



Request for Bids

Plant

**Design, Supply, and Installation
(Two-Envelope with Rated Criteria)**

Procurement of Contractor for:

Zambia-Tanzania Interconnector Project – Package 4

May 2025

PART 1 – BIDDING PROCEDURES

Section I - Instructions to Bidders (ITB)

This Section provides relevant information to help Bidders prepare their Bids. It is based on two-envelope bidding process with application of rated criteria. Information is also provided on the submission, opening, and evaluation of Bids and on the award of Contracts. **Section I contains provisions that are to be used without modification.**

Section II - Bid Data Sheet (BDS)

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

Section III- Evaluation and Qualification Criteria

This Section specifies the criteria to determine the Most Advantageous Bid, including the qualifications of the Bidder to execute the contract.

Section IV - Bidding Forms

This Section includes the forms to be completed and submitted by the Bidder as part of its Bid.

Section V - Eligible Countries

This Section contains information regarding eligible countries.

Section VI - Fraud and Corruption

the Fraud and Corruption provisions which apply to this Bidding process.

PART 2 – EMPLOYER’S REQUIREMENTS

Section VII - Employer’s Requirements

This Section contains the Specification, the Drawings, and supplementary information that describe the Plant and Installation Services to be procured. The Employer’s Requirements also include the environmental and social (ES) requirements.

PART 3 – CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VIII - General Conditions of Contract (GCC)

This Section contains the general clauses to be applied in all contracts. **The text of the clauses in this Section shall not be modified.**

Section IX - Particular Conditions of Contract (PCC)

This Section contains the Particular Conditions of Contract (PCC). The contents of this Section modify or supplement the General Conditions and shall be prepared by the Employer.

Section X - Contract Forms

This Section contains the Letter of Acceptance, Contract Agreement and other relevant forms.

Specific Procurement Notice

Request for Bids

Plant

Design, Supply and Installation

(Two-Envelope Bidding Process, Without Prequalification)

Employer: ZESCO Limited
Project: **Zambia-Tanzania Interconnector Project**
Contract title: Package -4- Design, Supply, and Installation for: (I) Nakonde Stepdown (330/(132)66/11kV) Substation, (ii) Kasama 330 kV Substation
Country: Zambia
Grant No.: E-3960-ZM and TF0D0134
RFB No: ZM-ZESCO-495237- CW-RFB
Issued on: 11 May 2026

1. ZESCO Limited has applied for financing from the World Bank, European Union and United Kingdom Government towards the cost of the **Zambia–Tanzania Interconnector Project**, and intends to apply part of the proceeds toward payments under the Contract for Package -4- Design, Supply, and Installation for: (I) Nakonde Stepdown (330/(132)66/11kV) Substation, (ii) Kasama 330 kV Substation. For this contract, the Borrower shall process the payments using the Direct Payment disbursement method, as defined in the World Bank’s Disbursement Guidelines for Investment Project Financing, except for those payments, which the contract provides to be made through letter of credit.
2. ZESCO Limited now invites sealed Bids from eligible Bidders for Design, Supply, and Installation for: (i) Nakonde Stepdown (330/(132)66/11kV) Substation, (ii) Kasama 330 kV Substation.
3. Bidding will be conducted through international competitive procurement using a Request for Bids (RFB) as specified in the “The World Bank Procurement Regulations for IPF Borrowers : Procurement in Investment Project Financing - Goods, Works, Non- Consulting and Consulting Services - Seventh Edition” (issued September 2025) (the “Procurement Regulations”) and is open to all eligible Bidders as defined in the Procurement Regulations.
4. Bids will be evaluated in accordance with the evaluation process set out in the bidding documents. The following weightings shall apply for Rated Criteria (including technical and non-price factors): 50% and for Bid cost: 50%.
5. Interested eligible Bidders may obtain further information from ZESCO Limited, Attention: Lemmy Nyirenda inyirenda@zesco.co.zm and inspect the bidding document during office hours 07:30 AM to 5:00 PM, CAT at the address given below.
6. The bidding document in English may be purchased by interested eligible Bidders upon the submission of a written application to the address below and upon payment of a nonrefundable fee of **USD 300** to be deposited in the ZESCO Limited Bank Account provided below:

Bank Name: **ABSA BANK ZAMBIA PLC**

Account Name: **ZESCO LIMITED**

Branch Name: **CORPORATE**
 Account Number: **01 - 1031102**
 SWIFT Code: **BARCZMLXXXX**
 Currency: **USD**

The document will be accessed by downloading from authorized ZESCO Limited website: <https://www.zesco.co.zm/tender.php> or sent by email on written request.

7. Bids must be delivered to the address below on or before **21 August 2026**. Electronic bidding will not be permitted. Late Bids will be rejected. The outer Bid envelopes marked "ORIGINAL BID", and the inner envelopes marked "TECHNICAL PART" will be publicly opened in the presence of the Bidders' designated representatives and anyone who chooses to attend, at the address below on **21 August 2026, at 10:30 AM CAT**. All envelopes marked "FINANCIAL PART" shall remain unopened and will be held in safe custody of the Employer until the second public Bid opening.
8. All Bids must be accompanied by a "*Bid Securing Declaration*" as per the details in the Request for Bids (RfB).
9. Attention is drawn to the Procurement Regulations requiring the Borrower to disclose information on the successful bidder's beneficial ownership, as part of the Contract Award Notice, using the Beneficial Ownership Disclosure Form as included in the bidding document.
10. The address(es) referred to above is:

Attention: **Lemmy Nyirenda**

Address: **Stand No. 6949, Great East Road, P.O. Box 33304**

Procurement Offices, LDCC Building

City: **Lusaka**

ZIP Code: **10101**

Country: **Zambia**

Telephone: **+260 211 362 335**

Electronic mail address: lnyirenda@zesco.co.zm, copy matthew.ndhlovu@zesco.co.zm

Request for Bids

Plant

**Design, Supply & Installation
(Without Prequalification)**

Procurement of

DESIGN, SUPPLY, AND INSTALLATION FOR:

- (I) NAKONDE STEPDOWN (330/(132)66/11KV) SUBSTATION,*
- (II) KASAMA 330 KV SUBSTATION*

RFB No: ZM-ZESCO-495237- CW-RFB

Project: Zambia-Tanzania Transmission Interconnector Project

Employer: ZESCO Limited

Country: ZAMBIA

Issued on: 11 May 2026

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PART 1 – Bidding Procedures

Section I - Instructions to Bidders

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Section I - Instructions to Bidders

A. General

- 1. Scope of Bid**
- 1.1 In connection with the Specific Procurement Notice - Request for Bids (RFB), specified in the Bid Data Sheet (BDS), the Employer, as specified **in the BDS**, issues this bidding document for the Design, Supply and Installation of Plant as specified in Section VII, Employer's Requirements. The name, identification, and number of lots (contracts) of this RFB are specified **in the BDS**.
- 1.2 Throughout this bidding document:
- (a) the term **"in writing"** means communicated in written form (e.g., by mail, e-mail, fax, including if specified **in the BDS**, distributed or received through the electronic-procurement system used by the Employer) with proof of receipt;
 - (b) if the context so requires, "singular" means "plural" and vice versa;
 - (c) **"Day"** means calendar day, unless otherwise specified as **"Business Day."** A Business Day is any day that is an official working day of the Borrower. It excludes the Borrower's official public holidays;
 - (d) **"ES"** means environmental and social (including Sexual Exploitation and Abuse (SEA), and Sexual Harassment (SH));
 - (e) **"Sexual Exploitation and Abuse" "(SEA)"** means the following:

Sexual Exploitation is defined as any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including, but not limited to,

profiting monetarily, socially or politically from the sexual exploitation of another.

Sexual Abuse is defined as the actual or threatened physical intrusion of a sexual nature, whether by force or under unequal or coercive conditions.

(f) **“Sexual Harassment” “(SH)”** is defined as unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature by the Contractor’s Personnel with other Contractor’s or Employer’s Personnel.

(g) **“Contractor’s Personnel”** is as defined in GCC Sub-Clause 1; and

(h) **“Employer’s Personnel”** is as defined in GCC Sub-Clause 1.

A non-exhaustive list of (i) behaviors which constitute SEA and (ii) behaviors which constitute SH is attached to the Code of Conduct form in Section IV.

- 2. Source of Funds**
- 2.1 The Borrower or Recipient (hereinafter called “Borrower”) indicated **in the BDS** has applied for or received financing (hereinafter called “funds”) from the World Bank (hereinafter called “the Bank”) in an amount specified **in BDS**, toward the project named **in BDS**. The Borrower intends to apply a portion of the funds to eligible payments under the contract(s) for which this bidding document is issued.
- 2.2 Payment by the Bank will be made only at the request of the Borrower and upon approval by the Bank in accordance with the terms and conditions of the Loan (or other financing) Agreement. The Loan (or other financing) Agreement prohibits a withdrawal from the loan account for the purpose of any payment to persons or entities, or for any import of goods, equipment, plant, or materials, if such payment or import is prohibited by a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations. No party other than the Borrower shall derive any rights from

the Loan (or other financing) Agreement or have any claim to the proceeds of the Loan (or other financing).

3. Fraud and Corruption

3.1 The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Section VI.

3.2 In further pursuance of this policy, bidders shall permit and shall cause their agents (where declared or not), subcontractors, subconsultants, service providers, suppliers, and personnel, to permit the Bank to inspect all accounts, records and other documents relating to any initial selection process, prequalification process, bid submission, proposal submission and contract performance (in the case of award), and to have them audited by auditors appointed by the Bank.

4. Eligible Bidders

4.1 A Bidder may be a firm that is a private entity, a state-owned enterprise or institution subject to ITB 4.6, or any combination of such entities in the form of a joint venture (JV) under an existing agreement or with the intent to enter into such an agreement supported by a letter of intent. In the case of a joint venture, all members shall be jointly and severally liable for the execution of the entire Contract in accordance with the Contract terms. The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the members of the JV during the Bidding process and, in the event the JV is awarded the Contract, during contract execution. Unless specified **in the BDS**, there is no limit on the number of members in a JV.

4.2 A Bidder shall not have a conflict of interest. Any Bidder found to have a conflict of interest shall be disqualified. A Bidder may be considered to have a conflict of interest for the purpose of this Bidding process, if the Bidder:

(a) directly or indirectly controls, is controlled by or is under common control with another Bidder; or

- (b) receives or has received any direct or indirect subsidy from another Bidder; or
- (c) has the same legal representative as another Bidder; or
- (d) has a relationship with another Bidder, directly or through common third parties, that puts it in a position to influence the Bid of another Bidder, or influence the decisions of the Employer regarding this Bidding process; or
- (e) or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the Plant and Installation Services that are the subject of the Bid; or
- (f) or any of its affiliates has been hired (or is proposed to be hired) by the Employer or Borrower as Project Manager for the Contract implementation; or
- (g) would be providing goods, works, or non-consulting services resulting from or directly related to consulting services for the preparation or implementation of the project specified in the BDS ITB 2.1 that it provided or were provided by any affiliate that directly or indirectly controls, is controlled by, or is under common control with that firm; or
- (h) has a close business or family relationship with a professional staff of the Borrower (or of the project implementing agency, or of a recipient of a part of the loan) who: (i) are directly or indirectly involved in the preparation of the bidding document or specifications of the Contract, and/or the Bid evaluation process of such Contract; or (ii) would be involved in the implementation or supervision of such contract unless the conflict stemming from such relationship has been resolved in a manner acceptable to the Bank throughout the Bidding process and execution of the Contract.

- 4.3 A firm that is a Bidder (either individually or as a JV member) shall not participate as a Bidder or as JV member in more than

one Bid except for permitted alternative Bids. Such participation shall result in the disqualification of all Bids in which the firm is involved. However, this does not limit the participation of a Bidder as subcontractor in another Bid or of a firm as a subcontractor in more than one Bid.

- 4.4 A Bidder may have the nationality of any country, subject to the restrictions pursuant to ITB 4.8. A Bidder shall be deemed to have the nationality of a country if the Bidder is constituted, incorporated or registered in and operates in conformity with the provisions of the laws of that country, as evidenced by its articles of incorporation (or equivalent documents of constitution or association) and its registration documents, as the case may be. This criterion also shall apply to the determination of the nationality of proposed subcontractors or subconsultants for any part of the Contract including related Services.
- 4.5 A Bidder that has been sanctioned by the Bank, pursuant to the Bank's Anti-Corruption Guidelines, in accordance with its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework as described in Section VI paragraph 2.2 d., shall be ineligible to be prequalified for, initially selected for, bid for, propose for, or be awarded a Bank-financed contract or benefit from a Bank-financed contract, financially or otherwise, during such period of time as the Bank shall have determined. The list of debarred firms and individuals is available at the electronic address specified in the BDS.
- 4.6 Bidders that are state-owned enterprises or institutions in the Employer's Country may be eligible to compete and be awarded a Contract(s) only if they can establish, in a manner acceptable to the Bank, that they (i) are legally and financially autonomous (ii) operate under commercial law, and (iii) are not under supervision of the Employer.
- 4.7 A Bidder shall not be under suspension from Bidding by the Employer as the result of the operation of a Bid-Securing Declaration or Proposal-Securing Declaration.

- 4.8 Firms and individuals may be ineligible if so indicated in Section V and (a) as a matter of law or official regulations, the Borrower's country prohibits commercial relations with that country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of goods or the contracting of works or services required; or (b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Borrower's country prohibits any import of goods or contracting of works or services from that country, or any payments to any country, person, or entity in that country. Where the procurement is implemented across jurisdictional boundaries (and more than one country is a Borrower, and is involved in the procurement), then exclusion of a firm or individual on the basis of ITB 4.8 (a) above by any country may be applied to that procurement across other countries involved, if the Bank and the Borrowers involved in the procurement agree.
- 4.9 A Bidder shall provide such documentary evidence of eligibility satisfactory to the Employer, as the Employer shall reasonably request.
- 4.10 A firm that is under a sanction of debarment by the Borrower from being awarded a contract is eligible to participate in this procurement, unless the Bank, at the Borrower's request, is satisfied that the debarment; (a) relates to fraud or corruption, and (b) followed a judicial or administrative proceeding that afforded the firm adequate due process.
- 4.11 This bidding is open only to prequalified Bidders unless specified **in the BDS**.

- 5. Eligible Plant and Installation Services**
- 5.1 The Plant and Installation Services to be supplied under the Contract and financed by the Bank may have their origin in any country in accordance with Section V, Eligible Countries.
- 5.2 For purposes of ITB 5.1 above, “origin” means the place where the Plant, or component parts thereof are mined, grown, produced or manufactured, and from which the services are provided. Plant components are produced when, through manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that is substantially different in its basic characteristics or in purpose or utility from its components.

B. Contents of Bidding Document

- 6. Sections of Bidding Document**
- 6.1 The bidding document consists of Parts 1, 2, and 3, which include all the sections indicated below, and should be read in conjunction with any Addenda issued in accordance with ITB 8.

PART 1. Bidding Procedures

- Section I - Instructions to Bidders (ITB)
- Section II - Bid Data Sheet (BDS)
- Section III - Evaluation and Qualification Criteria
- Section IV - Bidding Forms
- Section V - Eligible Countries
- Section VI - Fraud and Corruption

PART 2. Employer’s Requirements

- Section VII -Employer’s Requirements

PART 3. Conditions of Contract and Contract Forms

- Section VIII - General Conditions of Contract (GCC)
- Section IX -Particular Conditions of Contract (PCC)
- Section X -Contract Forms

- 6.2 The Specific Procurement Notice-Request for Bids (RFB) issued by the Employer, or the Notice of Request for Bids (RFB) issued

by the Employer to the prequalified Bidders are not part of the bidding document.

6.3 Unless obtained directly from the Employer, the Employer is not responsible for the completeness of the document, responses to requests for clarification, the Minutes of the pre-Bid meeting (if any), or Addenda to the bidding document in accordance with ITB 8. In case of any contradiction, documents obtained directly from the Employer shall prevail.

6.4 The Bidder is expected to examine all instructions, forms, terms, and specifications in the bidding document and to furnish with its Bid all information or documentation as is required by the bidding document.

**7. Clarification of
Bidding
Document, Site
Visit, Pre-Bid
Meeting**

7.1 A Bidder requiring any clarification of the bidding document shall contact the Employer in writing at the Employer's address indicated **in the BDS** or raise his enquiries during the pre-Bid meeting if provided for in accordance with ITB 7.4. The Employer will respond in writing to any request for clarification, provided that such request is received prior to the deadline for submission of Bids within a period specified **in the BDS**. The Employer shall forward copies of its response to all Bidders who have acquired the bidding document in accordance with ITB 6.3, including a description of the inquiry but without identifying its source. If so specified **in the BDS**, the Employer shall also promptly publish its response at the web page identified **in the BDS**. Should the clarification result in changes to the essential elements of the bidding document, the Employer shall amend the bidding document following the procedure under ITB 8 and ITB 23.2.

