer and Contractor, general acceptability of its provisions, and savings in time and cost for bid preparation and review, leading to more economic prices.

The FIDIC Conditions of Contract are copyrighted and may not be copied, faxed, or reproduced. Without taking any responsibility of its being accurate, Pakistan Engineering Council with prior consent of FIDIC Secretariat, has reproduced herein the FIDIC General Conditions of Contract for reference purpose only which cannot be used by the users for preparing their bidding documents. The bidding document may include a purchased copy, the cost of which can be retrieved as part of the selling price of the bidding document. Alternatively, the FIDIC Conditions of Contract can be referred to in the bidding documents, and the Bidders are advised to obtain copies directly from FIDIC.*

* Add the following text if the bidding documents, as issued, do not include a copy:

“Copies of the FIDIC Conditions of Contract can be obtained from:

FIDIC Secretariat
P.O. Box 86
1000 Lausanne 12
Switzerland

fidic.pub@fidic.org – FIDIC.org/bookshop]

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PART-I: GENERAL CONDITIONS OF CONTRACT

Definitions and Interpretations

1.1 Definitions

In the Contract (as hereinafter defined) the following words and expressions shall have the meanings hereby assigned to them:

- 1.1.1** "Commencement Date" means whichever the latest is of:
- i) the date specified in the Preamble as the date for commencement of the Works or the date when the Contractor receives,
 - ii) such payment in advance of the commencement of the Works as may be specified in the terms of payment, or
 - iii) notice of the issue of any import license necessary for commencing performance of the Contract, or
 - iv) notice that any legal requirements necessary for the Contract to enter into force have been fulfilled, or
 - v) notice that any necessary financial or administrative requirements specified in Part II as conditions precedent to commencement have been fulfilled.
- 1.1.2** "Conditions" means the Preamble to and these Conditions of Contract, Parts I and II.
- 1.1.3** "Contract" means the agreement between the Employer and the Contractor for the execution of the Works incorporating the Conditions, Specification, Employer's Drawings and Contractor's Drawings, priced and completed Schedules, Tender, Letter of Acceptance and such further documents as may be expressly incorporated by the Letter of Acceptance.
- 1.1.4** "Contract Agreement" means the documents recording the terms of the Contract between the Employer and the Contractor.
- 1.1.5** "Contract Price" means the sum stated in the Letter of Acceptance as payable to the Contractor for the execution of the Works.
- 1.1.6** "Contractor" means the person whose tender has been accepted by the Employer and the legal successors in title to the Contractor but not (except with the consent of the Employer) any assignee of the Contractor.
- 1.1.7** "Contractor's Drawings" means all drawings, samples, patterns, models and operation and maintenance manuals to be submitted by the Contractor in accordance with Clause 6.
- 1.1.8** "Contractor's Equipment" means all appliances or things of whatsoever nature required for the purposes of the Works but does not include Plant.
- 1.1.9** "Contractor's Risks" means the risks defined in Sub-Clause 37.3.

- 1.1.10** "Defects Liability Certificate" means the certificate to be issued by the Engineer to the Contractor in accordance with Sub-Clause 30.11.
- 1.1.11** "Defects Liability Period" means year or the period stated in Part II following taking over, during which the Contractor is responsible for making good defects and damage in accordance with Clause 30.
- 1.1.12** "Employer" means the person named as such in the Preamble and the legal successors in title to the Employer but not (except with the consent of the Contractor) any assignee of the Employer.
- 1.1.13** "Employer's Drawings" means all the drawings and information provided by the Employer or the Engineer to the Contractor under the Contract.
- 1.1.14** "Employer's Risks" means those risks defined in Sub-Clause 37.2.
- 1.1.15** "Engineer" means the person appointed by the Employer to act as Engineer for the purposes of the Contract and designated as such in the Preamble.
- 1.1.16** "Engineer's Representative" means any representative of the Engineer appointed from time to time by the Engineer under Sub-Clause 2.2.
- 1.1.17** "Final Certificate of Payment", means the certificate to be issued by the Engineer to the Employer in accordance with Sub-Clause 33.10.
- 1.1.18** "Force Majeure" has the meaning assigned to it under Sub-Clause 44.1.
- 1.1.19** "Foreign Currency" means a currency of a country other than that in which Plant is to be installed.
- 1.1.20** "Gross Misconduct" means any act or omission of the Contractor in violation of the most elementary rules of diligence which a conscientious contractor in the same position and under the same circumstances would have followed.
- 1.1.21** "Letter of Acceptance" means the formal acceptance by the Employer of the Tender incorporating any adjustments or variations to the Tender agreed between the Employer and the Contractor.
- 1.1.22** "Performance Security" means the security to be provided by the Contractor in accordance with Sub-clause 10.1. for the due performance of the Contract.
- 1.1.23** "Plant" means machinery, apparatus, materials and all things to be provided under the Contract for incorporation in the Works.
- 1.1.24** "Programme" means the Programme to be submitted by the Contractor in accordance with Sub-Clause 12.1 and any approved revision thereto.
- 1.1.25** "Provisional Sum" means a sum, described as such for the execution of work or for the supply of goods or services, to be used in accordance with Sub-Clause 36.1.
- 1.1.26** "Risks Transfer Date" means the date when the risk of loss of or damage to the Works passes from the Contractor to the Employer in accordance with Sub-Clause 39.1.

- 1.1.27** "Schedule of Prices" means the completed and priced Schedule of Prices, or any part or individual schedule thereof, submitted by the Contractor with his Tender and forming a part of the Contract documents.
- 1.1.28** "Section" means a part of the Works specifically identified as such as in the Contract.
- 1.1.29** "Site" means the place or places, provided or made available by the Employer where work is to be done by the Contractor or to which Plant is to be delivered, together with so much of the area surrounding the same as the Contractor shall with the consent of the Employer use in connection with the Works otherwise than merely for the purposes of access.
- 1.1.30** "Specification" means the specification of the Works included in the Contract and any modification thereof made in accordance with Clause 31.
- 1.1.31** "Subcontractor" means any person (other than the Contractor) named in the Contract for any part of the Works, or any person to whom any part of the Contract has been subcontracted with the consent of the Engineer, and the Subcontractor's legal successors in title but not any assignee of the Subcontractor.
- 1.1.32** "Taking-Over Certificate" means the certificate to be given by the Engineer to the Contractor in accordance with Clause 29.
- 1.1.33** "Tender" means the Contractor's priced offer to the Employer for the Execution of the Works.
- 1.1.34** "Tests on Completion" means the tests specified in the Contract or otherwise agreed by the Engineer and the Contractor to be performed before the Works are taken over by the Employer.
- 1.1.35** "Time for Completion" means the time stated in the Preamble for completing the Works or any Section thereof and passing the Tests on Completion calculated from the Commencement Date unless extended in accordance with Clause 26.
- 1.1.36** "Variation Order" means any written order, identified as such, issued to the Contractor by the Engineer under Sub-Clause 31.1.
- 1.1.37** "Works" means all Plant to be provided and work to be done by the Contractor under the Contract.

1.2 Headings and Titles

The headings and titles in these Conditions shall not be deemed part thereof or be taken into consideration in the interpretation or construction of the Contract.

1.3 Interpretation

Words importing persons or parties shall include firms and corporations and any organisation having legal capacity.

Words importing the singular only also include the plural and vice versa where the context requires.

1.4 Written Communications

Wherever in the contract provision is made for a communication to be "written" or "in writing" this means any hand-written, type-written or printed communication, including telex, cable and facsimile transmission.

1.5 Notices, Consents and Approvals

Wherever in the Contract provision is made for the giving of notice, consent or approval by any person, such consent or approval shall not be unreasonably withheld. Unless otherwise specified, such notice, consent or approval shall be in writing and the word "notify" shall be construed accordingly.

1.6 Costs, Overhead Charges and Profit

Whenever by these Conditions the Contractor is entitled to be paid cost, such cost shall be properly incurred and shall include any overhead charges properly allocable thereto but not profit unless so stated. Any profit entitlement shall be added to cost at the percentage stated in the Preamble.

1.7 Periods

In these Conditions "days" means calendar day and "year" means 365 days.

Engineer and Engineer's Representative

2.1 Engineer's Duties

The Engineer shall carry out the duties specified in the Contract.

If the Engineer is required, under the terms of his appointment by the Employer, to obtain the specific approval of the Employer before carrying out any of these duties, full particulars of such requirements shall be set out in Part II.

Except as expressly stated in the Contract the Engineer shall have no authority to relieve the Contractor of any of his obligations under the Contract.

2.2 Engineer's Representative

The Engineer's Representative shall be appointed by and be responsible to the Engineer and shall only carry out such duties and exercise such authority as may be delegated to him by the Engineer under Sub-Clause 2.3.

2.3 Engineer's Power to Delegate

The Engineer may from time to time delegate to the Engineer's Representative any of the duties vested in the Engineer and may at any time revoke such delegation.

Any such delegation or revocation shall be in writing and shall not take effect until a copy thereof has been delivered to the Contractor and the Employer.

Any decision, instruction or approval given by the Engineer's Representative to the Contractor in accordance with such delegation shall have the same effect as though it had been given by the Engineer. However:

(a) any failure of the Engineer's Representative to disapprove any Plant or workmanship shall not prejudice the right of the Engineer to disapprove such Plant or workmanship and to give instructions for the rectification thereof.

(b) if the Contractor questions any decision or instruction of the Engineer's Representative he may refer the matter to the Engineer who shall confirm, reverse or vary such decision or instruction.

2.4 Engineer to Act Impartially

Wherever under the Contract the Engineer is required to exercise his discretion by:

(a) giving his decision, opinion or consent, or

(b) expressing his satisfaction or approval, or

(c) determining value, or

(d) otherwise taking action which may affect the rights and obligations of the Employer or the Contractor,

he shall exercise such discretion impartially within the terms of the Contract and having regard to all the circumstances.

2.5 Engineer's Decisions and Instructions

The Contractor shall proceed with the decisions and instructions given by the Engineer in accordance with these Conditions.

2.6 Confirmation in Writing

The Contractor may require the Engineer to confirm in writing any decision or instruction of the Engineer which is not in writing. The Contractor shall notify the Engineer of such requirement without undue delay. Such a decision or instruction shall not be effective until written confirmation thereof has been received by the Contractor.

2.7 Disputing Engineer's Decisions and Instructions

If the Contractor disputes or questions any decision or instruction under Sub-Clause 2.5 or a written confirmation under Sub-Clause 2.6, he shall give notice to the Engineer within twenty eight (28) days after receipt thereof, giving his reasons.

The Engineer shall within a further period of twenty eight (28) days by notice to the Contractor and the Employer with reasons, confirm, reverse or vary such decision or instruction.

If either party disagrees with the action taken by the Engineer, or if the Engineer fails to reply to the Contractor's notice within the stipulated twenty eight (28) days, and the

matter cannot be settled amicably that party shall be at liberty, subject to Sub-Clause 50.1, to refer the matter to arbitration in accordance with the Contract.

2.8 Replacement of Engineer

The Employer shall not appoint any person to act in replacement of the Engineer without the consent of the Contractor.

Assignment and Subcontracting

3.1 Assignment

The Contractor shall not assign the Contract or any part of his obligations under the Contract. A charge in favour of the Contractor's bankers of any monies due under the Contract shall not be considered an assignment.

4.1 Subcontracting

The Contractor shall not subcontract the whole of the Works.

Except where otherwise provided by the Contract, the Contractor shall not subcontract any part of the Works without the prior consent of the Engineer.

The Contractor shall however, not require such consent for purchases of materials or to place contracts for minor details or for any part of the Works of which the manufacturer or supplier is named in the Contract.

The Contractor shall be responsible for the acts, defaults and neglects of any Subcontractor, his agents or employees as fully as if they were the acts, defaults or neglects of the Contractor, his agents or employees.

Contract Documents

5.1 Ruling Language

Where versions of the Contract are prepared in different languages, the version which is to prevail shall be specified in the Preamble. The language of such version is referred to as the ruling language.

5.2 Day to Day Communications

The language for day to day communications is stated in the Preamble.

5.3 Priority of Contract Documents

Unless otherwise provided in the Contract, the priority of the Contract documents shall be as follows:

1. The Letter of Acceptance
2. The Preamble
3. The Conditions of Contract, Part II

4. The Conditions of Contract, Part I
5. Any other documents forming part of the Contract.

5.4 Documents Mutually Explanatory

Subject to Sub-Clause 5.3, the Contract documents shall be taken as mutually explanatory. Any ambiguities or discrepancies shall be resolved by the Engineer, who shall then instruct the Contractor thereon.

If the Contractor considers that compliance with such instructions will result in any cost which the Contractor could not reasonably have anticipated, he shall forthwith inform the Engineer with full supporting details. The Engineer shall then, if he approves, certify such costs as may be reasonable, together with profit where appropriate, which shall be added to the Contract Price.

If on the other hand compliance with such instructions results in lower costs for the Contractor than he had reason to anticipate, the Engineer shall certify a deduction from the Contract Price allowing for profit where appropriate.

6.1 Contractor's Drawings

The Contractor shall submit to the Engineer for approval:

- (a) within the time given in the Contract or in the Programme such drawings, samples, models or information as may be called for therein, and in the numbers therein required, and
- (b) during the progress of the Works, such drawings of the general arrangement and details of the Works as specified in the Contract or as the Engineer may require.

The Engineer shall signify his approval or disapproval thereof. If he fails to do so within the time given in the Contract or the Programme or if no time limit is specified, within twenty eight (28) days of receipt, they shall be deemed to be approved.

Approved drawings, samples and models shall be signed or otherwise identified by the Engineer.

The Contractor shall supply additional copies of approved drawings in the form and numbers stated in the Contract.

6.2 Consequences of Disapproval of Contractor's Drawings

Any Contractor's Drawings which the Engineer disapprove shall be forthwith modified to meet the requirements of the Engineer and shall be re-submitted.

6.3 Approved Contractor's Drawings

Approved Contractor's Drawings shall not be departed from except as provided in Clause 31.

6.4 Inspection of Contractor's Drawings

The Engineer shall have the right at all reasonable times to inspect, at Contractor's premises, all Contractor's Drawings of any part of the Works.

6.5 Installation Information

The Contractor shall provide, within the times stated in the Contract or in the Programme, drawings showing how the Plant is to be affixed and any other information required for:

- (a) preparing suitable foundations or other means of support;
- (b) providing suitable access on the Site for the Plant and any necessary equipment to the place where the Plant is to be erected; and
- (c) making necessary connections to the Plant.

6.6 Operation and Maintenance Manuals

Before the Works are taken over in accordance with Clause 29 the Contractor shall supply operation and maintenance manuals together with drawings of the Works as built. These shall be in such detail as will enable the Employer to operate, maintain, adjust and repair all parts of the Works.

Unless otherwise stated in Part II the manuals and drawings shall be in the ruling language, and in such form and numbers as stated in the Contract.

Unless otherwise agreed, the Works shall not be considered to be completed for the purposes of taking over until such manuals and drawings have been supplied to the Employer.

6.7 Employer's Use of Contractor's Drawings

Contractor's Drawings may be used by the Employer for no other purpose than completing, operating, maintaining, adjusting and repairing the Works.

6.8 Contractor's Use of Employer's Drawings

The Employer's Drawings, Specification and other information submitted by the Employer or the Engineer to the Contractor shall remain the property of the Employer. These shall not, without the consent of the Employer, be used, copied or communicated to a third party by the Contractor unless necessary for the purposes of the Contract.

6.9 Manufacturing Drawings

Unless otherwise specified in Part II, the Contractor shall not be required to disclose to the Employer or the Engineer the Contractor's confidential manufacturing drawings, designs, know-how or manufacturing practices, processes or operations.

7.1 Errors in Contractor's Drawings

The Contractor shall be responsible for any errors or omissions in the Contractor's Drawings unless they are due to incorrect Employer's Drawings or other written

information supplied by the Employer or the Engineer. Approval by the Engineer of the Contractor's Drawings shall not relieve the Contractor from any responsibility under this Sub-Clause.

The Contractor shall bear any costs he may incur as a result of delay in providing Contractor's Drawings and other information or as a result of errors or omissions therein, for which the Contractor is responsible.

The Contractor shall at his own cost carry out any alterations or remedial work necessitated by such errors or omissions for which he is responsible and modify the Contractor's Drawings and such other information accordingly.

The performance of his obligations under this Clause shall be in full satisfaction of the Contractor's liability under this Clause but shall not relieve him of his liability under Sub-Clause 27.1.

7.2 Errors by Employer or Engineer

The Employer shall be responsible for the Employer's Drawings and for other written information supplied by the Employer or the Engineer and for the details of special work specified by either of them. If such Employer's Drawings, information or details are incorrect and necessitate alterations of the work, the Employer shall pay the Contractor the cost of the alterations together with profit as certified by the Engineer.

Obligations of the Contractor

8.1 General Obligations

The Contractor shall, in accordance with the Contract, with due care and diligence, design, manufacture, deliver to Site, erect, test and commission the Plant and carry out the Works within the Time for Completion. The Contractor shall also provide all necessary Contractor's Equipment, superintendence, labour and, except as stated in Part II, all necessary facilities therefor.

8.2 Setting Out

The Contractor shall set out the Works in relation to original points, lines and levels of reference given by the Engineer in writing and provide all necessary instruments, appliances and labour for such purposes.

If, at any time during the execution of the Works, any error appears in the positions, levels, dimensions or alignment of the Works, the Contractor shall rectify the error.

The Contractor shall bear the cost of rectifying the error, unless the error results from incorrect information supplied in writing by the Employer, the Engineer or from default by another contractor, in which case the cost together with profit shall be borne by the Employer.

The checking of any setting-out by the Engineer shall not relieve the Contractor of his responsibility for the accuracy thereof.

9.1 Contract Agreement

The Contractor shall, if called upon so to do, execute a Contract Agreement recording all the terms of the Contract, to be prepared by and completed at the cost of the Employer in the form annexed hereto.

10.1 Performance Security

If Part II requires the Contractor to obtain a Performance Security, he shall obtain the same in the sum required, within twenty eight (28) days after the receipt of the Letter of Acceptance. The Performance Security shall be provided by a person and in a form approved by the Employer. The cost of complying with the requirements of this Clause shall be borne by the Contractor.

10.2 Period of Validity

The Performance Security shall be valid until the Contractor has executed, completed and remedied defects in the Works in accordance with the Contract. No claim shall be made against the Performance Security after the issue of the Defects Liability Certificate and the Performance Security shall be returned to the Contractor within fourteen (14) days of the issue of the Defects Liability Certificate.

10.3 Claims under Performance Security

Whether or not the Performance Security is stated by its terms to be payable on the demand of the Employer the Employer shall not make a claim under the Performance Security unless one of the following conditions is satisfied:

- (a) the Contractor is in breach of the Contract and fails to remedy the breach within forty two (42) days after receiving written notice from the Employer requiring him so to do. The notice shall state the intention to claim under the Performance Security, the amount claimed and the breach relied upon, or
- (b) the Employer and the Contractor have agreed in writing that the amount demanded is payable to the Employer, and the amount has not been paid within forty two (42) days thereafter, or
- (c) the Employer has obtained an award in arbitration under Clause 50 and the amount awarded has not been paid within forty two (42) days after the award, or
- (d) the Contractor has gone into liquidation or is bankrupt.

In every case the Employer shall, when making the claim, send a copy to the Contractor.

11.1 Site Data

The Tender shall be deemed to have been based on such data on climatic, hydrological and general conditions on the Site and for the operation of the Works as the Employer or the Engineer has made available to the Contractor for the purposes of the Tender. The Contractor shall be responsible for his own interpretation of such data.

11.2 Sufficiency of Contract Price

The Contractor shall be deemed to have satisfied himself on and taken account of in his Tender:

- (a) all the conditions and circumstances affecting the Contract Price,
- (b) the possibility of carrying out the Works as described in the Contract,
- (c) the general circumstances at the Site (if access has been made available to him) and
- (d) the general labour position at the Site.

The Contractor shall not be responsible for the accuracy of information given in writing by the Employer or the Engineer but shall be responsible for his interpretation of information received from whatever source.

11.3 Physical Obstructions and Conditions

If during the execution of the Works on Site the Contractor encounters physical obstructions or conditions of the kind stipulated in Sub-Clause 26.1.c) the Contractor shall be entitled to recover the additional cost incurred in consequence.

The Engineer shall certify and there shall be added to the Contract Price the additional cost of:

- (a) complying with any instruction which the Engineer, after due consultation with the Employer and the Contractor, issues to the Contractor in connection therewith, and
- (b) any necessary measures which the Contractor may take in the absence of specific instructions from the Engineer.

12.1 Programme to be Furnished

The Contractor shall submit to the Engineer for his approval the Programme which shall contain the following:

- (a) the order in which the Contractor proposes to carry out the Works (including design, manufacture, delivery to Site, Installation, testing and commissioning),
- (b) the times when submission and approval of the Contractor's Drawing are required,
- (c) the times by which the Contractor requires the Employer:
 - (i) to furnish any Employer's Drawings,
 - (ii) to provide access to the Site,
 - (iii) to have completed the necessary civil engineering work (including foundations for the Plant) and
 - (iv) to have obtained any import licences, consents, wayleaves and approvals necessary for the purpose of the Works.

The Contractor shall submit the Programme in the form stated in the Preamble within twenty eight (28) days after the Commencement Date.

The approval by the Engineer of the Programme shall not relieve the Contractor or the Employer from any obligation under the Contract.

12.2 Alteration to Programme

No material alteration to the Programme shall be made without the approval of the Engineer.

12.3 Revision of Programme

If the progress of the Works does not conform to the Programme, the Engineer may instruct the Contractor to revise the Programme.

If such modifications are required for reasons for which the Contractor is not responsible, the cost of preparing the revised Programme shall be certified by the Engineer and added to the Contract Price.

13.1 Contractor's Representative

The Contractor shall employ one or more competent representatives to superintend the carrying out of the Works on Site. They shall be fluent in the language for day to day communications. Their names shall be communicated in writing to the Engineer before work on Site begins.

Any instruction or notice which the Engineer gives to the Contractor's representative shall be deemed to have been given to the Contractor.

13.2 Objection to Contractor's Employees

The Contractor shall, upon the Engineer's written instruction, remove from the Works any person employed by him in the execution of the Works, who misconducts himself or is incompetent or negligent.

14.1 Contractor's Equipment

Except to the extent specified in Part II, the Contractor shall provide all Contractor's Equipment necessary to complete the Works.

All Contractor's Equipment shall, when brought on to the Site, be deemed to be exclusively intended for the execution of the Works. The Contractor shall not remove from the Site any such equipment, except:

- (a) when it is no longer required for the completion of the Works, or
- (b) when the Engineer has given his consent.

14.2 Safety Precautions

The Contractor shall observe all applicable regulations regarding safety on the Site.

Unless otherwise agreed, the Contractor shall, from the commencement of work on Site until taking over provide:

- (a) fencing, lighting, guarding and watching of the Works, and
- (b) temporary roadways, footways, guards and fences which may be necessary for the accommodation and protection of owners and occupiers of adjacent property, the public and others.

14.3 Electricity Water and Gas

The Contractor shall be entitled to use for the purposes of the Works such supplies of electricity, water, gas and other services as may be available on the Site and of which details are given in the Preamble. The Contractor shall pay the Employer a fair price for such use. The Contractor shall at his own cost provide any apparatus necessary for such use.

14.4 Employer's Equipment

The Employer shall, if the Contractor so requests for the execution of the Works, operate any available equipment of which details are given in the Preamble. The Contractor shall pay the Employer a fair price for such use.

The Employer shall during such operation retain control of and be responsible for the safe working of the equipment.

14.5 Clearance of Site

The Contractor shall from time to time during the progress of the Works clear away and remove all surplus materials and rubbish. On completion of the Works the Contractor shall remove all Contractor's Equipment and leave the whole of the Site and the Works clean and in a workmanlike condition, to the satisfaction of the Engineer.

14.6 Opportunities for Other Contractors

The Contractor shall, in accordance with the Engineer's instructions, afford to other contractors engaged by the Employer to work on the Site and persons lawfully upon the Site all reasonable opportunities for carrying out their work provided that the same shall not obstruct or disturb the progress of the Works. The Contractor shall also afford such opportunities to the employees of the Employer.

If the Contractor, on the written request of the Engineer, makes available any Contractor's Equipment or provides any other service, the Employer shall pay the Contractor accordingly. The amount to be paid shall be certified by the Engineer and added to the Contract Price.

14.7 Authority for Access

No persons other than the employees of the Contractor and his Subcontractors shall be allowed on the Site except with the consent of the Engineer.

Facilities to inspect the Works shall at all times be afforded by the Contractor to the Engineer and his representative, the Employer's representatives, authorities and officials.

14.8 Information for Import Permits and Licenses

The Contractor shall submit to the Employer in good time such details of all Plant and Contractor's Equipment as will enable the Employer to obtain all necessary import permits or licenses.

15.1 Compliance with Statutes, Regulations

The Contractor shall, in all matters arising in the performance of the Contract, comply in all respects with, give all notices and pay all fees required by the provisions of any national or state statute, ordinance or other law or any regulation or bye-law of any duly constituted authority.

15.2 Compliance with Laws

The Contractor shall comply with the laws of the country of manufacture concerning the manufacture of the Plant, and the laws of the country where the Plant is to be erected so far as such laws concern the manufacture, Installation and operation of the Works.

16.1 Patent Rights

The Contractor shall indemnify the Employer against all claims of infringement of any patent, registered design, copyright, trade mark or trade name or other intellectual property right provided that all of following conditions are satisfied:

- (a) The claim or proceedings arise out of the design, construction, manufacture or use of Works or any Plant supplied by the Contractor.
- (b) The right was protected at the date of the Contract in the Contractor's country or the country in which the Plant is to be manufactured or erected.
- (c) The infringement or allegation of infringement was not caused by any use of the Works otherwise than for purpose indicated by or reasonably to be inferred from date Specification.
- (d) The infringement or allegation of infringement was not caused by the use of any Plant in association or combination with any plant not supplied by the Contractor, unless such association or combination was disclosed to the Contractor prior to the due of the Tender.
- (e) The infringement of or allegation of infringement was not caused by the Contractor following the design or instructions of the Employer or the Engineer.

16.2 Claims in respect of Patent Right

The Contractor shall be promptly notified of any claim under this Clause made against the Employer. The Contractor may at his own cost conduct negotiations for the settlement of such claim, and any litigation that may arise there from.

The Employer shall not make any admission which might be prejudicial to the Contractor unless the Contractor has failed to take over the conduct of the negotiations or litigation within a reasonable time after having been so requested.

The Contractor may not, however, conduct such negotiations or litigation before he has given the Employer such reasonable security as the Employer may require. The security shall be for an amount which is an assessment of the compensation, damages, expenses and costs for which the Employer may become liable and which are the subject of the indemnity under Sub-Clause 16.1.

The Employer shall, at the request of the Contractor, provide all available assistance for the purpose of contesting any such claim or action, and shall be repaid all reasonable costs incurred in so doing.

16.3 Employer's Warranty for Patent Rights

If any matter for which the Contractor is not liable to indemnify the Employer under Sub-Clause 16.1 causes the infringement or allegation of infringement by the Contractor of any patent, registered design, trade mark, copyright or other intellectual property right, the Employer shall indemnify the Contractor against all claims damages, expenses and costs which the Contractor may incur in relation thereto. The provisions of Sub-Clause 16.2 shall apply mutatis mutandis.

Obligations of the Employer

17.1 Access to and Possession of the Site

The Employer shall in reasonable time grant the Contractor access to and possession of the Site, which may, however, not be exclusive to the Contractor.

The Employer shall to the extent stated in the Specification provide means of access for the delivery of all Plant and Contractor's Equipment to the Site.

17.2 Assistance with Local Regulations

The Employer shall assist the Contractor in ascertaining the nature and extent of any laws, regulations, orders or bye-laws, and customs in the country where the Plant is to be erected, which may affect the Contractor in the performance of his obligations under the Contract. The Employer shall if so requested procure for the Contractor copies thereof and information relating thereto at the Contractor's cost.

17.3 Civil Works on Site

Any building, structure, foundation or means of access on the Site to be provided by the Employer shall be in a condition suitable for the reception, movement, installation and maintenance of the Works within the time or times indicated in the Programme.

17.4 Consents and Wayleaves

The Employer shall in due time obtain or grant all consents including permits-to-work, wayleaves and approvals required for the Works.

17.5 Import Permits and Licences

The Employer shall obtain all import permits or licences required for any part of the Plant or Works in reasonable time having regard to the time for delivery of the Plant and completion of the Works.

Labour

18.1 Engagement of Labour

The Contractor shall, unless otherwise provided in the Contract, make his own arrangements for the engagement of all labour and for their payment, housing feeding and transport.

18.2 Returns of Labour

The Contractor shall submit detailed returns showing the supervisory staff and the numbers of the several classes of labour from time to time employed by the Contractor and Subcontractors on the Site. The returns shall be submitted in such form and at such intervals as the Engineer may prescribe.

18.3 Working Hours

On the Site, the Contractor shall observe the normal working hours stated in the Preamble. The Employer shall allow the Contractor to carry out work on the Site continuously during such working hours.

The Engineer may after consulting the Employer and the Contractor, direct that work shall be done at other times. The extra cost, together with profit, shall be added to the Contract Price unless it has become necessary for the completion of the Works within the Time for Completion, and this is due to the default of the Contractor.

18.4 Restriction on Working Hours

No work shall be carried out on the Site outside normal working hours or on the locally recognised days of rest, unless:

- (a) the Contract so provides, or
- (b) the work is unavoidable or necessary for the saving of life or property or for the safety of the Works, in which case the Contractor shall immediately advise the Engineer, or
- (c) the Engineer gives his consent.

Workmanship and Materials

19.1 Manner of Execution

All Plant to be supplied shall be manufactured and all work to be done shall be executed in the manner set out in the Contract.

Where the manner of manufacture and execution is not set out in the Contract, the work shall be executed in a proper and workmanlike manner in accordance with recognised good practice.

19.2 Covering up Work

The Contractor shall give the Engineer full opportunity to examine, measure and test any work on Site which is about to be covered up or put out of view.

The Contractor shall give due notice to the Engineer whenever such work is ready for examination, measurement or testing.

The Engineer shall then, unless he notifies the Contractor that he considers it unnecessary, without unreasonable delay carry out the examination, measurement or testing.

19.3 Uncovering Work

If so instructed by the Engineer, the Contractor shall expose any parts of the Works. The Contractor shall reinstate and make good such parts to the Engineer's satisfaction.

If any parts of the Works have been covered up or put out of view by the Contractor after complying with Sub-Clause 19.2 and are found to be in accordance with the Contract the cost incurred by the Contractor in complying with the Engineer's instructions including profit shall be certified by the Engineer and added to the Contract Price.

20.1 Independent Inspection

The Engineer may, if so provided in the Contract or with the Contractor's consent, delegate inspection and testing of Plant to an independent inspector. Any such delegation shall be effected in the manner required by Sub-Clause 2.3 and for this purpose such independent inspector shall be considered as an Engineer's Representative. Notice of such appointment (being not less than 14 days) shall be given by the Engineer to the Contractor.

20.2 Inspection and Testing During Manufacture

The Engineer shall be entitled during manufacture to inspect, examine and test the materials and workmanship and check the progress of manufacture of all Plant to be supplied under the Contract. This shall take place on the Contractor's premises during working hours. If Plant is being manufactured on other premises, the Contractor shall obtain permission for the Engineer to carry out such inspection, examination and testing on those premises.

No such inspection, examination or testing shall release the Contractor from any obligation under the Contract.

20.3 Dates for Inspection and Testing

The Contractor shall agree with the Engineer the time and place for the testing of any Plant as provided in the Contract. The Engineer shall give the Contractor 24 hours notice of his intention to attend the tests.

If the Engineer does not attend on the date agreed, the Contractor may, unless the Engineer instructs the Contractor not to do so, proceed with the tests, which shall be deemed to have been made in the Engineer's presence.

The Contractor shall forthwith forward to the Engineer duly certified copies of the test results. If the Engineer has not attended the test, he shall accept the validity of the test readings.

20.4 Facilities for Testing

Where the Contract provides for tests on the premises of the Contractor or of any Sub-Contractor, the Contractor shall provide such assistance, labour materials, electricity, fuel, stores, apparatus and instruments as may be necessary to carry out the test efficiently.

20.5 Certificate of Testing

When Plant has passed the tests referred to in this Clause, the Engineer shall furnish to the Contractor a certificate or endorse the Contractor's test certificate to that effect.

21.1 Rejection

If, as a result of the inspection, examination or testing referred to in Clause 20, the Engineer decides that any Plant is defective or otherwise not in accordance with the Contract, he may reject such Plant and shall notify the Contractor thereof immediately. The notice shall state the Engineer's objections with reasons. The Engineer shall not reject any Plant for minor defects which do not affect the commercial operation of such Plant.

The Contractor shall then with all speed make good the defect or ensure that any rejected Plant complies with the Contract.

If the Engineer requires such Plant to be retested, the tests shall be repeated under the same terms and conditions. All costs incurred by the Employer by the repetition of the tests shall be deducted from the Contract Price.

22.1 Permission to Deliver

The Contractor shall apply in writing to the Engineer for permission to deliver any Plant or Contractor's equipment to the Site. No Plant or Contractor's Equipment may be delivered to the Site without the Engineer's written permission.

The Contractor shall be responsible for the reception on Site of the Plant and Contractor's Equipment.

Suspension of Works, Delivery or Installation

23.1 Order to Suspend

The Engineer may at any time instruct the Contractor to:

- (a) suspend progress of the Works, or
- (b) suspend delivery of Plant or Contractor's Equipment which is ready for delivery to the Site at the time for delivery specified in the Programme, or if no time is specified, at the time appropriate for it to be delivered, or
- (c) suspend the Installation of Plant which has been delivered to the Site.

When the Contractor is prevented from delivering or erecting Plant in accordance with the Programme the Engineer shall be deemed to have instructed a suspension except when such prevention is caused by the Contractor's default.

The Contractor shall during suspension protect and secure the Works or Plant affected at the Contractor's works or elsewhere or at the Site, as the case may be, against any deterioration, loss or damage.

24.1 Cost of Suspension

The additional cost incurred by the Contractor in protection, securing and insuring the Works or Plant and in following the Engineer's instructions under Sub-Clause 23.1 and in resumption of the work, shall be added to the Contract Price.

The Contractor shall not be entitled to be paid any additional costs if such suspension is necessary by reason of a default on the part of the Contractor.

The Contractor shall not be entitled to additional costs unless he notifies the Engineer of his intention to make such claim, within twenty eight (28) days after receipt of the order to suspend progress or delivery or of the date of deemed suspension under Sub-Clause 23.1.

24.2 Payment in Event of Suspension

The Contractor shall be entitled to payment for Plant which has not been delivered to Site if the work on Plant or delivery of Plant has been suspended for more than twenty eight (28) days. After twenty eight (28) days of suspension, the Contractor shall be entitled to payment of the value of such Plant as at the date of suspension.

A certificate of payment shall be issued on condition that:

- (a) the Contractor has marked the Plant as the Employer's property in accordance with the Engineer's instructions, and
- (b) the suspension is not due to the Contractor's default.

24.3 Prolonged Suspension

If suspension under Sub-Clause 23.1. has continued for more than eighty four (84) days, and the suspension is not due to the Contractor's default, the Contractor may by notice to the Engineer require permission to proceed within twenty eight (28) days.

If permission is not granted within that time, the Contractor may treat the suspension as an omission under Clause 31 of the Section it affects, or if the suspension affects the whole of the Works, terminate the Contract and the provisions of Clause 46 shall apply.

24.4 Resumption of Work

If the Contractor chooses not to treat prolonged suspension as an omission or termination under Sub-Clause 24.3, the Employer shall upon the request of the Contractor, take over the responsibility for protection, storage, security and insurance of the suspended Works and the risk of loss or damage thereto shall thereupon pass to the Employer.

After receipt of permission or an order to proceed, the Contractor, shall after due notice to the Engineer, examine the Works and the Plant affected by the suspension. The Contractor shall make good any deterioration or defect in or loss of the Works or Plant that may have occurred during the suspension. Cost properly incurred by the Contractor which would not have been incurred but for the suspension shall be added to the Contract Price together with profit.

The Contractor shall not be entitled to payment for costs incurred in making good any deterioration, defect or loss caused by faulty workmanship or materials or by the Contractor's failure to take the measures specified in Sub-Clause 23.1.

If the Employer has taken over risk and responsibility for the suspended Works under this Sub-Clause, risk and responsibility shall revert to the Contractor fourteen (14) days after receipt of the permission or order to proceed.

Completion

25.1 Time for Completion

The Works shall be completed and shall have passed the Tests on Completion within the Time for Completion

26.1 Extension of Time for Completion

The Contractor may claim an extension of the Time for Completion if he is or will be delayed in completing the Works by any of the following causes:

- (a) extra or additional work ordered in writing under Clause 31,
- (b) exceptional adverse weather conditions,
- (c) physical obstructions or conditions which could not reasonably have been foreseen by the Contractor,

- (d) Employer's or Engineer's instructions, otherwise than by reason of the Contractor's default,
- (e) the failure of the Employer to fulfil any of his obligations under the Contract,
- (f) delay by any other contractor engaged by the Employer,
- (g) any suspension of the Works under Clause 23, except when due to the Contractor's default,
- (h) any industrial dispute,
- (i) the Employer's Risks, or
- (j) Force Majeure.

The Contractor shall give to the Engineer notice of his intention to make a claim for an extension of time within fourteen (14) days of the circumstances for such a claim becoming known to the Contractor. The notice shall be followed as soon as possible by the claim with full supporting details.

The Engineer shall, after due consultation with the Employer and the Contractor, grant the Contractor from time to time, either prospectively or retrospectively, such extension of Time for Completions as may be justified. The Engineer shall notify the Employer and the Contractor accordingly.

The Contractor shall be entitled to such extension whether the delay occurs before or after the Time for Completion.

26.2 Delays by Subcontractors

The Contractor shall be entitled to claim an extension of time if delay on the part of a Subcontractor is due to a cause mentioned in Clause 26.1 and such delay prevents the Contractor from meeting the Time for Completion.

26.3 Earlier Completion

The Employer may require completion of the Works or part thereof earlier than the Time for Completion, on the following conditions:

- (a) The Employer and the Contractor shall first agree the extra sum to be paid for each day by which the Contractor completes the Works or part thereof earlier than the Time for Completion.
- (b) The Contractor shall not become liable under Sub-Clause 27.1 for any failure to complete the Works or the part thereof by the earlier time.

27.1 Delay in Completion

If the Contractor fails to complete the Works within the Time for Completion, the Employer shall be entitled to a reduction in the Contract Price unless it can be reasonably concluded from circumstance that the Employer will suffer no loss.

The Employer shall within a reasonable time give the Contractor notice of his intention to claim a reduction.

The reduction shall be the percentage per day stated in the Preamble of that part of the Contract Price which is attributable to such part of the Works as cannot in consequence of the failure be put to the intended use. The reduction shall be computed for each day between the Time for Completion and the actual date of completion.

The reduction shall in no case exceed the maximum percentage of the Contract Price of such part stated in the Preamble.

Except as provided in Sub-Clause 27.2, such reduction shall be to the exclusion of any other remedy of the Employer in respect of the Contractor's failure to complete within the Time for Completion.

27.2 Prolonged Delay

If the Employer has become entitled to the maximum reduction under Sub-Clause 27.1 for any part of the Works, he may by notice require the Contractor to complete. Such notice shall fix a final time for completion which shall be reasonable.

If the Contractor fails to complete within such time, and this is not due to a cause for which the Employer or some other contractor employed by him is responsible, the Employer may by further notice to the Contractor either:

- (a) require the Contractor to complete, or
- (b) may himself complete at the Contractor's cost provided that he does so in a reasonable manner, or
- (c) terminate the Contract.

If the Employer terminates the Contract, he shall be entitled to recover from the Contractor any loss he has suffered up to the maximum amount stated in the Preamble. If no maximum amount is stated, the Employer shall not be entitled to recover more than that part of the Contract Price which is attributable to that part of the Works which cannot by reason of the Contractor's failure be put to the intended use.

The Employer shall give credit for the value of any part of the Works which he retains.

Tests on Completion

28.1 Notice of Tests

The Employer shall give to the Engineer twenty one (21) day's notice of the date after which he will be ready to make the Tests on Completion (the Tests). Unless otherwise agreed, the Tests shall take place within fourteen (14) days after the said date on such day or days as the Engineer shall notify the Contractor.

28.2 Time for Tests

If the Engineer fails to appoint a time after having been asked to do so, or does not attend at the time and place appointed, the Contractor shall be entitled to proceed with the Test in his absence. The Tests shall then be deemed to have been made in the presence of the Engineer and the results of the Tests shall be accepted as accurate.

28.3 Delayed Tests

If the Tests are being unduly delayed by the Contractor the Engineer may by notice require the Contractor to make the Tests within twenty one (21) days after the receipt of such notice. The Contractor shall make the Tests on such days within that period as the Contractor may fix and of which he shall give notice to the Engineer.

If the Contractor fails to make the Tests within twenty one (21) days the Engineer may himself proceed with the Tests. All Tests so made by the Engineer shall be at the risk and cost of the Contractor and the cost thereof shall be deducted from the Contract Price. The tests shall then be deemed to have been made in the presence of the Contractor and the results of the Tests shall be accepted as accurate.

28.4 Facilities for Tests on Completion

Except where otherwise specified, the Employer shall provide free of charge such labour, materials, electricity, fuel, water, stores, apparatus and feedstock as may be reasonably required by the Contractor to carry out the Tests.

28.5 Retesting

If the Works or any Section fails to pass the Tests, the Engineer or the Contractor may require such Tests to be repeated on the same terms and conditions. All costs to which the Employer may be put by the repetition of the Tests under this Sub-Clause or under Sub-Clause 30.7 shall be deducted from the Contract Price.

28.6 Disagreement as to Result of Tests

If the Engineer and the Contractor disagree on the interpretation of the Test results, each shall give a statement of his views to the other within fourteen (14) days after such disagreement arises. The statement shall be accompanied by all relevant evidence.

28.7 Consequences of Failure to Pass Tests on Completion

If the Works or any Section fails to pass the Tests on the repetition thereof under Sub-Clause 28.5, the Engineer, after due consultation with the Employer and the Contractor, shall be entitled to:

- (a) order one further repetition of the Tests under the conditions of Sub-Clause 28.5, or
- (b) reject the Works or Section in which event the Employer shall have the same remedies against the Contractor as are provided under Sub-Clause 30.5 (c), or

- (c) issue a Taking-Over Certificate, if the Employer so wishes, notwithstanding that the Works are not complete. The Contract Price shall then be reduced by such amount as may be agreed by the Employer and the Contractor or, failing agreement, as may be determined by arbitration.

28.8 Use by the Employer

In considering the results of Tests carried out under Sub-Clauses 29.3, 29.4 and 30.7, the Engineer shall make allowances for the effect of any use of the Works by the Employer on the Certificate to the performance or other characteristics of the Works.

28.9 Test Certificate

As soon as the Works or any Section thereof has passed the Tests, the Engineer shall issue a Certificate to the Contractor and the Employer to that effect.

Taking Over

29.1 Taking Over

The Works shall be taken over by the Employer when they have been completed in accordance with the Contract, except in minor respects that do not affect the use of the Works for their intended purpose, have passed the Tests on Completion and a Taking-Over Certificate has been issued or deemed to have been issued in accordance with Sub-Clause 29.2.

29.2 Taking-Over Certificate

The Contractor may apply by notice to the Engineer for a Taking-Over Certificate not earlier than fourteen (14) days before the Works will in the Contractor's opinion be complete and ready for taking over under Sub-Clause 29.1.

The Engineer shall within twenty eight (28) days after the receipt of the Contractor's application either:

- (a) issue the Taking-Over Certificate to the Contractor with a copy to the Employer stating the date on which the Works were complete and ready for taking over, or
- (b) reject the application giving his reasons and specifying the work required to be done by the Contractor to enable the Taking-Over Certificate to be issued.

If the Engineer fails either to issue the Taking-Over Certificate or to reject the Contractor's application within the period of twenty eight (28) days he shall be deemed to have issued the Taking-Over Certificate on the last day of that period.

If the Works are divided by the Contract into Sections the Contractor shall be entitled to apply for separate Taking-Over Certificate for each such Section

29.3 Use before Taking Over

The Employer shall not use any part of the Works unless a Taking-Over Certificate has been issued in respect thereof.

If nevertheless the Employer uses any part of the Works, that part which is used shall be deemed to have been taken over at the date of such use. The Engineer shall on request of the Contractor issue a Taking-Over Certificate accordingly. If the Employer uses any part of the Works before taking over the Contractor shall be given the earliest opportunity of taking such steps as may be necessary to carry out the Tests on Completion.

The provisions of Sub-Clause 27.1 shall not apply to any part of the Works while being so used by the Employer. Clause 30 shall apply as if the part had been taken over on the date it was taken into use.

29.4 Interference With Tests on Completion

If the Contractor is prevented from carrying out the Tests on Completion by a cause for which the Employer or the Engineer or other contractors employed by the Employer are responsible, the Employer shall be deemed to have taken over the Works on the date when the Tests on Completion would have been completed but for such prevention. The Engineer shall issue a Taking-Over Certificate accordingly.

The Works shall not be deemed to have been taken over if they are not substantially in accordance with the Contract.

If the Works are taken over under this Clause the Contractor shall nevertheless carry out the Tests on Completion during the Defects Liability Period. The Engineer shall require the Tests on Completion to be carried out by fourteen (14) days notice and in accordance with the relevant provisions of Clause 28.

Any additional costs to which the Contractor may be put in making the Tests on Completion during the Defects Liability Period, shall be added to the Contract Price.

Defects after Taking Over

30.1 Defects Liability Period

Where any part of the Works is taken over separately from the Works the Defects Liability Period for that part shall commence on the date it was taken over.

30.2 Making Good Defects

The Contractor shall, subject to Sub-Clause 30.9, be responsible of making good any defect in or damage to any part of the Works which may appear or occur during the Defects Liability Period and which arises from, either:

- (a) any defective materials, workmanship or design, or
- (b) any act or omission of the Contractor during the Defects Liability Period.

The Contractor shall make good the Defects or damage as soon as practicable and at his own cost.

30.3 Notice of Defects

If any such defect appears or damage occurs, the Employer or the Engineer shall forthwith notify the Contractor thereof.

30.4 Extension of Defects Liability Period

The provision of this Clause shall apply to all replacements or renewals carried out by the Contractor as if the replacements and renewals had been taken over on the date they were completed.

The Defects Liability Period for the Works shall be extended by a period equal to the period during which the Works cannot be used by reason of a defect or damage. If only part of the Works cannot be used by reason of a defect, the Defect Liability Period shall be extended only for that part.

In neither case shall the Defects Liability Period be extended by more than one year.

When Installation or delivery of Plant has been suspended under Sub-Clause 23.1, the Contractor's obligations under this Clause shall not apply to any defects occurring more than three years after it would have been delivered but for the suspension or such period as may be stated in Part II.

30.5 Failure to Remedy Defects

If the Contractor fails to remedy a defect or damage within a reasonable time, the Employer may fix a final time for remedying the defect or damage.

If the Contractor fails to do so, the Employer may:

- (a) carry out the work himself or by others at the Contractor's risk and cost, provided that he does so in a reasonable manner. The costs properly incurred by the Employer in remedying the defect or damage shall be deducted from the Contract Price, but the Contractor shall have no responsibility for such work, or
- (b) require the Contractor to grant the Employer a reasonable reduction in the Contract Price to be agreed or fixed by arbitration under Clause 50, or
- (c) if the defect or damage is such that the Employer has been deprived of substantially the whole of the benefit of the Works or a part thereof, he may terminate the Contract in respect of such parts of the Works as cannot be put to the intended use. The Employer shall to the exclusion of any remedy under Clause 45 be entitled to recover all sums paid in respect of such parts of the Works together with the cost of dismantling the same, clearing the Site and returning Plant to the Contractor or otherwise disposing of it in accordance with the Contractor's instructions.

30.6 Removal of Defective Work

If the defect of damage is such that repairs cannot be expeditiously carried out on the Site, the Contractor may with the consent of the Engineer or the Employer remove from the Site for the purposes of repair any part of the Works which is defective or damaged.

30.7 Further Tests on Completion

If the replacements or renewals are such that they may affect the performance of the Works the Employer may request that Tests on Completion be repeated to the extent necessary. The request shall be made by notice within twenty eight (28) days after the replacement or renewal. The Tests shall be carried out in accordance with Clause 28.

30.8 Right of Access

Until the Final Certificate of Payment has been issued, the Contractor shall have the right of access to all parts of the Works and to records of the working and performance of the Works.

Such right of access shall be during the Employer's normal working hours at the Contractor's risk and cost. Access shall also be granted to any duly authorised representative of the Contractor whose name has been communicated in writing to the Engineer.

Subject to the Engineer's approval, the Contractor may also at his own risk and cost make any tests which he considers desirable.

30.9 Defects in Employer's and Engineer's Designs

The Contractor shall not be liable for any defects resulting from designs furnished or specified by the Employer or the Engineer.

30.10 Contractor to Search

The Contractor shall, if required by the Engineer in writing, search for the cause of any defect, under the direction of the Engineer. Unless the defect is one for which the Contractor is liable under this Clause, the cost of the work carried out by the Contractor in searching for the cause of the defect shall be added to the Contract Price.

30.11 Defects Liability Certificate

When the Defects Liability Period for the Works or any part thereof has expired and the Contractor has fulfilled all his obligations under the Contract for defects in the Works or that part, the Engineer shall issue within twenty eight (28) days to the Employer and the Contractor a Defects Liability Certificate to that effect.

30.12 Exclusive Remedies

Except in the case of Gross Misconduct, the Employer's remedies under this Clause shall be in place of and to the exclusion of any other remedy in relation to defects whatsoever.

30.13 Unfulfilled Obligation

After the Defects Liability Certificate has been issued, the Contractor and the Employer shall remain liable for the fulfillment of any obligation which remains unperformed at that time. For the purposes of determining the nature and extent of any such obligation, the Contract shall be deemed to remain in force.

Variations

31.1 Engineer's Right to Vary

The Engineer may by Variation Order to the Contractor at any time before the Works are taken over, instruct the Contractor to alter, amend, omit, add to or otherwise vary any part of the Works.

The Contractor shall not vary or alter any of the Works, except in accordance with a Variation Order from the Engineer. The Contractor may, however, at any time propose variations of the Works to the Engineer.

31.2 Variation Order Procedure

Prior to any Variation Order under Sub-Clause 31.1 the Engineer shall notify the Contractor of the nature and form of such variation.

As soon as possible after having received such notice, the Contractor shall submit to the Engineer:

- (a) a description of work, if any, to be performed and a programme for its execution, and
- (b) the Contractor's proposals for any necessary modifications to the Programme according to Sub-Clause 26.1 to any of the Contractor's obligations under the Contract, and
- (c) the Contractor's proposals for adjustment to the Contract Price.

Following the receipt of the Contractor's submission the Engineer shall, after due consultation with the Employer and the Contractor, decide as soon as possible whether or not the variation shall be carried out.

If the Engineer decides that the variation shall be carried out, he shall issue a Variation Order clearly identified as such in accordance with the Contractor's submission or as modified by agreement. If the Engineer and the Contractor are unable to agree the adjustment of the Contract Price, the provisions of Sub-Clause 31.3 shall apply.

31.3 Disagreement on Adjustment of the Contract Price

If the Contractor and the Engineer are unable to agree on the adjustment of the Contract Price, the adjustment shall be determined in accordance with the rates specified in the Schedule of Prices.

If the rates contained in the Schedule of Price are not directly applicable to the specific work in question, suitable rates shall be established by the Engineer reflecting the level of pricing in the Schedule of Prices.

Where rates are not contained in the said Schedule, the amount shall be such as is in all the circumstances reasonable. Due account shall be taken of any over-or under-recovery of overheads by the Contractor in consequence of the variation.

The Contractor shall also be entitled to be paid:

- (a) the cost of any partial execution of the Works rendered useless by any such variation,
- (b) the cost of making necessary alterations to Plant already manufactured or in the course of manufacture or of any work done that has to be altered in consequence of such a variation,
- (c) any additional costs incurred by the Contractor by the disruption of the progress of the Works as detailed in the Programme, and
- (d) the net effect of the Contractor's finance costs, including interest, caused by the variation.

The Engineer shall on this basis determine the rates or prices to enable on-account payment to be included in certificates of payment.

31.4 Contractor to Proceed

On receipt of a Variation Order, the Contractor shall forthwith proceed to carry out the variation and be bound to these Conditions in so doing as if such variation was stated in the Contract.

The work shall not be delayed pending the granting of an extension of the Time for Completion or an adjustment to the Contract Price under Sub-Clause 31.3.

31.5 Records of Costs

In any case where the Contractor is instructed to proceed with variation prior to the determination of the adjustment to the Contract Price in respect thereof the Contractor shall keep records of the cost of undertaking the variation and of time expended thereon. Such records shall be open to inspection by the Engineer at all reasonable times.

Ownership of Plant

32.1 Ownership of Plant

Plant to be supplied pursuant to the Contract shall become the property of the Employer at whichever is the earlier of the following times:

- (a) when Plant is delivered to Site, or
- (b) when by virtue of Sub-Clause 24.2 the Contractor becomes entitled to payment of the value of the Plant.

Certificates and Payment

33.1 Terms of Payment

The terms of payment shall be as stated in the Preamble.

33.2 Method of Application

Unless otherwise specified in Part II applications by the Contractor for payment shall be made to the Engineer as follows:

- (a) in respect of the progress of the Works accompanied by such evidence of the value of the work done as the Engineer may require, and
- (b) in respect of Plant shipped and en route to the Site identifying the Plant concerned and accompanied by such evidence of shipment and of payment of freight and insurance and by such other documents as the Engineer may require, and
- (c) for additional payment in accordance with Clause 34.

Any other application for payment shall state the amounts claimed and the detailed particulars in respect of which the application is made.

33.3 Issue of Certificate of Payment

Within fourteen (14) days after receiving an application for payment which the Contractor was entitled to make the Engineer shall issue a Certificate of Payment to the Employer showing the amount due, with a copy to the Contractor.

A certificate of payment, other than the Final Certificate of Payment, shall not be withheld on account of:

- (a) defects of a minor character which are not such as to affect the use of the Works, or
- (b) any part of the payment applied for being disputed. In such case a certificate of payment for the undisputed amount shall be issued.

33.4 Corrections to Certificates of Payment

The Engineer may in any certificate of payment make any correction or modification that should properly be made in respect of any previous certificate.

33.5 Payment

Unless otherwise specified in Part II, the Employer shall pay the amount certified within twenty eight (28) days from the date of issue of each certificate of payment to the Contractor at his principal place of business.

33.6 Delayed Payment

If payment of any sum payable under Sub-Clause 33.5 is delayed, the Contractor shall be entitled to receive interest on the amount unpaid during the period of delay. Unless

otherwise stated in Part II the interest shall be at the annual rate three percentage points above the discount rate of the central bank in the Contractor's country. The Contractor shall be entitled to such payment without formal notice and without prejudice to any other right or remedy.

33.7 Remedies on Failure to Certify or Make Payment

The Contractor shall be entitled to stop the Works by giving fourteen (14) days notice to the Engineer and the Employer, if either:

- (a) the Engineer fails to issue a certificate of payment upon proper application by the Contractor, or
- (b) the Employer fails to make any payment as provided in this Clause.

The cost to the Contractor together with profit occasioned by the stoppage and the subsequent resumption of work, shall be added to the Contract Price.

The Contractor shall also be entitled to terminate the Contract by giving twenty eight (28) days notice to the Engineer and the Employer in any case where the Engineer has failed to issue a certificate of payment upon proper application by the Contractor.

33.8 Payment by Measurement

For any part of the Works which is to be paid according to quantity supplied or work done, the provisions for measurement shall be stated in Part II.

33.9 Application for Final Certificate of Payment

The Contractor shall make application to the Engineer for the Final Certificate of Payment within twenty eight (28) days after the issue of the Defect Liability Certificate, or if more than one, the last Defect Liability Certificate.

The application for the Final Certificate of Payment shall be accompanied by a final account prepared by the Contractor. The final account shall give full details of the value of all Plant supplied and work done under the Contract together with:

- (a) such additions to or deductions from the Contract Price as have been agreed, and
- (b) all claims for additional payment to which the Contractor may consider himself entitled.

33.10 Issue of Final Certificate of Payment

The Engineer shall issue to the Employer with a copy to the Contractor, the Final Certificate of Payment within 28 days after receiving an application in accordance with Sub-Clause 33.9.

If the Contractor has not applied for a Final Certificate of Payment within the time specified in Sub-Clause 33.9 the Engineer shall request the Contractor to do so within a further period of 28 days. If the Contractor fails to make such an application, the Engineer shall issue the Final Certificate of Payment for such amount as he deems correct.

33.11 Final Certificate of Payment Conclusive

A Final Certificate of Payment shall be conclusive evidence of the value of the Works, that the Works are in accordance with the Contract and that the Contractor has performed all his obligations under the Contract.

Payment of the amount certified in the Final Certificate of Payment shall be conclusive evidence that the Employer has performed all his obligations under the Contract.

A Final Certificate of Payment or payment shall not be conclusive:

- (a) to the extent that fraud or dishonesty relates to or affects any matter dealt with in the certificate, or
- (b) if any arbitration or court proceedings under the Contract have been commenced by either party before the expiry of 84 days after the issue of the Final Certificate of Payment.

Claims

34.1 Procedure

In any case where under these Conditions there are circumstances which the Contractor considers entitle him to claim additional payment, the Contractor shall:

- (a) if he intends to make any claim for additional payment give to the Engineer notice of his intention to make such claim within twenty eight (28) days after the said circumstances became known to the Contractor stating the reasons for his claim, and
- (b) as soon as reasonably practical after the date of such notice submit to the Engineer full and detailed particulars of his claim but not later than one hundred and eighty two (182) days after such notice unless otherwise agreed by the Engineer. In any event such particulars shall be submitted no later than the application for the Final Certificate of Payment. The Contractor shall thereafter promptly submit such further particulars as the Engineer may reasonably require to assess the validity of the claim.

34.2 Assessment

When the Engineer has received full and detailed particulars of the Contractor's claim in accordance with Sub-Clause 34.1 and such further particulars as he may reasonably have required he shall after due consultation with the Employer and the Contractor determine whether the Contractor is entitled to additional payment and notify the parties accordingly.

The Engineer may reject any claim for additional payment which does not comply with the requirements of Sub-Clause 34.1.

Foreign Currency and Rates of Exchange

35.1 Payment in Foreign Currencies

Arrangements for payment in foreign currencies shall be as stated in the Preamble.