7.2 The Bidder is advised to visit and examine the site where the Plant is to be installed and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid and entering into a Contract for the provision of Plant and Installation Services. The costs of visiting the site shall be at the Bidder's own expense.

7.3 The Bidder and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and

lands for the purpose of such visit, but only upon the express condition that the Bidder, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

- 7.4 If so specified **in the BDS**, the Bidder's designated representative is invited to attend a pre-Bid meeting and/or a site visit. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.
- 7.5 The Bidder is requested to submit any questions in writing, to reach the Employer not later than one week before the meeting.
- 7.6 Minutes of the pre-Bid meeting, including the text of the questions raised without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Bidders who have acquired the bidding document in accordance with ITB 6.3. If so specified **in the BDS**, the Employer shall also promptly publish the Minutes of the pre-Bid meeting at the web page identified **in the BDS**. Any modification to the bidding document that may become necessary as a result of the pre-Bid meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to ITB 8 and not through the minutes of the pre-Bid meeting. Nonattendance at the pre-Bid meeting will not be a cause for disqualification of a Bidder.

- 8. Amendment of Bidding Document**
- 8.1 At any time prior to the deadline for submission of Bids, the Employer may amend the bidding document by issuing addenda.
- 8.2 Any addendum issued shall be part of the bidding document and shall be communicated in writing to all who have obtained the bidding document from the Employer in accordance with ITB 6.3. The Employer shall also promptly publish the addendum on the Employer's web page in accordance with ITB 7.1.
- 8.3 To give prospective Bidders reasonable time in which to take an addendum into account in preparing their Bids, the Employer may, at its discretion, extend the deadline for the submission of bids, pursuant to ITB 23.2.

C. Preparation of Bids

- 9. Cost of Bidding**
- 9.1 The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall not be responsible or liable for those costs, regardless of the conduct or outcome of the Bidding process.
- 10. Language of Bid**
- 10.1 The Bid, as well as all correspondence and documents relating to the Bid exchanged by the Bidder and the Employer, shall be written in the language specified **in the BDS**. Supporting documents and printed literature that are part of the Bid may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified **in the BDS**, in which case, for purposes of interpretation of the Bid, such translation shall govern.
- 11. Documents Comprising the Bid**
- 11.1 The Bid shall comprise two Parts, namely the Technical Part and the Financial Part. These two Parts shall be submitted simultaneously in two separate sealed envelopes (two-envelope Bidding process). One envelope shall contain only information relating to the Technical Part and the other, only information relating to the Financial Part. These two envelopes shall be enclosed in a separate sealed outer envelope marked "ORIGINAL BID"
- 11.2 The Technical Part shall comprise the following:

- (a) **Letter of Bid** - Technical Part, prepared in accordance with ITB12;
- (b) **Bid Security** or **Bid Securing Declaration**, in accordance with ITB 20;
- (c) **Alternative Bid** - Technical Part: if permissible in accordance with ITB 13, the Technical Part of any Alternative Bid;
- (d) **Authorization**: written confirmation authorizing the signatory of the Bid to commit the Bidder, in accordance with ITB 21.3;
- (e) **Eligibility of Plant and Installation Services**: documentary evidence established in accordance with ITB 14.1 that the Plant and Installation Services offered by the Bidder in its Bid or in any alternative Bid, if permitted, are eligible;
- (f) **Bidder's Eligibility and Qualifications**: documentary evidence in accordance with ITB 15.1 establishing the Bidder's eligibility and qualifications ;
- (g) **Conformity**: documentary evidence in accordance with ITB 16 that the Plant and Installation Services offered by the Bidder conform to the bidding document;
- (h) **Subcontractors**: list of subcontractors in accordance with ITB 16.2; and
- (i) any other document required **in the BDS**.

11.3 The Financial Part shall contain the following:

- (a) Letter of Bid – Financial Part: prepared in accordance with ITB 12 and ITB 14;
- (b) **Price Schedules** completed in accordance with ITB 12 and ITB 17;
- (c) Alternative Bid - Financial Part: if permissible in accordance with ITB 13, the Financial Part of any Alternative Bid; and
- (d) any other document required in the BDS.

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- 11.4 The Technical Part shall not include any information related to the Bid price. Where material financial information related to the Bid price is contained in the Technical Part the Bid shall be declared non-responsive.
- 11.5 In addition to the requirements under ITB 11.2, Bids submitted by a JV shall include in the Technical Part a copy of the Joint Venture Agreement entered into by all members. Alternatively, a letter of intent to execute a Joint Venture Agreement in the event of a successful Bid shall be signed by all members and submitted with the Bid, together with a copy of the proposed Agreement.
- 11.6 The Bidder shall furnish in the Letter of Bid - Financial Part information on commissions and gratuities, if any, paid or to be paid to agents or any other party relating to this Bid
- 12. Letters of Bid and Price Schedules**
- 12.1 The Letter of Bid - Technical Part and the Letter of Bid- Financial Part including the Price Schedules shall be prepared, using the relevant forms furnished in Section IV, Bidding Forms. The forms must be completed as instructed in each form without any alterations to the text, and no substitutes shall be accepted except as provided under ITB 21.3. All blank spaces shall be filled in with the information requested.

- 13. Alternative Bids**
- 13.1 Unless otherwise specified **in the BDS**, alternative Bids shall not be considered.
- 13.2 When alternatives to the Time Schedule are explicitly invited, a statement to that effect will be included **in the BDS**, and the method of evaluating different time schedules will be described in Section III, Evaluation and Qualification Criteria.
- 13.3 Except as provided under ITB 13.4 below, Bidders wishing to offer technical alternatives to the Employer's requirements as described in the bidding document must also provide: (i) a price at which they are prepared to offer a Plant meeting the Employer's requirements; and (ii) all information necessary for a complete evaluation of the alternatives by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, and proposed installation methodology and other relevant details. Only the technical alternatives, if any, of the Bidder with the Most Advantageous Bid conforming to the basic technical requirements shall be considered by the Employer.
- 13.4 When Bidders are invited **in the BDS** to submit alternative technical solutions for specified parts of the facilities, such parts will be identified **in the BDS**, as will the method for their evaluation, and described in Section VII, Employer's Requirements.
- 14. Documents Establishing the Eligibility of the Plant and Installation Services**
- 14.1 To establish the eligibility of the Plant and Installation Services in accordance with ITB 5, Bidders shall complete the country of origin declarations in the Price Schedule Forms, included in Section IV, Bidding Forms.
- 15. Documents Establishing the Eligibility and Qualifications of the Bidder**
- 15.1 To establish Bidder's eligibility in accordance with ITB 4, Bidders shall complete the Letter of Bid- Technical Part, included in Section IV, Bidding Forms.
- 15.2 To establish its qualifications to perform the Contract in accordance with Section III, Evaluation and Qualification Criteria, the Bidder shall provide the information requested in

the corresponding information sheets included in Section IV, Bidding Forms.

- 15.3 Any change in the structure or formation of a Bidder after being prequalified and invited to Bid, if applicable, (including, in the case of a JV, any change in the structure or formation of any member and also including any change in any specialized subcontractor whose qualifications were considered to prequalify the Applicant) shall be subject to the written approval of the Employer prior to the deadline for submission of Bids. Such approval shall be denied if (i) a Bidder proposes to associate with a disqualified Bidder or in case of a disqualified joint venture, any of its members; (ii) as a consequence of the change, the Bidder no longer substantially meets the qualification criteria; or (iii) in the opinion of the Employer, the change may result in a substantial reduction in competition. Any such change should be submitted to the Employer not later than fourteen (14) days after the date of the notice for RFB sent to the prequalified Bidders

16. Documents
Establishing the
Conformity of
the Plant and
Installation
Services

- 16.1 The Bidder shall furnish the information stipulated in Section IV, Bidding Forms in sufficient detail to demonstrate substantial responsiveness of the Bidders' proposal to the work requirements and the completion time.
- 16.2 For major items of Plant and Installation Services as listed by the Employer in Section III, Evaluation and Qualification Criteria, which the Bidder intends to purchase or subcontract, the Bidder shall give details of the name and nationality of the proposed Subcontractors, including manufacturers, for each of those items. In addition, the Bidder shall include in its Bid information establishing compliance with the requirements specified by the Employer for these items. Quoted rates and prices will be deemed to apply to whichever Subcontractor is appointed, and no adjustment of the rates and prices will be permitted.
- 16.3 The Bidder shall be responsible for ensuring that any Subcontractor proposed complies with the requirements of ITB 4, and that any Plant, or services to be provided by the

Subcontractor comply with the requirements of ITB 5 and ITB 16.1.

17. Bid Prices and Discounts

- 17.1 Unless otherwise specified **in the BDS**, Bidders shall quote for the entire Plant and Installation Services on a “single responsibility” basis. The total Bid price shall include all the Contractor’s obligations mentioned in or to be reasonably inferred from the bidding document in respect of the design, manufacture, including procurement and subcontracting (if any), delivery, construction, installation and completion of the Plant. This includes all requirements under the Contractor’s responsibilities for testing, pre-commissioning and commissioning of the Plant and, where so required by the bidding document, the acquisition of all permits, approvals and licenses, etc.; the operation, maintenance and training services and such other items and services as specified in the bidding document, all in accordance with the requirements of the General Conditions. Items against which no price is entered by the Bidder will not be paid for by the Employer when executed and shall be deemed to be covered by the prices for other items.
- 17.2 Bidders are required to quote the price for the commercial, contractual and technical obligations outlined in the bidding document.
- 17.3 Bidders shall give a breakdown of the prices in the manner and detail called for in the Price Schedules included in Section IV, Bidding Forms.
- 17.4 Depending on the scope of the Contract, the Price Schedules may comprise up to the six (6) schedules listed below. Separate numbered Schedules included in Section IV, Bidding Forms, from those numbered 1 to 4 below, shall be used for each of the elements of the Plant and Installation Services. The total amount from each Schedule corresponding to an element of the Plant and Installation Services shall be summarized in the schedule titled Grand Summary, (Schedule 5), giving the total Bid price(s) to be entered in the Letter of Bid. Bidders shall note that the plant and equipment included in Schedule Nos. 1 and

2 below exclude materials used for civil, building and other construction works. All such materials shall be included and priced under Schedule No. 4, Installation Services. The Schedules comprise:

Schedule No. 1: Plant (including Mandatory Spare Parts)
Supplied from Abroad

Schedule No. 2: Plant (including Mandatory Spare Parts)
Supplied from within the Employer's Country

Schedule No. 3: Design Services

Schedule No. 4: Installation Services

Schedule No. 5: Grand Summary (Schedule Nos.1 to 4)

Schedule No. 6: Recommended Spare Parts

17.5 In the Schedules, Bidders shall give the required details and a breakdown of their prices as follows:

(a) Plant to be supplied from abroad (Schedule No. 1):

The price of the Plant shall be quoted on CIP-named place of destination basis as specified **in the BDS**.

(b) Plant manufactured within the Employer's Country (Schedule No. 2):

(i) The price of the Plant shall be quoted on an EXW Incoterm basis (such as "ex-works," "ex-factory," "ex-warehouse" or "off-the-shelf," as applicable), including all customs duties, sales and other taxes already paid or payable on the components and raw materials used in the manufacture or assembly of the Plant;

(ii) Sales tax and all other taxes payable in the Employer's Country on the Plant if the contract is awarded to the Bidder;

(c) Design Services (Schedule No. 3);

(d) Installation Services shall be quoted separately (Schedule No. 4) and shall include rates or prices for local

transportation to named place of final destination as specified **in the BDS**, insurance and other services incidental to delivery of the Plant, all labor, contractor's equipment, temporary works, materials, consumables and all matters and things of whatsoever nature, including operations and maintenance services, the provision of operations and maintenance manuals, training, etc., where identified in the bidding document, as necessary for the proper execution of the installation and other services, including all taxes, duties, levies and charges payable in the Employer's Country as of twenty-eight (28) days prior to the deadline for submission of Bids;

- (e) Recommended spare parts shall be quoted separately (Schedule 6) as specified in either subparagraph (a) or (b) above in accordance with the origin of the spare parts.

17.6 The terms EXW, CIP, and other similar terms shall be governed by the rules prescribed in the current edition of Incoterms, published by the International Chamber of Commerce, as specified **in the BDS**.

17.7 The prices shall be either fixed or adjustable as specified **in the BDS**.

17.8 In the case of **Fixed Price**, prices quoted by the Bidder shall be fixed during the Bidder's performance of the contract and not subject to variation on any account. A Bid submitted with an adjustable price quotation will be treated as non-responsive and rejected.

17.9 In the case of **Adjustable Price**, prices quoted by the Bidder shall be subject to adjustment during performance of the contract to reflect changes in the cost elements such as labor, material, transport and contractor's equipment in accordance with the procedures specified in the corresponding Appendix to the Contract Agreement. A Bid submitted with a fixed price quotation will not be rejected, but the price adjustment will be treated as zero. Bidders are required to indicate the source of

labor and material indices in the corresponding Form in Section IV, Bidding Forms.

17.10 If so indicated in ITB 1.1, Bids are being invited for individual lots (contracts) or for any combination of lots (packages). Bidders wishing to offer any price reduction (discount) for the award of more than one Contract shall specify in their Letter of Bid the price reductions applicable to each package, or alternatively, to individual Contracts within the package, and the manner in which the price reductions will apply. **However, discounts on condition of award of more than one contract will not be used for Bid evaluation purpose.**

17.11 Bidders wishing to offer any unconditional discount shall specify in their Letter of Bid the offered discounts and the manner in which price discounts will apply.

18. Currencies of Bid and Payment

18.1 The currency(ies) of the Bid and the currency(ies) of payments shall be the same. The Bidder shall quote in the currency of the Employer's country the portion of the Bid price that corresponds to expenditures incurred in the currency of the Employer's Country, unless otherwise specified **in the BDS**.

18.2 The Bidder may express the Bid price in any currency. If the Bidder wishes to be paid in a combination of amounts in different currencies, it may quote its price accordingly but shall use no more than three foreign currencies in addition to the currency of the Employer's Country.

19. Period of Validity of Bids

19.1 Bids shall remain valid until the date specified **in the BDS** or any extended date if amended by the Employer in accordance with ITB 8. A Bid that is not valid until the date specified **in the BDS**, or any extended date if amended by the Employer in accordance with ITB 8, shall be rejected by the Employer as nonresponsive.

19.2 In exceptional circumstances, prior to the date of expiration of the Bid validity, the Employer may request Bidders to extend the period of validity of their Bids. The request and the responses shall be made in writing. If a Bid Security is requested in accordance with ITB 20, the Bidder granting the request shall

also extend the Bid Security for twenty-eight (28) days beyond the deadline of the extended validity period. A Bidder may refuse the request without forfeiting its Bid Security. A Bidder granting the request shall not be required or permitted to modify its Bid, except as provided in ITB 19.3.

19.3 If the award is delayed by a period exceeding fifty-six (56) days beyond the expiry of the initial Bid validity specified in accordance with ITB 19.1, the Contract price shall be determined as follows:

- (a) in the case of **fixed price** contracts, the Contract price shall be the Bid price adjusted by the factor or factors specified **in the BDS**;
- (b) in the case of **adjustable price** contracts, no adjustment shall be made; or
- (c) in any case, Bid evaluation shall be based on the Bid price without taking into consideration the applicable correction from those indicated above.

20. Bid Security

20.1 The Bidder shall furnish as part of the Technical Part of its Bid, either a Bid-Securing Declaration or a Bid Security as specified **in the BDS**, in original form and, in the case of a Bid Security, in the amount and currency specified **in the BDS**.

20.2 A Bid-Securing Declaration shall use the form included in Section IV Bidding Forms.

20.3 If a Bid Security is specified pursuant to ITB 20.1, the Bid security shall be a demand guarantee in any of the following forms at the Bidder's option:

- (a) an unconditional guarantee issued by a bank or non-bank financial institution (such as an insurance, bonding or surety company);
- (b) an irrevocable letter of credit;
- (c) a cashier's or certified check; or
- (d) another security indicated **in the BDS**,

from a reputable source from an eligible country. If an unconditional guarantee is issued by a non-bank financial institution located outside the Employer's Country the issuing non-bank financial institution shall have a correspondent financial institution located in the Employer's Country to make it enforceable unless the Employer has agreed in writing, prior to Bid submission, that a correspondent financial institution is not required. In the case of a bank guarantee, the Bid Security shall be submitted either using the Bid Security Form included in Section IV, Bidding Forms, or in another substantially similar format approved by the Employer prior to Bid submission. The Bid Security shall be valid for twenty-eight (28) days beyond the original date of expiry of the Bid validity, or beyond any extended date if requested under ITB 19.2.