35.2 Currency Restrictions

The Employer shall reimburse the Contractor for any loss arising from:

- (a) currency restrictions, and
- (b) restrictions on the transfer of currency in which the Contractor is to be paid which are imposed by the government or authorized agency of the government of the country from which any payments under the Contract are to be made.

This Sub-Clause only applies to restrictions imposed after the date 28 days prior to the latest date for submission of tenders for the Works.

35.3 Rates of Exchange (Not applicable)

Where the Contract provides for payment in Foreign Currency the rates of exchange between the currencies shall be fixed for the purpose of the Contract and shall be as stated in the Preamble.

If such rates of exchange are not stated in the Preamble the rates to be used shall be those quoted by the central bank of the country whose currency is to be sold 28 days or the nearest day thereto prior to the latest date for submission of tenders for the Works.

Provisional Sums

36.1 Use of Provisional Sums

A Provisional Sum shall only be used, in whole or in part in accordance with the Engineer's instructions.

The total sum paid to the Contractor shall include only such amounts in respect of work, supplies or services to which such Provisional Sums relate as the Engineer shall have instructed.

36.2 Ordering Work against Provisional Sums

In respect of every Provisional Sum the Engineer may after due consultation with the Employer and the Contractor order:

- (a) work to be executed, including goods, materials or services to be supplied by the Contractor. The value of such work executed, determined in accordance with Clause 31, shall be paid to the Contractor in accordance with Clause 33, and
- (b) goods and materials to be purchased by the Contractor, for which payment will be made in accordance with Sub-Clause 36.4.

36.3 Invoices and Receipts

The Contractor shall, when required by the Engineer, produce quotations, invoices, vouchers and accounts or receipts in connection with expenditure in respect of Provisional Sums.

36.4 Payment against Provisional Sums

For all work executed or goods, materials or services supplied or purchased by the Contractor under Sub-Clause 36.2(b), there shall be included in the sums paid to the Contractor:

- (a) the actual price paid or due to be paid by the Contractor, and
- (b) in respect of all other charges and profit, a percentage of the actual price paid or due to be paid. Such percentage shall be as stated in the Preamble.

Risk and Responsibility

37.1 Allocation of Risk and Responsibility

The Risks of loss of or damage to physical property and of death and personal injury which arise in consequence of the performance of the Contract shall be allocated between the Employer and the Contractor as follows:

- (a) the Employer: the Employer's Risks as specified in Sub-Clause 37.2
- (b) the Contractor: the Contractor's Risks as specified in Sub-Clause 37.3.

37.2 Employer's Risks

The Employer's Risks are:

- (a) war and hostilities (whether war be declared or not), invasion, act of foreign enemies,
- (b) rebellion, revolution, insurrection, military or usurped power or civil war insofar as it relates to the country in which the Works are located or countries through which plant must be transported,
- (c) ionising radiation or contamination by radio-activity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radio-active toxic explosives or other hazardous properties of any explosive nuclear assembly or nuclear components thereof,
- (d) pressure waves caused by aircraft travelling at sonic or supersonic speed,
- (e) riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of his Subcontractors,
- (f) use or occupation of the Works or any part thereof by the Employer,

- (g) fault, error, defect or omission in the design of any part of the Works by the Engineer, Employer or those for whom the Employer is responsible,
- (h) the use or occupation of the Site by the Works or any part thereof, or for the purposes of the Contract; or interference, whether temporary or permanent with any right of way, light, air or water or with any easement, wayleaves or right of a similar nature which is the inevitable result of the construction of the Works in accordance with the Contract,
- (i) the right of the Employer to construct the Works or any part thereof on, over, under, in or through any land,
- (j) damage (other than that resulting from the Contractor's method of construction) which is the inevitable result of the construction of the Works in accordance with the Contract,
- (k) the act, neglect or omission or breach of contract or of statutory duty of the Engineer, the Employer or other contractors engaged by the Employer or of their respective employees or agents,

and all risks which an experienced contractor could not have foreseen or, if foreseeable, against which measures to prevent loss, damage or injury from occurring could not reasonably have been taken by such contractor.

37.3 Contractor's Risks

The Contractor's Risks are all risks other than those identified as the Employer's Risks.

Care of the Works and Passing of Risk

38.1 Contractor's Responsibility for the Care of the Works

The Contractor shall be responsible for the care of the Works or any Section thereof from the Commencement until the Risk Transfer Date applicable thereto under Sub-Clause 38.2.

The Contractor shall also be responsible for the care of any part of the Works upon which any outstanding work is being performed by the Contractor during the Defects Liability Period until completion of such outstanding work.

38.2 Risk Transfer Date

The Risk Transfer Date in relation to the Works or a Section thereof is the earliest of either:

- (a) the date of issue of the Taking-Over Certificate, or
- (b) the date when the Engineer is deemed to have issued the Taking Certificate or the Works are deemed to have been taken over in accordance with Clause 29, or
- (c) the date of expiry of the notice of termination when the Contract is terminated by the Employer or the Contractor in accordance with these Conditions.

39.1 Passing of Risk of Loss of or Damage to the Works

The risk of loss of or damage to the Works or any Section thereof shall pass from the Contractor to the Employer on the Risk Transfer Date applicable thereto.

39.2 Loss or Damage Before Risk Transfer Date

Loss of or damage to the Works or any Section thereof occurring before the Risk Transfer Date shall:

- (a) to the extent caused by any of the Contractor's Risks, be made good forthwith by the Contractor at his own cost, and
- (b) to the extent caused by any of the Employer's Risks, be made good by the Contractor at the Employer's expense if so required by the Engineer within twenty eight (28) days after the occurrence of the loss or damage. The price for making good such loss and damage shall be in all circumstances reasonable and shall be agreed by the Employer and the Contractor, or in the absence of agreement, shall be fixed by arbitration under Clause 50.

39.3 Loss or Damage After Risk Transfer Date

After the Risk Transfer Date, the Contractor's liability in respect of loss of or damage to any part of the Works shall, except in the case of Gross Misconduct, be limited:

- (a) to the fulfillment of the Contractor's obligations under Clause 30 in respect of defects therein, and
- (b) to making good forthwith loss or damage caused by the Contractor during the Defects Liability Period.

Damage to Property and Injury to Persons

40.1 Contractor's Liability

Except as provided under Sub-Clause 41.1, the Contractor shall be liable for and shall indemnify the Employer against all losses, expenses and claims in respect of any loss of or damage to physical property (other than the Works), death or personal injury occurring before the issue of the last Defects Liability Certificate to the extent caused by:

- (a) defective design, material or workmanship of the Contractor, or
- (b) negligence or breach of statutory duty of the Contractor, his Subcontractors or their respective employees and agents.

40.2 Employer's Liability

The Employer shall be liable for and shall indemnify the Contractor against all losses, expenses or claims in respect of loss of or damage to any physical property or of death or personal injury whenever occurring, to the extent caused by any of the Employer's Risks.

41.1 Accidents

The Contractor shall be liable for and shall indemnify the Employer against all losses, expenses or claims arising in connection with the death of or injury to any person employed by the Contractor or his Subcontractors for the purposes of the Works, unless caused by any acts or defaults of the Engineer, the Employer, or other contractors engaged by the Employer or by their respective employees or agents. In the latter cases the Employer shall be liable for and shall indemnify the Contractor against all losses, expenses and claims arising in connection therewith.

Limitations of Liability

42.1 Liability for Indirect or Consequential Damage

Neither party shall be liable to the other for any loss of profit, loss of use, loss of production, loss of contracts or for any other indirect or consequential damage that may be suffered by the other, except:

- (a) as expressly provided in Clause 27, and
- (b) those provisions of these Conditions whereby the Contractor is expressly entitled to receive profit.

42.2 Maximum Liability

The liability of the Contractor to the Employer under these Conditions shall in no case exceed the sum stated in the Preamble or, if no such sum is stated, the Contract Price.

42.3 Liability after Expiration of Defects Liability Period

The Contractor shall have no liability to the Employer for any loss of or damage to the Employer's physical property which occurs after the expiration of the Defects Liability Period unless caused by Gross Misconduct of the Contractor.

42.4 Exclusive Remedies

The Employer and the Contractor intend that their respective rights, obligations and liabilities as provided for in these Conditions shall alone govern their rights under the Contract and in relation to the Works.

Accordingly, the remedies provided under the contract in respect of or in consequence of:

- (a) any breach of contract, or
- (b) any negligent act or omission, or
- (c) death or personal injury, or
- (d) loss or damage to any property

are, save in the case of Gross Misconduct, to be to the exclusion of any other remedy that either may have against the other under the law governing the Contract or otherwise.

42.5 Mitigation of Loss of Damage

In all cases the party claiming a breach of Contract or a right to be indemnified in accordance with the Contract shall be obliged to take all reasonable measures to mitigate loss or damage which has occurred or may occur.

42.6 Foreseen Damage

Where either the Employer or the Contractor is liable in damages to the other these shall not exceed the damage which the party in default could reasonably have foreseen at the date of the Contract.

Insurance

43.1 The Works

The Contractor shall insure the Works in the joint names of the Contractor and the Employer to their full replacement value with deductible limits not exceeding those stated in the Preamble.

- (a) from the Commencement Date until the Risk Transfer Date against any loss or damage caused by any of the Contractor's Risks and any other risks specified in the Preamble, and
- (b) during the Defects Liability period against any loss or damage which is caused either:
 - (i) by the Contractor in completing any outstanding work or complying with his obligations under Clause 30, or
 - (ii) by any of the Contractor's Risks which occurred prior to the Risks Transfer Date.

43.2 Contractor's Equipment

The Contractor shall insure Contractor's Equipment for its full replacement value whilst in transit to the Site, from commencement of loading until completion of unloading at the Site and while on the Site against all loss or damage caused by any of the Contractor's Risks.

43.3 Third Party Liability

The Contractor shall insure against liability to third parties for any death or personal injury and loss of or damage to any physical property arising out of the performance of the Contract and occurring before the issue of the last Defects Liability Certificate.

Such insurance shall be effected before the Contractor begins any work on the Site. The insurance shall be for not less than the amount specified in the Preamble.

43.4 Employees

The Contractor shall insure and maintain insurance against his liability under Sub-Clause 41.1.

43.5 General Requirements of Insurance Policies

The Contractor shall:

- (a) whenever required by the Employer produce the policies or certificates of any insurance which he is required to effect under the Contract together with receipts for the premiums,
- (b) effect all insurances for which he is responsible with an insurer and in terms approved by the Employer,
- (c) make no material alterations to the terms of any insurance without the Employer's approval. If an insurer makes any material alteration to the terms the Contractor shall forthwith notify the Employer, and
- (d) in all respect comply with any conditions stipulated in the insurance policies which he is required to place under the Contract.

43.6 Permitted Exclusions from Insurance Policies

The insurance cover affected by the Contractor may exclude any of the following:

- (a) the cost of making good any part of the Works which is defective or otherwise does not comply with the Contract provided that it does not exclude the cost of making good any loss or damage to any other part of the Works attributable to such defect or non-compliance,
- (b) indirect or consequential loss of damage including any reductions in the Contract Price for delay,
- (c) wear and tear, shortages and theft, or
- (d) risks relating to vehicles for which third party or other insurance is required by law.

43.7 Remedies on the Contractor's Failure to Insure

If the Contractor fails to produce evidence of insurance cover as stated in Sub-Clause 43.5 (a) then the Employer may effect and keep in force such insurance. Premiums paid by the Employer for this purpose shall be deducted from the Contract Price.

43.8 Amounts not Recovered

Any amounts not recovered from the insurers shall be borne by the Employer or Contractor in accordance with their responsibilities under Clause 37.

Force Majeure

44.1 Definition of Force Majeure

Force Majeure means any circumstances beyond the control of the parties, including but not limited to:

- (a) war and other hostilities, (whether war be declared or not), invasion, act of foreign enemies, mobilisation, requisition or embargo,
- (b) ionising radiation or contamination by radio-activity from any nuclear fuel or from any nuclear waste from the combustion of nuclear fuel, radio-active toxic explosives, or other hazardous properties of any explosive nuclear assembly or nuclear components thereof,
- (c) rebellion, revolution, insurrection, military or usurped power and civil war,
- (d) riot, commotion or disorder, except where solely restricted to employees of the Contractor.

44.2 Effect of Force Majeure

Neither party shall be considered to be in default or in breach of his obligations under the Contract to the extent that performance of such obligations is prevented by any circumstances of Force Majeure which arise after the date of the Letter of Acceptance or the date when the Contract becomes effective, whichever is the earlier.

44.3 Notice of Occurrence

If either party considers that any circumstances of Force Majeure have occurred which may affect performance of his obligations he shall promptly notify the other party and the Engineer thereof.

44.4 Performance to Continue

Upon the occurrence of any circumstances of Force Majeure the Contractor shall endeavour to continue to perform his obligations under the Contract so far as reasonably practicable. The Contractor shall notify the Engineer of the steps he proposes to take including any reasonable alternative means for performance which is not prevented by Force Majeure. The Contractor shall not take any such steps unless directed so to do by the Engineer.

44.5 Additional Costs caused by Force Majeure

If the Contractor incurs additional costs in complying with the Engineer's directions under Sub-Clause 44.4, the amount thereof shall be certified by the Engineer and added to the Contract Price.

44.6 Damage Caused by Force Majeure

If in consequence of Force Majeure the Works shall suffer loss or damage the Contractor shall be entitled to have the value of the work done, without regard to the loss or damage that has occurred, included in a Certificate of Payment.

44.7 Termination in Consequence of Force Majeure

If circumstances of Force Majeure have occurred and shall continue for a period of one hundred and eighty two (182) days then, notwithstanding that the Contractor may by reason thereof have been granted an extension of Time for Completion of the Works, either party shall be entitled to serve upon the other twenty eight (28) days' notice to terminate the Contract. If at the expiry of the period of twenty eight (28) days Force Majeure shall still continue the Contract shall terminate.

44.8 Payment on Termination for Force Majeure

If the Contract is terminated under Sub-Clause 44.7 the Contractor shall be paid the value of the work done.

The contractor shall also be entitled to receive:

- (a) the amounts payable in respect of any preliminary items so far as the work or service comprised therein has been carried out and a proper proportion of any such item in which the work or service comprised has only been partially carried out,
- (b) the cost of materials or goods ordered for the Works or for use in connection with the Works which have been delivered to the Contractor or of which the Contractor is legally liable to accept delivery. Such materials or goods shall become the property of and be at the risk of the Employer when paid for by the Employer and the Contractor shall place the same at the Employer's disposal,
- (c) the amount of any other expenditure which in the circumstances was reasonably incurred by the Contractor in the expectation of completing the whole of the Works,
- (d) the reasonable cost of removal of Contractor's Equipment from the Site and the return thereof to the Contractor's works in his country or to any other destination at no greater cost, and
- (e) the reasonable cost of repatriation of the Contractor's staff and workmen employed wholly in connection with the Works at the date of such termination.

44.9 Release from Performance

If circumstances of Force Majeure occur and in consequence thereof under the law governing the Contract the parties are released from further performance of the Contract, the sum payable by the Employer to the Contractor shall be the same as that which would have been payable under Sub-Clause 44.8 if the Contract had been terminated under Sub-Clause 44.7.

44.10 Force Majeure Affecting Engineer's Duties

The provisions of Clause 44 shall also apply in circumstances where the Engineer is prevented from performing any of his duties under the Contract by reason of Force Majeure.

Default

45.1 Notice of Default

If the Contractor is not executing the Works in accordance with the Contract or is neglecting to perform his obligations thereunder so as seriously to affect the carrying out of the Works, the Engineer may give notice to the Contractor requiring him to make good such failure or neglect.

45.2 Contractor's Default

If the Contractor:

- (a) has failed to comply within a reasonable time with a notice under Sub-Clause 45.1, or
- (b) assigns the Contract or subcontracts the whole of the Works without the Employer's written consent, or
- (c) becomes bankrupt or insolvent, has a receiving order made against him or compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors or goes into liquidation.

The Employer may, after having given seven (7) days notice to the Contractor, terminate the Contract and expel the Contractor from the Site.

Any such expulsion and termination shall be without prejudice to any other rights or powers of the Employer, the Engineer or the Contractor under the Contract.

The Employer may upon such termination complete the Works himself or by any other contractor.

45.3 Valuation at Date of Termination

The Engineer shall, as soon as possible after such termination, certify the value of the Works and all sums then due to the Contractor as at the date of termination in accordance with Clause 33.

45.4 Payment after Termination

The Employer shall not be liable to make any further payments to the Contractor until the Works have been completed. When the Works are so complete, the Employers shall be entitled to recover from the Contractor the extra costs, if any, of completing the Works after allowing for any sum due to the Contractor under Sub-Clause 45.3. If there is no such extra cost the Employer shall pay any balance due to the Contractor.

45.5 Effect on Liability for Delay

The Contractor's liability under Clause 27 shall immediately cease when the Employer expels him from the Site without prejudice to any liability thereunder that may have already occurred.

46.1 Employer's Default

The Contractor may, by giving fourteen (14) days notice to the Employer and the Engineer, terminate the Contract if the Employer:

- (a) fails to pay the Contractor the amount due under any certificate of the Engineer within twenty eight (28) days after the amount became payable, or
- (b) interferes with or obstructs the issue of any certificate of the Engineer, or
- (c) becomes bankrupt or insolvent, has a receiving order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors or goes into liquidation, or goes into liquidation, or
- (d) consistently fails to meet his contractual obligations, or
- (e) appoints, a person to act with or in replacement of the Engineer without the Contractor's consent.

Any such termination shall be without prejudice to any other rights of the Contractor under the Contract.

46.2 Removal of Contractor's Equipment

On such termination, the Contractor shall be entitled to remove immediately all Contractor's Equipment which is on the Site.

46.3 Payment on Termination for Employer's Default

In the event of such termination the Employer shall pay the Contractor an amount calculated in accordance with Sub-Clause 44.8.

The Employer shall pay in addition the amount of any loss or damage, including loss of profit which the Contractor may have suffered in consequence of termination. The additional amount shall, however, not exceed the limit specified in the Preamble.

Change in Cost and Legislation

47.1 Labour, Materials and Transport

Where the Contract Price is to be adjusted for changes in the cost of labour, materials, transport or other costs of execution of the Works, the method for calculating such adjustment shall be specified in the Preamble.

When calculating the adjustment no account shall be taken of any increased cost which results from the Contractor's default or negligence.

47.2 Statutory and Other Regulations

The Contract Price shall be adjusted to take account of any increase or decrease in cost resulting from changes in legislation of the country where the Site is located or in its generally accepted interpretation.

Legislation means any law, order, regulation or bye-law having the force of law, which affects the Contractor in the performance of his obligations under the Contract, made after the date 28 days prior to the latest date for submission of tenders for the Works.

The Engineer shall certify the amount of the resulting increase or decrease in cost, which shall be added to or deducted from the Contract Price.

Customs

48.1 Customs and Import Duties

Unless otherwise stated in Part II the Employer shall pay all customs, import duties and taxes in consequence of the importation of Plant. If the Contractor is required to pay such customs, import duties and taxes, the Employer shall reimburse the amount thereof.

48.2 Clearance through Customs

The Employer shall assist the Contractor in obtaining clearance through the customs of all Plant and Contractor's Equipment and in procuring any necessary government consent to the re-export of Contractor's Equipment when it is removed from the Site.

Notices

49.1 Notices to Contractor

All certificates, notices or written orders to be given to the Contractor by the Employer or the Engineer under these Conditions shall be sent by airmail post, cable, telex or facsimile transmission to or left at the Contractor's principal place of business or such other address as the Contractor shall nominate for that purpose, or may be handed over to the Contractor's representative.

49.2 Notice to Employer and Engineer

Any notice to be given to the Employer or to the Engineer under these Conditions shall be sent by airmail post, cable, telex or facsimile transmission to or left at the respective addresses nominated for that purpose in the Preamble, or handed over to the Engineer's or the Employer's representative authorised to receive it.

49.3 Minutes of Meetings

Instructions or notices to the Contractor and notices from the Contractor to the Engineer or the Employer recorded in a minute or protocol signed by the authorized representatives of the giver and recipient of such notice or instruction shall be valid notice or instruction for the purposes of the Contract.

Disputes and Arbitration

50.1 Disputes concerning Engineer's Decisions

If either party is dissatisfied with a decision or instruction of the Engineer as confirmed, reversed or varied in accordance with Clause 2 he may refer the matter to arbitration pursuant to Sub-Clause 50.2.

Unless the dissatisfied party has notified the other party and the Engineer within fifty six (56) days of such decision or instruction of his intention to refer the matter to arbitration, he shall be deemed to have accepted the decision as final.

Reference to arbitration shall not relieve the Contractor of his obligation to proceed with the Works in accordance with the Engineer's decision or instruction, nor relieve the Employer of any of his obligations under the Contract.

The Contractor shall in any such arbitration be at liberty to rely on reasons additional to the reasons stated in the notice given under Sub-Clause 2.7.

50.2 Arbitration

If at any time any question, dispute or difference shall arise between the Employer and the Contractor in connection with or arising out of the Contract or the carrying out of the Works either party shall be entitled to refer the matter to be finally settled by arbitration in accordance with the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with those Rules, or by arbitration in accordance with such other rules as are specified in Part II.

The Arbitrator(s) shall have full power to open up, review and revise:

- (a) any decision or instruction of the Engineer referred to arbitration pursuant to Sub-Clause 50.1, and
- (b) any certificate of the Engineer related to the dispute.

50.3 Works to Continue

Performance of the Contract shall continue during arbitration proceedings unless the Employer shall order suspension. If any such suspension is ordered the reasonable costs incurred by the Contractor and occasioned thereby shall be added to the Contract Price.

No payments due or payable by the Employer shall be withheld on account of pending reference to arbitration.

50.4 Time Limit for Arbitration

Formal notice of arbitration must be given to the other party, and where required to the appropriate arbitration body, no later than eighty four (84) days after the issue of the Final Certificate of Payment

Law and Procedure

51.1 Applicable Law

The law which is to apply to the Contract and under which the Contract is to be construed is stated in the Preamble.

51.2 Procedural Law

The law governing the procedure and administration of any arbitration instituted pursuant to Clause 50 is stated in the Preamble.

51.3 Language

The language and place of the arbitration are stated in the Preamble.

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OF
CONTRACT**

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PART-II: PARTICULAR CONDITIONS OF CONTRACT

These Conditions of Particular Application Part-II are additions, deletions, and amendments to the General Conditions of Contract (GCC) Part-I.

Single Responsibility Clause: This Contract is a single-responsibility **EPC/Turnkey Contract**. The Contractor is responsible for the design, procurement, construction, and successful stabilization of the system. Any mentions in the Contract Agreement contrary to the spirit of EPC/Turnkey methodology shall be ignored.

1.1 Definitions

- **Sub-Clause 1.1.1 (Commencement Date):** Deleted and substituted by: "Commencement Date" means the date specified in the Preamble to Conditions of Contract or the date of issuance of the Project Manager's 'Notice to Proceed', whichever is earlier.
- **Sub-Clause 1.1.11 (Defects Liability Period):** The Defects Liability Period (DLP) shall be a extended duration of one (1) year beyond the successful completion of the at least two-year O&M tenure). This ensures that any defects arising after the transition to independent QESCO operation are covered under the Contractor's responsibility.
- **Sub-Clause 1.1.15 (Project Manager/Engineer):** For this EPC/Turnkey Contract, the term 'Engineer' is construed as **Project Manager/Engineer**, representing the Employer.
- **Sub-Clause 1.1.40 (Warranty Certificate):** The Contractor shall issue a Warranty Certificate for the plant/equipment, ensuring all items are new and incorporate the latest MMC/STATCOM improvements. This warranty runs concurrently with the at least two-year O&M training tenure.
- **Sub-Clause 1.1.43 (EPC/Turnkey Basis):** Means the Contractor takes total responsibility for design and execution. This includes making the Plant operationally complete in accordance with the ± 70 MVA_r guarantees, regardless of whether specific items were mentioned in the Schedule of Prices or Drawings.

2.1 Project Manager/Engineer's Duties

The Project Manager/Engineer is required to obtain **specific written approval** of the Employer before:

1. Approving Subcontractors.
2. Granting extensions of time.
3. Issuing a Taking-Over Certificate (TOC) after the 72-hour Reliability Run.
4. Issuing a Variation Order.
5. Certifying any costs under Sub-Clause 44.5 (Force Majeure) or 47.2 (Statutory Changes).

5.3 Priority of Contract Documents

In case of discrepancies, the priority shall be:

1. The Contract Agreement.
2. The Letter of Acceptance.
3. Particular Conditions of Contract (PCC).
4. General Conditions of Contract (GCC).

5. The Specifications (Special & Technical Provisions).
6. The Drawings.
7. The Priced Schedule of Prices.
8. Completed Schedules to Bid (A to L).

10.1 Performance Security

The Performance Security (10%) shall remain valid until twenty-eight (28) days beyond the expiry of at least 2-year O&M and extended 1 Year DLP. However, the amount may be reduced to 2.5% of the Contract Price for the final year (the post-O&M year) provided all O&M milestones and spares replenishment have been verified.

- **Form:** Pay Order, CDR, or Bank Guarantee from a Scheduled Bank of Pakistan.
- **Validity:** Valid until twenty-eight (28) days beyond the Defect Liability Period.

12.4 Monthly Progress Report & EPADS

The Contractor shall submit progress reports via the **EPAD Portal Correspondence Module** not later than the 8th day of each month. Reports must include:

- **S-Curves** and CPM schedules.
- Status of **Long-Lead Items** (IGBT Modules, Converters).
- **Color digital photographs** of site progress at Pasni.
- HSE and Security incident logs.

16.5 Training of QESCO/Consultant Staff

The Contractor shall act as a **Master Trainer**.

1. **EPC Phase:** Provide Overseas Factory Training for 10 Employer and 5 Consultant Engineers.
2. **O&M Phase:** Execute a "Shadow-Operator" program for at least two (2) year.
3. **Language:** All manuals and training shall be in **English**.

4. 16.5.1 Training Evaluation & Certification Methodology

Within ninety (90) days of the Commencement Date, the Contractor shall submit a detailed 'Training Evaluation & Competency Roadmap' for approval by the Employer and the Consultant Engineer. This methodology must define the specific KPIs required for QESCO staff to gain the mandatory O&M proficiency levels. The evaluation shall include:

- 6-a) **Theoretical Assessment:** Written examinations covering MMC-VSC control logic, cooling system thermal dynamics, and protection relay coordination.
- 7-b) **Practical Maneuvers:** Witnessed execution of cold and hot restart sequences, isolation of VSC branches, and simulated fault response for Severity I and II scenarios.
- 8-c) **Minimum Proficiency Threshold:** A cumulative score of 80% across all modules is required for a QESCO team to be deemed 'Eligible for Independent Operation'. No transition to independent operation shall occur until the Consultant Engineer formally vets the evaluation results and certifies the QESCO team's

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readiness

27.1 Liquidated Damages for Delay

If the Contractor fails to complete the EPC works within **365 Days**:

- **Rate:** 0.1% of the Contract Price per day of delay.
- **Maximum:** 10% of the total Contract Price.
- **Availability Liquidated Damages:** During at least two-year O&M phase, failure to meet **99.7% availability** will trigger separate deductions as specified in Schedule G.

The following reproduction maintains a formal, technically rigorous tone suitable for the Particular Conditions of Contract (PCC) and the General Conditions of Contract (GCC) amendments.

30.14 Performance-Linked Defects Liability & Availability Reset

30.14.1 O&M and Warranty Tenure Alignment

The Contractor shall provide specialized 24/7 O&M and Training for a period of 730 days (2 years) post-TOC. The primary Warranty for Plant and Equipment shall remain in full force for the duration of the O&M phase and shall continue for an additional 365 days thereafter.

30.14.2 Mandatory Availability Thresholds

The Contractor guarantees an Annual Equivalent Availability of $\geq 99.7\%$ for forced outages and $\geq 99.0\%$ for scheduled outages. The maximum permissible frequency is restricted to one (1) forced outage and five (5) scheduled outages per annum.

- a) Calculation Basis: Availability metrics shall be annualized starting from the TOC date. An unavailability event commences immediately upon a plant trip/interruption and terminates only when the plant is energized and restored to unrestricted fundamental operation.
- b) De-rating Protocol: For partial system availability across multiple VSC converters, the equivalent outage duration shall be the product of the de-rated duration and the proportion of the output range (\$MVAR\$) unavailable.
- c) Exclusions: Outages demonstrated to be caused exclusively by Employer-side grid faults or verified Force Majeure events shall be excluded.
- d) Guarantee Extension: Should actual performance deviate below these benchmarks within the two-year tenure, the Contractor shall execute all remedial measures and replenish spare parts at zero cost to the Employer. In such events, the Availability Guarantee and O&M obligations shall automatically extend by one (1) further year, subject to a total cumulative cap of three (3) years from the TOC.
- e) Persistent O&M failures or a failure by the Contractor to demonstrate that QESCO staff have achieved the required proficiency level through the approved methodology shall entitle the Employer to withhold the FAC. The Independent Team Eligibility Certificate, signed by both the Employer and the Consultant Engineer, is a mandatory prerequisite for the final handover. This certificate confirms that QESCO staff have reached the 'Master Level' of training and are eligible to take over the O&M of the plant as an independent team upon the expiration of the 730-day O&M tenure.

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30.14.3 Restart of Warranty Period (The "Reset" Clause)

If a major technical defect occurs during the final year of the DLP (the year after O&M has ended), and such defect is found to be a Latent Defect or a result of improper design/manufacturing, the DLP for that specific component shall be reset for an additional 365 days from the date of rectification, notwithstanding that the Contractor's O&M staff are no longer on site. Notwithstanding the initial the warranty shall be subject to mandatory extension or "Reset" under the following conditions:

- a. **Critical System Downtime:** If the STATCOM system, or any independently isolable VSC branch, remains non-functional due to a technical defect for a period exceeding the equivalent of one (1) forced outage (as defined in Schedule A), the warranty shall be extended by a duration equal to the total defect-driven unavailability. This extension shall be branch-specific where isolation is possible, or apply to the whole Works if the system is compromised. Total warranty extension under this sub-clause is capped at one (1) year beyond the original expiry.
- b. **Recurring Faults on a Major Subsystem:** If a primary subsystem (VSC Valve assembly, MMC sub-module group, Central Control Unit, or Loss of Rated Cooling Capacity) experiences a defect-driven forced outage more than once during the warranty period, thereby breaching the annual forced outage limit, the Warranty for that specific subsystem shall be reset for 365 days from the original expiry date. The Contractor must perform comprehensive root-cause analysis (RCA) and implement permanent hardware/software modifications at no cost to the Employer.

30.15 Failure to Perform O&M Requirements

Should the Contractor fail to provide 24/7 specialized staffing, neglect scheduled preventive maintenance, or breach the Service Level Agreement (SLA) response/rectification timeframes defined in Section IB.1 Clause 1.1.2 (Severity I-IV), the following legal remedies shall apply:

- a. **Notice and Remedy:** The Employer shall issue a written Notice of Default under GCC Sub-Clause 45.1. Failure by the Contractor to remedy the breach within the period stipulated for the specific Severity classification shall constitute a Contractor Default under GCC Sub-Clause 45.2.
- b. **Employer Step-in Right:** Upon expiry of the notice period without adequate remediation, the Employer reserves the right to deploy emergency teams or third-party specialists to restore operation as per GCC Sub-Clause 30.5(a). All incurred costs, including a 15% administrative surcharge, shall be recovered via deduction from the Contract Price or Performance Security.
- c. **Availability Liquidated Damages:** Any O&M failure resulting in a forced outage or a drop below the guaranteed benchmarks ($\geq 99.7\%$ Forced $\geq 99.0\%$ Scheduled) shall trigger Availability Liquidated Damages per Clause 27.1, independent of cost recovery under the Step-in Right.
- d. **Automatic O&M Guarantee Extension:** The Contractor fail to maintain the mandatory performance benchmarks (Annual Equivalent Availability $\geq 99.7\%$ for forced outages and $\geq 99.0\%$ for scheduled outages) during the primary 730-day (two-year) O&M tenure, the Availability and Reliability Guarantee shall be subject to an automatic, non-reimbursable extension of one (1) additional year. This extension shall run concurrently with the terminal year of the original at least 1,095-day (2-year) O&M and extended 1 Year Defects Liability Period (DLP). Throughout this extension period, the Contractor shall remain solely liable for the provision of all required spare parts, the execution of complex corrective engineering, and the systematic stabilization of the STATCOM system at no additional cost to the Employer.

Impact on Final Acceptance Certificate (FAC): The issuance of the FAC is the final contractual act and shall occur only upon the expiration of the at least 3rd year of the DLP. This follows:

- i. Completion of the at least 2-year O&M phase and the subsequent extended 1-year 'unattended' warranty year.
- ii. Verified replenishment of all mandatory spares at the end of the O&M phase.
- iii. Confirmation that no major failures occurred during the final year of independent QESCO operation that were attributable to Contractor design/material defects.

33.5 Payment Terms

Payments shall be made in **Pak Rupees (PKR)** within **30 days** of joint verification of Interim Payment Certificates (IPCs).

- **Part A (EPC):** Milestone-based as per Schedule K.
- **Part B (Training):** Quarterly installments based on training performance and system availability.

43.1 Insurance of Works

The Contractor shall provide **Construction All Risks (CAR)** and **Marine Cargo** insurance in the joint names of the Employer and Contractor.

- **Sum Insured:** Full replacement value plus **30%** to cover additional costs.
- **Insurer:** Must be a Category **AA** rated company by PACRA/JCR-VIS.

50. Disputes and Arbitration

1. **Amicable Settlement:** Parties shall attempt to settle disputes through mutual negotiation within 90 days.
2. **Arbitration:** If not settled, disputes shall be referred to arbitration under the **Pakistan Arbitration Act, 1940**.
3. **Venue:** The venue of arbitration shall be **Quetta**, Pakistan.

Additional Conditions

52. Liens

Each contractor, for himself and for any persons directly or indirectly responsible to him, and for his or their material, equipment and employees, and for all other persons performing any labor or furnishing any labor or material for any/or all of the Work covered by his Contract, will be required to release or waive, to the full extent permitted by law, all mechanical and other liens, for or on account of the Work done or equipment and material furnished hereunder and the improvements or structures herein same may be incorporated, and the land to which they are appurtenant shall at all times be free and clear of all such liens.

53.1 Payment of Income Tax, Etc.

The Contractor shall be responsible for the payment, if any is required, of all Pakistani Income Tax, Super Tax, and other taxes on income arising out of the Contract, and the rates and prices stated in the priced Schedule of Prices shall be deemed to cover all such taxes.

53.2 Personnel, Taxes and Duties

The Contractor or his personnel shall pay all personal income tax or other taxes due in Pakistan, if any, for the personnel employed by the Contractor for implementing the work or any other activity required by the Contract. The Contractor shall obtain, at his own cost, work permits from competent authorities to enable any foreign personnel to work in Pakistan. The Contractor shall be responsible for all formalities in connection with passports, obtaining visas, police permits, and expenses for customs duties, if any, related to personal goods of foreign personnel employed on the Project. However, the Employer will, if requested, assist the Contractor in obtaining visas and work permits.

53.3 Income Taxes Provisions in Subcontracts

Provisions to the like effect as those contained in this Clause shall be incorporated in Subcontracts.

54. Liability of the Contractor

The Contractor or his Subcontractors or assigns shall follow strictly, all relevant labour laws including the Workmen's Compensation Act and the Employer shall be fully indemnified for all claims, damages etc. arising out of any dispute between the Contractor, his Subcontractors or permitted assigns and the labour employed by them.

55. Joint and Several Liability

If the Contractor is a joint venture of two or more persons, all such persons shall be jointly and severally bound to the Employer for the fulfilment of the terms of the Contract and shall designate one of such persons to act as leader with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered without the prior consent of the Employer.

56. Details to be Confidential

The Contractor shall treat the details of the Contract as private and confidential, save in so far as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the prior consent in writing of the Employer or the Project Manager/Engineer. If any dispute arises as to the necessity of any publication or disclosure for the purpose of the Contract, the same shall be referred to the decision of the Project Manager/Engineer whose award shall be final.

STANDARD FORMS

STANDARD FORMS

Standard Forms include the following:

- Form of Bid Security
(Bank Guarantee)
- Form of Contract Agreement
- Form of Performance Security
(Bank Guarantee/ Insurance Bond)
- Form of Bank Guarantee for Advance Payment
- Indemnity Bond For Secured Advance
- Service Level Agreement

FORM OF BID SECURITY
(Bank Guarantee)

Guarantee No. _____
Executed on _____
Expiry date _____

Name of Guarantor (Bank) with address: _____

Name of Principal (Bidder) with address: _____

Penal Sum of Security (express in words and figures): _____

Bid Reference No. _____ Date of Bid Opening _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bid and at the request of the said Principal, we the Guarantor above-named are held and firmly bound unto the _____, (hereinafter called the "Employer") in the sum stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted the accompanying Bid numbered dated as above for _____ (Particulars of Bid) to the said Employer; and

WHEREAS, the Employer has required as a condition for considering the said Bid that the Principal furnishes a Bid Security in the above said sum to the Employer, conditioned as under:

- (1) that the Bid Security shall remain valid for a period 28 days beyond the period of validity of the Bid,
- (2) that in the event of;
 - (a) the Principal withdraws his Bid during the period of validity of Bid, or
 - (b) the Principal does not accept the correction of his Bid Price, pursuant to Sub-Clause 24.2 of Instructions to Bidders, or
 - (c) failure of the successful Bidder to
 - (i) furnish the required Performance Security, in accordance with Clause 34 of Instructions to Bidders, or
 - (ii) sign the proposed Contract Agreement, in accordance with Clause 35 of Instructions to Bidders,

then the entire sum be paid immediately to the said Employer as liquidated damages and not as penalty for the successful Bidder's failure to perform.

NOW THEREFORE, if the successful Bidder shall, within the period specified therefor, on the prescribed form presented to him for signature enter into a formal Contract with the said Employer

in accordance with his Bid as accepted and furnish within twenty eight (28) days of his being requested to do so, a Performance Security with good and sufficient surety , as may be required, upon the form prescribed by the said Employer for the faithful performance and proper fulfilment of the said Contract or in the event of non-withdrawal of the said Bid within the time specified for its validity then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

PROVIDED THAT the Guarantor shall forthwith pay to the Employer the said sum stated above upon first written demand of the Employer without cavil or argument and without requiring the Employer to prove or to show grounds or reasons for such demand notice of which shall be sent by the Employer by registered post duly addressed to the Guarantor at its address given above.

PROVIDED ALSO THAT the Employer shall be the sole and final judge for deciding whether the Principal has duly performed his obligations to sign the Contract Agreement and to furnish the requisite Performance Security within the time stated above, or has defaulted in fulfilling said requirements and the Guarantor shall pay without objection the sum stated above upon first written demand from the Employer forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above bounden Guarantor has executed the instrument under its seal on the date indicated above, the name and seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

Guarantor (Bank)

Witness:

Signature _____

1. _____

Name _____

Corporate Secretary (Seal)

Title _____

2. _____

(Name, Title & Address)

Corporate Guarantor (Seal)

FORM OF CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the ____ day of _____ (month) 20____ between _____

(hereafter called the "Employer") of the one part and _____ (hereafter called the "Contractor") of the other part.

WHEREAS the Employer is desirous that certain Works, viz _____ should be executed by the Contractor and has accepted a Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW this Agreement witnesseth as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents after incorporating addenda, if any except those parts relating to Instructions to Bidders shall be deemed to form and be read and construed as part of this Agreement, viz:
 - (a) The Contract Agreement
 - (b) The Letter of Acceptance
 - (c) The completed Form of Bid
 - (d) The Preamble to Conditions of Contract
 - (e) The Particular Conditions of Contract
 - (f) The General Conditions of Contract
 - (g) The priced Schedule of Prices
 - (h) The completed Schedules to Bid (A to L)
 - (i) The Specifications
 - (j) The Drawings
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy defects therein in conformity and in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works as per provisions of the Contract, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed on the day, month and year first before written in accordance with their respective laws.

Signature of the Contactor

(Seal)

Signature of Employer

(Seal)

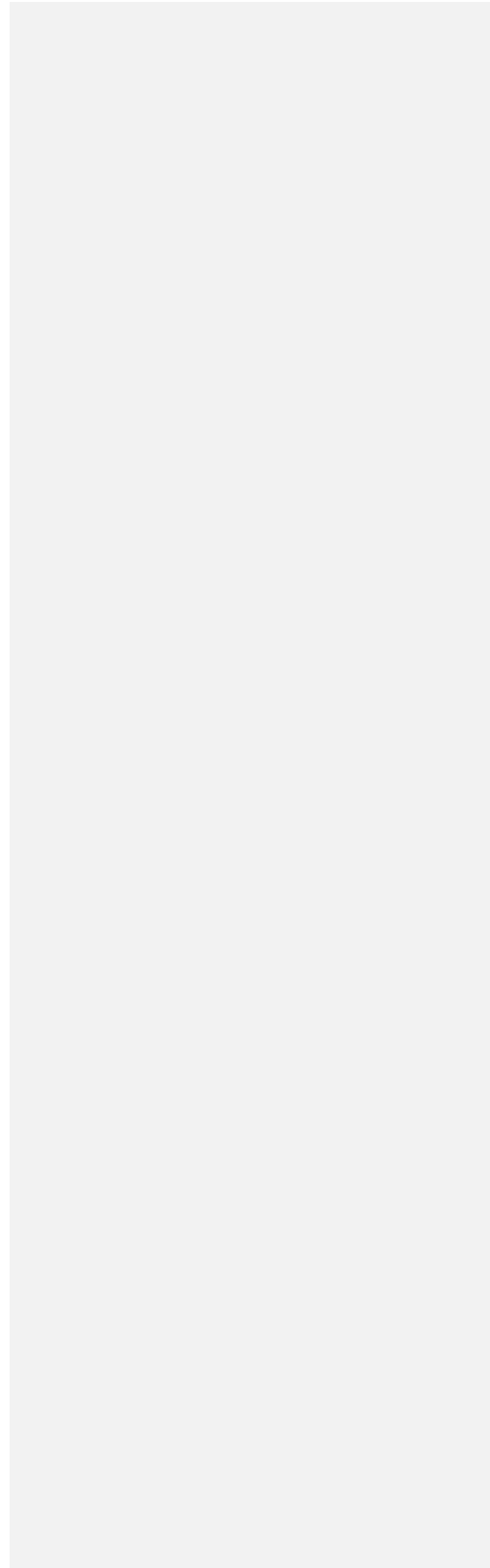
Signed, Sealed and Delivered in the presence of:

Witness:

(Name, Title and Address)

Witness:

(Name, title and Address)



FORM OF PERFORMANCE SECURITY
(Bank Guarantee/ Insurance Bond)

Guarantee No. _____
Executed on _____
Expiry date _____

Name of Guarantor (Bank/Approved Insurance Company) with address: _____

Name of Principal (Contractor) with address: _____

Penal Sum of Security (express in words and figures) _____

Letter of Acceptance No. _____ Dated _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the "Employer") in the penal sum of the amount stated above for the payment of which sum well and truly to be made to the said Employer, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has accepted the Employer's above said Letter of Acceptance for _____ (Name of Contract) for the _____ (Name of Project).

NOW THEREFORE, if the Principal (Contractor) shall well and truly perform and fulfill all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Employer, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of Clause 30, Defects after Taking Over, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

We, _____ (the Guarantor), waiving all objections and defences under the Contract, do hereby irrevocably and independently guarantee to pay to the Employer without delay upon the Employer's first written demand without cavil or arguments and without requiring the Employer to prove or to show grounds or reasons for such demand any sum or

sums up to the amount stated above, against the Employer's written declaration that the Principal has refused or failed to perform the obligations under the Contract which payment will be effected by the Guarantor to Employer's designated Bank & Account Number.

PROVIDED ALSO THAT the Employer shall be the sole and final judge for deciding whether the Principal (Contractor) has duly performed his obligations under the Contract or has defaulted in fulfilling said obligations and the Guarantor shall pay without objection any sum or sums up to the amount stated above upon first written demand from the Employer forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above-bounden Guarantor has executed this Instrument under its seal on the date indicated above, the name and corporate seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Witness:
1. _____

Corporate Secretary (Seal)

2. _____

Name, Title & Address

Guarantor (Bank/Approved Insurance Co.)

Signature _____

Name _____

Title _____

Corporate Guarantor (Seal)

FORM OF BANK GUARANTEE FOR ADVANCE PAYMENT

Guarantee No. _____
Executed on _____
Expiry date _____

WHEREAS the _____ (hereinafter called the Employer) has entered into a Contract for _____

_____ (Particulars of Contract), with
_____ (hereinafter called the Contractor).

AND WHEREAS the Employer has agreed to advance to the Contractor, at the Contractor's request, an amount of _____ (Rs. _____) which amount shall be advanced to the Contractor as per provisions of the Contract.

AND WHEREAS the Employer has asked the Contractor to furnish Guarantee to secure advance payment for performance of his obligations under the said Contract.

AND WHEREAS _____ (Bank) (hereinafter called the Guarantor) at the request of the Contractor and in consideration of the Employer agreeing to make the above advance to the Contractor, has agreed to furnish the said Guarantee.

NOW THEREFORE the Guarantor hereby guarantees that the Contractor shall use the advance for the purpose of above mentioned Contract and if he fails, and commits default in fulfillment of any of his obligations for which the advance payment is made, the Guarantor shall be liable to the Employer for payment not exceeding the aforementioned amount.

Notice in writing of any default, of which the Employer shall be the sole and final judge, as aforesaid, on the part of the Contractor, shall be given by the Employer to the Guarantor, and on such first written demand payment shall be made by the Guarantor of all sums then due under this Guarantee without any reference to the Contractor and without any objection.

This guarantee shall come into force as soon as the advance payment has been credited to the account of the Contractor.

This guarantee shall expire not later than _____ by which date we must have received any claims by registered letter, telegram, telex or telefax.

It is understood that you will return this Guarantee to us on expiry or after settlement of the total amount to be claimed hereunder.

Guarantor (Bank)

Witness:

1. _____

Signature _____

Corporate Secretary (Seal)

Name _____

Title _____

2. _____

Name, Title & Address

Corporate Guarantor (Seal)

INDEMNITY BOND FOR SECURED ADVANCE

AGAINST MATERIALS BROUGHT AT SITE

(ON RS.40 NONJUDICIAL STAMP PAPER)

This Deed of Indemnity is issued by M/s. _____
_____ (Name of the Contractor) in favour of
M/s. _____ (Name of the Employer).

Whereas _____ (hereinafter called the Employer) has agreed to pay the Secured Advance against the cost of material through any Bank or like agency by any other method by virtue of the terms of the contract existing between the parties. The details of the material and their price for which secured advance is being sought for the period till consumption of the material is as under :-

- 1. _____ at Rs. _____ per _____ = Rs.
- 2. _____ at Rs. _____ per _____ = Rs.
- 3. _____ at Rs. _____ per _____ = Rs.
- 4. _____ at Rs. _____ per _____ = Rs.

THEREFORE THIS DEED OF INDEMNITY WITNESSETH AS FOLLOWS:

I/We _____ of M/s. _____ do hereby indemnify M/s _____ for all losses due to thefts, arson, pilferage, loss due to flood and inundation, shortage, deterioration and depreciation etc. through any act of Man or God or slump in the Market of any or all the materials financed or paid by the Employer on our request for financing payment against material.

I/We _____ shall indemnify _____ against any or all claims, action damages arising out of or resulting to the said material.

I/We _____ further declare that we will faithfully abide by the above declaration and solemnly affirm that we will not remove, sell, pilferage any of the materials against which M/s _____ has paid us such a secured advance and will not pledge the same with any Bank, Finance Corporation, Firm, Company, Individual or the like agency or create any change whereon in any from what so ever.

I/We _____ do hereby also declare that in the event of my/our infringement of the declaration made above _____ will be entitled to forfeit all such material and also proceed against me/us according to the relevant clause pertaining to breach of contract and further invoke the power or seek any remedies secured of _____ under the contract Agreement signed with us or otherwise available under law.

Place _____ Dated _____

Contractor _____

SERVICE LEVEL AGREEMENT (SLA) MATRIX

To be included in Section IB.1 Clause 1.1.2 and Schedule G.

The Contractor shall maintain a 24/7 specialized technical team at the **132kV Pasni Grid Station**. The following response and resolution times are mandatory throughout the at least two-year O&M tenure.

Severity Level	Technical Definition	Remote Acknowledgment	On-Site Mobilization	Target Resolution Time
Severity I (Critical)	Total System Outage: STATCOM trip or loss of MMC valve control rendering the plant unable to provide reactive support.	15 Minutes	4 Hours	12 Hours
Severity II (Major)	Degraded State: Loss of one VSC branch or redundancy in the cooling system. Plant running at reduced capacity.	30 Minutes	8 Hours	48 Hours
Severity III (Minor)	Non-Critical Fault: Failure of a single redundant component (e.g., 1 pump out of N+1) that does not impact MVAR output.	1 Hour	24 Hours	7 Days
Severity IV (Routine)	Maintenance/Admin: Routine software log downloads, HMI updates, or cosmetic infrastructure repairs.	4 Hours	48 Hours	Next Scheduled Outage

Contractual Enforcement:

- **Availability Impact:** Any time elapsed beyond the "Target Resolution Time" for Severity I and II

shall be deducted from the **Guaranteed Availability (99.7%)**.

- **Step-in Right:** Failure to mobilize within the specified time triggers **QESCO's right** to engage third-party specialists at the Contractor's cost plus a **15% administrative overhead**.

FINAL ACCEPTANCE CERTIFICATE (FAC)

Standard Form for Milestone B.5 (Schedule K).

Project: Design, Supply, Installation & Commissioning of ± 70 MVar STATCOM at 132kV GS Pasni.

Contract Ref: [Insert ID] | **Contractor:** [Name of JV] | **FAC Date:** [Date]

1. Completion Declaration

This certificate confirms that the Contractor has successfully completed the at least **Operational Training/O&M Phase** and one-year extended **Defects Liability Period (DLP)** after at least 2 year O&M. The Works were formally taken over on [TOC Date].

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2. Mandatory Handover Conditions (Pass/Fail)

The issuance of this FAC is contingent upon the verified fulfillment of the following five conditions:

No.	Condition for Acceptance	Reference	Status
1	Availability Guarantee: Final at least Two-2 availability verified at $\geq 99.7\%$ (Forced) and Year-2 tracking is legally secured.	Schedule A	
2	Defect Rectification: All items identified during the DLP and all "Recurring Faults" have been permanently rectified.	PCC 30.14	
3	Technical Self-Sufficiency: QESCO staff have successfully completed the "Shadow-Operator" program and are certified for independent operation.	IB.1.6.5	
4	Documentation & Licenses: Delivery of final "As-Built" drawings and all permanent, non-expiring software licenses.	IB.6.10	
5	Spares Replenishment: Physical verification of the mandatory spare parts inventory (replenished for any items used during DLP).	IB.8.15	[

3. Performance Summary

- **Annual Forced Outage Availability Achieved:** _____ %
- **Total DLP Extension applied due to downtime:** _____ Days.

4. Final Release

Subject to the above, the Works are hereby accepted. This certificate entitles the Contractor to the final payment (Milestone B.5) and the release of the remaining Performance Security.

Authorized Signatory (QESCO): _____

Date: _____

Countersigned (Consultant): _____

Date: _____

**SPECIFICATIONS
TECHNICAL PROVISIONS**

Please refer to Annexures A, B, and C attached to this document.

DRAWINGS

Please refer to Annexures D and E attached to this document.

ANNEXURE

Annexure-A

STATCOM & POWER SYSTEM DESCRIPTION

A-1 The STATCOM shall be installed at 132kV PASNI Bus AIS, indoor manned substation situated in Balochistan, Pakistan.

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A-2 STATCOM Rating & Design

- i. The purpose of the STATCOM is to regulate the Voltage of 132kV PASNI busbar. The nominal Rating of the STATCOM is -70 MVAR Inductive at 1.0 PU Voltage to +70MVAR Capacitive at 1.0 PU Voltage. The minimum requirements are defined in Clause 7 of this specification document.
- ii. The specification herein defines the minimum performance and functional requirements of the STATCOM system and shall not be construed as prescribing or limiting the detailed design, internal configuration, or implementation approach, provided that all specified requirements are met or exceeded.

A-3 STATCOM Configuration

- i. The STATCOM configuration, including but not limited to the selection of topology, modular arrangement, voltage levels, converter technology, redundancy philosophy, cooling method, and physical layout, shall be the responsibility of the Bidder/Contractor.
- ii. The Bidder/Contractor shall design, engineer, supply, install, test, and commission a STATCOM system that fully complies with all technical, functional, performance, reliability, environmental, and safety requirements specified.
- iii. The proposed STATCOM configuration may be based on any proven and commercially deployed technology, including but not limited to modular or non-modular converter arrangements, provided that the selected configuration demonstrates:
 - a. Compliance with steady-state and dynamic performance requirements
 - b. Compliance with grid code, harmonic, and power quality limits
 - c. Adequate redundancy and availability consistent with the specified reliability criteria
 - d. Suitability for the specified environmental and site conditions
 - e. Compatibility with the specified control, protection, and communication requirements

A-4 The following AC Power System Characteristics apply at the point of connection. Normal STATCOM operation is required within parameter values given in Table-1

Table-1: Power System Characteristics

Sr. No.	Power System Characteristic	Value	Unit
1	Nominal AC Voltage Line to Line	132	kV
2	Maximum Continuous AC System Voltage Line to Line	Refer to NEPRA Grid Code	% of Nominal
3	Minimum Continuous AC System Voltage Line to Line	Refer to NEPRA Grid Code	% of Nominal
4	Maximum Short-term AC System Voltage Line to Line	1.2	PU
5	Maximum duration of item 4	3	Sec
6	Maximum Short-term AC System Voltage Line to Line	Zero	kV
7	Maximum duration of item 6	300	msec
8	Continuous Negative Sequence Voltage Components	1	%
9	Continuous AC Frequency	50	Hz
10	Maximum Short-term AC Frequency	47	Hz
11	Maximum duration of item 10	20	Sec
12	Maximum Short-term AC Frequency	53	Hz
13	Maximum duration of item 12	20	Sec

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Annexure-A

Note: In case any value differs from NEPRA Grid Code 2023, values from Grid Code shall supersede these value.

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Annexure-B

B-1 Network Earthing Solidly Earthed with Earth Fault Factor Below 1.4
B-2 Insulation Coordination Refer to NEPRA Grid Code 2023 Clause CC6.1.2

Table CC 3: Reference minimum withstand Voltages AC

Parameter (Minimum) (kV)	66 kV	132 kV	220 kV	500 kV	765 kV
Insulation level					
Lightning impulse	325	650	1050	1550	2100
Switching impulse		-	-	1300	1550
Power Frequency (1 min)	140	275	460	620	830

Additional parameters are tabulated in Table-1

Table-1: Typical Values for Insulation Coordination

Parameters Based on prevailing standards		132kV	220kV	500kV
Lightening Impulse Level (1.2/50µsec)	To earth and between phases, kV _{Peak}	650	1050	1550
	Between Open Isolator contacts, kV _{Peak}	750	1200	1865
One minute Power Frequency withstand	To earth and between phases, kV _{rms}	275	460	620
	Between Open Isolator contacts, kV _{rms}	315	530	800

B-3 Maximum Short Circuit Levels for Switchgear ratings

Parameters	132kV	220kV	500kV
Three phase symmetrical short circuit current, kA rms	31.5/40	40	40
Three phase symmetrical peak withstand current, kA peak	80/100	100/125	100/125

B-3 Short Circuit Levels for STATCOM Design

Location	Fault Type	Fault Category	Parameter	Unit	Value
132kV PASNI	Three Phase	Maximum	I ^{”k}	kA	0.5458
			MVA _{SC}	MVA	124.78
			X/R	-	2.24807
		Minimum	I ^{”k}	kA	0.4466
			MVA _{SC}	MVA	102.11
			X/R	-	2.24764
		Abnormal	I ^{”k}	kA	0.4404
			MVA _{SC}	MVA	100.7
			X/R	-	2.26721

Note: The short circuit specified shall not be used for equipment or grounding design. The maximum, minimum and abnormal short circuit currents specified in this document are intended for the design studies.

B-4 Transmission Data for Harmonic Studies (To be provided Later on)

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Annexure-B

i) Harmonic impedance sectors (or performance)	See Figure _____
ii) Harmonic impedance sectors for rating filter components	See Figure _____
iii) Background harmonic voltage (or current) spectrum (for rating filter components)	See Figure _____
iv) Harmonic requirement Existing single harmonic distortion value	$U_v \leq \quad \%$
v) Total harmonic distortion value	THD $\leq \quad \%$
vi) Permissible single harmonic distortion value from 2nd to 25 th harmonics	$U_v \leq \quad 1.5\%$
vii) Maximum allowed total harmonic distortion value	THD $\leq 2.5\%$
viii) TIF	\leq
ix) Total Harmonic current factor (IT)	$\leq 2.0 \%$
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Annexure-C

1. SYSTEM STUDIES, DESIGNS STUDIES AND SIMULATION MODELS

1.1. System Studies

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This annexure contains the requirements for the system and design studies to be performed by the Contractor, including requirements on the STATCOM simulation models that the Contractor has to provide, to be used by the Company to simulate the STATCOM performance and its control and protective functions in different time frames.

All simulations software adopted has to be fully specified (e.g. version) in order to allow the Company to use all models in its own simulation environment.

In the study reports, findings that affects the operation of the STATCOM and recommendations how to operate the power grid with the new device(s) shall be given. Highlight any concerns/actions required for satisfactory use of the STATCOM.

1.1.1. Requirements for the Report

The Contractor shall carry out and report on the system studies and optional studies specified herein and any additional studies which are determined to be necessary. The cost of any additional studies determined to be necessary shall be included in the Contract price.

The Contractor shall satisfy the Company as to the adequacy (meeting the international standards as well as NGC requirements) of the studies carried out in accordance with the Contract.

The Company shall have the right to observe and participate in all of the studies and shall have access to all data necessary for a complete understanding of the purpose of such studies, as well as validity of the results. For each study item, the Contractor shall submit to the Company, by the specified date, the specified number of copies of the study report. The work shall include, but not limited to the following:

- a) study objective
- b) initial conditions, data and assumptions
- c) codes, standards and criteria used in the studies
- d) description of means and methods used in the studies
- e) computer models and data used in the studies to represent the Contractor's equipment and the Company equipment
- f) summary of study results
- g) conclusions
- h) reference(s)

A study outline abstract containing items a) through e) above shall be submitted to the Company for review and comment prior to commencement of each study. The study shall be performed after the approval of respective outline.

Contractor shall provide simulation files, plots in high definition, results in native software file format and a detailed report. The report shall highlight possible interactions (if any), optimization of the controllers and signals that are required to be exchanged. Contractor shall provide system model soft files of PSCAD, Power Factory & PSS/E software.