- 20.4 If a Bid Security or a Bid-Securing Declaration is specified pursuant to ITB 20.1, any Bid not accompanied by a substantially responsive Bid Security or Bid-Securing Declaration shall be rejected by the Employer as nonresponsive.
- 20.5 If a Bid Security is specified pursuant to ITB 20.1, the Bid Security of unsuccessful Bidders shall be returned as promptly as possible upon the successful Bidder's furnishing of the Performance Security pursuant to ITB 47.
- 20.6 The Bid Security of the successful Bidder shall be returned as promptly as possible once the successful Bidder has signed the Contract and furnished the required Performance Security.
- 20.7 The Bid Security may be forfeited:
 - (a) if a Bidder withdraws its Bid prior to the expiry date of the Bid validity specified by the Bidder on the Letter of Bid or any extended date provided by the Bidder; or
 - (b) if the successful Bidder fails to:
 - (i) sign the Contract in accordance with ITB 46; or
 - (ii) furnish a Performance Security in accordance with ITB 47.

- 20.8 The Bid Security or the Bid-Securing Declaration of a JV shall be in the name of the JV that submits the Bid. If the JV has not been legally constituted into a legally enforceable JV at the time of bidding, the Bid Security or the Bid Securing Declaration shall be in the names of all future members as named in the letter of intent referred to in ITB 4.1 and ITB 11.5.
- 20.9 If a Bid Security is not required **in the BDS**: and
- (a) if a Bidder withdraws its Bid prior to the expiry date of the Bid validity specified by the Bidder on the Letter of Bid, or any extended date provided by the Bidder; or
 - (b) if the successful Bidder fails to:
 - (i) sign the Contract in accordance with ITB 46; or
 - (ii) furnish a Performance Security in accordance with ITB 47;

the Borrower may, if provided for **in the BDS**, declare the Bidder disqualified to be awarded a contract by the Employer for a period of time as stated **in the BDS**.

**21. Format and
Signing of Bid**

- 21.1 The Bidder shall prepare the Bid, in accordance with this Instruction, ITB 11 and ITB 22.
- 21.2 Bidders shall mark as “CONFIDENTIAL” information in their Bids which is confidential to their business. This may include proprietary information, trade secrets or commercial or financially sensitive information.
- 21.3 The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Bidder. This authorization shall consist of a written confirmation as specified **in the BDS** and shall be attached to the Bid. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Bid where entries or amendments have been made shall be signed or initialed by the person signing the Bid.
- 21.4 In the case that the Bidder is a JV, the Bid shall be signed by an authorized representative of the JV on behalf of the JV, and so

as to be legally binding on all the members as evidenced by a power of attorney signed by their legally authorized representatives.

- 21.5 Any interlineations, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the Bid.

D. Submission of Bids

22. Submission, Sealing and Marking of Bids

- 22.1 The Bidder shall deliver the Bid in two separate, sealed envelopes (the Technical Part and the Financial Part.). These two envelopes shall be enclosed in a separate sealed outer envelope marked "Original Bid". In addition, the Bidder shall submit copies of the Bid in the number specified **in the BDS**. Copies of the Technical Part shall be placed in a separate sealed envelope marked "COPIES: TECHNICAL PART". Copies of the Financial Part shall be placed in a separate sealed envelope marked "COPIES: FINANCIAL PART". The Bidder shall place both of these envelopes in a separate, sealed outer envelope marked "BID COPIES". In the event of any discrepancy between the original and the copies, the original shall prevail.
- 22.2 If alternative Bids are permitted in accordance with ITB 13, the alternative Bids shall be submitted as follows: the original of the alternative Bid Technical Part shall be placed in a sealed envelope marked "ALTERNATIVE BID – TECHNICAL PART" and the Financial Part shall be placed in a sealed envelope marked "ALTERNATIVE BID – FINANCIAL PART" and these two separate sealed envelopes then enclosed within a sealed outer envelope marked "ALTERNATIVE BID – ORIGINAL", the copies of the alternative Bid will be placed in separate sealed envelopes marked "ALTERNATIVE BID – COPIES OF TECHNICAL PART", and "ALTERNATIVE BID – COPIES OF FINANCIAL PART" and enclosed in a separate sealed outer envelope marked "ALTERNATIVE BID - COPIES".
- 22.3 The envelopes marked "ORIGINAL BID" and "BID COPIES" (and, if appropriate, a third envelope marked "ALTERNATIVE BID") shall be enclosed in a separate sealed outer envelope for submission to the Employer.
- 22.4 The inner and outer envelopes shall:

- (a) bear the name and address of the Bidder;
 - (b) be addressed to the Employer in accordance with ITB 23.1;
 - (c) bear the specific identification of this Bidding process indicated in accordance with ITB 1.1; and
 - (d) bear a warning not to open before the time and date for Bid opening.
- 22.5 If all envelopes are not sealed and marked as required, the Employer will assume no responsibility for the misplacement or premature opening of the Bid.
- 23. Deadline for Submission of Bids**
 - 23.1 Bids must be received by the Employer at the address and no later than the date and time indicated **in the BDS**. When so specified **in the BDS**, Bidders shall have the option of submitting their Bids electronically. Bidders submitting Bids electronically shall follow the electronic Bid submission procedures specified **in the BDS**.
 - 23.2 The Employer may, at its discretion, extend the deadline for the submission of Bids by amending the bidding document in accordance with ITB 8, in which case all rights and obligations of the Employer and Bidders previously subject to the deadline shall thereafter be subject to the deadline as extended.
- 24. Late Bids**
 - 24.1 The Employer shall not consider any Bid that arrives after the deadline for submission of Bids, in accordance with ITB 23. Any Bid received by the Employer after the deadline for submission of Bids shall be declared late, rejected, and returned unopened to the Bidder.

- 25. Withdrawal, Substitution, and Modification of Bids**
- 25.1 A Bidder may withdraw, substitute, or modify its bid after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the authorization in accordance with ITB 21.3, (except that withdrawal notices do not require copies). The corresponding substitution or modification of the Bid must accompany the respective written notice. All notices must be:
- (a) prepared and submitted in accordance with ITB 21 and ITB 22 (except that withdrawals notices do not require copies), and in addition, the respective envelopes shall be clearly marked “Withdrawal,” “Substitution,” “Modification”; and
 - (b) received by the Employer prior to the deadline prescribed for submission of Bids, in accordance with ITB 23.
- 25.2 Bids requested to be withdrawn in accordance with ITB 25.1 shall be returned unopened to the Bidders.
- 25.3 No Bid may be withdrawn, substituted, or modified in the interval between the deadline for submission of Bids and the date of expiry of the Bid validity specified by the Bidder on the Letter of Bid or any extended date thereof.

E. Public Opening of Technical Parts of Bids

- 26. Public Opening of Technical Parts of Bids**
- 26.1 Except as in the cases specified in ITB 24 and ITB 25.2, the Employer shall publicly open and read out all Bids received by the deadline at the date, time and place specified **in the BDS** in the presence of Bidders’ designated representatives and anyone who choose to attend. Any specific electronic Bid opening procedures required if electronic Bidding is permitted in accordance with ITB 23.1, shall be as specified **in the BDS**.
- 26.2 First, the written notice of withdrawal in the envelopes marked “Withdrawal” shall be opened and read out and the envelope with the corresponding Bid shall not be opened but returned to the Bidder. No bid withdrawal shall be permitted unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is read out at Bid opening.

- 26.3 Next, envelopes marked “Substitution” shall be opened and read out and exchanged with the corresponding Bid being substituted, and the substituted Bid shall not be opened, but returned to the Bidder. No Bid substitution shall be permitted unless the corresponding substitution notice contains a valid authorization to request the substitution and is read out at Bid opening.
- 26.4 Next, envelopes marked “Modification” shall be opened and read out with the corresponding Bid. No Bid modification shall be permitted unless the corresponding modification notice contains a valid authorization to request the modification and is read out at Bid opening.
- 26.5 Next, all other envelopes marked “TECHNICAL PART” shall be opened one at a time. All envelopes marked “SECOND ENVELOPE: Financial PART” shall remain sealed and kept by the Employer in safe custody until they are opened at a later public opening, following the evaluation of the Technical Part parts of the Bids. On opening the envelopes marked “TECHNICAL PART” the Employer shall read out: the name of the Bidder, the presence or the absence of a Bid Security, or Bid-Securing Declaration, if required, and whether there is a modification; and Alternative Bid - Technical Part; and any other details as the Employer may consider appropriate.
- 26.6 Only Technical Parts of Bids and Alternative Bid - Technical Parts that are read out at Bid opening shall be considered further for evaluation. The Letter of Bid- Technical Part and the separate sealed envelope marked “SECOND ENVELOPE: FINANCIAL PART” are to be initialled by representatives of the Employer attending Bid opening in the manner specified **in the BDS**.
- 26.7 The Employer shall neither discuss the merits of any Bid nor reject any Bid (except for late Bids, in accordance with ITB 24.1).
- 26.8 The Employer shall prepare a record of the Bid opening that shall include, as a minimum:
- (a) the name of the Bidder and whether there is a withdrawal, substitution, or modification;

- (b) the receipt of envelopes marked “SECOND ENVELOPE: FINANCIAL PART”;
- (c) if applicable, any alternative Bid-Technical Part; and
- (d) the presence or absence of a Bid Security or a Bid-Securing Declaration.

26.9 The Bidders’ representatives who are present shall be requested to sign the record. The omission of a Bidder’s signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Bidders.

F. Evaluation of Bids – General Provisions

- 27. Confidentiality**
- 27.1 Information relating to the evaluation of the Technical Part shall not be disclosed to Bidders or any other persons not officially concerned with the Bidding process until the notification of evaluation of the Technical Part in accordance with ITB 33. Information relating to the evaluation of Financial Part, the evaluation of combined Technical Part and Financial Part, and recommendation of contract award shall not be disclosed to Bidders or any other persons not officially concerned with the RFB process until the Notification of Intention to Award the Contract is transmitted to Bidders in accordance with ITB 42.
- 27.2 Any effort by a Bidder to influence the Employer in the evaluation of the bids or Contract award decisions may result in the rejection of its Bid.
- 27.3 Notwithstanding ITB 27.2, from the time of Bid opening to the time of Contract Award, if any Bidder wishes to contact the Employer on any matter related to the Bidding process, it should do so in writing.

- 28. Clarification of Bids**
- 28.1 To assist in the examination, evaluation, and comparison of the Bids, and qualification of the Bidders, the Employer may, at its discretion, ask any Bidder for a clarification of its Bid. Any clarification submitted by a Bidder that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing. No change in the prices or substance of the Bid shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Bids, in accordance with ITB 35.
- 28.2 If a Bidder does not provide clarifications of its Bid by the date and time set in the Employer's request for clarification, its Bid may be rejected.
- 29. Deviations, Reservations, and Omissions**
- 29.1 During the evaluation of Bids, the following definitions apply:
- (a) "Deviation" is a departure from the requirements specified in the bidding document;
 - (b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the bidding document; and
 - (c) "Omission" is the failure to submit part or all of the information or documentation required in the bidding document.
- 29.2 Provided that a Bid is substantially responsive, the Employer may waive any nonmaterial nonconformities in the Bid.
- 29.3 Provided that a Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any aspect of the price of the Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

G. Evaluation of Technical Part of Bids

30. Determination of Responsiveness of Technical Part	30.1	The Employer's determination of the Technical Part's responsiveness shall be based on the contents of the Bid, as specified in ITB 11.
	30.2	Preliminary examination of the Technical Part shall be carried out to identify proposals that are incomplete, invalid or substantially nonresponsive to the requirements of the Bidding documents. A substantially responsive Bid is one that materially confirms to the requirements of the Bidding document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that, (a) if accepted, would: (i) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or (ii) limit in any substantial way, inconsistent with the Bidding document, the Employer's rights or the Bidder's obligations under the proposed Contract; or (b) if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.
	30.3	If the Technical Part is not substantially responsive to the requirements of the Bidding document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.
	31. Eligibility and Qualifications of the Bidder	31.1
31.2		The determination shall be based upon an examination of the documentary evidence of the Bidder's eligibility and qualifications submitted by the Bidder, pursuant to ITB 15. The determination shall not take into consideration the qualifications of other firms such as the Bidder's subsidiaries,

parent entities, affiliates, subcontractors (other than Specialized Subcontractors if permitted in the bidding document), or any other firm.

31.3 Prior to Contract award, the Employer will verify that the successful Bidder (including each member of a JV) is not disqualified by the Bank due to noncompliance with contractual SEA/SH prevention and response obligations. The Employer will conduct the same verification for each subcontractor proposed by the successful Bidder. If any proposed subcontractor does not meet the requirement, the Employer will require the Bidder to propose a replacement subcontractor.

31.4 Only substantially responsive bids submitted by eligible and qualified bidders shall proceed to the detailed technical evaluation specified in ITB 32.

32. Detailed Evaluation of Technical Part	32.1	The Employer's evaluation of Technical Part will be carried out as specified in Section III, Evaluation and Qualification Criteria.
	32.2	The scores and weightings to be given to Rated Criteria (including technical and non-price factors and sub factors) are specified in the BDS.

H. Notification of Evaluation of Technical Parts and Public Opening of Financial Parts

33. Notification of Evaluation of Technical Parts and Public Opening of Financial Parts	33.1	Following the completion of the evaluation of the Technical Parts of the Bids, the Employer shall notify in writing those Bidders whose Bids were considered substantially non-responsive to the bidding document or failed to meet the eligibility and qualification requirements, advising them of the following information: (a) the grounds on which their Technical Part of Bid failed to meet the requirements of the bidding document; (b) their envelopes marked "SECOND ENVELOPE: FINANCIAL PART" will be returned to them unopened after the completion of the selection process and the signing of the Contract; and

- (c) notify them of the date, time and location of the public opening of the envelopes marked “SECOND ENVELOPE: FINANCIAL PART”.

33.2 The Employer shall, simultaneously, notify in writing those Bidders whose Technical Part have been evaluated as substantially responsive to the bidding document and met the eligibility and qualification requirements, advising them of the following information:

- (a) their Bid has been evaluated as substantially responsive to the bidding document and met the eligibility and qualification requirements;
- (b) their envelope marked “SECOND ENVELOPE: FINANCIAL PART” will be opened at the public opening of the Financial Parts; and
- (c) notify them of the date, time and location of the second public opening of the envelopes marked “SECOND ENVELOPE: FINANCIAL PART” as specified **in the BDS**.

33.3 The opening date shall be not less than ten (10) Business Days from the date of notification of the results of the technical evaluation, specified in ITB 33.1 and 33.2. However, if the Employer receives a complaint on the results of the technical evaluation within the ten (10) Business Days, the opening date shall be subject to ITB 48.1. The Financial Part of the Bid shall be opened publicly in the presence of Bidders’ designated representatives and anyone who chooses to attend.

33.4 At this public opening, the Financial Parts will be opened by the Employer in the presence of Bidders, or their designated representatives and anyone else who chooses to attend. Bidders who met the eligibility and qualification requirements and whose bids were evaluated as substantially responsive will have their envelopes marked “SECOND ENVELOPE: FINANCIAL PART” opened at the second public opening. Each of these envelopes marked “SECOND ENVELOPE: FINANCIAL PART” shall be inspected to confirm that they have remained sealed and unopened. These envelopes shall then be opened by the Employer. The Employer

shall read out the names of each Bidder, the technical score and the total Bid prices, per lot (contract) if applicable, including any discounts and Alternative Bid - Financial Part, and any other details as the Employer may consider appropriate.

- 33.5 Only envelopes of Financial Part of Bids, Financial Parts of Alternative Bids and discounts that are opened and read out at Bid opening shall be considered further for evaluation. The Letter of Bid – Financial Part and the Priced Activity Schedules are to be initialed by a representative of the Employer attending the Bid opening in the manner specified **in the BDS**.
- 33.6 The Employer shall neither discuss the merits of any Bid nor reject any envelopes marked “SECOND ENVELOPE: FINANCIAL PART” at this public opening.
- 33.7 The Employer shall prepare a record of the Financial Part of the Bid opening that shall include, as a minimum: (a) the name of the Bidder whose Financial Part was opened; (b) the Bid price, per lot (contract) if applicable, including any discounts; and (c) if applicable, any Alternative Bid – Financial Part.
- 33.8 The Bidders whose envelopes marked “SECOND ENVELOPE: FINANCIAL PART” have been opened or their representatives who are present shall be requested to sign the record. The omission of a Bidder’s signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Bidders.