Note: All STATCOM design studies performed during various stages of the project shall be submitted along with the corresponding simulation models such as PSS/E, PSCAD and Power Factory models used in the studies. The simulation models shall be used to reproduce and verify *the reported results*. Contractor shall provide all supporting files including models (*.dll), python scripts and instruction file to facilitate the quick review of the report. The studies report shall not be reviewed without models.

1.1.2. STATCOM Design Verification Studies

The Contractor shall perform studies to determine the design ratings and requirements of all plant and material to be supplied under this contract. The Contractor shall confirm the design ratings and requirements of all plant and material to be supplied under this contract.

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1. The Contractor shall perform studies using electromagnetic transient simulation principles to determine the design ratings and requirements of all plant and material to be supplied under this contract. Engineering studies should be performed within the scope of supply. Studies are required to demonstrate that the STATCOM meets all specified performance criteria. The Bid must contain a list all engineering studies. All dynamic simulations shall be done using PSS/E version 33.10.0, all EMT studies shall be done using PSCAD (latest version). Contractor shall specify the compiler version used. Contractor shall provide the two licenses for the PSCAD compiler.
2. Prior to manufacture of the STATCOM, the Contractor shall perform simulation studies within agreed time frames for review, comment and participation by the Company. The Company reserves the right to perform parallel verification studies on its own, or by a third party. The Contractor shall provide all required information for independent design verification and system modeling (including PSS/E, PSCAD & Power Factory software files, assumption basis, etc.). The Company shall be utilizing the electromagnetic transient simulation package (PSCAD version 4.6.3 or higher), PSS/E version 33 and Power Factory Version 22 for verification and require the data to be either in the correct format or available EMTDC, PSS/E and Power Factory data format.
3. If the Company's or third party's studies indicate disagreement with the Contractor's results, the Contractor shall be prepared to work with the Company or his representative to reach an agreement on the controversial issues and/or to make the required design corrections, in accordance with this specification.
4. When performing the designs, all modes of operation specified in the technical specifications and the worst-case system conditions up to and including first contingency outage in the Company network shall be considered.
5. The Contractor shall identify, and the Company shall provide, all existing equipment and network data reasonably needed by the Contractor in performing their studies (Contractor shall provide the list of input data requirements at Bidding Stage). The simulation studies will be based upon the Company's network, considering the list of contingencies described in section E.4.2.2 Table-2: Fault Cases. The maximum and minimum generation as well the maximum and minimum load networks shall be considered. The data not provided by the Company shall be clearly indicated in the Bid Proposals if the information provided in this specification is inadequate. The Bidders shall also clearly state the reasons for requiring such data and the purposes for which it will be used.
Contractor shall not share any details to other parties without Company's written approval. Company will consider that all the required data has been provided to the Contractor if no additional data request received at the bidding stage from the Contractor.

1.2. Design Studies

Contractor shall perform the following studies and prepare the study reports as specified below. The Contractor shall carry out such electrical simulation (EMT) studies and basic design studies as are required to design the STATCOM. The Contractor shall perform design and simulation verification studies to ensure proper design and operation of the system. These studies shall consider all the defined modes of operation. The Contractor shall allow the Company or his representative to witness, review and provide comment on such studies and simulations.

1.2.1. Harmonic Performance Study

This is to verify the adequacy (meeting the international standards as well as Company requirements) of the STATCOM harmonic design through simulation of the Company's network response to STATCOM harmonics. It should include evaluating maximum harmonic levels at the STATCOM point of common coupling (PCC).

The Contractor should perform detailed harmonic performance study at Base Design Stage.

Determination of maximum system harmonic levels should be based on the following:

- Network impedance sectors.

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- Evaluation of specified system operating conditions with maximum harmonic generation at any operating point in the STATCOM range.
- Evaluation with maximum filter component tolerances.
- Evaluation with maximum system voltage unbalance and firing angle unbalance for non-characteristic harmonic generation.
- Evaluation of possible resonant over-voltages
- Evaluation of the filter thermal ratings based on specified operating conditions.
- Transformer saturation induced harmonics.

1.2.2. Harmonic Performance Study

Detailed harmonic impedance and impact design and measurements to verify the filter design. The detailed filter configuration shall be supplied. This is to verify the adequacy of the STATCOM harmonic filter design through simulation of the Company's equivalent network response to STATCOM harmonics. It should include evaluating maximum harmonic levels at the STATCOM point of common coupling (PCC).

Determination of maximum system harmonic levels should be based on the following:

1. Calculation of the network harmonic impedance using the network data supplied in the specification considering the worst case for both maximum current and voltage distortion and amplification. This shall be based on contingencies as specified.
2. Evaluation of specified system operating conditions, including maximum and minimum system voltage levels, and maximum and minimum reactive power output of the STATCOM with maximum harmonic generation at any operating point in the STATCOM range.
3. Evaluation with maximum filter component tolerances.
4. Evaluation with maximum system voltage unbalance and firing angle unbalance for non-characteristic harmonic generation.
5. Evaluation of possible resonant overvoltage
6. Evaluation of the filter thermal ratings based on specified operating conditions.
7. Transformer saturation induced harmonics.

1.2.3. Dynamic Performance Studies

Studies shall be performed to define control strategies as well as identify voltage and current stresses (besides harmonic performance, short circuit studies and V-I characteristic requirements). Fault scenarios are described in E.4.2.2 Table-2: Fault Cases.

Transient and stability studies to verify the STATCOM control system performance, evaluate STATCOM control system function and optimize the control of STATCOM during system disturbances, such as major faults (three phase faults with normal clearing, single line to ground faults with delayed clearing, etc.) load rejection or loss of generation in the Company's network (the Company network and contingency list described in E.4.2.2 Table-2: Fault Cases). The design shall investigate the adequacy (meeting the international standards as well as Company requirements) of the STATCOM to ensure stability and prevent under-voltages or over-voltages during system transient, dynamic and fault conditions.

1.2.3.1. PSSE Dynamic Performance Study

The PSSE base cases to be considered for system healthy conditions are as follows and listed in section E4.2.1 PSSE Study Cases:

- Peak and minimum load case for the energization year
- Peak and Minimum load case for the ultimate year.

The Contractor shall include the STATCOM model in the above PSSE cases and perform dynamic performance studies. The Contractor shall consider the fault cases as mentioned in the section E.4.2.2 Table-2: Fault Cases of this Annexure. The studies shall verify that the STATCOM provides adequate dynamic control to meet the system requirements and performance criteria for selected disturbances (faults/tripping/load rejections). The studies shall also verify the behaviour and contribution of STATCOM

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to the system's recovery from a fault. The Contractor shall also document the contingencies resulting in instability as part of the Dynamic Performance Study. The PSSE model used in the study shall contain all necessary control functions/strategies relevant to the RMS time frame and test results shall be provided to confirm the modelling of function and/or strategies in PSSE dynamic performance study report.

1.2.3.2. PSCAD Functional and Dynamic Performance Study

The PSCAD base cases created in section E.4.3.1 PSCAD to be considered for system healthy conditions. The Contractor should perform detailed PSCAD functional and dynamic performance study at Base Design Stage.

This study is divided in a number of separate studies:

- STATCOM response time and of the STATCOM's behaviour and contribution to the system's recovery from faults. The studies shall indicate the methodology used in determining the STATCOM response to network identified faults. This is of primary importance considering the application of the STATCOM in the Company's network and the defined requirements as stipulated in this specification in order to provide rapid voltage control through reactive power support at the selected system nodes.
- Bandwidth Study: The open loop transfer function on the STATCOM and main circuit shall be demonstrated. The ability to suppress harmonics from interaction with the control shall be verified.
- Study of control functions, including transformer and STATCOM energization, shutdown, and other switching events.
- Balancing of unsymmetrical system voltage. The STATCOM performance during large system unbalances such as line faults shall be studied. Special care shall be taken to the performance when one or several of the controllable elements in the STATCOM reach their capability limits. A strategy for operation at the limits of the STATCOM power range shall be developed. The studies shall cover unsymmetrical operation with the VSC. The optimal strategy for operation during single line to ground faults shall be developed. Company aims for maximal voltage support while avoiding severe line to line over-voltages.
- Interaction with nearby Generators, Converter based resources (renewables), SVC/STATCOMs & TCRs. The Contractor shall study control system interaction and suggest remedies if needed. The nearby Generators, SVC/STATCOMs & TCRs shall be modelled as built/designed.
- Switching & Ferro-resonance Studies: All studies related to switching, Ferro resonance shall be performed. These studies shall also consider the effect of existing transformers and all Voltage transformers.

The Contractor shall consider the cases (faults/tripping) in E.4.2.2 Table-2: Fault Cases for PSCAD dynamic performance studies. However, additional cases to assure robust dynamic performance of the STATCOM shall be added as necessary. Signal list mentioned in E.4.3.3 Recorded Signals shall be considered as minimum.

1.2.3.2.1. Step Response Study

Step response shall be performed during according to the mentioned requirement.

Step response study with different slopes (1% and 5%) shall be performed during Base Design Stage. The step response study shall be performed for Maximum, Minimum & Abnormal network conditions.

Step response requirements shall be met for both strong and weak network conditions without changing the controller regulator/gain settings.

The Contractor shall prove that system shall remain stable at abnormal network condition with the same regulator/gain settings as considered for Maximum & Minimum Short Circuit Level.

The Contractor shall also prove that overshoot shall be in the limit (mentioned in Specification sub-clause 7.5 Control System Response and stability) that it cannot cause any equipment damage/failure.

The requirements shall be verified by PSCAD simulation for strong, weak & abnormal network condition. A simple Thevenin equivalent giving the correct short circuit impedances and X/R ratio shall be used for the study. Actual Short circuit impedance and X/R mentioned in the Annexure-A System Characteristic shall be used.

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A table shall be provided in the report to show the following quantities for each case (small signal behaviour & large signal behaviour):

Initial primary voltage before giving voltage step

1. Slope
2. Step change in Vref (%)
3. Final Primary voltage
4. Initial Iref (based on 100MVA base)
5. Final Iref (based on 100MVA base)
6. Settling time
7. Response time
8. Overshoot (%)
9. Gain value
10. QSTATCOM

The following study shall be performed by the Contractor as a part of step response study. The simulations for the voltage response shall be drawn.

1.2.3.2.1.1. Small Signal Behaviour

1) Positive Step

- a) Start with the STATCOM operating at a current order (Iref) for VSC equal to zero (0) for the complete STATCOM. Make a positive step in the STATCOM positive phase sequence voltage reference (Vref) such that Iref, after the settling time has elapsed, becomes just below the maximum Iref given by the STATCOM MVAR rating. For this case the STATCOM is allowed to hit its capacitive limit for the overshoot.
- b) Repeat the sequence above four (4) times but make the step in Vref gradually smaller. The voltage step size shall be such that Iref/Bref, after the settling time has elapsed, is reduced by 20% of maximum Iref/Bref for each step.

2) Negative Step

- a) Start with the STATCOM operating at a Iref equal to zero (0). Make a negative step in Vref such that Iref, after the settling time has elapsed, becomes just above the minimum Iref given by the STATCOM MVAR rating. For this case the STATCOM is allowed to hit its inductive limit for the overshoot.
- b) Repeat the sequence above four (4) times but make the step in Vref gradually smaller. The voltage step size shall be such that Iref/Bref, after the settling time has elapsed, is increased by 20% of minimum Iref for each step.

The five (5) simulations in each (1) and (2) above for the voltage shall be drawn in one common separate diagram.

The following signals shall be plotted:

Plot 1 (separate subplots for each signal below).

- System positive phase sequence voltage as measured by the STATCOM (nonfiltered signal) and the step change in Vref.
- STATCOM output Iref as ordered by the STATCOM controller.
- QSTATCOM

Plot 2 (separate subplots for each signal below).

- Ivsc, Ifilter and ISTATCOM

1.2.3.2.1.2. Large Signal Behaviour

1) Positive Step

Start with the STATCOM operating at a current order (Iref) equal to zero (0) for the complete STATCOM. Make a positive step in the STATCOM positive phase sequence voltage reference (Vref) of 50%. For this case the STATCOM shall hit its capacitive limit.

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2) Negative Step

Start with the STATCOM operating at an I_{ref} equal to zero (0). Make a negative step in V_{ref} of 50%. For this case the STATCOM shall hit its inductive limit.

3) Single Line to Ground Fault

Make a stiff single line to ground fault on the HV side of the STATCOM power transformer. Use the same template for plotting the signals as for the small signal behaviour simulations.

1.2.3.2.2. Bandwidth

A study demonstrating the bandwidth of the complete STATCOM shall be performed during project design stage.

The STATCOM shall operate close to zero output. A voltage source with small magnitude ramping up the frequency from 0 to 600 Hz shall be superimposed on the input of its voltage measuring circuits. Fundamental frequency voltage shall be given by an infinitely strong voltage source. The effect on voltage at the point of connection shall be studied. This point shall be decoupled from the input voltage. The impedance at the point of connections shall be as given by max and min short circuit power.

A Bode diagram of the gain and phase of the open loop difference on input and output voltage shall be shown. A Thevenin equivalent is sufficient for the study.

1.2.3.2.3. Control Stability at System Faults

The contractor shall perform the following simplified study for the control stability.

STATCOM behaviour during large voltage changes, both in amplitude and in angle shall be demonstrated. The STATCOM at location specified in Annexure-A, together with the lines one bus away shall be modelled in PSCAD. The lines shall be modelled with distributed parameters. At each ending bus a Thevenin equivalent shall be placed, the impedances shall be as given by twice the maximum and minimum short circuit impedances at the STATCOM location. The lines shall be loaded by a 60-degree difference in voltage between the two voltage sources. Single line to ground, line to line and 3 phases to ground faults shall be simulated. For the line to line, a fault reactance such as the line-to-line voltage at the STATCOM becomes just above 0.5 p.u. shall be introduced. For the phase to ground faults a fault reactance such as the positive phase sequence voltage becomes just above 0.3 p.u. shall be introduced. Fault clearing time shall be considered for 3 cycles.

1.2.3.3. Control Functions

Contractor shall perform the following study cases during Base Design Stage in PSCAD:

- EMT Study Description
 - Basic STATCOM Functionality
 - Energization of STATCOM, Start sequence
 - Automatic operation, linear voltage control over complete STATCOM range
 - STATCOM slope over complete STATCOM range
 - STATCOM step response in HIGH fault level network with slope = 1% and 5%.
 - STATCOM step response in LOW fault level network with slope = 1% and 5%.
 - De-energization of STATCOM, Stop sequence
 - Loss of system voltage
 - Variation of system frequency
 - Undervoltage/Overvoltage strategies
 - All control strategies
 - All other control and protection functions
 - Local and remote faults in PSCAD dynamic network
 - All other control and protection functions
 - Interaction Study with other FACTS, Converter Based Resources (Renewables), Generators and HVDC

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Notes:

- i. Step response study with all slopes (1% and 5%) shall be performed during Base Design Stage.**
- ii. Signals related to each case shall be reported. Contractor shall provide signal list in his Study Outlines.**

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1.2.4. Interaction Studies

Contractor shall perform comprehensive STATCOM interactions studies during Base Design Stage. The outcome of interactions studies shall define any coordination required and any signals that are needed to be exchanged with Generators, SVCs/STATCOMs & TCRs. The study shall be performed in PSCAD.

1.2.4.1. Interaction Studies with Other SVC/STATCOMs

Contractor shall perform the following for interaction with the other STATCOMs present in the network by considering the detail models of STATCOMs Gain optimization test: The study shall show if the other STATCOMs are contributing when optimization test is performed. The study shall be performed for minimum system fault level.

- Step response test
- System disturbances
- Gain optimization test

The aim of the study is to define the impact of operating STATCOM with Other STATCOMs controllers in consideration and inherent STATCOMs dynamics. The study shall cover steady state and transient simulations.

If any abnormal operation found in the STATCOM operation, Contractor shall provide the remedial solution. In case there is a risk of interaction, Contractor is required to do all necessary modifications (software and hardware) to eliminate the risk of interactions.

Moreover, Contractor shall provide the gain freeze signal (sending and receiving) in the STATCOM controller with adjustable freeze time 0-60sec in the steps of 0.1sec. Additional signals may be required for coordination such as initiating a request, sharing acknowledgement, sudden unfrozen due to system disturbance. Contractor shall reserve sufficient number of signals for proper coordination.

The interaction studies shall include STATCOMs connected at location specified in Annexure-A (Can be multiple depending on design selected by the contractor) and any other nearby SVC/STATCOM that may have impact shall also be considered in the studies. In case there is a risk of interaction between STATCOMs installed at the same bus or with other SVC/STATCOM buses, Contractor is required to do all necessary modifications (software and hardware) to eliminate the risk of interactions between STATCOMs/SVCs.

1.2.4.2. STATCOM Resonance Studies with Capacitor Bank

Contractor shall make sure that there is no resonance between STATCOMs and the existing capacitor banks. If resonance found, Contractor shall provide necessary solution to eliminate the resonance risk.

1.3. STATCOM Digital Models

The Contractor shall provide the following digital models to enable simulation of the STATCOM and its control and protective functions during steady-state operation, dynamic, and transient conditions in different timeframes. Models shall be provided with the User Manual (how to run the model). The models shall represent the entire STATCOM control and protective mode specified in this specification, which are relevant to each timeframe, including the interaction with the transmission line/cable protection. For each model, the Contractor shall provide an equivalent circuit representing the AC system at the STATCOM point of common coupling. The Contractor shall supply the Company with a preliminary PSCAD model within 8 weeks and with a preliminary PSS/E model within 12 weeks after Contract award Date.

The detailed (final) models including documentation shall be supplied before the start of the performance verification testing.

Contractor shall validate and benchmark the following models in factory acceptance test (FAT):

1. PSS/E user define model
2. PSS/E standard library model
3. PSCAD model

1.3.1. PSS/E Model

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This model shall be compatible with the principles of PSS/E (Power System Simulator for Engineers) dynamic simulations. It shall represent the fundamental frequency steady-state and dynamic behaviour of the STATCOM. The model shall be versatile enough to allow representation of additional control upgrades that may be expected during the guarantee period of the project. The dynamic model shall be written for the PSS/E version as used by the Company in the state space and extended term. The Contractor shall also provide the STATCOM model dll files for PSSE version # 33 & 36.

The Contractor shall provide PSS/E model (version 33) for time simulations of 10 ms up to 30s. Also, the model shall be suitable for extended simulations. PSS/E model shall be provided in the following formats:

- i. User define model flecs code format or FORTRAN open source.
- ii. Standard STATCOM model present in the PSS/E Library

The Contractor shall match the response of both PSS/E STATCOM model. Also, Contractor shall provide updates for the new versions that are released after version 36 up to the end of warranty period of this Project.

a. Model Verification

The performance of the digital model shall be verified by comparison with the fundamental frequency component of corresponding simulator and/or field tests for:

- i. Steady-state dominant modes of operation
- ii. Dynamic operation
- iii. All relevant control functions/strategies

b. Model Documentation

The model shall be described in enough detail and shall be in such a form as to allow the Company to code it directly in the PSS/E dynamic simulation software and obtain the same results. The model documentation shall include:

- i. A brief description of the overall structure of the model and an overview of all module and user-defined parameters
- ii. A brief description of the mathematical background and the basic characteristics and limitations of the model
- iii. A brief description and diagram of each module, and a detailed diagram showing all parameters and their dimensions
- iv. A diagram showing all module-interface variable and control signals.
- v. An explanation of all approximations, lumped or equivalent components
- vi. A brief description of each simulation verification case
- vii. A detailed table indicating the PSS/E parameters and the corresponding values.

1.3.2. PSCAD Model

This model shall be compatible with the principles of PSCAD/EMTDC simulations. It shall represent the STATCOM in enough detail to obtain simulation results, which match field tests and analogue simulator results. It shall allow the Company the ability to adjust STATCOM standard control parameters similar to those in the actual STATCOM HMI system. The following parameters, but not limited to, shall be accessible: voltage reference, gain, slope, UV and OV strategies, unsymmetrical control including enabling and disabling, slow regulation control, fixed current operating mode, STATCOM ON/OFF sequence, STATCOM trip, step response and any other special control features. The model shall represent the actual digital and analogue control and the main STATCOM. Furthermore, the individual control strategies shall have the ability to be activated or disabled and their control parameters must be fully adjustable.

a. Model Verification

The performance of the digital model shall be verified by comparison to the corresponding RTDS simulator results and field test for:

- i. Transient operation to demonstrate the behavior of the STATCOM to system events
- ii. Fault recovery performance: internal faults and external faults

b. Model Documentation

The model documentation shall include:

- i. A brief description of the overall structure of the model and an overview of all modules and user-defined parameters

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- ii. A brief description and diagram of each module, and a detailed diagram, in a form compatible with PSCAD/EMTDC representation techniques, showing all parameters with their dimensions
- iii. A diagram showing all module-interface variables and relevant control signals with their dimensions
- iv. A brief description of each simulation verification case
- v. Contractor shall provide/add detailed STATCOM model in the provided PSCAD file(s). The following control signals shall be accessible (as minimum):
 - 1. STATCOM ON/OFF command.
 - 2. Voltage setting.
 - 3. Slope setting.
 - 4. Gain adjustment.
 - 5. Undervoltage and Overvoltage strategy setting.
 - 6. Step response

Contractor shall submit the PSCAD (Windows version 4.6.3 and above) STATCOM model. Fortran Compiler used for compiling the PSCAD Model shall be mentioned and a copy of Fortran Compiler provided to Company. Contractor shall provide the one licenses for the compiler. Contractor shall provide updates for the new versions that are released after version 4.6.3 up to the end of warranty period of this Project.

1.3.3. DigSilent Power Factory Model

The Harmonic Study Model shall be developed using DIgSILENT PowerFactory and shall be fully compatible with the principles of frequency-domain and time-domain harmonic analysis as implemented in the software. The model shall accurately represent the harmonic emission, propagation, and interaction characteristics of the STATCOM and associated power electronic components under steady-state and dynamic operating conditions.

The model shall be suitable for conducting harmonic load flow, frequency scan, impedance scan, resonance assessment, and harmonic compliance studies in accordance with applicable international standards (including but not limited to IEEE 519 and IEC 61000 series). The harmonic model shall be sufficiently flexible to allow incorporation of additional control upgrades or filter configurations that may be introduced during the warranty and guarantee period of the Project.

The Contractor shall provide the Harmonic Study Model compatible with the PowerFactory version as used by the Company, including backward and forward compatibility within the same major release family. The model shall be suitable for harmonic studies over the frequency range required to assess characteristic, non-characteristic, and inter-harmonics relevant to the STATCOM operation.

The Harmonic Study Model shall be provided in the following formats:

- i. Native DIgSILENT PowerFactory DSL-based or library-based harmonic model, utilizing standard PowerFactory harmonic elements.
- ii. User-defined harmonic source representations using current source or frequency-dependent impedance models, as appropriate.

The Contractor shall ensure consistency between the harmonic behaviour represented in PowerFactory and that observed in PSCAD/RTDS or field measurements. The Contractor shall also provide model updates for new PowerFactory versions released during the warranty period of the Project.

a. Model Verification

The performance and accuracy of the harmonic model shall be verified through comparison with corresponding simulation results and/or field measurements for the following cases:

- i. Steady-state harmonic distortion levels, including individual harmonic components and Total Harmonic Distortion (THD) at the Point of Connection.
- ii. System impedance and resonance characteristics, verified through frequency scan analysis.
- iii. Harmonic interaction under different STATCOM operating modes, including varying reactive power output and voltage control settings.
- iv. Harmonic performance under different network configurations, including normal operation and credible contingency conditions.

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- v. Verification cases shall demonstrate compliance with applicable harmonic limits and confirm that the model reliably reproduces dominant harmonic phenomena observed in practical operation.

b. Model Documentation

The Harmonic Study Model documentation shall be provided in sufficient detail to enable the Company to independently use, modify, and validate the model within DIgSILENT PowerFactory. The documentation shall include, as a minimum:

- i. A brief description of the overall harmonic modelling philosophy, including assumptions and scope of applicability.
- ii. A description of the harmonic source representation, including characteristic harmonic orders, magnitude, phase angle assumptions, and frequency dependency.
- iii. A detailed description and diagram of each harmonic-related module, including filters, network impedances, transformers, and STATCOM harmonic emission models, with all parameters and units clearly indicated.
- iv. A diagram showing interface variables and harmonic signal paths, including interaction with the fundamental-frequency load flow model.
- v. An explanation of all approximations, lumped representations, and equivalent circuit assumptions used in the harmonic model.
- vi. A brief description of each harmonic verification and compliance assessment case, including study objectives and acceptance criteria.
- vii. A detailed table listing PowerFactory harmonic parameters, their definitions, and the corresponding values used in the studies.

The Contractor shall provide the complete PowerFactory project file(s) containing the detailed harmonic model, with all relevant elements clearly labelled and documented. All harmonic-related parameters shall be accessible to the Company for review and adjustment.

1.4. System Description and Data Files

This Section contains the system input data including PSS/E files for design studies to be performed by the Contractor and requirements for the system & design studies to be performed by the Contractor and, including requirements on the STATCOM simulation models that the Contractor has to provide, to be used by the Company to simulate the STATCOM performance and its control and protective functions in different time frames.

All simulations software adopted has to be fully specified (e.g. version) in order to allow the Company to use all models in its own simulation environment.

The studies mentioned in this Annexure shall also be performed during design stage of STATCOM project and submitted for Company review and approval.

1.4.1. System Data

System Data can be found in Annexure-A.

Note: The short circuit specified in Annexure-A shall not be used for equipment or grounding design. The maximum, minimum and abnormal short circuit currents specified in this document are intended for the design studies only.

1.4.2. PSSE System Study Data

1.4.2.1. PSSE Study Cases

The PSSE base cases for year 2027 and 2028/29 to be considered for system healthy conditions (Intact system) as follows:

- Ultimate Year Peak Load Case
- Ultimate Year Minimum Load Case
- Energization Year Peak Load Case
- Energization Year Minimum Load Case

Table 1: PSSE Files

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Study Scenario	Power Flow Data (v33)	Dynamic Data	UDM DLL/ python Files
Energization Year Peak Load Case	Summer_Peak_2026.sav	Summer_Peak_2026.dyr	1.10_GNET_P_JUL_26.py
Energization Year Minimum Load Case	Winter Off-Peak_2027.sav	Winter Off-Peak_2027.dyr	1.10_GNET P_JAN_27.py
Ultimate Year Peak Load Case	Summer_Peak_2028.sav	Summer_Peak_2028.dyr	1.10_GNET P_JUL_28.py
Ultimate Year Minimum Load Case	Winter Off-Peak_2029.sav	Winter Off-Peak_2029.dyr	GNET OP_JAN_29.py

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The following dynamic solution parameters shall be used in PSSE dynamic runs:

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- Iterations: 200
- Acceleration: 0.2
- DELT: 0.005

1.4.2.2. Fault Cases

The following contingency table shall be considered for Ultimate Year 2028/29 (Peak & Minimum Load Case) and Energization Year 2026/27 (Peak & Minimum Load Case) as a minimum requirement.

The Contractor shall make the case studies and if they found any critical/extreme cases, which is not mentioned in Table 2: Contingency List.

The Contractor shall incorporate such cases in the following table and consider in the study for PSSE & PSCAD.

Table 2: Contingency List

Sr. No.	Fault Description
1	3PH Fault at Bus 986 Trip T/F From Bus 986 To Bus 9860 Circuit ID 1
2	3PH Fault at Bus 9860 Trip T/F From Bus 9860 To Bus 986 Circuit ID 1
3	3PH Fault at Bus 9860 Trip T/L From Bus 9860 To Bus 9865 Circuit ID 1
4	3PH Fault at Bus 9865 Trip T/L From Bus 9865 To Bus 9860 Circuit ID 1
5	3PH Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 9859 Circuit ID 1
6	3PH Fault at Bus 9859 Trip T/L From Bus 9859 To Bus 80044 Circuit ID 1
7	3PH Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 9865 Circuit ID 1
8	3PH Fault at Bus 9865 Trip T/L From Bus 9865 To Bus 80044 Circuit ID 1
9	3PH Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 80040 Circuit ID 1
10	3PH Fault at Bus 80040 Trip T/L From Bus 80040 To Bus 80044 Circuit ID 1
11	3PH Fault at Bus 80040 Trip T/L From Bus 80040 To Bus 80030 Circuit ID 1
12	3PH Fault at Bus 80030 Trip T/L From Bus 80030 To Bus 80040 Circuit ID 1
13	3PH Fault at Bus 80030 Trip T/L From Bus 80030 To Bus 80020 Circuit ID 1
14	3PH Fault at Bus 80020 Trip T/L From Bus 80020 To Bus 80030 Circuit ID 1
15	3PH Fault at Bus 80020 Trip T/L From Bus 80020 To Bus 80050 Circuit ID 1
16	3PH Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80020 Circuit ID 1

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Annexure-C

Sr. No.	Fault Description
17	3PH Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80060 Circuit ID 1
18	3PH Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80050 Circuit ID 1
19	3PH Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80075 Circuit ID 1
20	3PH Fault at Bus 80075 Trip T/L From Bus 80075 To Bus 80050 Circuit ID 1
21	3PH Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80105 Circuit ID 1
22	3PH Fault at Bus 80105 Trip T/L From Bus 80105 To Bus 80060 Circuit ID 1
23	3PH Fault at Bus 80105 Trip T/L From Bus 80105 To Bus 80070 Circuit ID 1
24	3PH Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80105 Circuit ID 1
25	3PH Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80070 Circuit ID 5
26	3PH Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80060 Circuit ID 5
27	3PH Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80075 Circuit ID 1
28	3PH Fault at Bus 80075 Trip T/L From Bus 80075 To Bus 80070 Circuit ID 1
29	SLG Fault at Bus 986 Trip T/L From Bus 986 To Bus 9860 Circuit ID 1
30	SLG Fault at Bus 9860 Trip T/L From Bus 9860 To Bus 986 Circuit ID 1
31	SLG Fault at Bus 9860 Trip T/L From Bus 9860 To Bus 9865 Circuit ID 1
32	SLG Fault at Bus 9865 Trip T/L From Bus 9865 To Bus 9860 Circuit ID 1
33	SLG Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 9859 Circuit ID 1
34	SLG Fault at Bus 9859 Trip T/L From Bus 9859 To Bus 80044 Circuit ID 1
35	SLG Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 9865 Circuit ID 1
36	SLG Fault at Bus 9865 Trip T/L From Bus 9865 To Bus 80044 Circuit ID 1
37	SLG Fault at Bus 80044 Trip T/L From Bus 80044 To Bus 80040 Circuit ID 1
38	SLG Fault at Bus 80040 Trip T/L From Bus 80040 To Bus 80044 Circuit ID 1
39	SLG Fault at Bus 80040 Trip T/L From Bus 80040 To Bus 80030 Circuit ID 1
40	SLG Fault at Bus 80030 Trip T/L From Bus 80030 To Bus 80040 Circuit ID 1
41	SLG Fault at Bus 80030 Trip T/L From Bus 80030 To Bus 80020 Circuit ID 1
42	SLG Fault at Bus 80020 Trip T/L From Bus 80020 To Bus 80030 Circuit ID 1
43	SLG Fault at Bus 80020 Trip T/L From Bus 80020 To Bus 80050 Circuit ID 1
44	SLG Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80020 Circuit ID 1

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Annexure-C

Sr. No.	Fault Description
45	SLG Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80060 Circuit ID 1
46	SLG Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80050 Circuit ID 1
47	SLG Fault at Bus 80050 Trip T/L From Bus 80050 To Bus 80075 Circuit ID 1
48	SLG Fault at Bus 80075 Trip T/L From Bus 80075 To Bus 80050 Circuit ID 1
49	SLG Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80105 Circuit ID 1
50	SLG Fault at Bus 80105 Trip T/L From Bus 80105 To Bus 80060 Circuit ID 1
51	SLG Fault at Bus 80105 Trip T/L From Bus 80105 To Bus 80070 Circuit ID 1
52	SLG Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80105 Circuit ID 1
53	SLG Fault at Bus 80060 Trip T/L From Bus 80060 To Bus 80070 Circuit ID 5
54	SLG Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80060 Circuit ID 5
55	SLG Fault at Bus 80070 Trip T/L From Bus 80070 To Bus 80075 Circuit ID 1
56	SLG Fault at Bus 80075 Trip T/L From Bus 80075 To Bus 80070 Circuit ID 1
57	Contingencies for Generation, FACTS, CAPACITORS and REACTORS, big inductive/capacitive loads switch ON/OFF in all Substations as per Single Line Diagram attached end of this Annexure.

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1.4.2.3. Recorded Signals

As minimum following signals shall be recorded during the studies. Contractor shall include others as deemed necessary to facilitate the studies.

Table-3: Minimum List of Recorded Signals

Channel Number	Channel Description	Channel Identifier
1	BUS VOLTAGE BUS 986	VOLT 986 [KHUZDAR 220.00]
2	BUS VOLTAGE BUS 9860	VOLT 9860 [KHUZDAR 132.00]
3	BUS VOLTAGE BUS 80000	VOLT 80000 [MAND 132.00]
4	BUS VOLTAGE BUS 80010	VOLT 80010 [TUMP 132.00]
5	BUS VOLTAGE BUS 80020	VOLT 80020 [TURBAT 132.00]
6	BUS VOLTAGE BUS 80021	VOLT 80021 [TURBAT-1 132.00]
7	BUS VOLTAGE BUS 80030	VOLT 80030 [HOSHAB 132.00]
8	BUS VOLTAGE BUS 80040	VOLT 80040 [PANJGUR 132.00]
9	BUS VOLTAGE BUS 80050	VOLT 80050 [PASNI 132.00]

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Annexure-C

Channel Number	Channel Description	Channel Identifier
10	BUS VOLTAGE BUS 80060	VOLT 80060 [GWADAR IND 132.00]
11	BUS VOLTAGE BUS 80070	VOLT 80070 [GWADAR 132.00]
12	BUS VOLTAGE BUS 80075	VOLT 80075 [NGIA 132.00]
13	BUS VOLTAGE BUS 80077	VOLT 80077 [JIWANI 132.00]
14	BUS VOLTAGE BUS 80105	VOLT 80105 [DEEPSEA 132.00]
15	BUS VOLTAGE BUS 80120	VOLT 80120 [ORMARA 132.00]
16	BUS VOLTAGE BUS 80001	VOLT 80001 [T-1 11.000]
17	BUS VOLTAGE BUS 80011	VOLT 80011 [T-1 11.000]
18	BUS VOLTAGE BUS 80022	VOLT 80022 [T-3 11.000]
19	BUS VOLTAGE BUS 80031	VOLT 80031 [T-1 11.000]
20	BUS VOLTAGE BUS 80041	VOLT 80041 [T-1 11.000]
21	BUS VOLTAGE BUS 80042	VOLT 80042 [T-2 11.000]
22	BUS VOLTAGE BUS 80061	VOLT 80061 [T-1 11.000]
23	BUS VOLTAGE BUS 80071	VOLT 80071 [T-1 11.000]
24	BUS VOLTAGE BUS 80072	VOLT 80072 [T-2 11.000]
25	BUS VOLTAGE BUS 80121	VOLT 80121 [T-1 11.000]
26	BUS VOLTAGE BUS 88051	VOLT 88051 [T-1 11.000]
27	BUS VOLTAGE BUS 800206	VOLT 800206 [T-2 11.000]
28	BUS VOLTAGE BUS 800207	VOLT 800207 [T-1 11.000]
29	BUS VOLTAGE BUS 800751	VOLT 800751 [T-1 11.000]
30	BUS VOLTAGE BUS 800752	VOLT 800752 [T2 11.000]
31	BUS VOLTAGE BUS 800771	VOLT 800771 [T-1 11.000]
32	BUS VOLTAGE BUS 801051	VOLT 801051 [T-1 11.000]
33	MW FLOW 986-9860 CKT 1	KHUZDAR-160MVA-T1_P
34	MVAR FLOW 986-9860 CKT 1	KHUZDAR-160MVA-T1_Q
35	MW FLOW 986-9860 CKT 2	KHUZDAR-160MVA-T2_P
36	MVAR FLOW 986-9860 CKT 2	KHUZDAR-160MVA-T2_Q
37	MW FLOW 9860-9865 CKT 1	KHUZDAR-NAL-1_P
38	MVAR FLOW 9860-9865 CKT 1	KHUZDAR-NAL-1_Q
39	MW FLOW 9860-9865 CKT 2	KHUZDAR-NAL-2_P
40	MVAR FLOW 9860-9865 CKT 2	KHUZDAR-NAL-2_Q
41	MW FLOW 9865-9859 CKT 1	NAL-BASIMA-1_P
42	MVAR FLOW 9865-9859 CKT 1	NAL-BASIMA-1_Q
43	MW FLOW 9865-80044 CKT 1	NAL-NAG-1_P
44	MVAR FLOW 9865-80044 CKT 1	NAL-NAG-1_Q

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Channel Number	Channel Description	Channel Identifier
45	MW FLOW 9859-80044 CKT 1	BASIMA-NAG-1_P
46	MVAR FLOW 9859-80044 CKT 1	BASIMA-NAG-1_Q
47	MW FLOW 80044-80040 CKT 1	NAG-PAJGOUR-1_P
48	MVAR FLOW 80044-80040 CKT 1	NAG-PAJGOUR-1_Q
49	MW FLOW 80044-80040 CKT 2	NAG-PAJGOUR-2_P
50	MVAR FLOW 80044-80040 CKT 2	NAG-PAJGOUR-2_Q
51	MW FLOW 80040-80030 CKT 1	PAJGOUR-HOSHAB-1_P
52	MVAR FLOW 80040-80030 CKT 1	PAJGOUR-HOSHAB-1_Q
53	MW FLOW 80040-80030 CKT 2	PAJGOUR-HOSHAB-2_P
54	MVAR FLOW 80040-80030 CKT 2	PAJGOUR-HOSHAB-2_Q
55	MW FLOW 80030-80020 CKT 1	HOSHAB-TURBAT-1_P
56	MVAR FLOW 80030-80020 CKT 1	HOSHAB-TURBAT-1_Q
57	MW FLOW 80030-80020 CKT 2	HOSHAB-TURBAT-2_P
58	MVAR FLOW 80030-80020 CKT 2	HOSHAB-TURBAT-2_Q
59	MW FLOW 80020-80050 CKT 1	TURBAT-PASNI-1_P
60	MVAR FLOW 80020-80050 CKT 1	TURBAT-PASNI-1_Q
61	MW FLOW 80020-80050 CKT 2	TURBAT-PASNI-2_P
62	MVAR FLOW 80020-80050 CKT 2	TURBAT-PASNI-2_Q
63	MW FLOW 80050-80060 CKT 1	PASNI-GWADAR-1_P
64	MVAR FLOW 80050-80060 CKT 1	PASNI-GWADAR-1_Q
65	MW FLOW 80050-80075 CKT 1	PASNI-NGIA-1_P
66	MVAR FLOW 80050-80075 CKT 1	PASNI-NGIA-1_Q
67	MW FLOW 80070-80105 CKT 1	GWADAR-DEEPSEA-1_P
68	MVAR FLOW 80070-80105 CKT 1	GWADAR-DEEPSEA-1_Q
69	MW FLOW 80070-80060 CKT 5	GWADAR-GWADARIND-5_P
70	MVAR FLOW 80070-80060 CKT 5	GWADAR-GWADARIND-5_Q

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Channel Number	Channel Description	Channel Identifier
71	MW FLOW 80070-80075 CKT 1	GWADAR-NGIA-1_P
72	MVAR FLOW 80070-80075 CKT 1	GWADAR-NGIA-1_Q
73	Study STATCOM I _{ref}	As Ordered by STATCOM Controller
74	I _{VSC}	For STATCOM Under Study
75	I _{Filters}	For STATCOM Under Study
76	I _{STATCOM}	For STATCOM Under Study
77	Q _{STATCOM}	For STATCOM Under Study
78	QSVC/QSTATCOM	For All Nearby STATCOMS/SVC
79	Any additional signal that may seem necessary to facilitate the study review	

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1.4.3. PSCAD System Study Data

1.4.3.1. PSCAD Study Cases

The Contractor shall convert all PSSE files into PSCAD files through ETRAN for the area as specified in provided PSSE sld's. For the STATCOMs under study the Contractor shall use detailed model whereas for remaining SVC/STATCOM generic models can be used.

The Contractor shall submit the following at the project design stage

- Fully Working PSCAD Files as developed through ETRAN Conversion
- Supporting files such as
 - ETRAN Library Files
 - ETRAN Compiler File
- Corresponding Dyr Files which works with the converted PSCAD Model

1.4.3.2. Fault Cases

Refer to section E.4.2.2 Fault Cases.

1.4.3.3. Recorded PSCAD Signals

Magnitude to be monitor during the simulations will include as minimum:

1. Power flows (MW and Mvar) shall be monitored for all branches connected to 132kV PASNI, Gwadar, NAL, BASIMA, TURBAT, PANJGOUR.
2. 132kV PASNI STATCOMs output I_{ref} as ordered by STATCOM controller and IVSC, Ifilters, ISTATCOM & QSTATCOM.
3. All Nearby SVC/STATCOM reactive Power QSVC/ QSTATCOM, as per single line diagram.
4. ALL generators station real and reactive power as per single line diagram in all cases applicable.
5. Voltages 132/11kV at all substations as per Single Line diagram.
6. Any additional signal that may seem necessary to facilitate the study review.
7. Slope, Gain supervision signals, Signals for under and over-voltage strategies, Trip signals.
8. HV & MV arrester energy and currents.
9. VSC firing and blocking signals.
10. VSC protection signals.
11. Contractor shall propose other signals in the STATCOM.

1.4.4. Harmonic Study Data

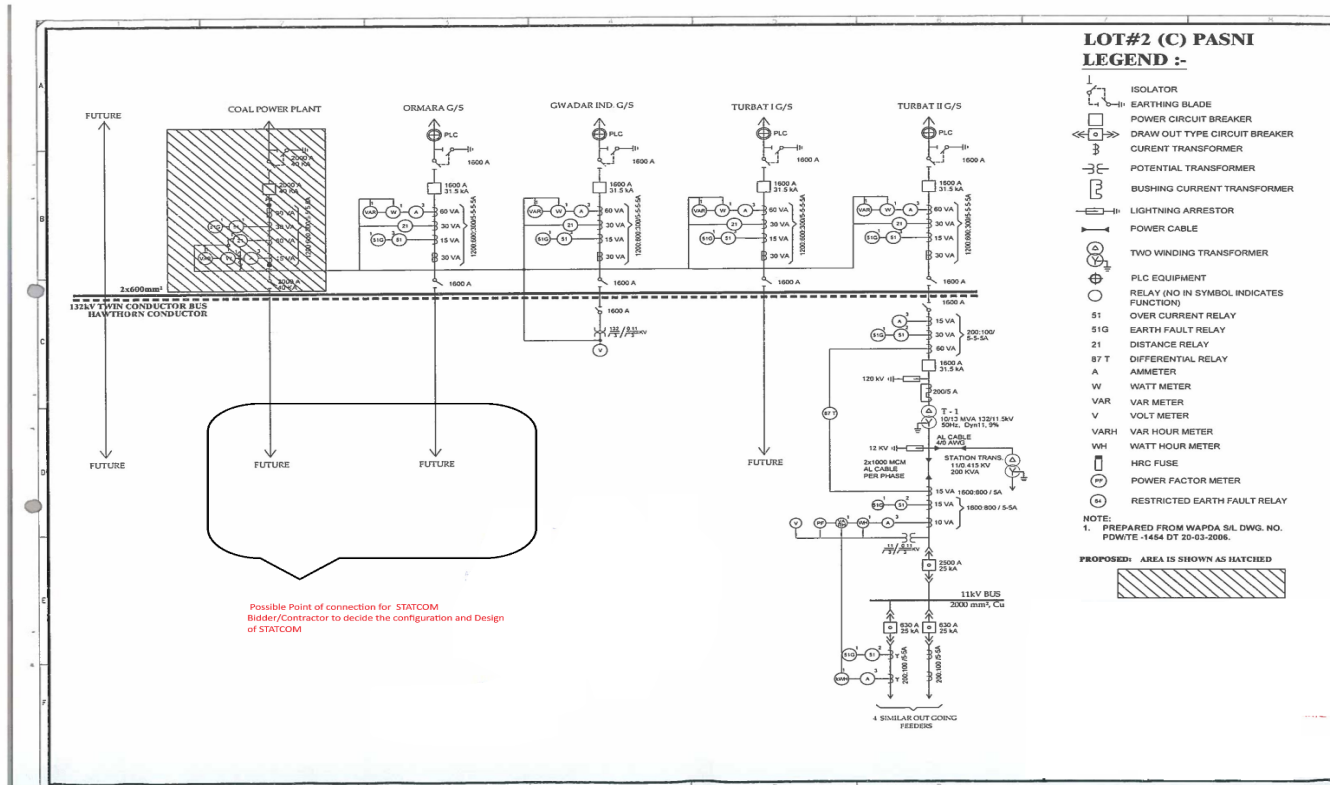
CONTRACTOR need to perform Harmonic Study at project design stage. Software used shall be Digsilent Power Factory. The Contractor shall perform study in accordance with specifications and corresponding Annexures.

Annexure-C

SUBSTATIONS AS PER SINGLE LINE DIAGRAM

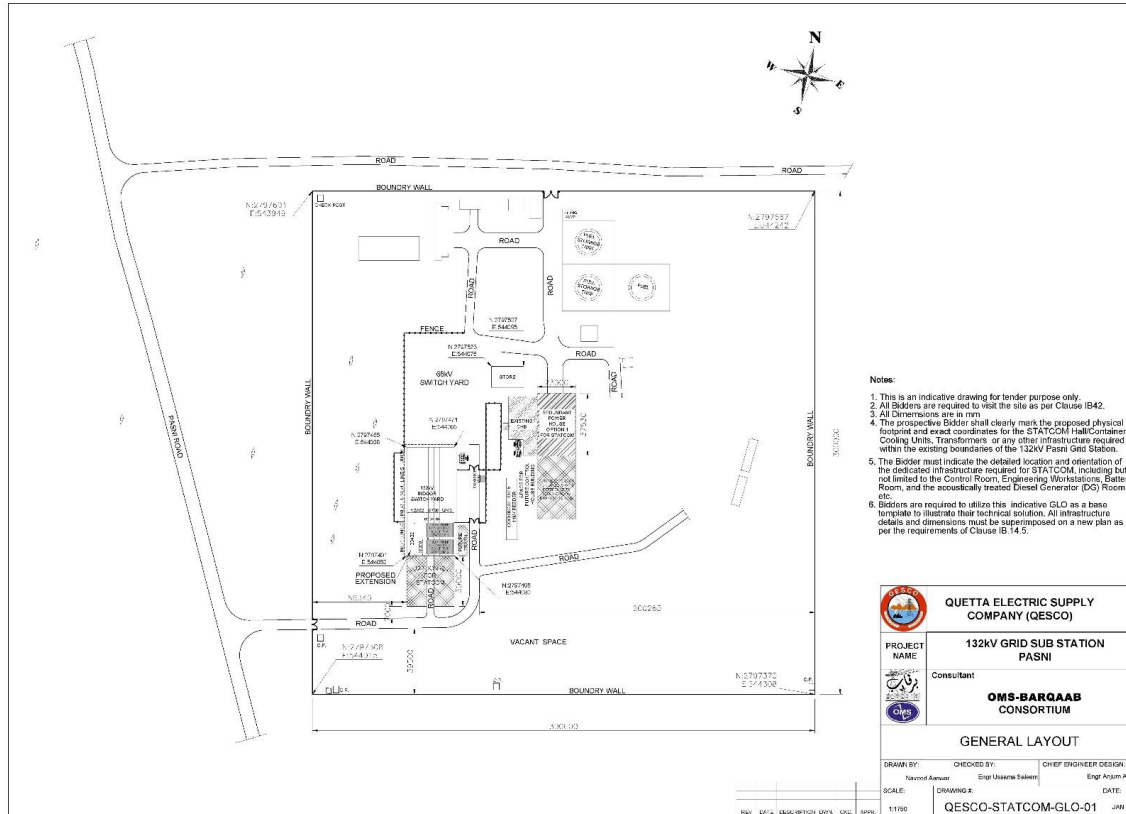
Annexure-D

D-1: Single Line Diagram 132kV Grid Station Pasni



Annexure-D

D-2: General Layout 132kV Grid Station Pasni



Annexure-E

2. SYSTEM STUDIES, DESIGNS STUDIES AND SIMULATION MODELS

2.1. System Studies

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This annexure contains the requirements for the system and design studies to be performed by the Contractor, including requirements on the STATCOM simulation models that the Contractor has to provide, to be used by the Company to simulate the STATCOM performance and its control and protective functions in different time frames.

All simulations software adopted has to be fully specified (e.g. version) in order to allow the Company to use all models in its own simulation environment.

In the study reports, findings that affects the operation of the STATCOM and recommendations how to operate the power grid with the new device(s) shall be given. Highlight any concerns/actions required for satisfactory use of the STATCOM.

2.1.1. Requirements for the Report

The Contractor shall carry out and report on the system studies and optional studies specified herein and any additional studies which are determined to be necessary. The cost of any additional studies determined to be necessary shall be included in the Contract price.

The Contractor shall satisfy the Company as to the adequacy (meeting the international standards as well as NGC requirements) of the studies carried out in accordance with the Contract.

The Company shall have the right to observe and participate in all of the studies and shall have access to all data necessary for a complete understanding of the purpose of such studies, as well as validity of the results. For each study item, the Contractor shall submit to the Company, by the specified date, the specified number of copies of the study report. The work shall include, but not limited to the following:

- i) study objective
- j) initial conditions, data and assumptions
- k) codes, standards and criteria used in the studies
- l) description of means and methods used in the studies
- m) computer models and data used in the studies to represent the Contractor's equipment and the Company equipment
- n) summary of study results
- o) conclusions
- p) reference(s)

A study outline abstract containing items a) through e) above shall be submitted to the Company for review and comment prior to commencement of each study. The study shall be performed after the approval of respective outline.

Contractor shall provide simulation files, plots in high definition, results in native software file format and a detailed report. The report shall highlight possible interactions (if any), optimization of the controllers and signals that are required to be exchanged. Contractor shall provide system model soft files of PSCAD, Power Factory & PSS/E software.

Note: All STATCOM design studies performed during various stages of the project shall be submitted along with the corresponding simulation models such as PSS/E, PSCAD and Power Factory models used in the studies. The simulation models shall be used to reproduce and verify *the reported results*. Contractor shall provide all supporting files including models (*.dll), python scripts and instruction file to facilitate the quick review of the report. The studies report shall not be reviewed without models.

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2.1.2. STATCOM Design Verification Studies

The Contractor shall perform studies to determine the design ratings and requirements of all plant and material to be supplied under this contract. The Contractor shall confirm the design ratings and requirements of all plant and material to be supplied under this contract.

Annexure-E

6. The Contractor shall perform studies using electromagnetic transient simulation principles to determine the design ratings and requirements of all plant and material to be supplied under this contract. Engineering studies should be performed within the scope of supply. Studies are required to demonstrate that the STATCOM meets all specified performance criteria. The Bid must contain a list all engineering studies. All dynamic simulations shall be done using PSS/E version 33.10.0, all EMT studies shall be done using PSCAD (latest version). Contractor shall specify the compiler version used. Contractor shall provide the two licenses for the PSCAD compiler.
7. Prior to manufacture of the STATCOM, the Contractor shall perform simulation studies within agreed time frames for review, comment and participation by the Company. The Company reserves the right to perform parallel verification studies on its own, or by a third party. The Contractor shall provide all required information for independent design verification and system modeling (including PSS/E, PSCAD & Power Factory software files, assumption basis, etc.). The Company shall be utilizing the electromagnetic transient simulation package (PSCAD version 4.6.3 or higher), PSS/E version 33 and Power Factory Version 22 for verification and require the data to be either in the correct format or available EMTDC, PSS/E and Power Factory data format.
8. If the Company's or third party's studies indicate disagreement with the Contractor's results, the Contractor shall be prepared to work with the Company or his representative to reach an agreement on the controversial issues and/or to make the required design corrections, in accordance with this specification.
9. When performing the designs, all modes of operation specified in the technical specifications and the worst-case system conditions up to and including first contingency outage in the Company network shall be considered.
10. The Contractor shall identify, and the Company shall provide, all existing equipment and network data reasonably needed by the Contractor in performing their studies (Contractor shall provide the list of input data requirements at Bidding Stage). The simulation studies will be based upon the Company's network, considering the list of contingencies described in section E.4.2.2 Table-2: Fault Cases. The maximum and minimum generation as well the maximum and minimum load networks shall be considered. The data not provided by the Company shall be clearly indicated in the Bid Proposals if the information provided in this specification is inadequate. The Bidders shall also clearly state the reasons for requiring such data and the purposes for which it will be used.
Contractor shall not share any details to other parties without Company's written approval. Company will consider that all the required data has been provided to the Contractor if no additional data request received at the bidding stage from the Contractor.

2.2. Design Studies

Contractor shall perform the following studies and prepare the study reports as specified below. The Contractor shall carry out such electrical simulation (EMT) studies and basic design studies as are required to design the STATCOM. The Contractor shall perform design and simulation verification studies to ensure proper design and operation of the system. These studies shall consider all the defined modes of operation. The Contractor shall allow the Company or his representative to witness, review and provide comment on such studies and simulations.

2.2.1. Harmonic Performance Study

This is to verify the adequacy (meeting the international standards as well as Company requirements) of the STATCOM harmonic design through simulation of the Company's network response to STATCOM harmonics. It should include evaluating maximum harmonic levels at the STATCOM point of common coupling (PCC).

The Contractor should perform detailed harmonic performance study at Base Design Stage.

Determination of maximum system harmonic levels should be based on the following:

- Network impedance sectors.

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- Evaluation of specified system operating conditions with maximum harmonic generation at any operating point in the STATCOM range.
- Evaluation with maximum filter component tolerances.
- Evaluation with maximum system voltage unbalance and firing angle unbalance for non-characteristic harmonic generation.
- Evaluation of possible resonant over-voltages
- Evaluation of the filter thermal ratings based on specified operating conditions.
- Transformer saturation induced harmonics.

2.2.2. Harmonic Performance Study

Detailed harmonic impedance and impact design and measurements to verify the filter design. The detailed filter configuration shall be supplied. This is to verify the adequacy of the STATCOM harmonic filter design through simulation of the Company's equivalent network response to STATCOM harmonics. It should include evaluating maximum harmonic levels at the STATCOM point of common coupling (PCC).

Determination of maximum system harmonic levels should be based on the following:

8. Calculation of the network harmonic impedance using the network data supplied in the specification considering the worst case for both maximum current and voltage distortion and amplification. This shall be based on contingencies as specified.
9. Evaluation of specified system operating conditions, including maximum and minimum system voltage levels, and maximum and minimum reactive power output of the STATCOM with maximum harmonic generation at any operating point in the STATCOM range.
10. Evaluation with maximum filter component tolerances.
11. Evaluation with maximum system voltage unbalance and firing angle unbalance for non-characteristic harmonic generation.
12. Evaluation of possible resonant overvoltage
13. Evaluation of the filter thermal ratings based on specified operating conditions.
14. Transformer saturation induced harmonics.

2.2.3. Dynamic Performance Studies

Studies shall be performed to define control strategies as well as identify voltage and current stresses (besides harmonic performance, short circuit studies and V-I characteristic requirements). Fault scenarios are described in E.4.2.2 Table-2: Fault Cases.

Transient and stability studies to verify the STATCOM control system performance, evaluate STATCOM control system function and optimize the control of STATCOM during system disturbances, such as major faults (three phase faults with normal clearing, single line to ground faults with delayed clearing, etc.) load rejection or loss of generation in the Company's network (the Company network and contingency list described in E.4.2.2 Table-2: Fault Cases). The design shall investigate the adequacy (meeting the international standards as well as Company requirements) of the STATCOM to ensure stability and prevent under-voltages or over-voltages during system transient, dynamic and fault conditions.

2.2.3.1. PSSE Dynamic Performance Study

The PSSE base cases to be considered for system healthy conditions are as follows and listed in section E4.2.1 PSSE Study Cases:

- Peak and minimum load case for the energization year
- Peak and Minimum load case for the ultimate year.

The Contractor shall include the STATCOM model in the above PSSE cases and perform dynamic performance studies. The Contractor shall consider the fault cases as mentioned in the section E.4.2.2 Table-2: Fault Cases of this Annexure. The studies shall verify that the STATCOM provides adequate dynamic control to meet the system requirements and performance criteria for selected disturbances

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(faults/tripping/load rejections). The studies shall also verify the behaviour and contribution of STATCOM to the system's recovery from a fault. The Contractor shall also document the contingencies resulting in instability as part of the Dynamic Performance Study. The PSSE model used in the study shall contain all necessary control functions/strategies relevant to the RMS time frame and test results shall be provided to confirm the modelling of function and/or strategies in PSSE dynamic performance study report.

2.2.3.2. PSCAD Functional and Dynamic Performance Study

The PSCAD base cases created in section E.4.3.1 PSCAD to be considered for system healthy conditions. The Contractor should perform detailed PSCAD functional and dynamic performance study at Base Design Stage.

This study is divided in a number of separate studies:

- STATCOM response time and of the STATCOM's behaviour and contribution to the system's recovery from faults. The studies shall indicate the methodology used in determining the STATCOM response to network identified faults. This is of primary importance considering the application of the STATCOM in the Company's network and the defined requirements as stipulated in this specification in order to provide rapid voltage control through reactive power support at the selected system nodes.
- Bandwidth Study: The open loop transfer function on the STATCOM and main circuit shall be demonstrated. The ability to suppress harmonics from interaction with the control shall be verified.
- Study of control functions, including transformer and STATCOM energization, shutdown, and other switching events.
- Balancing of unsymmetrical system voltage. The STATCOM performance during large system unbalances such as line faults shall be studied. Special care shall be taken to the performance when one or several of the controllable elements in the STATCOM reach their capability limits. A strategy for operation at the limits of the STATCOM power range shall be developed. The studies shall cover unsymmetrical operation with the VSC. The optimal strategy for operation during single line to ground faults shall be developed. Company aims for maximal voltage support while avoiding severe line to line over-voltages.
- Interaction with nearby Generators, Converter based resources (renewables), SVC/STATCOMs & TCRs. The Contractor shall study control system interaction and suggest remedies if needed. The nearby Generators, SVC/STATCOMs & TCRs shall be modelled as built/designed.
- Switching & Ferro-resonance Studies: All studies related to switching, Ferro resonance shall be performed. These studies shall also consider the effect of existing transformers and all Voltage transformers.

The Contractor shall consider the cases (faults/tripping) in E.4.2.2 Table-2: Fault Cases for PSCAD dynamic performance studies. However, additional cases to assure robust dynamic performance of the STATCOM shall be added as necessary. Signal list mentioned in E.4.3.3 Recorded Signals shall be considered as minimum.