I. Evaluation of Financial Part of Bids

- 34. Adjustments for Non-material Nonconformities**
- 34.1 Provided that a Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component by adding the average price of the item or component quoted by substantially responsive Bidders. If the price of the item or component cannot be derived from the price of other substantially responsive Bidders, the Employer shall use its best estimate.

- 35. Correction of Arithmetic Errors**
- 35.1 In evaluating the Financial Part of each Bid, the Employer shall correct arithmetical errors on the following basis:
- (a) where there are errors between the total of the amounts given under the column for the price breakdown and the amount given under the Total Price, the former shall prevail and the latter will be corrected accordingly;
 - (b) where there are errors between the total of the amounts of Schedule Nos. 1 to 4 and the amount given in Schedule No. 5 (Grand Summary) the former shall prevail and the latter will be corrected accordingly;
 - (c) if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.
- 35.2 Bidders shall be requested to accept correction of arithmetical errors. Failure to accept the correction in accordance with ITB 35.1, shall result in the rejection of the Bid.
- 36. Evaluation Process, Financial Part**
- 36.1 To evaluate the Financial Part, the Employer shall consider the following:
- (a) the Bid price, excluding provisional sums and the provision, if any, for contingencies in the Price Schedules;
 - (b) price adjustment for correction of arithmetic errors in accordance with ITB 35.1;
 - (c) price adjustment due to discounts offered in accordance with ITB 17.11;
 - (d) price adjustment due to quantifiable nonmaterial nonconformities in accordance with ITB 34.1;
 - (e) converting the amount resulting from applying (a) to (c) above, if relevant, to a single currency in accordance with ITB 36.2; and
 - (f) the evaluation factors indicated in the BDS and detailed in Section III, Evaluation and Qualification Criteria.

- 36.2 For evaluation and comparison purposes, the currency(ies) of the Bid shall be converted into a single currency **as specified in the BDS.**
- 36.3 No margin of domestic preference shall apply.
- 36.4 If price adjustment is allowed in accordance with ITB 17.7, the estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Bid evaluation.
- 36.5 If this bidding document allows Bidders to quote separate prices for different lots (contracts), each lot will be evaluated separately to determine the Most Advantageous Bid using the methodology specified in Section III, Evaluation and Qualification Criteria. **Discounts that are conditional on the award of more than one lot or slice shall not be considered for Bid evaluation.**
- 37. Abnormally Low Bids**
- 37.1 An Abnormally Low Bid is one where the Bid price, in combination with other elements of the Bid, appears so low that it raises material concerns as to the capability of the Bidder to perform the Contract for the offered Bid Price.
- 37.2 In the event of identification of a potentially Abnormally Low Bid, the Employer shall seek written clarifications from the Bidder, including detailed price analyses of its Bid price in correlation to the subject matter of the contract, scope, proposed methodology, schedule, allocation of risks and responsibilities and any other requirements of the bidding document.
- 37.3 After evaluation of the price analyses, in the event that the Employer determines that the Bidder has failed to demonstrate its capability to deliver the contract for the offered tender price, the Employer shall reject the Bid.
- 38. Unbalanced or Front Loaded Bids**
- 38.1 If the Bid that is evaluated as the lowest evaluated cost is, in the Employer's opinion, seriously unbalanced or front loaded the Employer may require the Bidder to provide written clarifications. Clarifications may include detailed price analyses to demonstrate the consistency of the Bid prices with the scope

of works, proposed methodology, schedule and any other requirements of the bidding document.

38.2 After the evaluation of the information and detailed price analyses presented by the Bidder, the Employer may:

- (a) accept the Bid; or
- (b) if appropriate, require that the total amount of the Performance Security be increased, at the expense of the Bidder, to a level not exceeding twenty percent (20%) of the Contract Price; or
- (c) reject the Bid.

J. Evaluation of Combined Technical and Financial Parts, Most Advantageous Bid and Notification of Intention to Award

**39. Evaluation of
combined
Technical and
Financial Parts,
Most
Advantageous
Bid**

39.1 The Employer's evaluation of responsive Bids will take into account technical factors, in addition to cost factors in accordance with Section III Evaluation and Qualification Criteria. The weight to be assigned for the Technical factors and cost is specified in the BDS. The Employer will rank the Bids based on the evaluated Bid score (B).

39.2 The Employer shall determine the Most Advantageous Bid. The Most Advantageous Bid is the Bid of the Bidder that meets the Qualification Criteria and whose Bid has been determined to be substantially responsive to the Bidding document and is the Bid with the highest combined technical and financial score.

39.3 The capabilities of the manufacturers and subcontractors proposed in its Bid to be used by the Bidder with the Most Advantageous Bid for identified major items of supply or services will also be evaluated for acceptability in accordance with Section III, Evaluation and Qualification Criteria. Their participation should be confirmed with a letter of intent between the parties, as needed. Should a manufacturer or subcontractor be determined to be unacceptable, the Bid will not be rejected, but the Bidder will be required to substitute an acceptable manufacturer or subcontractor without any change to the Bid price. Prior to signing the Contract, the

corresponding Appendix to the Contract Agreement shall be completed, listing the approved manufacturers or subcontractors for each item concerned.

40. Employer's right to Accept Any Bid and to Reject Any or All Bids	40.1	The Employer reserves the right to accept or reject any Bid, and to annul the Bidding process and reject all Bids at any time prior to Contract Award, without thereby incurring any liability to Bidders. In case of annulment, all Bids submitted and specifically, Bid securities shall be promptly returned to the Bidders.
41. Standstill Period	41.1	The Contract shall not be awarded earlier than the expiry of the Standstill Period. The Standstill Period shall be ten (10) Business Days unless extended in accordance with ITB 45. The Standstill Period commences the day after the date the Employer has transmitted to each Bidder the Notification of Intention to Award the Contract. Where only one Bid is submitted, or if this contract is in response to an emergency situation recognized by the Bank, the Standstill Period shall not apply.
42. Notification of Intention to Award	42.1	The Employer shall send to each Bidder the Notification of Intention to Award the Contract to the successful Bidder. The Notification of Intention to Award shall contain, at a minimum, the following information: (a) the name and address of the Bidder submitting the successful Bid; (b) the Contract price of the successful Bid; (c) the total combined score of the successful Bid; (d) the names of all Bidders who submitted Bids, and their Bid prices as readout, and as evaluated and technical score; (e) a statement of the reason(s) the Bid (of the unsuccessful Bidder to whom the notification is addressed) was unsuccessful; (f) the expiry date of the Standstill Period; and (g) instructions on how to request a debriefing and/or submit a complaint during the standstill period.

K. Award of Contract

- 43. Award Criteria** 43.1 Subject to ITB 40, the Employer shall award the Contract to the successful Bidder. This is the Bidder whose Bid has been determined to be the Most Advantageous Bid.
- 44. Notification of Award** 44.1 Prior to the date of expiry of the bid validity, and upon expiry of the Standstill Period, specified in ITB 41.1 or any extension thereof, and upon satisfactorily addressing any complaint that has been filed within the Standstill Period, the Employer shall notify the successful Bidder, in writing, that its Bid has been accepted. The notification of award (hereinafter and in the Contract Forms called the “Letter of Acceptance”) shall specify the sum that the Employer will pay the Contractor in consideration of the execution of the contract (hereinafter and in the Conditions of Contract and Contract Forms called “the Contract Price”).
- 44.2 Within ten (10) Business Days after the date of transmission of the Letter of Acceptance, the Employer shall publish the Contract Award Notice which shall contain, at a minimum, the following information:
- (a) name and address of the Employer;
 - (b) name and reference number of the contract being awarded, and the selection method used;
 - (c) names of all Bidders that submitted Bids, and their Bid prices as read out at Bid opening, and as evaluated;
 - (d) names of all Bidders whose Bids were rejected either as nonresponsive or as not meeting qualification criteria, or were not evaluated, with the reasons therefor;
 - (e) the name of the successful Bidder, the final total contract price, the contract duration and a summary of its scope; and
 - (f) successful Bidder’s Beneficial Ownership Disclosure Form.
- 44.3 The Contract Award Notice shall be published on the Employer’s website with free access if available, or in at least

one newspaper of national circulation in the Employer's Country, or in the official gazette.

44.4 Until a formal contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.

**45. Debriefing by
the Employer**

45.1 On receipt of the Employer's Notification of Intention to Award referred to in ITB 42, an unsuccessful Bidder has three (3) Business Days to make a written request to the Employer for a debriefing. The Employer shall provide a debriefing to all unsuccessful Bidders whose request is received within this deadline.

45.2 Where a request for debriefing is received within the deadline, the Employer shall provide a debriefing within five (5) Business Days, unless the Employer decides, for justifiable reasons, to provide the debriefing outside this timeframe. In that case, the standstill period shall automatically be extended until five (5) Business Days after such debriefing is provided. If more than one debriefing is so delayed, the standstill period shall not end earlier than five (5) Business Days after the last debriefing takes place. The Employer shall promptly inform, by the quickest means available, all Bidders of the extended standstill period.

45.3 Where a request for debriefing is received by the Employer later than the three (3)-Business Day deadline, the Employer should provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of Public Notice of Award of contract. Requests for debriefing received outside the three (3)-day deadline shall not lead to extension of the standstill period.

45.4 Debriefings of unsuccessful Bidders may be done in writing or verbally. The Bidder shall bear their own costs of attending such a debriefing meeting.

**46. Signing of
Contract**

46.1 The Employer shall send to the successful Bidder the Letter of Acceptance including the Contract Agreement, and a request to submit the Beneficial Ownership Disclosure Form providing additional information on its beneficial ownership. The

Beneficial Ownership Disclosure Form shall be submitted within eight (8) Business Days of receiving this request.

- 46.2 The successful Bidder shall sign, date and return to the Employer, the Contract Agreement within twenty-eight (28) days of its receipt.
- 46.3 Notwithstanding ITB 46.2 above, in case signing of the Contract Agreement is prevented by any export restrictions attributable to the Employer, to the country of the Employer, or to the use of the Plant and Installation Services to be supplied, where such export restrictions arise from trade regulations from a country supplying those Plant and Installation Services, the Bidder shall not be bound by its Bid, always provided, however, that the Bidder can demonstrate to the satisfaction of the Employer and of the Bank that signing of the Contract Agreement has not been prevented by any lack of diligence on the part of the Bidder in completing any formalities, including applying for permits, authorizations and licenses necessary for the export of the Plant and Installation Services under the terms of the Contract.

**47. Performance
Security**

- 47.1 Within twenty-eight (28) days of the receipt of the Letter of Acceptance from the Employer, the successful Bidder shall furnish the Performance Security in accordance with the General Conditions GCC 13.3, subject to ITB 38, using for that purpose the Performance Security Form included in Section X, Contract Forms, or another form acceptable to the Employer. If the Performance Security furnished by the successful Bidder is in the form of a bond, it shall be issued by a bonding or insurance company that has been determined by the successful Bidder to be acceptable to the Employer. A foreign institution providing a bond shall have a correspondent financial institution located in the Employer's Country, unless the Employer has agreed in writing that a correspondent financial institution is not required.
- 47.2 Failure of the successful Bidder to submit the above-mentioned Performance Security or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security. In that event the Employer may

award the Contract to the Bidder offering the next Most Advantageous Bid.

48. Procurement Related Complaint	48.1 The procedures for making a Procurement-related Complaint are as specified in the BDS.

Section II – Bid Data Sheet

The following specific data for the Facilities to be procured shall complement, supplement, amend the provisions in the Instructions to Bidders (ITB). Whenever there is a conflict, provisions herein shall prevail over those in ITB.

A. General	
ITB 1.1	The reference number of the Request for Bids (RFB) is : ZM-ZESCO-495237-CW-RFB The Employer is: ZESCO Limited The name of the RFB is: Design, Supply, and Installation for: i) Nakonde Stepdown (330/(132)66/11kV) Substation, ii) Kasama 330 kV substation. The number and identification of lots (contracts) comprising this RFB is: – None
ITB 1.2 (a)	N/A
ITB 2.1	The Borrower is: Republic of Zambia. The Project Implementation Entity is: ZESCO Limited The amount of the financing is: USD 292 Million The name of the Project is: Zambia-Tanzania Interconnector Project (ZTIP) - P507033
ITB 4.1	Maximum number of members in the Joint Venture (JV) shall be: Three (03)
ITB 4.5	A list of debarred firms and individuals is available on the Bank's external website: https://www.worldbank.org/en/projects-operations/procurement/debarred-firms
ITB 4.11	This Bidding Process is not subject to prequalification.
B. Bidding Document	
ITB 7.1	For Clarification of Bid purposes only, the Employer's address is:

	Attention: Lemmy Nyirenda Address: Stand No. 6949, Great East Road, P.O. Box 33304 Floor/ Room number: Procurement Offices, LDCC Building City: Lusaka ZIP Code: 10101 Country: Zambia Telephone: +260 211 362 330 Electronic mail address: lnyirenda@zesco.co.zm Requests for clarification shall be received by the Employer no later than: 28 days before the bid deadline as per ITB 23.1. In case a Bidder requests clarification of the Request for Bid Documents, a copy of the request sent to the Employer shall be sent to the Employer's Consultant Sweco, to the following e-mail addresses: - Maria Vabulis – maria.vabulis@sweco.se - Lars Wennmark – lars.wennmark@sweco.se
ITB 7.4	A Pre-Bid meeting and Site visit shall take place at the following date, time and place: Date: 1 June 2026 Time: 9:00 AM, CAT Place: Kasama and Nakonde, Zambia Alternatively, interested bidders may participate virtually through a link that will be shared prior to the meeting. If for any reason the virtual meeting has any problem the project will not be responsible. At the Pre-Bid meeting, the Employer will present the key environmental and social (E&S) risks and mitigation measures from the project ESIA, BMP, ESMP, ESCP, SEP, LMP, and other E&S instruments. Bidders may submit questions and preliminary comments for their better understanding to managing E&S risks in their bids. A site visit shall be organized by the Employer, immediately thereafter. <u>The costs of visiting the site shall be at the Bidder's own expense.</u>

	Bidders are requested to submit (if any) questions in writing at least one week before the Pre-Bid meeting to above address.
ITB 7.6	Web page https://www.zesco.co.zm/tender.php
C. Preparation of Bids	
ITB 10.1	The language of the Bid is: English All correspondence exchange shall be in English language. Language for translation of supporting documents and printed literature is English.
ITB 11.2 (i)	The Bidder shall submit the following additional documents in the Technical Part of its Bid: a) Manufacturer's authorization in case the bidder is not a manufacturer. b) Technical Particulars/characteristics duly completed and signed by the manufacturer as per Guaranteed Technical Characteristics of the Technical Specifications. c) Manufacturers shall have ISO 9001:2015 or equivalent quality assurance certificate. A copy of such certificate shall be submitted with the bid. d) Bidder shall have ISO 9001:2015 (or equivalent quality assurance certificate) and ISO 14001:2015 or ISO 45001:2018 certifications (or equivalent). A copy of such certificates shall be submitted with the bid. e) Type Tests certificates from accredited Laboratories as required in the Technical Specifications and Post Qualifications. f) The accreditation certificate for the testing lab to ISO/IEC 17025. g) Additional information such as brochures/catalogues/drawings and any other describing in detail the proposed items. h) The Manufacturer's Declaration of Conformity to reference standards. i) Statement of compliance to Employer's Requirements (indicate deviations if any and supporting documents in the bid). j) Documentary Evidence indicating the Bidder's Supplies record as stipulated in Section III of the Evaluation criteria, Post Qualification Requirements.

	k) Code of Conduct for Contractor's Personnel (ES) The Bidder shall submit its Code of Conduct that will apply to the Contractor's Personnel (as defined in GCC Sub- Clause 1) employed for the execution of Installation Services (defined in GCC Sub- Clause 1) at the Site (or other places in the country where the Site is located), to ensure compliance with the Contractor's Environmental and Social (ES) obligations under the Contract. The Bidder shall use for this purpose the Code of Conduct form provided in Section IV. No substantial modifications shall be made to this form, except that the Bidder may introduce additional requirements, including as necessary to take into account specific Contract issues/risks. l) Management Strategies and Implementation Plans (MSIP) to manage the (ES) risks The Bidder shall submit Management Strategies and Implementation Plans (MSIPs) to manage key Environmental and Social (ES) risks.: The following documents will be prepared by the bidders to address the above listed risks • Contractor Environmental and Social Management Plan (C-ESMP) (30 days after contract effectiveness) (The Bidder shall demonstrate commitment to prepare a Contractor's Environmental and Social Management Plan (C-ESMP) covering labor management, OHS, traffic, waste, pollution control, and grievance mechanisms); • Labour Management Plan (LMP); • Specific management plans as per Environment and Social Management Plan (ESMP); and • Evidence of prior implementation of E&S management systems in at least one comparable project., The Employer shall provide the following safeguard documents (link below) upon which the bidder shall prepare the afore stated documents https://www.zesco.co.zm/projects.php: • Environmental and Social Management Plan (ESMP) • Environmental and Social Impact Assessment (ESIA) • Stakeholder Engagement Plan (SEP) • Environmental and Social Commitment Plan (ESCP)

	• Labor Management Procedure (LMP) • Resettlement Action Plan (RAP) • Biodiversity Management Plan (BMP) m) Quality Assurance/Control Plans The Contractor shall submit their programme of quality control and inspection procedures for the Project to assure that the Plant during design, manufacture, installation and on completion complies with the specified requirements. The programme shall relate 'quality control and inspection activities' to the 'production cycle'. In support of the quality control and inspection programme, the Contractor shall provide details of quality control and inspection procedures available for use in the execution of the Contract. The Contractor shall retain responsibility for quality control and inspection activities made by his sub-contractors and shall indicate on the programme which items are to be sub-contracted. n) Risk Assessment and Management Plan Risks to manufacturing, shipment, transportation and construction, E&S aspects, engineering design, quality, costs, project cash flow, time schedule etc. The Bidder shall create a <i>Table of Content for the documents required</i> to comprise the Bid with a composition complying with the instructions in ITB 11 and BDS ITB 11.
ITB 11.3 (d)	The Bidder shall submit the following additional documents in the Financial Part of its Bid: N/A
ITB 13.1	Alternative Bids shall not be considered.
ITB 13.2	Alternatives to the Time Schedule shall not be permitted.
ITB 13.4	Alternative technical solutions shall be permitted for the following parts of the Plant and Installation Services: N/A .

ITB 17.1	Bidders shall quote for the following components or services on a single responsibility basis: Design, Supply, and Installation for: i) Nakonde Stepdown (330/(132) 66/11kV) Substation, and ii) Kasama 330 kV substation.
ITB 17.5 (a) and (d)	Place of destination: NAKONDE, NORTHERN PROVINCE, ZAMBIA. Final destination (Project Site): NAKONDE AND KASAMA SUBSTATIONS Prices stated shall include transportation of Plant for substation to the project sites.
ITB 17.6	The Incoterms edition is: INCOTERMS 2020 (Updated 2025)
ITB 17.7	The prices quoted by the Bidder <i>shall</i> be subject to adjustment during the performance of the Contract.
ITB 18.1	The Bidder <i>is</i> required to quote in the currency of the Employer's Country the portion of the Bid price that corresponds to expenditures incurred in that currency.
ITB 19.1	The Bid shall be valid until 180 days after the bid submission deadline date.
ITB 19.3 (a)	The Bid price shall be adjusted by the following factor(s): N/A
ITB 20.1	A Bid Security <i>shall not be</i> required. A Bid-Securing Declaration <i>shall be</i> required.
ITB 20.3 (d)	Other types of acceptable securities: NONE
ITB 20.9	If the Bidder performs any of the actions prescribed in ITB 20.9 (a) or (b), the Borrower will declare the Bidder ineligible to be awarded a contract by the Employer for a period of three (03) years starting from the date the Bidder performs any of the actions.
ITB 21.3	The written confirmation of authorization to sign on behalf of the Bidder shall consist of "Power of Attorney" (either notarized or attested by the appropriate authority in the Bidder's home country) <u>along with a copy of relevant Board Resolution (if applicable).</u>

	Notes: (a) The Power of Attorney shall indicate that the person signing the Bid has the authority to sign the Bid and the Bid is binding upon the Bidder during the full period of its validity. (b) In the case of Bids submitted by an existing or intended JV, an undertaking signed by all parties (i) stating that all parties shall be jointly and severally liable, if so required in accordance with ITB 4.1, and (ii) nominating a representative who shall have the authority to conduct all business for and on behalf of any and all the parties of the JV during the bidding process and, in the event the JV is awarded the Contract, during contract execution. ➤ All the conditions of ITB 21.3 will be applicable. Authorization letter must be on official letterhead of the bidder's company.
D. Submission and Opening of Bids	
ITB 22.1	In addition to the original Bid, the number of copies is: Three (3). Notes: (a) Electronic copies of the bid (PDF format) shall also be submitted on a USB flash drive with appropriate password protection /encryption, malware scanning, and integrity (hash) of electronic copies (bidder will only provide the password at the time of bid opening). The electronic copy shall be structured in the same way as the printed edition of the Bid. Searchable PDF and signed scanned PDF shall be included in the submittal. (b) The Price Schedules and Technical Schedules in MS-Excel format shall be submitted (bidder will only provide the password at the time of bid opening). (c) Electronic copies shall preserve the two-envelope process. The Bidder shall submit the Technical Part and Financial Part in separate encrypted folders/files/media. The password for the Technical Part may be disclosed at the public opening of Technical Parts. The password for the Financial Part shall be disclosed only at the second public opening of Financial Parts for those Bidders whose Technical Parts are found substantially responsive.

	In case of discrepancies, the “ORIGINAL” hardcopy will take precedence over the electronic version. Notes: Copies of the Technical Part shall be placed in a separate sealed envelope marked “COPIES: TECHNICAL PART”. Copies of the Financial Part shall be placed in a separate sealed envelope marked “COPIES: FINANCIAL PART”.
ITB 23.1	For <u>Bid submission purposes</u> only, the Employer’s address is: Attention: Head Procurement Street Address: Stand No. 6949, Great East Road Floor/ Room number: Procurement Offices, ZESCO Head Quarters City: LUSAKA ZIP/Postal Code: 10101 Country: ZAMBIA The deadline for Bid submission is: Date: 21 August 2026 Time: 10:30AM CAT Bidders shall not have the option of submitting their Bids electronically. The electronic Bidding submission procedures shall be: N/A
E. Public Opening of Technical Parts of Bids	
ITB 26.1	The Bid opening shall take place at: Street Address: Stand No. 6949, Great East Road Floor/ Room number: Procurement Offices, ZESCO Head Quarters City: LUSAKA Country: ZAMBIA Date: 21 August 2026 Time: 10:30AM CAT The electronic Bid opening procedures shall be: N/A

ITB 26.6	The Letter of Bid – Technical Part and the sealed envelope marked “SECOND ENVELOPE: FINANCIAL PART” shall be initialed by representatives of the Employer conducting Bid opening. The Financial Parts submitted will not be opened at this Stage. <i>Each Bid shall be initialed by all representatives and shall be numbered.</i>			
G. Evaluation of Technical Part of Bids				
ITB 32.2	The weighting to be given for Rated Criteria (including technical and non-price factors) is: 50% The technical factors and sub-factors, which for purposes of this document carry the same meaning as Rated Criteria, and the corresponding scores in % are:			
	Item No.	Technical Factor	Weight Score [%]	Allocation
	1	Guaranteed Technical Schedules (List of deviations, if any, will also be assessed; evaluate based on compliance with Employer's Requirements (ER) and Guaranteed Technical Schedules (GTS) alignment for specific technical data for specific key equipment and facilities. Deviations (if any) clearly tabulated and justified for assessment)	10	
	2	Project Management	45	
	2.1	Site Organization (Assess structure, roles, and oversight; score based on clarity and fit for greenfield Nakonde SS and brownfield Kasama SS; explicit interface management with the ZESCO dispatching center and adjacent DVSD, and coordination across civil, primary, secondary and telecom disciplines)		5
	2.2	Method Statement for Design, Procurement, Shipment and Construction	--	
	2.2.1	Pre-Execution Methodologies (Process and approach for how to develop and manage the detailed design and calculation during pre-construction; how GTS, ER, and IEC/ZESCO standards will		10

		be applied; management of interfaces across GCB/DS/ES, transformers, reactors, protection, metering, AC/DC auxiliaries, SCADA, and DVSD. The score is not for the final design specifications)		
	2.2.2	Testing and Supply Methodologies (High-level FAT/Type test compliance to applicable IEC standards; plan for SAT and quality gates (confirming all tests complying with relevant IEC standards and ER); supply/logistics overview including heavy-haul for transformers/reactors, oil storage and treatment, and SF ₆ management; assessment of the bidder's plan for managing the supply chain for long-lead items)		10
	2.2.3	Execution and Commissioning Methodologies (Bidder's work plan and sequence for civil and electrical installation/works, AIS equipment installation, oil processing, SF ₆ handling for GCBs, functional/protection checks, SCADA integration, and staged energization; specific approach to brownfield outages/cutover management at Kasama, and general approach to greenfield Nakonde; Comprehensive plan for SAT, end-to-end testing, and staged energization)		10
	2.2.4	Supply Chain Risk Management and Quality Assurance Plan (Risk register for long-lead items and critical equipment, and overall project implementation with mitigations and qualified alternates plans; QA / QC plan and Inspection and Test Plans (ITPs) for managing quality from OEM's factory to the site; oil management (PCB-free oils, spill prevention/response, segregated storage, fire protection), and mechanical risks (heavy transportation and lifting)		5
	2.2.5	Methodology for Local Involvement (Specific and measurable plan to engage local subcontractors, suppliers and personnel and women-owned businesses (WOB), to use locally sourced materials (Zambian-registered SMEs, WOB, Zambian workforce, aggregates, cement)		5
	3	Mobilization Schedule	5	

		(Realism and completeness, plan for long-lead for transformers and reactors, integration with construction critical paths, heavy-haul transport and crange for transformers/reactors; SF ₆ cylinder logistics for GCBs; Oil logistics for transformers and reactors, site access and temporary works and storage)		
	4	Construction Schedule (Coherent CPM showing long-lead deliveries, primary/secondary works, protection & SCADA, and staged energization aligned with outage windows)	5	
	5	Environmental, Social, Health and Safety Strategy	15	
	5.1	Environmental strategy demonstrated by the Bidder (ESMSIP includes: biodiversity protection for both flora and fauna, waste management, pollution control, oil handling and containment (incl. fuel oil and PCB-free oils) spill prevention/response, SF ₆ management for GCBs (leak detection, gas recovery/recycling, cylinder inventory and labelling, emissions reporting), and noise management for transformers/reactors, construction equipment.)		5
	5.2	Social strategy demonstrated by the Bidder (A clear Social Management Strategy addressing key social risks, especially community engagement, GRM and strong GBV/SEAH prevention and response measures. The Strategy also outlines traffic and road safety during heavy-haul movements, and as well as mitigation for dust and noise impacts.)		5
	5.3	Health and safety strategy demonstrated by the Bidder (A clear OHS strategy that meets compliance requirements, includes risk assessment, disease prevention and vaccination, PPE and safety tools, hygiene measures, emergency response procedures, and worker training.)		5
	6	Adequacy of Resources (Equipment and Personnel) Allocation for Design and Construction Stage Activities	20	
	6.1	For Project Manager (CVs, certifications, resource allocation plan)		5

	6.2	For the Rest of the Personnel (CVs, certifications, resource allocation plan)		10
	6.3	Proposed Equipment (Adequacy and deployment plan for key construction and testing equipment, especially specialized gear for transformer oil processing and SF ₆ recovery)		5
		Total	100	
	The Technical Part Scoring Methodology is specified in Section III – Evaluation and Qualification Criteria. For the “Technical Part”, a minimum ‘Total Technical Part Score (T)’ required to pass is <u>60% (Sixty Percent)</u> . Note: The “Financial Part” of the Bids will be publicly opened only of those Bidders who will be considered substantially responsive according to ITB 30.1 and passed the aforesaid minimum threshold.			
H. Notification of Evaluation of Technical Parts and Public Opening of Financial Parts				
ITB 33.5	The Letter of Bid – Financial Part and Schedules shall be initialed by three (03) representatives of the Employer conducting Bid opening. <i>Each Financial Part of Bid shall be initialed by all the three (03) representatives of the Employer and shall be numbered.</i> . In addition to the bid opening procedure specified in ITB 33.5 , the Letter of Bid and price schedules of each bid shall be initialed by the member of the Employer’s Bid Opening Committee who are present at the time of bid opening. Any inter-lineation, erasures, or overwriting that were already made by the bidder prior to the bid submission deadline, which shall be valid only if signed or initialed by the person signing the bid, shall also be initialed by member of the Employer’s Bid Opening Committee who are present at the time of bid opening.			
I. Evaluation of Financial Part of Bids				

36.1(f)	The adjustments shall be determined using the following criteria, from amongst those set out in Section III, Evaluation and Qualification Criteria: (a) Deviation in Time for Completion: No; (b) Life cycle costs: the projected operating and maintenance costs during the life of the Facilities: Yes; (c) Functional Guarantees of the Facilities: Yes; and (d) Work, services, facilities, etc., to be provided by the Employer: No.

ITB 36.2	The currency that shall be used for Bid evaluation and comparison purposes to convert (at the selling exchange rate) all Bid prices expressed in various currencies into a single currency is: United States Dollars (USD) The source of exchange rate shall be: OANDA www.oanda.com The date for the exchange rate shall be: date not earlier than 28 days prior to the deadline for submission of the Bids, nor later than the date for the expiry of Bid validity specified in accordance with ITB BDS 19.1.
J. Evaluation of Combined Technical and Financial Parts and Most Advantageous Bid	
ITB 39.1	The weight to be given for cost is: 50%
K. Award of Contract	
ITB 48.1	The procedures for making a Procurement-related Complaint are detailed in the “The World Bank Procurement Regulations for IPF Borrowers : Procurement in Investment Project Financing - Goods, Works, Non-Consulting and Consulting Services - Seventh Edition” (issued September 2025). If a Bidder wishes to make a Procurement-related Complaint, the Bidder should submit its complaint following these procedures, in writing (by the quickest means available, that is either by email or fax), to: For the attention: <i>Lemmy Nyirenda</i> Title/position: <i>Procurement Specialist</i> Employer: <i>ZESCO Limited</i> Email address: <i>lnyirenda@zesco.co.zm</i> In summary, a Procurement-related Complaint may challenge any of the following: 1. the terms of the Bidding Documents; and 2. the Employer’s decision to award the contract.

Section III – Evaluation and Qualification Criteria

(Without prequalification)

This section contains all the criteria that the Employer shall use to evaluate Bids and qualify Bidders. No other factors, methods or criteria shall be used other than specified in this Bidding document.

The Bidder shall provide all the information requested in the forms included in Section IV, Bidding Forms.

Wherever a Bidder is required to state a monetary amount, Bidders should indicate the USD equivalent using the rate of exchange determined as follows:

- For turnover or financial data required for each year - Exchange rate prevailing on the last day of the respective calendar year (in which the amount for that year is to be converted) was originally established.
- Value of single contract - Exchange rate prevailing on the date of the contract.

Exchange rates shall be taken from the publicly available source identified in the ITB 36.2. Any error in determining the exchange rates in the Bid may be corrected by the Employer.

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1. Qualification

1.1 Qualification Requirements

The Bidder's qualifications shall be assessed in accordance with the Qualification table included in this section.

1.2 Contractor's Representative and other Key Personnel

The Bidder must demonstrate that it will have suitably qualified Contractor's Representative and other suitably qualified (and in adequate numbers) key personnel, as described in the Employer's Requirements.

The Bidder shall provide details of the Contractor's Representative and other key personnel, and such other key personnel that the Bidder considers appropriate, together with their academic qualifications and work experience. The Bidder shall complete the relevant Forms in Section IV, Bid Forms.

Copies of qualifications for key personnel shall be provided together with the bid.