2.2.3.2.1. Step Response Study

Step response shall be performed during according to the mentioned requirement.

Step response study with different slopes (1% and 5%) shall be performed during Base Design Stage. The step response study shall be performed for Maximum, Minimum & Abnormal network conditions.

Step response requirements shall be met for both strong and weak network conditions without changing the controller regulator/gain settings.

The Contractor shall prove that system shall remain stable at abnormal network condition with the same regulator/gain settings as considered for Maximum & Minimum Short Circuit Level.

The Contractor shall also prove that overshoot shall be in the limit (mentioned in Specification sub-clause 7.5 Control System Response and stability) that it cannot cause any equipment damage/failure.

The requirements shall be verified by PSCAD simulation for strong, weak & abnormal network condition. A simple Thevenin equivalent giving the correct short circuit impedances and X/R ratio shall be used for the

Annexure-E

study. Actual Short circuit impedance and X/R mentioned in the Annexure-A System Characteristic shall be used.

A table shall be provided in the report to show the following quantities for each case (small signal behaviour & large signal behaviour):

Initial primary voltage before giving voltage step

11. Slope
12. Step change in Vref (%)
13. Final Primary voltage
14. Initial Iref (based on 100MVA base)
15. Final Iref (based on 100MVA base)
16. Settling time
17. Response time
18. Overshoot (%)
19. Gain value
20. QSTATCOM

The following study shall be performed by the Contractor as a part of step response study. The simulations for the voltage response shall be drawn.

2.2.3.2.1.1. Small Signal Behaviour

3) Positive Step

- a) Start with the STATCOM operating at a current order (Iref) for VSC equal to zero (0) for the complete STATCOM. Make a positive step in the STATCOM positive phase sequence voltage reference (Vref) such that Iref, after the settling time has elapsed, becomes just below the maximum Iref given by the STATCOM MVAR rating. For this case the STATCOM is allowed to hit its capacitive limit for the overshoot.
- b) Repeat the sequence above four (4) times but make the step in Vref gradually smaller. The voltage step size shall be such that Iref/Bref, after the settling time has elapsed, is reduced by 20% of maximum Iref/Bref for each step.

4) Negative Step

- a) Start with the STATCOM operating at a Iref equal to zero (0). Make a negative step in Vref such that Iref, after the settling time has elapsed, becomes just above the minimum Iref given by the STATCOM MVAR rating. For this case the STATCOM is allowed to hit its inductive limit for the overshoot.
- b) Repeat the sequence above four (4) times but make the step in Vref gradually smaller. The voltage step size shall be such that Iref/Bref, after the settling time has elapsed, is increased by 20% of minimum Iref for each step.

The five (5) simulations in each (1) and (2) above for the voltage shall be drawn in one common separate diagram.

The following signals shall be plotted:

Plot 1 (separate subplots for each signal below).

- System positive phase sequence voltage as measured by the STATCOM (nonfiltered signal) and the step change in Vref.
- STATCOM output Iref as ordered by the STATCOM controller.
- QSTATCOM

Plot 2 (separate subplots for each signal below).

- Ivsc, Ifilter and ISTATCOM

2.2.3.2.1.2. Large Signal Behaviour

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4) Positive Step

Start with the STATCOM operating at a current order (I_{ref}) equal to zero (0) for the complete STATCOM. Make a positive step in the STATCOM positive phase sequence voltage reference (V_{ref}) of 50%. For this case the STATCOM shall hit its capacitive limit.

5) Negative Step

Start with the STATCOM operating at an I_{ref} equal to zero (0). Make a negative step in V_{ref} of 50%. For this case the STATCOM shall hit its inductive limit.

6) Single Line to Ground Fault

Make a stiff single line to ground fault on the HV side of the STATCOM power transformer. Use the same template for plotting the signals as for the small signal behaviour simulations.

2.2.3.2.2. Bandwidth

A study demonstrating the bandwidth of the complete STATCOM shall be performed during project design stage.

The STATCOM shall operate close to zero output. A voltage source with small magnitude ramping up the frequency from 0 to 600 Hz shall be superimposed on the input of its voltage measuring circuits. Fundamental frequency voltage shall be given by an infinitely strong voltage source. The effect on voltage at the point of connection shall be studied. This point shall be decoupled from the input voltage. The impedance at the point of connections shall be as given by max and min short circuit power.

A Bode diagram of the gain and phase of the open loop difference on input and output voltage shall be shown. A Thevenin equivalent is sufficient for the study.

2.2.3.2.3. Control Stability at System Faults

The contractor shall perform the following simplified study for the control stability.

STATCOM behaviour during large voltage changes, both in amplitude and in angle shall be demonstrated. The STATCOM at location specified in Annexure-A, together with the lines one bus away shall be modelled in PSCAD. The lines shall be modelled with distributed parameters. At each ending bus a Thevenin equivalent shall be placed, the impedances shall be as given by twice the maximum and minimum short circuit impedances at the STATCOM location. The lines shall be loaded by a 60-degree difference in voltage between the two voltage sources. Single line to ground, line to line and 3 phases to ground faults shall be simulated. For the line to line, a fault reactance such as the line-to-line voltage at the STATCOM becomes just above 0.5 p.u. shall be introduced. For the phase to ground faults a fault reactance such as the positive phase sequence voltage becomes just above 0.3 p.u. shall be introduced. Fault clearing time shall be considered for 3 cycles.

2.2.3.3. Control Functions

Contractor shall perform the following study cases during Base Design Stage in PSCAD:

- EMT Study Description
 - Basic STATCOM Functionality
 - Energization of STATCOM, Start sequence
 - Automatic operation, linear voltage control over complete STATCOM range
 - STATCOM slope over complete STATCOM range
 - STATCOM step response in HIGH fault level network with slope = 1% and 5%.
 - STATCOM step response in LOW fault level network with slope = 1% and 5%.
 - De-energization of STATCOM, Stop sequence
 - Loss of system voltage

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- Variation of system frequency
- Undervoltage/Overvoltage strategies
- All control strategies
- All other control and protection functions
- Local and remote faults in PSCAD dynamic network
- All other control and protection functions
- Interaction Study with other FACTS, Converter Based Resources (Renewables), Generators and HVDC

Notes:

- iii. **Step response study with all slopes (1% and 5%) shall be performed during Base Design Stage.**
- iv. **Signals related to each case shall be reported. Contractor shall provide signal list in his Study Outlines.**

2.2.4. Interaction Studies

Contractor shall perform comprehensive STATCOM interactions studies during Base Design Stage. The outcome of interactions studies shall define any coordination required and any signals that are needed to be exchanged with Generators, SVCs/STATCOMs & TCRs. The study shall be performed in PSCAD.

2.2.4.1. Interaction Studies with Other SVC/STATCOMs

Contractor shall perform the following for interaction with the other STATCOMs present in the network by considering the detail models of STATCOMs Gain optimization test: The study shall show if the other STATCOMs are contributing when optimization test is performed. The study shall be performed for minimum system fault level.

- Step response test
- System disturbances
- Gain optimization test

The aim of the study is to define the impact of operating STATCOM with Other STATCOMs controllers in consideration and inherent STATCOMs dynamics. The study shall cover steady state and transient simulations.

If any abnormal operation found in the STATCOM operation, Contractor shall provide the remedial solution. In case there is a risk of interaction, Contractor is required to do all necessary modifications (software and hardware) to eliminate the risk of interactions.

Moreover, Contractor shall provide the gain freeze signal (sending and receiving) in the STATCOM controller with adjustable freeze time 0-60sec in the steps of 0.1sec. Additional signals may be required for coordination such as initiating a request, sharing acknowledgement, sudden unfrozen due to system disturbance. Contractor shall reserve sufficient number of signals for proper coordination.

The interaction studies shall include STATCOMs connected at location specified in Annexure-A (Can be multiple depending on design selected by the contractor) and any other nearby SVC/STATCOM that may have impact shall also be considered in the studies. In case there is a risk of interaction between STATCOMs installed at the same bus or with other SVC/STATCOM buses, Contractor is required to do all necessary modifications (software and hardware) to eliminate the risk of interactions between STATCOMs/SVCs.

2.2.4.2. STATCOM Resonance Studies with Capacitor Bank

Contractor shall make sure that there is no resonance between STATCOMs and the existing capacitor banks. If resonance found, Contractor shall provide necessary solution to eliminate the resonance risk.

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2.3. STATCOM Digital Models

The Contractor shall provide the following digital models to enable simulation of the STATCOM and its control and protective functions during steady-state operation, dynamic, and transient conditions in different timeframes. Models shall be provided with the User Manual (how to run the model). The models shall represent the entire STATCOM control and protective mode specified in this specification, which are relevant to each timeframe, including the interaction with the transmission line/cable protection. For each model, the Contractor shall provide an equivalent circuit representing the AC system at the STATCOM point of common coupling. The Contractor shall supply the Company with a preliminary PSCAD model within 8 weeks and with a preliminary PSS/E model within 12 weeks after Contract award Date.

The detailed (final) models including documentation shall be supplied before the start of the performance verification testing.

Contractor shall validate and benchmark the following models in factory acceptance test (FAT):

4. PSS/E user define model
5. PSS/E standard library model
6. PSCAD model

2.3.1. PSS/E Model

This model shall be compatible with the principles of PSS/E (Power System Simulator for Engineers) dynamic simulations. It shall represent the fundamental frequency steady-state and dynamic behaviour of the STATCOM. The model shall be versatile enough to allow representation of additional control upgrades that may be expected during the guarantee period of the project. The dynamic model shall be written for the PSS/E version as used by the Company in the state space and extended term. The Contractor shall also provide the STATCOM model dll files for PSSE version # 33 & 36.

The Contractor shall provide PSS/E model (version 33) for time simulations of 10 ms up to 30s. Also, the model shall be suitable for extended simulations. PSS/E model shall be provided in the following formats:

- iii. User define model flecs code format or FORTRAN open source.
- iv. Standard STATCOM model present in the PSS/E Library

The Contractor shall match the response of both PSS/E STATCOM model. Also, Contractor shall provide updates for the new versions that are released after version 36 up to the end of warranty period of this Project.

c. Model Verification

The performance of the digital model shall be verified by comparison with the fundamental frequency component of corresponding simulator and/or field tests for:

- iv. Steady-state dominant modes of operation
- v. Dynamic operation
- vi. All relevant control functions/strategies

d. Model Documentation

The model shall be described in enough detail and shall be in such a form as to allow the Company to code it directly in the PSS/E dynamic simulation software and obtain the same results. The model documentation shall include:

- viii. A brief description of the overall structure of the model and an overview of all module and user-defined parameters
- ix. A brief description of the mathematical background and the basic characteristics and limitations of the model
- x. A brief description and diagram of each module, and a detailed diagram showing all parameters and their dimensions
- xi. A diagram showing all module-interface variable and control signals.
- xii. An explanation of all approximations, lumped or equivalent components
- xiii. A brief description of each simulation verification case

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- xiv. A detailed table indicating the PSS/E parameters and the corresponding values.

2.3.2. PSCAD Model

This model shall be compatible with the principles of PSCAD/EMTDC simulations. It shall represent the STATCOM in enough detail to obtain simulation results, which match field tests and analogue simulator results. It shall allow the Company the ability to adjust STATCOM standard control parameters similar to those in the actual STATCOM HMI system. The following parameters, but not limited to, shall be accessible: voltage reference, gain, slope, UV and OV strategies, unsymmetrical control including enabling and disabling, slow regulation control, fixed current operating mode, STATCOM ON/OFF sequence, STATCOM trip, step response and any other special control features. The model shall represent the actual digital and analogue control and the main STATCOM. Furthermore, the individual control strategies shall have the ability to be activated or disabled and their control parameters must be fully adjustable.

c. Model Verification

The performance of the digital model shall be verified by comparison to the corresponding RTDS simulator results and field test for:

- iii. Transient operation to demonstrate the behavior of the STATCOM to system events
- iv. Fault recovery performance: internal faults and external faults

d. Model Documentation

The model documentation shall include:

- vi. A brief description of the overall structure of the model and an overview of all modules and user-defined parameters
- vii. A brief description and diagram of each module, and a detailed diagram, in a form compatible with PSCAD/EMTDC representation techniques, showing all parameters with their dimensions
- viii. A diagram showing all module-interface variables and relevant control signals with their dimensions
- ix. A brief description of each simulation verification case
- x. Contractor shall provide/add detailed STATCOM model in the provided PSCAD file(s). The following control signals shall be accessible (as minimum):
 - 7. STATCOM ON/OFF command.
 - 8. Voltage setting.
 - 9. Slope setting.
 - 10. Gain adjustment.
 - 11. Undervoltage and Overvoltage strategy setting.
 - 12. Step response

Contractor shall submit the PSCAD (Windows version 4.6.3 and above) STATCOM model. Fortran Compiler used for compiling the PSCAD Model shall be mentioned and a copy of Fortran Compiler provided to Company. Contractor shall provide the one licenses for the compiler. Contractor shall provide updates for the new versions that are released after version 4.6.3 up to the end of warranty period of this Project.

2.3.3. DigSilent Power Factory Model

The Harmonic Study Model shall be developed using DiGSILENT PowerFactory and shall be fully compatible with the principles of frequency-domain and time-domain harmonic analysis as implemented in the software. The model shall accurately represent the harmonic emission, propagation, and interaction characteristics of the STATCOM and associated power electronic components under steady-state and dynamic operating conditions.

The model shall be suitable for conducting harmonic load flow, frequency scan, impedance scan, resonance assessment, and harmonic compliance studies in accordance with applicable international standards (including but not limited to IEEE 519 and IEC 61000 series). The harmonic model shall be sufficiently

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flexible to allow incorporation of additional control upgrades or filter configurations that may be introduced during the warranty and guarantee period of the Project.

The Contractor shall provide the Harmonic Study Model compatible with the PowerFactory version as used by the Company, including backward and forward compatibility within the same major release family. The model shall be suitable for harmonic studies over the frequency range required to assess characteristic, non-characteristic, and inter-harmonics relevant to the STATCOM operation.

The Harmonic Study Model shall be provided in the following formats:

- iii. Native DIgSILENT PowerFactory DSL-based or library-based harmonic model, utilizing standard PowerFactory harmonic elements.
- iv. User-defined harmonic source representations using current source or frequency-dependent impedance models, as appropriate.

The Contractor shall ensure consistency between the harmonic behaviour represented in PowerFactory and that observed in PSCAD/RTDS or field measurements. The Contractor shall also provide model updates for new PowerFactory versions released during the warranty period of the Project.

c. Model Verification

The performance and accuracy of the harmonic model shall be verified through comparison with corresponding simulation results and/or field measurements for the following cases:

- vi. Steady-state harmonic distortion levels, including individual harmonic components and Total Harmonic Distortion (THD) at the Point of Connection.
- vii. System impedance and resonance characteristics, verified through frequency scan analysis.
- viii. Harmonic interaction under different STATCOM operating modes, including varying reactive power output and voltage control settings.
- ix. Harmonic performance under different network configurations, including normal operation and credible contingency conditions.
- x. Verification cases shall demonstrate compliance with applicable harmonic limits and confirm that the model reliably reproduces dominant harmonic phenomena observed in practical operation.

d. Model Documentation

The Harmonic Study Model documentation shall be provided in sufficient detail to enable the Company to independently use, modify, and validate the model within DIgSILENT PowerFactory. The documentation shall include, as a minimum:

- viii. A brief description of the overall harmonic modelling philosophy, including assumptions and scope of applicability.
- ix. A description of the harmonic source representation, including characteristic harmonic orders, magnitude, phase angle assumptions, and frequency dependency.
- x. A detailed description and diagram of each harmonic-related module, including filters, network impedances, transformers, and STATCOM harmonic emission models, with all parameters and units clearly indicated.
- xi. A diagram showing interface variables and harmonic signal paths, including interaction with the fundamental-frequency load flow model.
- xii. An explanation of all approximations, lumped representations, and equivalent circuit assumptions used in the harmonic model.
- xiii. A brief description of each harmonic verification and compliance assessment case, including study objectives and acceptance criteria.
- xiv. A detailed table listing PowerFactory harmonic parameters, their definitions, and the corresponding values used in the studies.

The Contractor shall provide the complete PowerFactory project file(s) containing the detailed harmonic model, with all relevant elements clearly labelled and documented. All harmonic-related parameters shall be accessible to the Company for review and adjustment.

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2.4. System Description and Data Files

This Section contains the system input data including PSS/E files for design studies to be performed by the Contractor and requirements for the system & design studies to be performed by the Contractor and, including requirements on the STATCOM simulation models that the Contractor has to provide, to be used by the Company to simulate the STATCOM performance and its control and protective functions in different time frames.

All simulations software adopted has to be fully specified (e.g. version) in order to allow the Company to use all models in its own simulation environment.

The studies mentioned in this Annexure shall also be performed during design stage of STATCOM project and submitted for Company review and approval.

2.4.1. System Data

System Data can be found in Annexure-A.

Note: The short circuit specified in Annexure-A shall not be used for equipment or grounding design. The maximum, minimum and abnormal short circuit currents specified in this document are intended for the design studies only.

2.4.2. PSSE System Study Data

2.4.2.1. PSSE Study Cases

The PSSE base cases for year 2027 and 2028/29 to be considered for system healthy conditions (Intact system) as follows:

- Ultimate Year Peak Load Case
- Ultimate Year Minimum Load Case
- Energization Year Peak Load Case
- Energization Year Minimum Load Case

Table 1: PSSE Files

Study Scenario	Power Flow Data (v33)	Dynamic Data	UDM DLL/ python Files
Energization Year Peak Load Case	Summer_Peak_2026.sav	Summer_Peak_2026.dyr	1.10_GNET_P_JUL_26.py
Energization Year Minimum Load Case	Winter_Off-Peak_2027.sav	Winter_Off-Peak_2027.dyr	1.10_GNET P_JAN_27.py
Ultimate Year Peak Load Case	Summer_Peak_2028.sav	Summer_Peak_2028.dyr	1.10_GNET P_JUL_28.py
Ultimate Year Minimum Load Case	Winter_Off-Peak_2029.sav	Winter_Off-Peak_2029.dyr	GNET OP_JAN_29.py

The following dynamic solution parameters shall be used in PSSE dynamic runs:

- Iterations: 200
- Acceleration: 0.2
- DELT: 0.005

2.4.2.2. Fault Cases

The following contingency table shall be considered for Ultimate Year 2028/29 (Peak & Minimum Load Case) and Energization Year 2026/27 (Peak & Minimum Load Case) as a minimum requirement.

The Contractor shall make the case studies and if they found any critical/extreme cases, which is not mentioned in Table 2: Contingency List.

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Channel Number	Channel Description	Channel Identifier
65	MW FLOW 80050-80075 CKT 1	PASNI-NGIA-1_P
66	MVAR FLOW 80050-80075 CKT 1	PASNI-NGIA-1_Q
67	MW FLOW 80070-80105 CKT 1	GWADAR-DEEPSEA-1_P
68	MVAR FLOW 80070-80105 CKT 1	GWADAR-DEEPSEA-1_Q
69	MW FLOW 80070-80060 CKT 5	GWADAR-GWADARIND-5_P
70	MVAR FLOW 80070-80060 CKT 5	GWADAR-GWADARIND-5_Q
71	MW FLOW 80070-80075 CKT 1	GWADAR-NGIA-1_P
72	MVAR FLOW 80070-80075 CKT 1	GWADAR-NGIA-1_Q
73	Study STATCOM I _{ref}	As Ordered by STATCOM Controller
74	I _{VSC}	For STATCOM Under Study
75	I _{Filters}	For STATCOM Under Study
76	I _{STATCOM}	For STATCOM Under Study
77	Q _{STATCOM}	For STATCOM Under Study
78	QSVC/QSTATCOM	For All Nearby STATCOMS/SVC
79	Any additional signal that may seem necessary to facilitate the study review	

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2.4.3. PSCAD System Study Data

2.4.3.1. PSCAD Study Cases

The Contractor shall convert all PSSE files into PSCAD files through ETRAN for the area as specified in provided PSSE sld's. For the STATCOMs under study the Contractor shall use detailed model whereas for remaining SVC/STATCOM generic models can be used.

The Contractor shall submit the following at the project design stage

- Fully Working PSCAD Files as developed through ETRAN Conversion
- Supporting files such as
 - ETRAN Library Files
 - ETRAN Compiler File
- Corresponding Dyr Files which works with the converted PSCAD Model

2.4.3.2. Fault Cases

Refer to section E.4.2.2 Fault Cases.

2.4.3.3. Recorded PSCAD Signals

Magnitude to be monitor during the simulations will include as minimum:

12. Power flows (MW and Mvar) shall be monitored for all branches connected to 132kV PASNI, Gwadar, NAL, BASIMA, TURBAT, PANJGOUR.
13. 132kV PASNI STATCOMs output I_{ref} as ordered by STATCOM controller and IVSC, Ifilters, ISTATCOM & QSTATCOM.

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14. All Nearby SVC/STATCOM reactive Power QSVC/ QSTATCOM, as per single line diagram.
15. ALL generators station real and reactive power as per single line diagram in all cases applicable.
16. Voltages 132/11kV at all substations as per Single Line diagram.
17. Any additional signal that may seem necessary to facilitate the study review.
18. Slope, Gain supervision signals, Signals for under and over-voltage strategies, Trip signals.
19. HV & MV arrester energy and currents.
20. VSC firing and blocking signals.
21. VSC protection signals.
22. Contractor shall propose other signals in the STATCOM.

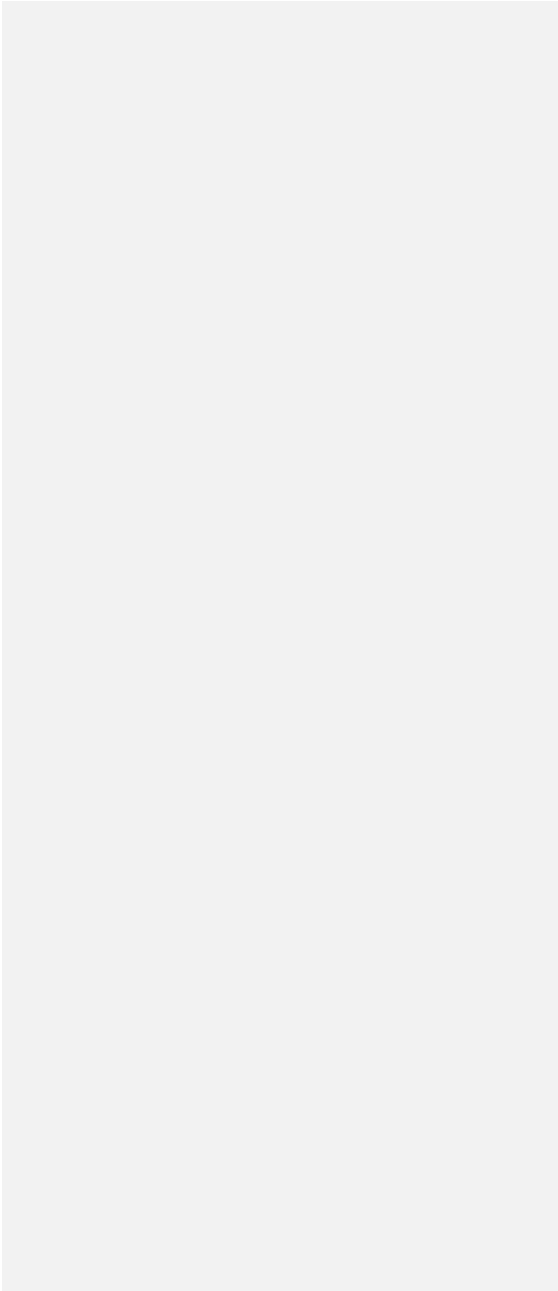
2.4.4. Harmonic Study Data

CONTRACTOR need to perform Harmonic Study at project design stage. Software used shall be Digsilent Power Factory. The Contractor shall perform study in accordance with specifications and corresponding Annexures.

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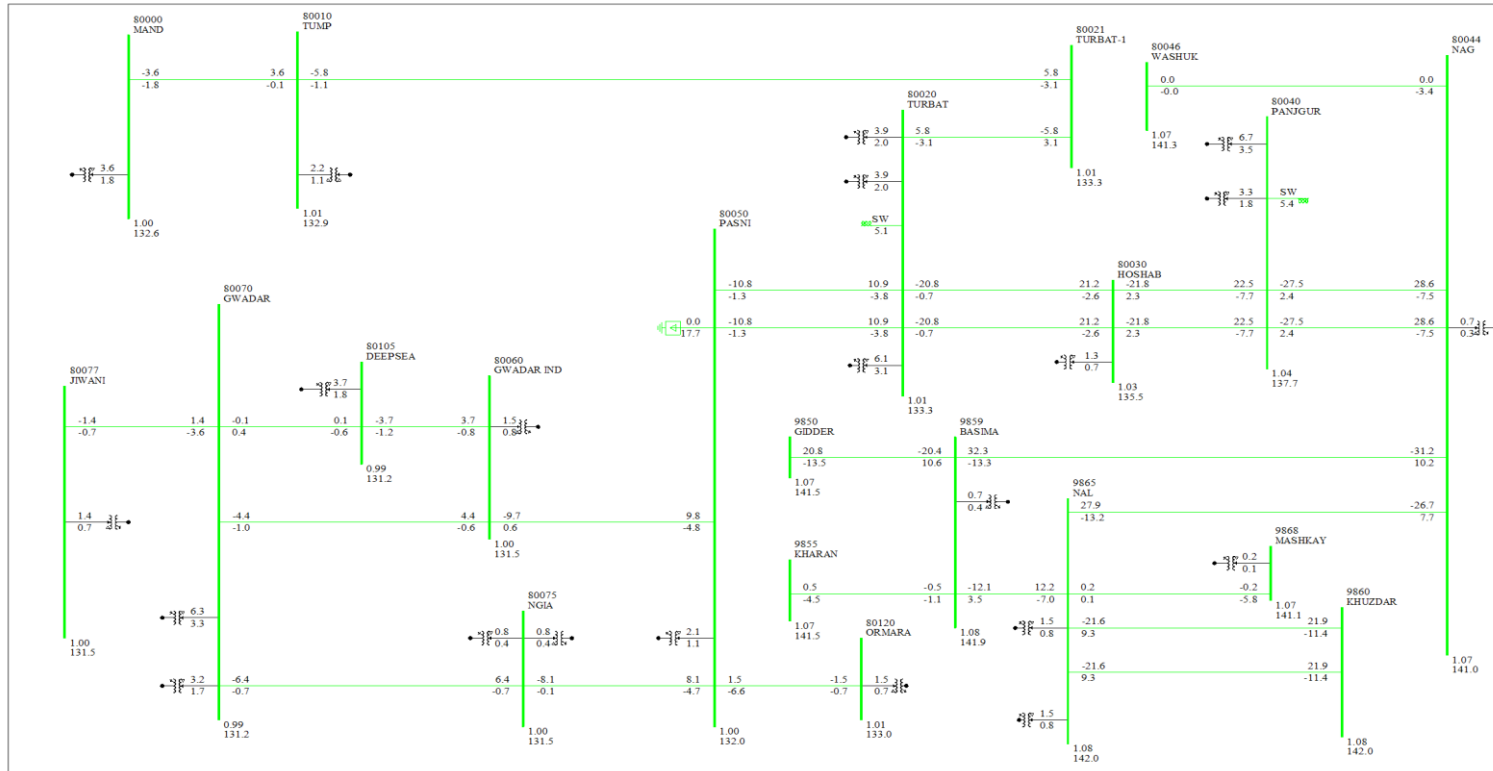
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SINGLE LINE DIAGRAM (Power Flow)