1 **Minimum Qualifications for Key Personnel**2 **Table 1: Minimum Qualifications for Key Personnel**

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
1.	Contractor's Representative	Bachelor's Degree in Engineering/ Law/ Procurement/ Business administration/ project management/ International Relations Or Equivalent	Not less than ten (10)	Managing international contracts with specific experience: a) Engineering; b) Procurement; c) Business administration and/or d) Managing international turn-key contracts in the power sector
2.	Project Manager	At least a Degree in Electrical/ Civil / mechanical engineering/project management or other similar degree in engineering	General: At least fifteen (15) Relevant: Not less than ten (10)	a) Designing, supply, installation and commissioning of both greenfield (new build) and brownfield (extension) substation projects. b) At least three (3) successfully completed similar substation projects of 330kV and above. c) Proven proficiency in English.
3.	Construction Site Manager	At least a Bachelor's Degree in Electrical/ Electro-mechanical	Minimum of ten (10)	a) At least three (3) successfully completed both greenfield (new build) and brownfield (extension) substation projects of 330kV and above

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
		engineering/ Civil engineering/ project management		b) Above project experiences should include site supervision, plant engineering design, supply, installation, testing, and commissioning. c) Proven proficiency in English.
4.	Contract Manager	Bachelor's Degree in Engineering / Law/ Procurement Or Equivalent	Not less than ten (10)	a) At least two (2) similar procurement and managing international turn-key contracts and/or civil contracts. b) Proven proficiency in English.
5.	Sub-Station Automation System/SCADA Engineer	Bachelor's Degree in Electronics / Telecommunications/Ele ctrical Engineering	Not less than ten (10)	a) 330kV and above Substation's Automation System (SAS) and Protection system's design, installations and commissioning. b) Design, installation and commissioning of SAS and SCADA system on at least three (3) projects of a similar scope.
6.	Telecommunicati on Engineer	Bachelor's Degree in Electronics/ Telecommunications	Not less than ten (10)	a) The complete life cycle design, testing and commissioning of fibre optic-based communication systems b) Design, installation and commissioning of telecommunication systems c) Similar three (3) successfully completed telecommunication system projects

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
7.	Civil/ Construction/ Structural/ Foundations Design Expert	University degree in Civil / Construction / Structural Engineering	Minimum eight (8)	a) Steel structure design and Quality control b) Full scale structure testing, design of electrical apparatus foundations c) Project completion experience i) At least three (3) successfully completed substation projects including 330kV and above ii) Above projects should include at least one (1) international project.
8.	Geotechnical Engineer (Geotechnical / Foundations Design Expert)	University degree in Civil / Geotechnical Engineering	Minimum eight (8)	a) Conducting site-specific geotechnical investigations, including soil borings, in-situ testing, laboratory soil classification, groundwater assessment, and evaluation of soil bearing capacity, settlement potential, and subsurface variability. b) Interpreting geotechnical data and developing geotechnical baseline and design reports to support substation civil and structural design. c) Designing foundations for substation equipment and structures, including shallow foundations, deep foundations, mat foundations, machine foundations, and specialized foundations for transformers, circuit breakers, steel structures, and cable trenches. d) General experience in i) Soil survey, record soil types, surface soils ii) Any risk of flooding, light ram sounding (Kunzelstab test)

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				iii) Shallow test pit with soil classification iv) Standard Penetration Tests (SPT) or CPT v) Vane shear tests
9.	Substation Electrical Engineer (Design)	Bachelor's Degree in Electronics/Electrical Engineering	Not less than ten (10)	a) Design of Substation electrical apparatus b) Project completion experience i) Three (3) successfully completed substation projects with 330kV and above ii) Above projects should include at least one (1) international project.
10.	Substation Site supervision Engineer (Civil / Construction/ Structural)	Bachelor's Degree in Civil/ Construction/ Structural Engineering	Not less than ten (10)	a) Substation construction supervision for voltages of at least 330 kV b) Carrying out steel structure erections, quality control, supervising Substation equipment and electrical apparatus foundations works c) Project completion experience i) Three (3) similar successfully completed substation projects with 330kV and above ii) Above projects should include at least one (1) international project.
11.	Substation Site supervision Engineer (Electrical)	Bachelor's Degree in Electronics/Electrical Engineering	Not less than ten (10)	a) Substation site erection, installation and commissioning of primary equipment for voltage level at least 330kV b) Project completion experience i) At least three (3) completed similar projects

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				ii) Above projects in similar position in the last ten (10) years
12.	Protection/Metering Engineer	Bachelor's Degree in Electronics/Electrical Engineering	Not less than ten (10)	a) Substation network protection/metering systems design, installations and commissioning
13.	Quality Control Engineer as QA/QC Manager	Bachelor's Degree in Engineering (Electrical, Civil, Industrial Engineering, Construction Management, Quality Engineering)	Not less than Five (5)	a) Relevant work experience of QC/QA b) At least three (3) completed substation and/or power station project at voltage level 330 kV Advantage experience Experience of higher voltage than 330kV
14.	Testing and Commissioning Engineer	Bachelor's Degree in Engineering (Electrical, Mechanical, Civil, Industrial Engineering,)	Not less than Five (5)	a) Relevant work experience of testing and commissioning b) At least three completed substation and/or power station project at voltage level 330 kV Advantage experience Experience of higher voltage than 330kV
15.	Environmental, Health and	Bachelor's degree in Environmental Management, Natural Resources	Minimum of ten (10)	Experience

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
	Safety (EHS) Manager ¹ (Team Management Level)	Management, Public Health, Environmental Engineering, Occupational Health and Safety. Or Related field. - Formal training in accident/incident investigation. Preferred: Master's degree in a relevant field. Advantage:		a) EHS management of construction or large infrastructure projects, including high voltage works, working at heights, and heavy machinery. b) Managing multidisciplinary EHS teams and preparing EHS reports to demonstrate strong supervisory and coordination skills Knowledge/Capability/Skill a) Ability to develop, review, and implement ESMPs & OHS Plans. b) Strong knowledge of national environmental regulations and OHS legislation, as well as international standards, including: - World Bank Environmental and Social Standards (ESS) 1 to 10, - World Bank Environmental Health and Safety Guidelines (EHSGs), and - World Bank Gender Strategy 2024-2030. c) Fluency in English Advantage:

¹ (Expected Role for EHS Manager): Lead implementation of ESMP and OHS-related plans; ensure contractor compliance with national regulations and World Bank ESF; conduct site inspections, audits, and incident investigations; lead EHS training and worker induction; oversee environmental controls and hazardous materials management; supervise EHS and social staff; prepare periodic EHS performance reports; ensure gender-responsive EHS practices.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
		Professional certifications, such as i) NEBOSH, ii) IOSH, iii) ISO 14001 Implementation or Lead Auditor, iv) ISO 45001 Implementation or Lead Auditor.		a) Implementing international safeguards systems such as World Bank Environmental and Social Safeguards, IFC Performance Standards, AfDB Integrated Safeguards System, or equivalent. b) Working on large infrastructure projects with experience in Environmental and Social Impact Assessment (ESIA), and implementing ESMPs, CESMPs, BMPs, RAPs, Grievance Redress Mechanisms, Labour Management Plans/Procedures and other relevant E&S instruments. c) Experience working with gender mainstreaming and in managing Sexual Exploitation, Abuse and Harassment issues on similar projects.
16.	Environmental Officer ²	Bachelor's degree in Environmental Management, Natural Resources Management,	Minimum of eight (8)	Experience a) Environmental or sustainability management for large construction or infrastructure projects. Knowledge/Capability

² (Expected Role for EHS Manager): Implement ESMP environmental measures; conduct routine site inspections (dust, noise, water, waste, vegetation); monitor hazardous waste handling and biodiversity protection measures; support chance finds and erosion control; maintain environmental records; assist with periodic environmental reporting; support environmental awareness and training; provide ecological expertise including support in biodiversity surveys, species assessment, habitat mapping, and contribution to EIA/ESMP biodiversity mitigation using the mitigation hierarchy.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
		Environmental Science, Ecology. Or Related field. Advantage: i) Master's degree in a relevant field. ii) Certificate in Environmental Auditing or Monitoring, iii) Certificate in ISO 14001 Implementation or Lead Auditor		a) Strong knowledge of national environmental regulatory frameworks, including Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plans (ESMPs). b) Ability to conduct field sampling, environmental monitoring, data analysis, and reporting. c) Sound understanding of vegetation management and soil and water protection measures. d) Good knowledge of World Bank Environmental and Social Framework (ESF), particularly i) ESS3 (Resource Efficiency & Pollution Prevention and Management) ii) ESS6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources.) e) Fluency in English Advantage a) Working on large infrastructure projects with experience in Environmental and Social Impact Assessment (ESIA), and implementation of ESMPs, CESMPs, BMPs and other relevant E&S instruments.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				b) Implementing international safeguards systems such as World Bank Environmental and Social Safeguards, IFC Performance Standards, AfDB Integrated Safeguards System, or equivalent
17.	Health and Safety Officer (HSO) ³	Degree or diploma in Occupational Health and Safety, Industrial Safety, Engineering, Or Related fields. • Alternatively: OSHA certification or NEBOSH IGC.	OHS: Minimum of eight (8) OHS under High-risk infrastructure: Minimum of three (3)	Experience a) Occupational health and safety management for construction or large infrastructure projects b) High-risk infrastructure works (e.g., transmission lines, substations, power plants, or major civil works). c) Managing high-risk activities associated with substation works, including high-voltage electrical systems, working at heights, fall protection, live-line or energized equipment, lifting and rigging, traffic safety, and emergency response. Knowledge/Capability/Skill a) Strong knowledge of national OHS laws and local labour and health regulations, Project ESIA/ESMP requirements, and World Bank Group EHS Guidelines .

³ (Expected Role for Health and Safety Officer (HSO)): Implement and maintain the Occupational Health and Safety (OHS) Management Plan in line with the World Bank EHS Guidelines, International Labour Organization (ILO) standards, Project ESIA and ESMP requirements, Local Labour and Health Ordinances, and any other applicable national and project-specific regulations; conduct routine safety inspections and hazard identification; lead job hazard analyses (JHA); deliver OHS training and worker inductions; monitor, document, and report workplace health and safety risks, incidents, and corrective actions to ensure full regulatory and contractual compliance.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
		- Formal training in accident/incident investigation. Advantage: i) Certificate in ISO 45001 Lead Auditor ii) Certificate in ISO 45001 Implementation		b) Ability to conduct daily safety inspections, hazard identification, prepare and implement Safe Work Method Statements (SWMS), and carry out incident investigations, including root cause analysis (RCA). c) Ability to deliver OHS training and inductions, maintain safety records, and prepare incident and compliance reports. d) Good understanding of the World Bank Environmental and Social Framework (ESF), particularly i) ESS2 (Labor and Working Conditions) and ii) ESS4 (Community Health and Safety). e) Fluency in English Advantage a) Working on large infrastructure projects with experience in implementation of CESMPs, Health and Safety Management Plans, Labour Management Plans, and other relevant E&S instruments. b) Strong knowledge of OSHA principles and ILO standards.
18.	Social Officer (including Community	Bachelor's Degree in Sociology, Social Work, Community Development,	Minimum of eight (8)	Experience a) Large infrastructure projects (e.g., power transmission lines, roads, water, mining).

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
	Liaison & Gender) ⁴	Anthropology, Gender Studies Or Related Social Sciences. • Alternatively: A diploma in the above fields plus 5 additional years of relevant field experience.		b) Community engagement with project-affected communities, including managing sensitive issues with cultural awareness and diplomacy. c) Stakeholder Consultation with project-affected communities d) Implementing or supporting a Community/Project Grievance Redress Mechanism (GRM), including documentation, follow-up, and reporting. f) Applying World Bank ESF social standards, particularly i) ESS2 (Labor and Working Conditions), ii) ESS4 (Community Health and Safety), iii) ESS5 (Land Acquisition/Resettlement), and iv) ESS10 (Stakeholder Engagement), including monitoring basic labor risks. g) Implementing gender actions and GBV/SEA/SH prevention measures, including training on Codes of Conduct and reporting protocols, and promoting women's inclusion. Knowledge/Capability/Skill

⁴ (Expected Role for Social Officer (incl. Community Liaison & Gender)): Implement the Stakeholder Engagement Plan (SEP) and Grievance Redress Mechanism (GRM); serve as the primary liaison between the Contractor and affected communities; conduct community consultations and construction-related awareness activities; implement gender actions and GBV/SEA/SH prevention measures; deliver worker inductions and training on social risks, Codes of Conduct, and labor rights; monitor and report labor and community social risks; maintain social records and contribute to ESMP reporting in line with the World Bank ESF.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				a) Strong facilitation and communication skills for community meetings, awareness sessions, and risk communication; ability to prepare clear reports and records. b) Knowledge of relevant local language(s) c) Fluency in English d) Ability to monitor social risks, collect sex-disaggregated data, and contribute to social and ESMP reporting. Advantage a) Familiarity with the World Bank Gender Strategy 2024–2030. b) Experience in gender mainstreaming, and in conducting analysis, training, and or implementation of activities to promote gender equality. c) Experience in managing GBV / Sexual Exploitation Abuse and Harassment (SEAH) issues on similar projects
19.	Biodiversity Expert	Bachelor's Degree in Ecology, Forestry, Natural Resource Management, Environment studies or equivalent,	Minimum of five (5) years	Experience a) Environmental management in large infrastructure projects (Transmission lines, roads, energy, or linear projects) b) Biodiversity Management Plans (BMPs), ESIA's, ESMPs, CESMPs and other relevant instruments development and implementation.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				c) Implementing and applying the World Bank Environmental and Social Safeguards to experienced projects. Knowledge/Capability/Skill a) The World Bank's Environmental and Social Framework b) Good knowledge of World Bank Environmental and Social Framework (ESF), particularly ESS6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources.) c) Fluency in English. Advantage: a) Implementing international safeguards systems such as World Bank Environmental and Social Safeguards, IFC Performance Standards, AfDB Integrated Safeguards System, or equivalent
20.	Archaeologist	Bachelor's Degree in Archaeology, Anthropology, Cultural Heritage Management, or a related field.	Minimum of eight (8) years	Experience a) Completing field surveys to identify and document archaeological sites particularly in large infrastructure projects b) Cultural Heritage Management Plans (CHMP), ESIA's, ESMPs, CESMPs and other relevant instruments development and implementation.

S/N	Position/ specialization	Relevant academic qualifications	Years of relevant work experience	Minimum relevant work experience and/or knowledge
				c) Cultural heritage assessments, Chance Find and Procedures, and relevant fieldwork d) Applying the World Bank's Environmental and Social Framework Knowledge/Capability/Skill a) Strong understanding of local laws and regulations regarding cultural heritage. b) Knowledge of, and experience in the application of the World Bank's Environmental and Social Framework. c) Knowledge of relevant local language(s). d) Fluency in English. Advantage: a) Implementing and applying the World Bank Environmental and Social Safeguards

3

1.3 Equipment

The Bidder must demonstrate that it will have access to the key equipment required to fulfill the contract.

Table 2: Minimum Quantity of Key Equipment

S/N	Description	Minimum Qty
1	Excavator	2
2	Tipper Truck - 30 Ton	2
3	Crane, minimum 50 Ton	1
4	Bulldozer	1
5	10 Ton Truck (Material Transportation)	1
6	Concrete Mixer	2
7	Conductor Crimping Tools	2
8	Light Vehicles	6
9	Roller Compactor	1
10	Front End Loader	2
11	Vibrator / Poker Vibrator	10
12	Rebar Cutting & Bending Machine	4
13	Water Tank (min. 2500 L)	2
14	Transformer Oil Filtration Plant (High Vacuum Oil Purification Machine)	1
15	SF6 Gas Handling Set	1
16	High-Capacity Test Equipment (Primary injection, secondary injection sets)	1
17	Man-lift / Boom lift	2
18	Portable welding machine	2

19	Portable generator	2
20	Setting-out Equipment (Total Station / GPS Survey Kit)	2
21	Fire Fighting Equipment Set	1

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

1.4 Subcontractors/Manufacturers

Subcontractors/manufacturers for major items of supply or services identified in Table 3 of this Section must meet or continue to meet the minimum criteria specified therein for each item.

The following support documents shall be submitted with the bids:

- Reference list
- End-user certificates/letter
- Employer's minimum technical requirements filled in and duly signed by the OEMs
- Manufacturers' Authorization letter
- Proof of implementation of ISO 9001
- List of performed type tests and type tests reports as per the requirements in the Technical Specifications
- Technical data sheets duly signed
- Drawings
- Catalogue and other technical documents

The Bidder shall submit documentary evidence of compliance with the following standards:

- ISO 9001:2015 (Quality Management) – for both Contractor and Manufacturer
- ISO 14001:2015 or ISO 45001:2018 (Environmental/Occupational Health & Safety Management) – for Contractor
- Type test reports certified by laboratories accredited to ISO/IEC 17025.
- Manufacturer's Declaration of Conformity with IEC and/or IEEE standards specified in Employer's Requirements.

Note that **all the above documents need to be in English** or translated to English by an authorized and notarized agent.

Subcontractors for the following additional major items of supply or services must meet the following minimum criteria, herein listed for that item:

Table 3: Minimum Criteria of Major Equipment

S/N	Description (Major Equipment)	Minimum Criteria to be Met
1.	Circuit Breakers	• Six (6) years supply records including three (3) years supply outside the country of manufacturing; • Installed and in service for at least three (3) years outside the country of the manufacturer evidenced by performance certificates; • Five (5) performance certificates issued by Owner, Employer, and/or Main Contractor to certify the completion and satisfactory performance; • Current ISO 9001 or equivalent certification; • Current ISO 45001 or equivalent certification; • Current ISO 14001 or equivalent certification; and • Valid type test certificates from an independent institute not older than 8 years from independent laboratories which have the accreditation certificate for the testing lab to ISO/IEC 17025. • If type-test reports are older than 8 years, the Bidder shall perform selected confirmatory type tests on a representative production unit to re-validate critical performance parameters at an ISO/IEC 17025 accredited laboratory. The representative unit shall be of the same model family, rating, and internal design as the originally type-tested unit. Test items and acceptance criteria shall comply with the relevant IEC standards.

S/N	Description (Major Equipment)	Minimum Criteria to be Met
2.	Transformers and Reactors	• Six (6) years supply records including three (3) years supply outside the country of manufacturing; • Installed and in service for at least three (3) years outside the country of the manufacturer evidenced by performance certificates; • Five (5) performance certificates issued by Owner, Employer, and/or Main Contractor to certify the completion and satisfactory performance; • Current ISO 9001 or equivalent certification; • Current ISO 45001 or equivalent certification; • Current ISO 14001 or equivalent certification; and • Valid type test certificates from an independent institute not older than 8 years. • If type-test reports are older than 8 years, the Bidder shall perform selected confirmatory type tests on a representative production unit to re-validate critical performance parameters at an ISO/IEC 17025 accredited laboratory. The representative unit shall be of the same model family, rating, and internal design as the originally type-tested unit. Test items and acceptance criteria shall comply with the relevant IEC standards
3.	330kV Post & Disc Insulators, Surge Arrester, Instrument Transformers, Disconnect Switch	• Six (6) years manufacturing experience of 330kV or applicable specified equipment; • 330kV specified equipment being in successful operation for at least 3 years; • Supply of 330kV specified equipment to at least three (3) projects sites of which one shall be outside of manufacturer's home country; • Current ISO 14001 or equivalent certification; • Current ISO 9001 or equivalent certification; and • Current ISO 45001 or equivalent certification.

S/N	Description (Major Equipment)	Minimum Criteria to be Met
4.	Battery and Charger	• At least last Six (6) years of experience in manufacturing battery, Charger and/or complete DC system; • Minimum average supply record over the last 3 years of ten (10) complete substation DC systems; • Manufactured at least 5 units of same or higher rating & voltage in last 3 years, which have been supplied outside the country of origin; • Verifiable operational certificates (at least three) on the letterhead of the utility/user in English must be provided to ascertain the above-mentioned requirements; • Manufacturer's authorization letter; • Proof of implementation of ISO 9001; • List of performed type tests and type test reports as per the requirements in Section VII; and • Technical data sheets, drawings, catalogues and other technical documents.

S/N	Description (Major Equipment)	Minimum Criteria to be Met
5	Substation Automation System & Protection Relay	• At least last Six (6) years of experience in manufacturing high-voltage substation automation systems, as per IEC 61850 standard, with the equipment in satisfactory service for a minimum of three (3) years on the date of bid opening; • At least last Six (6) years of experience in manufacturing protection relay with the equipment in satisfactory service for a minimum of three (3) years on the date of bid opening; • Minimum average delivery over the last 3 years of ten (10) complete substation automation systems, as per IEC 61850 standard; • Supplied at least 3 systems/units for substations of same or higher primary voltage (330kV or above) in last 3 years which have been supplied outside the country of origin; • Verifiable operational certificates (at least three) on the letterhead of the utility/user in English must be provided to ascertain the above-mentioned requirements; • Manufacturer's authorization letter; • Implemented ISO 9001; • List of performed type tests and type test reports are per the requirements of Section VII; and • Technical data sheets, drawings, catalogues and other technical documents. • Role-based access with unique accounts, encrypted engineering/ remote access, signed firmware / secure boot, time-stamped audit logs

S/N	Description (Major Equipment)	Minimum Criteria to be Met
6	Telecommunication System - Fiber optic multiplexer equipment for communication and protection	• At least last Six (6) years of experience in manufacturing communication equipment, with the equipment in satisfactory service for a minimum of three (3) years on the date of bid opening; • Minimum average delivery over the last 3 years of ten (10) complete substation communication equipment; • Manufactured at least 3 units of same or higher rating & voltage in last 3 years which have been supplied outside the country of origin; • Verifiable operational certificates (at least three) on the letterhead of the utility/user in English must be provided to ascertain the above-mentioned requirements; • Manufacturer's authorization letter; • Implemented ISO 9001; • List of performed type tests and type test reports as per the requirements of Section VII; and • Technical data sheets, drawings, catalogue and other technical documents to demonstrate substation-hardened multiplexer delivering protection channels with latency ≤ 5 ms, jitter ≤ 250 μs, availability $\geq 99.99\%$, failover ≤ 50 ms;
7.	Civil Works Subcontractor	• At least last Six (6) years of experience in civil works during construction of new substations of 330kV or higher rated voltage; and • Subcontractor's reference list and end user's letters.

S/N	Description (Major Equipment)	Minimum Criteria to be Met
8.	Subcontractor for executing the installation works	If a bidder proposes a subcontractor, the subcontractor shall meet the following criteria: • At least three (3) contracts for the installation of new similar AIS substation 330kV or higher rated voltage with at least four (4) line bays, two (2) transformer bays and double busbar in last Six (6) years. • Provide site managers' qualifications/certifications, method statements, test & commissioning procedures (FAT/SAT), and HSE plans
9.	Long-Term Support	For critical items listed above (Circuit Breakers, Transformers, Reactors, Substation Automation System, Protection Relay, Fiber optic multiplexer), the Bidder shall submit the Manufacturer's Authorization Form containing the specific '10-Year Availability Guarantee' clause. Failure to provide this specific guarantee from the OEM and/or the Bidder will result in the equipment being rejected.

Failure to comply with this requirement will result in rejection of the subcontractor.

In the case of a Bidder who offers to supply and/or install Plant and equipment under the contract that the Bidder did not manufacture or otherwise produce and/or install as per key equipment tables above, the Bidder shall provide the manufacturer's authorization, using the form provided in Section IV, showing that the Bidder has been duly authorized by the manufacturer or producer of the related Plant and equipment or component to supply and/or install that item in the Employer's country. The Bidder is responsible for ensuring that the manufacturer or producer complies with the requirements of **ITB 4** and **ITB 5** and meets the minimum criteria listed above for that item.

Qualification Tables

Table 4: Qualification (1) - Eligibility

Factor	1. Eligibility					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each Partner	At least one Partner	
1.1 Nationality	Nationality in accordance with ITB 4.4.	Must meet requirement	must meet requirement	Must meet requirement	N / A	Form ELI –1.1 and 1.2, with attachments
1.2 Conflict of Interest	No- conflicts of interests as described in ITB 4.2	Must meet requirement	must meet requirement	Must meet requirement	N / A	Letter of Bid
1.3 Bank Ineligibility	Not having been declared ineligible by the Bank as described in 4.5.	Must meet requirement	must meet requirement	Must meet requirement	N / A	Letter of Bid
1.4 State Owned Enterprise or Institution	Compliance with conditions of ITB 4.6	Must meet requirement	Must meet requirement	Must meet requirement	N / A	Form ELI –1.1 and 1.2, with attachments

1.5 Ineligibility based on a United Nations resolution or Borrower's country law	Not having been excluded as a result of the Borrower's country laws or official regulations, or by an act of compliance with UN Security Council resolution, in accordance with ITB 4.8 and Section V.	Must meet requirement	must meet requirement	Must meet requirement	N / A	Letter of Bid

Table 5: Qualification (2) – Historical Contract Non-Performance

Factor	2. Historical Contract Non-Performance					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder			At least one member	
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member		
2.1 History of non-performing contracts	Non-performance ⁵ of a contract did not occur within the last five (5) years prior to the deadline for application submission, based on all information on fully settled disputes or litigation. A fully	Must meet requirement by itself or as member to past or existing JV	N / A	Must meet requirement ⁶	N / A	Form CON - 2

⁵ Nonperformance, as decided by the Employer, shall include all contracts where (a) nonperformance was not challenged by the contractor, including through referral to the dispute resolution mechanism under the respective contract, and (b) contracts that were so challenged but fully settled against the contractor. Nonperformance shall not include contracts where Employers decision was overruled by the dispute resolution mechanism. Nonperformance must be based on all information on fully settled disputes or litigation, i.e., dispute or litigation that has been resolved in accordance with the dispute resolution mechanism under the respective contract and where all appeal instances available to the Bidder have been exhausted.

⁶ This requirement also applies to contracts executed by the Bidder as JV member.

Factor	2. Historical Contract Non-Performance					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	settled dispute or litigation is one that has been resolved in accordance with the Dispute Resolution Mechanism under the respective contract, and where all appeal instances available to the Bidder have been exhausted.					
2.2 Suspension	Not under suspension based on execution of a Bid Securing Declaration or Proposal Securing Declaration pursuant to ITB 4.7 and ITB 20.9	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Bid

Factor	2. Historical Contract Non-Performance					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member		At least one member
2.3 Pending Litigation	Bid’s financial position and prospective long-term profitability still sound according to criteria established in 3.1 below and assuming that all pending litigation will be resolved against the Bidder	Must meet requirement	N / A	Must meet requirement	N / A	Form CON – 2
2.4 Litigation History	No consistent history of court/arbitral award decisions against the Bidder ⁷ since 1 st June 2020.	Must meet requirement	Must meet requirement	Must meet requirement	N/A	Form CON – 2

⁷ The Bidder shall provide accurate information on the related Letter of Bid about any litigation or arbitration resulting from contracts completed or ongoing under its execution over the last five years.

A consistent history of awards against the Bidder or any member of a joint venture may result in failure of the Bid.

Factor	2. Historical Contract Non-Performance					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member		At least one member
2.5 Declaration: Environmental and Social (ES) past performance	Declare any contract that has been suspended or terminated and/or performance security called by an employer for reasons of breach of environmental, or social (including Sexual Exploitation, and Abuse) contractual obligations in the past five years ⁸ .	Must make the declaration . Where there are Specialized Subcontractor/s, the Specialized Subcontractor/s must also make the declaration .	N/A	Each must make the declaration . Where there are Specialized Subcontractor/s, the Specialized Subcontractor/s must also make the declaration .	N/A	Form CON-3 ES Performance Declaration

Factor	2. Historical Contract Non-Performance					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
2.6 Bank’s SEA and/or SH Disqualification	At the time of Contract Award, not subject to disqualification by the Bank for non-compliance with SEA/ SH obligations	Must meet requirement (including each subcontractor proposed by the Bidder)	N/A	Must meet requirement (including each subcontractor proposed by the Bidder)	N/A	Letter of Bid, Form CON-4

⁸ The Employer may use this information to seek further information or clarifications in carrying out its due diligence.

Table 6: Qualification (3) – Financial Situation

Factor		3 Financial Situation					
Sub-Factor	Criteria					Documentation Required	
	Requirement	Bidder					
		Single Entity	Joint Venture (existing or intended)				
			All members combined	Each member	At least one member		
3.1 Financial Capabilities	Submission of audited balance sheets or if not required by the law of the Bidder’s Country, other financial statements acceptable to the Employer, for the last three (3) years (2023 to 2025) to demonstrate the current soundness of the Bidders financial position and its prospective long-term profitability.	Must meet requirement	N / A	Must meet requirement	N / A	Form FIN – 3.1 with Attachments Copies of financial statements (balance sheets, incl. all related notes, and income statements) for the years required complying with the conditions. See Form FIN – 3.1. more detail.	

Factor	3 Financial Situation					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
3.2 Average Annual Turnover	Minimum average annual turnover in Energy sector not less than USD 42 Million , calculated as total certified payments received for contracts in progress or completed, within the last three (3) years.	Must meet requirement	Must meet requirement	Must meet twenty-five percent (25%) of the requirement	Must meet forty percent (40%) of the requirement	Form FIN – 3.2
3.3 Financial Resources	Bidder shall demonstrate access to, or availability of, financial resources such as liquid assets, <u>unencumbered</u> real assets, lines	Must meet requirement	Must meet requirement	Must meet twenty-five	Must meet forty percent	Form FIN – 3.3

Factor	3 Financial Situation					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	of credit, and other financial means, other than any contractual advance payments to meet: (i) the following cash-flow requirement: at least USD 7 (seven) million, and (ii) the overall cashflow requirements for this contract and its current commitments.			percent (25%) of the requirement	(40%) of the requirement	

Table 7: Qualification (4) – Experience

Factor	4. Experience						
Sub-Factor	Criteria					Documentation Required	
	Requirement	Bidder			Documentation Required		
		Single Entity	Joint Venture (existing or intended)				Documentation Required
			All members combined	Each member			
4.1 General Experience	Experience in Greenfield <i>Power Transmission Substation projects</i> under contracts in the role of <i>contractor</i> , subcontractor, or management contractor for the last ten (10) years preceding the bid submission deadline [maximum 20 projects].	Must meet requirement	N / A	Must meet requirement	N / A	Form EXP-4.1	
4.2(a) Specific Experience	(a) Participation as contractor, joint venture member, management contractor, or subcontractor, in at least two (02) contracts within the last ten (10) years preceding the bid submission deadline , each with a value of at least United States Dollars Twenty Million (USD 20 m) or at least one (01) contract within the last ten (10) years	Must meet requirement	Must meet requirements	N / A	N/A	- Form EXP 4.2(a) - Evidence of contract value. In case of JV member / sub-contractor, total contract value &	

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	preceding the bid submission deadline with a value of at least United States Dollars Forty Million (USD 40 m) that have been successfully/substantially ⁹ completed and that are similar to the proposed Plant and Installation Services. The similarity of the contracts shall be based on the following Air Insulated Substation: 330kV (minimum) of new (greenfield) substation with at least two Transformers of 330kV or above. - At least two 330kV or above line bays with associated line reactors.					shared value (net value). Completion Certificate with Scope of Work information to validate requirement.

⁹ Substantial completion shall be based on 80% or more Plant and installation completed under the contract.

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
4.2(b) Specific Experience	(b) For the above or other contracts executed during the period stipulated in 4.2(a) above, a minimum experience in the following key activities: i) Completion of Design, supply and installation of at least one 330kV and above substation (green field and/or expansion) having at least two (2) line bays and two 330kV or above transformer bays during the last ten (10) years preceding the bid submission deadline. ii) Successful operation of the above substation(s) for at least one (1) year after	Must meet requirements	Must meet requirements	N / A	N/A	• Form EXP-4.2(b) • Completion Certificate with Scope of Work information to validate specific requirements. • Operation Certificate by Owner / Employer

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	the completion, evidenced by employer / owner performance certificates. iii) At least one (1) 330kV or above substation designed, supplied and installed outside of the bidder’s home country. iv) Completion of Design, supply and installation of at least two 330kV or above line bays with 330kV, 30MVAR or above line reactors during the last ten (10) years preceding the bid submission deadline. v) Successful operation of the above line bays with line reactors at least one (1) year after completion, evidenced by employer / owner performance certificates.					

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
	All members combined		Each member	At least one member		
	vi) At least one contract must include the design, supply, installation, and commission of a 330 kV or a higher voltage substation with Substation Automation System (SAS) and protection systems.					
4.2(c) Specific Experience in managing ES aspects as per requirements in the attached ESMP document.	For the contracts in 4.2 (a) above and/or any other contracts substantially ¹⁰ completed and under implementation as prime contractor, joint venture member, or Subcontractor during the last ten (10) years preceding the bid submission deadline, evidence of prior implementation of E&S management systems in at least one	Must meet requirements	Must meet requirements	Must meet the following requirement: N/A	Must meet the following requirements: N/A	Form EXP – 4.2 (c) with relevant Environmental Management document, Social Management Document, and Health and Safety

¹⁰ Substantial completion shall be based on 80% or more Plant and installation completed under the contract.

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	comparable project in the following aspects, should be clearly detailed: <i>i. Environmental Management (including Waste Management, Pollution Prevention, Biodiversity Management (flora and fauna))</i> <i>ii. Social Management (including Stakeholder Engagement, Grievance Mechanism, anti-GBV/SEAH prevention/Gender Management, and Labour Management)</i> <i>iii. Health and Safety Management (including community and worker occupational health and safety,</i>					Management Document.

Factor	4. Experience					
Sub-Factor	Criteria					Documentation Required
	Requirement	Bidder				
		Single Entity	Joint Venture (existing or intended)			
			All members combined	Each member	At least one member	
	emergency preparedness, and incident management)					

2. Evaluation of Technical Part

The total technical points assigned to each Bid in the Evaluated Bid Formula will be determined by adding and weighting the scores assigned by an evaluation committee to technical factors of the Bid in accordance with the criteria set forth below.

The technical factors to be evaluated are generally defined below and specifically identified **in the BDS**:

- (i) to what extent that the performance, capacity, or functionality features meet or exceed the levels specified in the performance / functional requirements and/or influence the life-cycle cost and effectiveness of the Plant;
- (ii) degree of suitability of the Plant and Installation Services offered in relation to the environmental and climatic conditions prevailing at the site; and quality, function and operation of any process control concept included in the Technical Part of the Bid;
- (iii) quality of Technical Part in terms of risk assessment, method statement, key personnel, access to key equipment, work program and organization, and any other activities as specified by the Employer and based on the Bidder's experience;
- (iv) suitability of proposed subcontractors/manufacturers and completeness of required manufacturer's authorizations;
- (v) long-term availability of mandatory and recommended spare parts and maintenance services; and
- (vi) Any sustainable procurement requirement if specified in Section VII-Employer's Requirements.