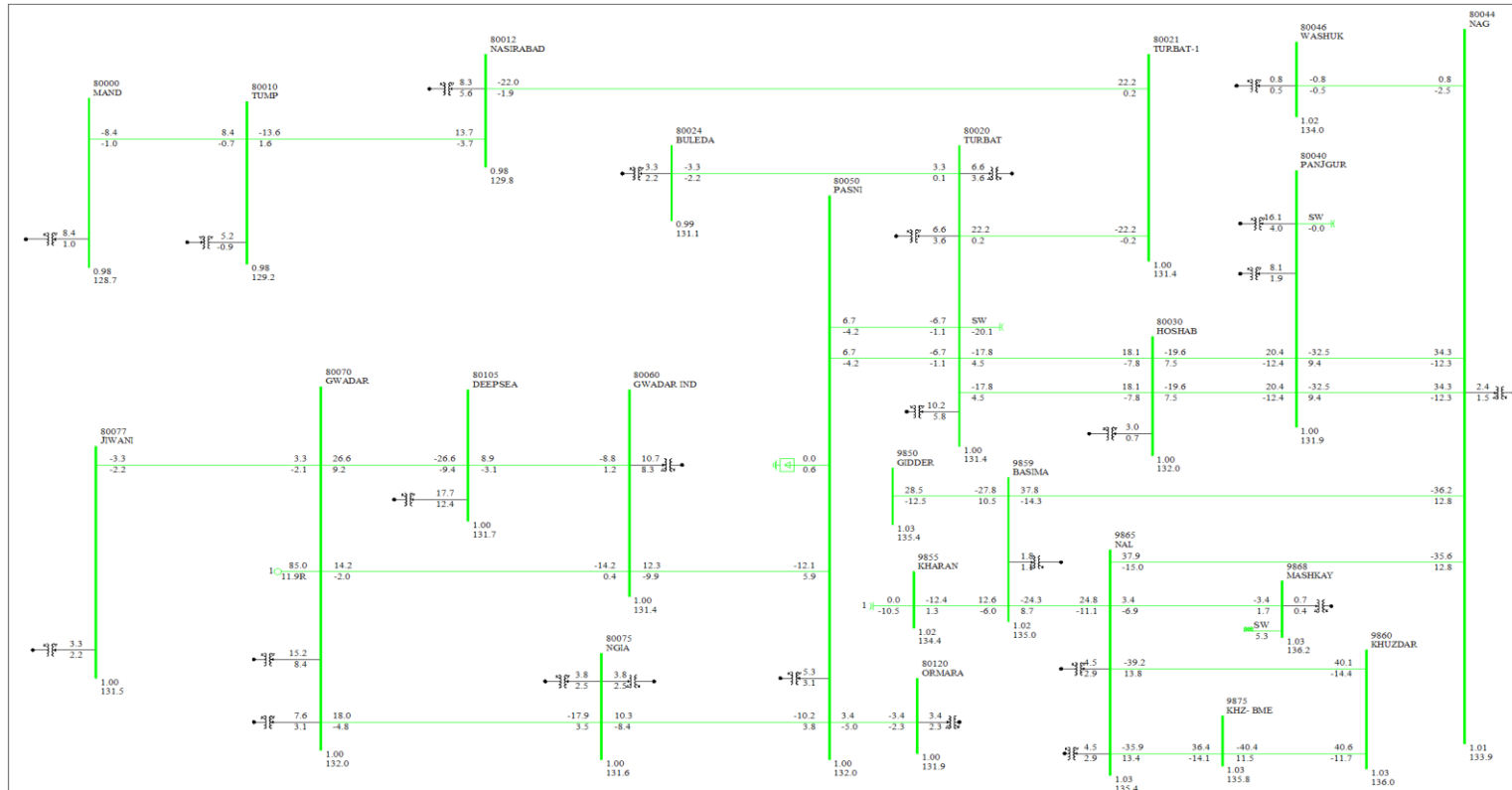
Annexure-E

Off Peak Load Winter January 2027 Scenario - Area 35
132 kV Network



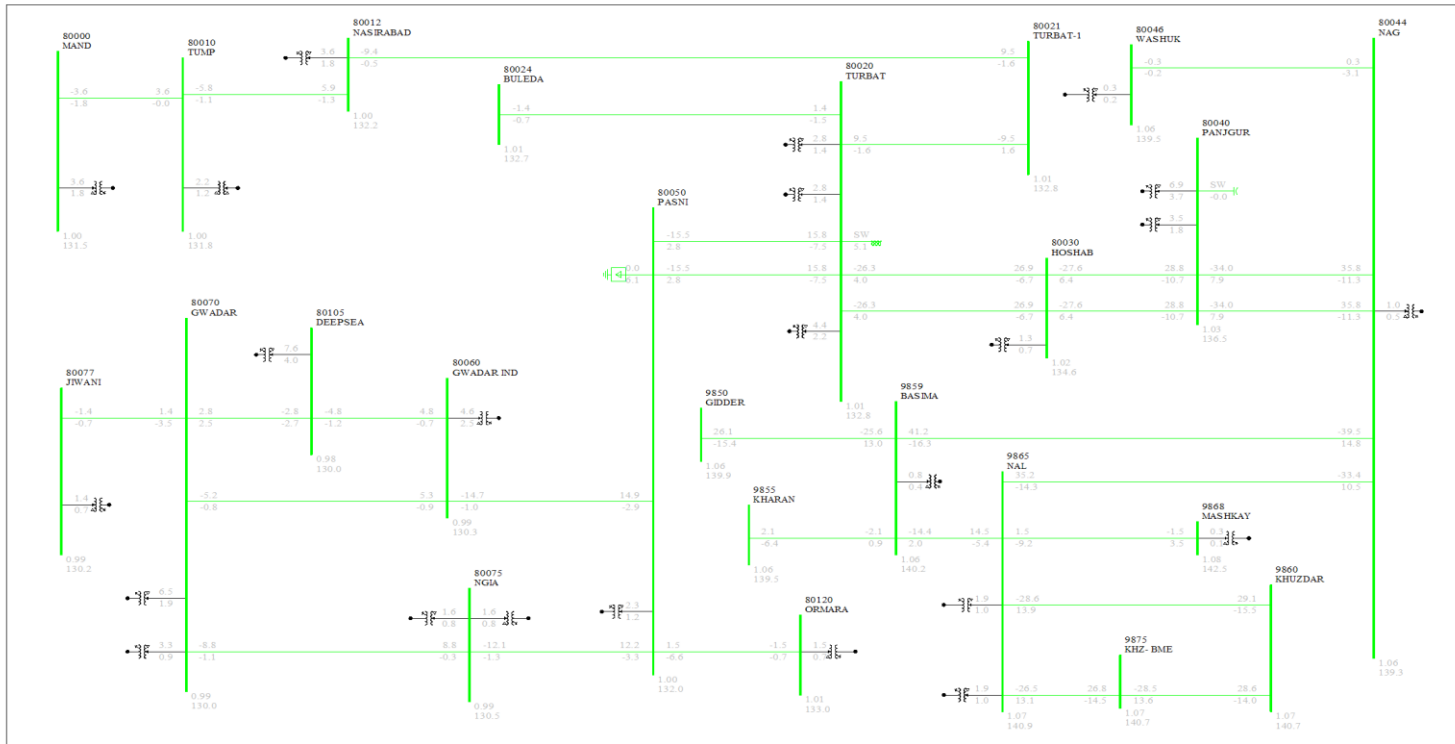
Annexure-E

Peak Load Summer July 2028 Scenario - Area 35
132 kV Network



Annexure-E

Off-Peak Load Winter January 2029 Scenario - Area 35
132 kV Network

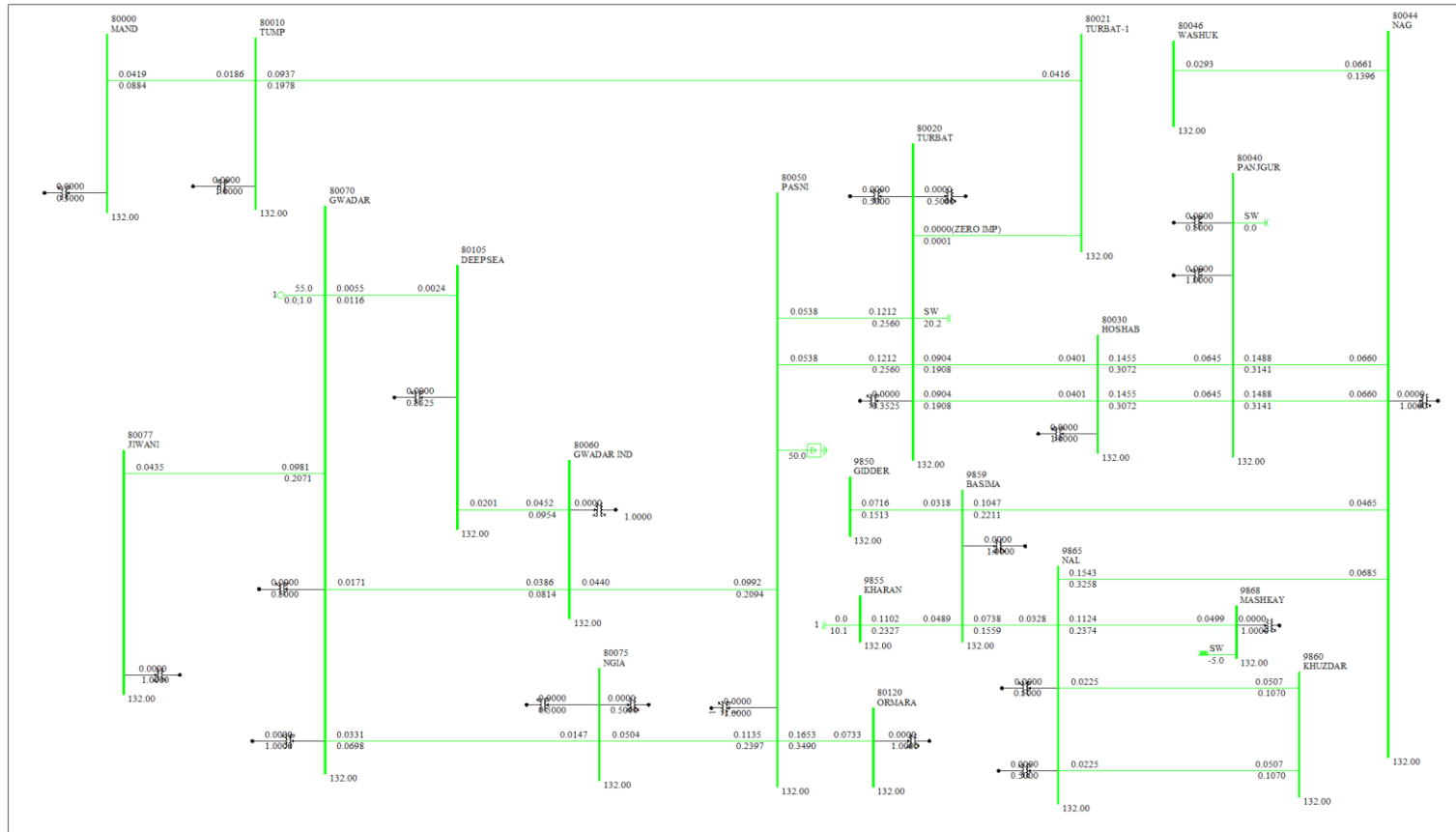


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SINGLE LINE DIAGRAM (IMPEDENCE DIAGRAM)

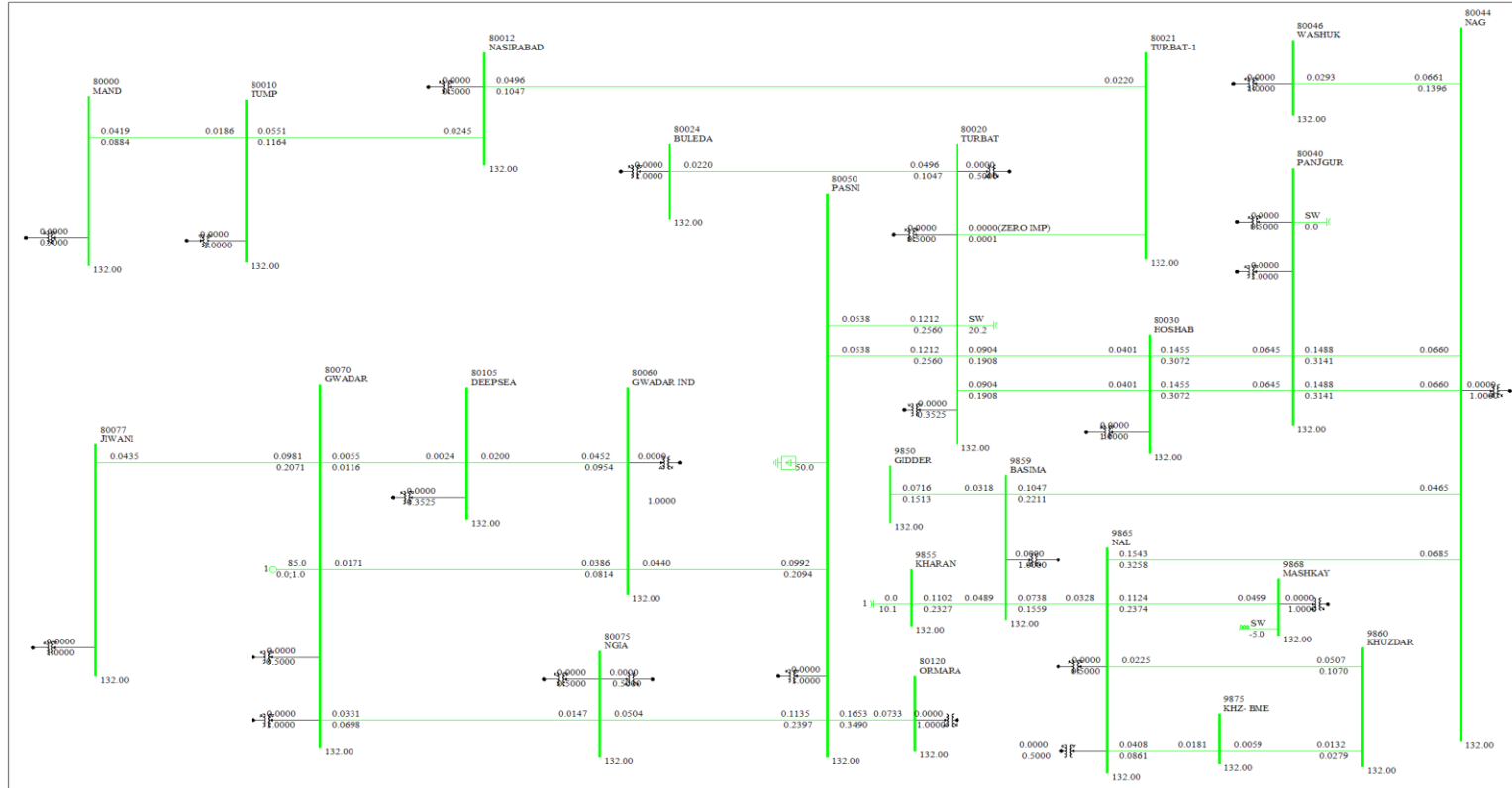
Annexure-E

Peak Load Summer July 2026 Scenario - Area 35
132 kV Network



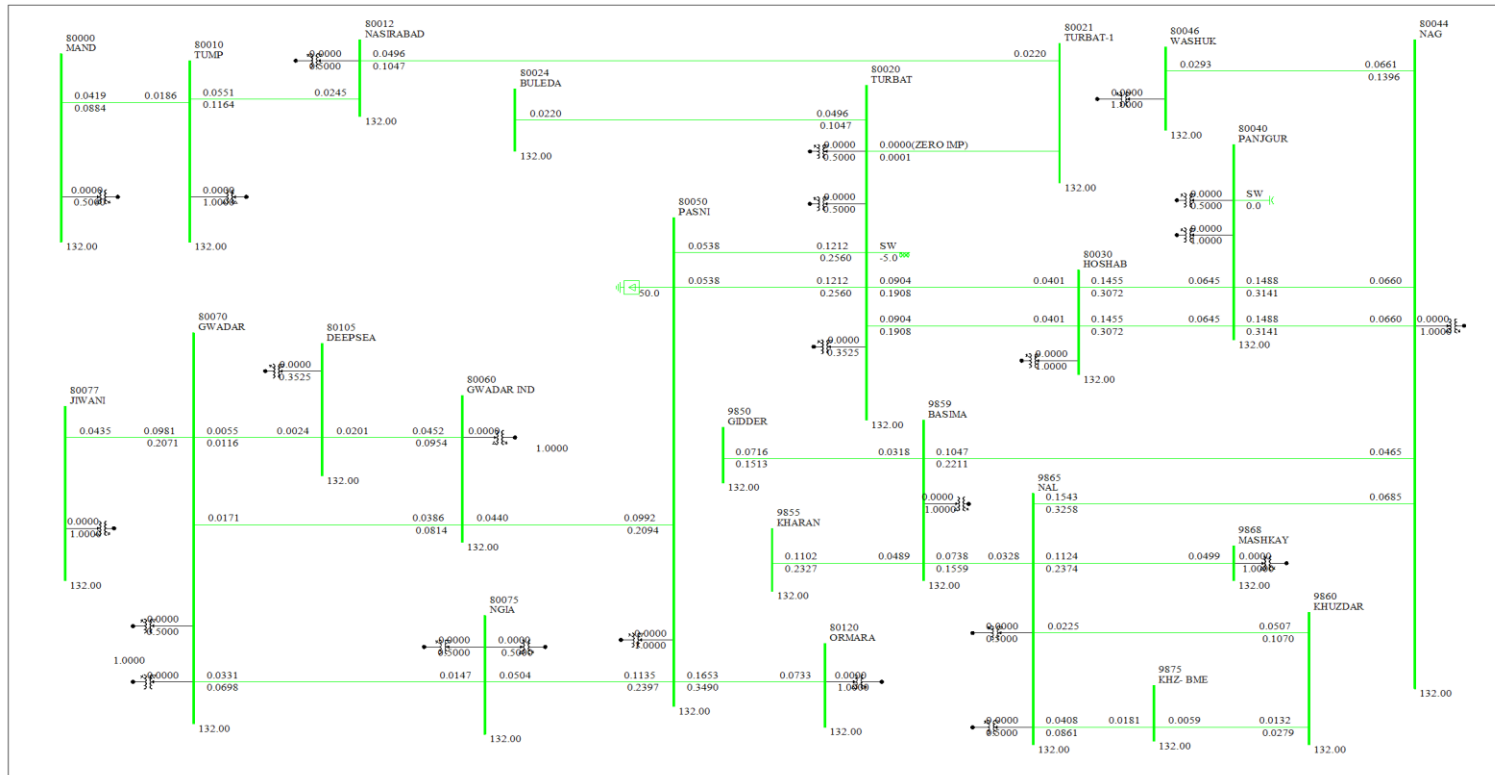
Annexure-E

**Peak Load Summer July 2028 Scenario - Area 35
132 kV Network**



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Off-Peak Load Winter January 2029 Scenario - Area 35
132 kV Network



Annexure-F

PRELIMINARY STATCOM PERFORMANCE STUDY

3. Preliminary STATCOM Performance Study

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3.1. General Study Requirements

All preliminary studies shall be based on the Single Machine Infinite Bus (SMIB) system representation. The Bidder shall construct the SMIB model using the network Thevenin equivalent provided in Annexure B, with the Thevenin impedance corresponding to abnormal short-circuit conditions. The SMIB representation shall include the STATCOM coupling transformer (with the impedance proposed by the Bidder), the VSC branch reactor or arm inductance as applicable, and the proposed control system model. The Bidder shall clearly document all SMIB model parameters, assumptions, and simplifications in each study report and shall confirm that the SMIB representation is conservative relative to the full network for each study type.

The following three categories of preliminary study are mandatory and shall each be submitted as a separate, clearly titled study report forming part of the bid technical submission.

3.1.1. RMS Stability Study (PSSE)

The RMS stability study shall be performed using Siemens PTI PSS/E (version 35, or as agreed with the Company). The study shall use the SMIB network model with the PSS/E dynamic model of the proposed STATCOM, including the voltage controller, gain supervisor, gain optimizer, and current limiter. The Bidder shall provide the PSS/E user-defined model (UDM) used for the study, together with all model parameters, as part of the bid submission. The study shall demonstrate the following as a minimum:

- a) Small signal response: step change in voltage reference of $\pm 5\%$ at nominal voltage, demonstrating that 90% of the desired voltage change is achieved within 40 ms (2 cycles at 50 Hz) and that the maximum overshoot does not exceed 10% of the final change, with settling within $\pm 5\%$ of the final value within 100 ms, in accordance with Clause 7.3.1 of this specification;
- b) Large signal response: application and clearance of a three-phase fault at the 132kV bus at the normal minimum short-circuit level specified in Annexure B, demonstrating that the STATCOM reaches its reactive current limit within 20 ms (1 cycle) of fault initiation and recovers to steady-state voltage regulation within the specified settling time following fault clearance;
- c) Performance under abnormal short-circuit conditions per Annexure B: the study shall repeat the large signal fault cases at each abnormal short-circuit level identified in Annexure B, demonstrating stable STATCOM operation and voltage recovery without manual adjustment of controller gains, consistent with the mandatory requirement of Clause 6.3.5 that step response requirements are met across the full short-circuit range without manual gain adjustment;
- d) Single line-to-ground (SLG) fault: application and clearance of an SLG fault at the 132kV bus, demonstrating that the STATCOM remains in service, that line-to-line voltages at the PCC do not exceed 1.3 PU during the fault (or the settable limit per Clause 6.3.1.2), and that the unsymmetrical current injection control is functioning correctly; and
- e) Gain supervisor activation: a scenario in which the short-circuit level is stepped from the normal maximum to the abnormal minimum value specified in Annexure B during STATCOM operation, demonstrating that the gain supervisor detects the instability condition and reduces the controller gain automatically to restore stable operation, and that the gain optimizer subsequently re-adjusts the gain in the correct direction.

3.1.2. Electromagnetic Transient Study (PSCAD/EMTDC)

Annexure-F

The electromagnetic transient (EMT) study shall be performed using Manitoba Hydro International PSCAD/EMTDC (version 5.0 or later, or as agreed with the Company). The PSCAD model shall represent the full MMC valve structure including individual half-bridge submodule switching (or an equivalent averaged/detailed equivalent model, subject to justification by the Bidder), the arm inductors, the DI water cooling thermal equivalent circuit if relevant to switching performance, the coupling transformer saturation characteristic, and the complete proposed control system hierarchy from cell-level modulator to station supervisory. The Bidder shall provide the PSCAD model files and a model description document as part of the bid submission, in a format accessible to the Company's engineers.

The EMT study shall demonstrate the following as a minimum:

- a) Valve energization and de-energization: the controlled ON and OFF sequences per Clause 6.5.2, demonstrating that the transient voltage disturbance at the 132kV PCC does not exceed 5% of the prevailing voltage at any short-circuit level specified in Annexure B, and that the reactive output ramp rate is within 3 MVar per second as specified;
- b) DC capacitor voltage balancing: demonstration that the distributed MMC cell capacitor voltages remain balanced within the Bidder's stated tolerance under all operating points across the full ± 70 MVar range, including during the transient following a three-phase fault;
- c) Low voltage ride-through: demonstration that the STATCOM maintains full capacitive current injection at 0.3 PU terminal voltage for 10 seconds and at 0.7 PU for 2.5 minutes without valve blocking, as required by Clause 6.1.2;
- d) Overvoltage withstand behavior: demonstration of STATCOM response at 1.3 PU for 3 seconds and 1.5 PU for 1 second, as required by Clause 6.1.2, confirming that no valve damage occurs and that the STATCOM resumes voltage control within the specified time following overvoltage clearance;

3.1.3. Harmonic Performance Study (Dig Silent Power Factory)

The harmonic performance study shall be performed using Dig SILENT Power Factory (version 2022 or later, or as agreed with the Company). The study shall assess the harmonic voltage and current emissions of the proposed STATCOM at the 132kV PCC against the limits of IEEE Std 519-2014, applied in accordance with Clause 6.10.1 of this specification, including the 50% geometric subtraction methodology and the VLIMIT calculation specified therein.

Background harmonic voltage levels shall be taken from IEEE Std 519-2014 Table 1 limits as the assumed background harmonic source, applied as a harmonic voltage source in series with the SMIB Thevenin impedance at the 132kV bus. Individual background harmonic voltages shall be applied for harmonic orders $n = 2$ to 50 as required by Clause 6.10.1. The Bidder shall clearly state the assumed background harmonic levels used in the study and the basis for any deviation from the IEEE 519-2014 Table 1 values.

The harmonic study shall demonstrate the following as a minimum:

- a) Harmonic voltage distortion at the 132kV PCC: calculated individual harmonic voltages ($n = 2$ to 50) and Total Harmonic Distortion (THD) at each STATCOM operating point across the full ± 70 MVar continuous range, in steps of 3 MVar as required by Clause 6.13.3, confirming compliance with the VLIMIT values derived per Clause 6.10.1 at all operating points;
- b) Harmonic current distortion injected by the STATCOM: confirmation that the harmonic current injection does not cause the values of IEEE Std 519-2014 Tables 3 and 4 to be exceeded at the PCC;
- c) Sensitivity analysis: harmonic performance shall be demonstrated at the normal minimum and normal maximum short-circuit levels from Annexure B, and at each abnormal short-circuit level identified in Annexure B, to confirm that harmonic compliance is maintained across the full specified fault level range; recognizing that harmonic impedance at the PCC is a strong function of network short-circuit strength at the weak-grid Pasni location;

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- d) Second harmonic resonance assessment: a frequency scan from the STATCOM MV bus, demonstrating that the second harmonic current amplification factor is below 20 as required by Clause 6.10.3.5, and confirming that the proposed transformer impedance and VSC tuning have been optimised to minimise second harmonic amplification; this is of particular importance given the very low SCR at 132kV Pasni and the potential for low-frequency resonances that are characteristic of weak grid conditions;

F.1.4. Study Submission Requirements

Each of the three study reports submitted at bid stage shall include as a minimum: a model description and parameter listing; all input assumptions and their source references; graphical results for each simulation scenario (voltage, current, reactive power, and controller output waveforms for RMS and PSCAD studies; harmonic spectra and frequency scan plots for the PowerFactory study); a tabulated summary of compliance against each applicable specification requirement; and a clear statement of any operating condition or simulation scenario in which the proposed STATCOM design does not comply, together with the Bidder's proposed design modification or mitigation measure. Model files (PSS/E UDM, PSCAD .pscx, and PowerFactory .pfd) shall be submitted to the Company in a usable format as part of the bid technical documentation and shall remain the property of the Company upon contract award.

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F1.2 Electromagnetic Transient Study (PSCAD/EMTDC)

The electromagnetic transient (EMT) study shall be performed using Manitoba Hydro International PSCAD/EMTDC (version 5.0 or later, or as agreed with the Company). The PSCAD model shall represent the full MMC valve structure including individual half-bridge submodule switching (or an equivalent averaged/detailed equivalent model, subject to justification by the Bidder), the arm inductors, the DI water cooling thermal equivalent circuit if relevant to switching performance, the coupling transformer saturation characteristic, and the complete proposed control system hierarchy from cell-level modulator to station supervisory. The Bidder shall provide the PSCAD model files and a model description document as part of the bid submission, in a format accessible to the Company's engineers.

The EMT study shall demonstrate the following as a minimum:

- e) Valve energisation and de-energisation: the controlled ON and OFF sequences per Clause 6.5.2, demonstrating that the transient voltage disturbance at the 132kV PCC does not exceed 5% of the prevailing voltage at any short-circuit level specified in Annexure B, and that the reactive output ramp rate is within 3 MVAR per second as specified;
- f) DC capacitor voltage balancing: demonstration that the distributed MMC cell capacitor voltages remain balanced within the Bidder's stated tolerance under all operating points across the full ± 70 MVAR range, including during the transient following a three-phase fault;
- g) Low voltage ride-through: demonstration that the STATCOM maintains full capacitive current injection at 0.3 PU terminal voltage for 10 seconds and at 0.7 PU for 2.5 minutes without valve blocking, as required by Clause 6.1.2;
- h) Overvoltage withstand behaviour: demonstration of STATCOM response at 1.3 PU for 3 seconds and 1.5 PU for 1 second, as required by Clause 6.1.2, confirming that no valve damage occurs and that the STATCOM resumes voltage control within the specified time following overvoltage clearance;

F1.3 Harmonic Performance Study (DigSilent Power Factory)

The harmonic performance study shall be performed using DIGSILENT PowerFactory (version 2022 or later, or as agreed with the Company). The study shall assess the harmonic voltage and current emissions of the proposed STATCOM at the 132kV PCC against the limits of IEEE Std 519-2014, applied in accordance with Clause 6.10.1 of this specification, including the 50% geometric subtraction methodology and the VLIMIT calculation specified therein.

Background harmonic voltage levels shall be taken from IEEE Std 519-2014 Table 1 limits as the assumed background harmonic source, applied as a harmonic voltage source in series with the SMIB Thevenin impedance at the 132kV bus. Individual background harmonic voltages shall be applied for harmonic orders $n = 2$ to 50 as required by Clause 6.10.1. The Bidder shall clearly state the assumed background harmonic levels used in the study and the basis for any deviation from the IEEE 519-2014 Table 1 values.

The harmonic study shall demonstrate the following as a minimum:

- e) Harmonic voltage distortion at the 132kV PCC: calculated individual harmonic voltages ($n = 2$ to 50) and Total Harmonic Distortion (THD) at each STATCOM operating point across the full ± 70 MVAR continuous range, in steps of 3 MVAR as required by Clause 6.13.3, confirming compliance with the VLIMIT values derived per Clause 6.10.1 at all operating points;
- f) Harmonic current distortion injected by the STATCOM: confirmation that the harmonic current injection does not cause the values of IEEE Std 519-2014 Tables 3 and 4 to be exceeded at the PCC;
- g) Sensitivity analysis: harmonic performance shall be demonstrated at the normal minimum and normal maximum short-circuit levels from Annexure B, and at each abnormal short-circuit level

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identified in Annexure B, to confirm that harmonic compliance is maintained across the full specified fault level range; recognizing that harmonic impedance at the PCC is a strong function of network short-circuit strength at the weak-grid Pasni location;

- h) Second harmonic resonance assessment: a frequency scan from the STATCOM MV bus, demonstrating that the second harmonic current amplification factor is below 20 as required by Clause 6.10.3.5, and confirming that the proposed transformer impedance and VSC tuning have been optimised to minimise second harmonic amplification; this is of particular importance given the very low SCR at 132kV Pasni and the potential for low-frequency resonances that are characteristic of weak grid conditions;

F.1.4. Study Submission Requirements

Each of the three study reports submitted at bid stage shall include as a minimum: a model description and parameter listing; all input assumptions and their source references; graphical results for each simulation scenario (voltage, current, reactive power, and controller output waveforms for RMS and PSCAD studies; harmonic spectra and frequency scan plots for the PowerFactory study); a tabulated summary of compliance against each applicable specification requirement; and a clear statement of any operating condition or simulation scenario in which the proposed STATCOM design does not comply, together with the Bidder's proposed design modification or mitigation measure. Model files (PSS/E UDM, PSCAD .pscx, and PowerFactory .pfd) shall be submitted to the Company in a usable format as part of the bid technical documentation and shall remain the property of the Company upon contract award.

Annexure-G

SOIL INVESTIGATION REPORT