Rated Criteria

The technical factors (sub factors) to be evaluated and corresponding weight in % are given in table below:

Table 8: Rated Criteria

Item No.	Technical Factor	Weight Score [%]	Allocation
1	Guaranteed Technical Schedules (List of deviations, if any, will also be assessed; evaluate based on compliance with Employer's Requirements (ER) and Guaranteed Technical Schedules (GTS) alignment for specific technical data for specific key equipment and facilities. Deviations (if any) clearly tabulated and justified for assessment)	10	
2	Project Management	45	
2.1	Site Organization (Assess structure, roles, and oversight; score based on clarity and fit for greenfield Nakonde SS and brownfield Kasama SS; explicit interface management with the ZESCO dispatching centre and adjacent DVSD, and coordination across civil, primary, secondary and telecom disciplines)		5
2.2	Method Statement for Design, Procurement, Shipment and Construction		
2.2.1	Pre-Execution Methodologies (Process and approach for how to develop and manage the detailed design and calculation during pre-construction; how GTS, ER, and IEC/ZESCO standards will be applied; management of interfaces across GCB/DS/ES, transformers, reactors, protection, metering, AC/DC auxiliaries, SCADA, and DVSD. The score is not for the final design specifications)		10
2.2.2	Testing and Supply Methodologies		10

	(High-level FAT/Type test compliance to applicable IEC standards; plan for SAT and quality gates (confirming all tests complying with relevant IEC standards and ER); supply/logistics overview including heavy-haul for transformers/reactors, oil storage and treatment, and SF ₆ management; assessment of the bidder's plan for managing the supply chain for long-lead items)		
2.2.3	Execution and Commissioning Methodologies (Bidder's work plan and sequence for civil and electrical installation/works, AIS equipment installation, oil processing, SF ₆ handling for GCBs, functional/protection checks, SCADA integration, and staged energization; specific approach to brownfield outages/cutover management at Kasama, and general approach to greenfield Nakonde; Comprehensive plan for SAT, end-to-end testing, and staged energization)		10
2.2.4	Supply Chain Risk Management and Quality Assurance Plan (Risk register for long-lead items and critical equipment, and overall project implementation with mitigations and qualified alternates plans; QA / QC plan and Inspection and Test Plans (ITPs) for managing quality from OEM's factory to the site; oil management (PCB-free oils, spill prevention/response, segregated storage, fire protection), and mechanical risks (heavy transportation and lifting)		5
2.2.5	Methodology for Local Involvement (Specific and measurable plan to engage local subcontractors, suppliers and personnel and women-owned businesses (WOB), to use locally sourced materials (Zambian-registered SMEs, WOB, Zambian workforce, aggregates, cement)		5
3	Mobilization Schedule (Realism and completeness, plan for long lead for transformers and reactors, integration with construction critical paths, heavy-haul transport and craneage for	5	

	transformers/reactors; SF ₆ cylinder logistics for GCBs; Oil logistics for transformers and reactors, site access and temporary works and storage)		
4	Construction Schedule (Coherent CPM showing long-lead deliveries, primary/secondary works, protection & SCADA, and staged energization aligned with outage windows)	5	
5	Environmental, Social, Health and Safety Strategy	15	
5.1	Environmental strategy demonstrated by the Bidder (ESMSIP includes: biodiversity protection for both flora and fauna, waste management, pollution control, oil handling and containment (incl. fuel oil and PCB-free oils) spill prevention/response, SF ₆ management for GCBs (leak detection, gas recovery/recycling, cylinder inventory and labelling, emissions reporting), and noise management for transformers/reactors, construction equipment. The Strategy also outlines mitigation for dust and noise impacts)		5
5.2	Social strategy demonstrated by the Bidder (A clear Social Management Strategy addressing key social risks, especially community engagement, GRM and strong GBV/SEAH prevention and response measures.		5
5.3	Health and safety strategy demonstrated by the Bidder (A clear OHS strategy that meets compliance requirements, includes risk assessment, disease prevention and vaccination, PPE and safety tools, hygiene measures, emergency response procedures, and worker training. The Strategy also outlines traffic and road safety during heavy-haul movements, as well as mitigation for dust and noise impacts. Strategy also includes community and worker health and safety management measures.)		5

6	Adequacy of Resources (Equipment and Personnel) Allocation for Design and Construction Stage Activities	20	
6.1	For Project Manager (CVs, certifications, resource allocation plan)		5
6.2	For the Rest of the Personnel (CVs, certifications, resource allocation plan)		10
6.3	Proposed Equipment (Adequacy and deployment plan for key construction and testing equipment, especially specialized gear for transformer oil processing and SF ₆ recovery.		5
	Total	100	
The Technical Part Scoring Methodology is specified in Section III – Evaluation and Qualification Criteria. For the “Technical Part”, <u>a minimum</u> ‘Total Technical Part Score (T)’ required to pass is <u>60% (Sixty Percent)</u>. Note: The “Financial Part” of the Bids will be publicly opened only of those Bidders who will be considered substantially responsive according to ITB 30.1 and passed the aforesaid minimum threshold.			

Common Basis for Scoring Rated Technical Criteria

The rated technical criteria in this section (all factors and sub-factors) will be scored using a common six-level scale shown in the “Basis for Scoring Evaluation” table below and will be scored using a common 0–5 scale, with the corresponding percentage scores shown below. Evaluators will assign one integer score (0, 1, 2, 3, 4 or 5) to each rated item based on the evidence provided in the bid; fractional scores will not be used. The scale measures (i) completeness of the information requested, (ii) conformity with the Employer’s Requirements and the bidding documents, and (iii) quality and feasibility of the proposed approach. Each factor or sub-factor will first be placed in one of the six levels according to this table, and the numerical score within the range will be converted to the corresponding percentage and multiplied by the weight of that factor or sub-factor. This common scale is used for all rated items to ensure consistency and transparency. Only features not already assessed on a pass/fail basis in Section III will be rated. Evaluators in Evaluation Committee

will cite the relevant bid references and justification for each score and will apply the scale consistently across all bids, avoiding subjective language.

Table 9: Basis for Scoring Evaluation

Score	Description of Scoring Criteria	Percentage Weightings for Point
0	Non-responsive: Fails mandatory requirements or presents material deviations; or the requested information is not provided.	0%
1	Weak: Meets the minimum requirement only on paper; evidence is incomplete or unclear; significant implementation risks.	20%
2	Adequate: meets generally the critical requirement with acceptable evidence; only minor gaps or risks.	40%
3	Good: Fully meets the requirement in important aspects and is supported by robust, contract specific evidence; low implementation risk.	60%
4	Excellent: Substantially exceeds the requirement; approach or solution clearly demonstrates significant added value and risk reduction.	80%
5	Superior: Demonstrates a proven, superior approach or solution with clear, verifiable evidence from comparable projects; delivers material additional value to the Project.	100%

Detail Technical Factors of the Rated Criteria (Table 8)

1. Guaranteed Technical Schedule [10%]

This is evaluated based on compliance with Employer's Requirements (ER) and Guaranteed Technical Schedules (GTS) alignment for specific technical data for specific key equipment and facilities. Deviations (if any) clearly tabulated and justified for assessment

The bidder shall submit all Guaranteed Technical Schedules (GTS) required in the bidding documents. This factor is to confirm that the bidder has fully

translated the Employer's Requirements (ER) into equipment-specific, standard-compliant commitments for primary and secondary systems.

The evaluation will mainly examine following aspects, but limited to:

- Completeness of GTS for power transformers, line/bus/earth-switches, gas-circuit breakers (GCBs with SF₆), shunt reactors, CTs/VTs/MCBs, protection and control panels, AC/DC auxiliaries, batteries/chargers, SCADA/RTU, telecom/DVSD interfaces, firefighting, and substation civil works.
- Consistency (ratings, insulation levels, short-circuit duties, SF₆ class, oil type, tap ranges, accessories) across greenfield and brownfield parts.
- Conformity with ER, ZESCO standards and grid codes, and applicable IEC standards as referenced in the bidding documents.
- Clear tabulation of any permitted deviations (e.g. alternative transformer cooling, alternative Current Transformer cores, alternative cable types), with justification for assessment.

2. Project Management [45%]

This factor assesses how the bidder proposes to organize, plan, and control this contract for (i) management at a new 330 kV AIS yard and (ii) management inside a live/brownfield substation; including multi-discipline interfaces (civil, primary, secondary, telecom, SCADA) and ZESCO dispatch/Protection approvals., using contract-specific arrangements rather than generic corporate descriptions.

2.1. Site Organization [5%]

This will assess structure, roles, and oversight; score based on clarity and fit for greenfield Nakonde SS and brownfield Kasama SS; explicit interface management with the ZESCO dispatching centre and adjacent DVSD, and coordination across civil, primary, secondary and telecom disciplines.

The bidder shall demonstrate a contract-specific site organization showing reporting lines from the Project Manager to construction teams, survey/design support, logistics/procurement interface, HSES, and local subcontractors. The description should indicate which functions are self-performed and which are subcontracted, and how reporting to ZESCO/Owner's Engineer (OE) will be done, to confirm that the structure is

clear, sized for parallel work fronts, and able to control quality, safety, and progress.

2.2. Method Statement for Design, Procurement, Shipment and Construction [40%]

This is a contract-specific narrative and/or flow that shows how the bidder will move from pre-construction to commissioning, and how design/procurement will support site works. It has five parts.

2.2.1. Pre-Execution Methodologies [10%]

This will assess process and approach for how to develop and manage detailed design and calculation during pre-construction; how GTS, ER, and IEC/ZESCO standards will be applied; management of interfaces across GCB/DS/ES, transformers, reactors, protection, metering, AC/DC auxiliaries, SCADA, and DVSD. The score is not for the final design specifications.

The bidder shall explain how they will complete site investigations, geotechnical verification, and final substation layout aligning with SLD concept, and how they will develop and manage detailed substation design and calculations before construction, including: application of ER, GTS and IEC/ZESCO standards; earth/civil work, layout and equipment placement for 330 kV AIS, and the interface with DVSD; integration of power transformers and shunt reactors; earthing/grid design; AC/DC auxiliary sizing; and interface definition for protection, metering, SCADA and DVSD. For the brownfield substation, bidders shall describe how they will survey existing panels/cubicles, cable trenches, foundations and earthing to avoid clashes and how they will sequence cut-ins. This sub-factor checks contract-specific design thinking, not final drawings.

2.2.2. Testing and Supply Methodologies [10%]

This will assess High-level FAT/Type test compliance to applicable IEC standards; plan for SAT and quality gates (confirming all tests complying with relevant IEC standards and ER); supply/logistics overview including heavy-haul for transformers/reactors, oil storage

and treatment, and SF₆ management; assessment of the bidder's plan for managing the supply chain for long-lead items.

The bidder shall describe the procurement-to-site chain for power transformers, shunt reactors, GCBs with SF₆, instrument transformers, protection/SCADA panels, batteries/chargers, AC/DC boards, and control cables, OPGW interface, indicating FAT/type tests to the relevant IEC standards, SAT plans, and quality gates. Because the package includes heavy, oil-filled equipment and SF₆-filled equipment, the bidder shall also describe heavy-haul transport, lifting /set-down, oil receipt / filtration / vacuum filling / fire prevention/firefighting, oil storage and spill prevention, and SF₆ cylinder logistics and gas-quality checks. The intent is to confirm a realistic, quality-controlled supply plan for long-lead and critical items.

2.2.3. Execution and Commissioning Methodologies [10%]

This will assess Bidder's work plan and sequence for civil and electrical installation/works, AIS equipment installation, oil processing, SF₆ handling for GCBs, functional/protection checks, SCADA integration, and staged energization; specific approach to brownfield outages/cutover management at Kasama, and general approach to greenfield Nakonde; Comprehensive plan for SAT, end-to-end testing, and staged energization.

The bidder shall explain the step-by-step work plan for: civil works and foundations; erection of AIS structures/equipment; transformer / reactor installation, oil processing and tests; SF₆ handling, filling and leak-tests for GCBs; cabling and marshalling; protection / SCADA / optical fibre wiring checks; integrated functional tests; and staged energization. For the brownfield substation they shall set out the outage / cut-over / re-energization method, temporary protections, and how they will protect existing circuits. This is to show that the bidder understands the different risks at each substation's yard.

2.2.4. Supply Chain Risk Management and Quality Assurance Plan [5%]

This will assess Risk register for long-lead items and critical equipment, and overall project implementation with mitigations and

qualified alternates plans; QA / QC plan and Inspection and Test Plans (ITPs) for managing quality from OEM's factory to the site; oil management (PCB-free oils, spill prevention/response, segregated storage, fire protection), and mechanical risks (heavy transportation and lifting).

The bidder shall provide a risk register focused on long-lead and critical substation items (power transformers, reactors, GCBs / SF₆, P&C panels, telecom equipment), with mitigations (alternative qualified OEMs, earlier call-off, factory inspection milestones, spare SF₆ cylinders, spare oil). QA/QC part should include inspection and test plans (ITPs) from OEM to site, oil-quality and gas-quality testing, winding soundness testing, and controls for PCB-free oils, spill prevention/response, and fire-protection interfaces. This confirms that bidder's QA/ITP is tailored to oil and SF₆ equipment, not just a generic plan.

2.2.5. Methodology for Involvement of Local subcontractors, suppliers and personnel and women-owned businesses (WOB) [5%]

This will assess specific and measurable plan to engage local subcontractors, suppliers and personnel and women-owned businesses (WOB), to use locally sourced materials (Zambian-registered SMEs, WOB, Zambian workforce, aggregates, cement).

The bidder shall demonstrate clear participation of local subcontractors, suppliers and personnel during the entire phase of the contract as required, and outline which work packages or services will be offered to Zambian-registered SMEs, WOBs, and local labour, and which inputs can be sourced locally (aggregates, cement, basic steel, transport, camp services). The plan should be practical and consistent with the project timeline; i.e. local participation should be integrated without causing delays. This will confirm that the bidder has a concrete plan, not just a statement of intent.

3. Mobilization Schedule [5%]

This will assess realism and completeness, plan for long-lead for transformers and reactors, integration with construction critical paths, heavy-haul transport and craneage for transformers/reactors; SF₆ cylinder logistics for

GCBs; Oil logistics for transformers and reactors, site access and temporary works and storage.

The Bidder should submit a time-bound mobilization schedule showing establishment of camps/yards/offices, arrival and customs clearance of initial tools and equipment, mobilization of erection and stringing equipment, deployment of key supervisory and HSES staff; establishment of substation site facilities; delivery / mobilization of civil works plant; arrangements for heavy-haul and craneage for transformers / reactors; arrival of tools and equipment for oil processing and SF₆ handling; mobilization of protection / SCADA / test teams; and readiness to start works at each substations.

This will confirm that the bidder can start the works promptly and at sufficient scale in the first months, considering local logistics and any use of local subcontractors. The mobilization schedule should correspond to the resources described in the project management section - not only civil crews, but also oil/SF₆ and secondary-systems testers.

4. Construction Schedule [5%]

(Coherent CPM showing long-lead deliveries, primary/secondary works, protection & SCADA, and staged energization aligned with outage windows)

The Bidder should submit a construction schedule/programme covering all major stages: design finalization, procurement/deliveries, foundations, tower erection, stringing, section-wise testing, interface with the Tanzanian section, and final commissioning.

- The Bidder shall provide in detail how the works will be carried out from site mobilization, design, procurement, manufacturing, shipment, transportation, installation and commissioning.
- The Schedule shall cover all the details as mentioned in the Construction Schedule Form under section IV – Bidding Forms; Evaluate critical paths, milestones, and resource integration.
- The involvement of any subcontractors at any stage of the supply chain and works delivery process shall be demonstrated.
- The Bidders' Proposed Programme shall demonstrate completeness, appropriate level of detail, knowledge of works and soundness of durations.

- The schedule shall indicate the sequence of construction and completion dates for the works and parts thereof.
- The Programme shall indicate key constraints & Milestones in the schedule detailing, approval & procurement processes.
- The Programme shall clearly depict the critical paths; Critical path network showing procurement, equipment/material orders, deliveries, and site installation period as per standard procedures.
- The bidder shall provide a risk matrix covering the different stages of the project execution and measures for risk management/mitigation.
- Specifically, this should show how brownfield outages at Kasama will be minimized and sequenced, and how the new Nakonde yard will be energized including phase and rotation check.

This factor will assess that the bidder's proposed schedule is coherent, time-feasible, and properly integrated (procurement, deliveries, site activities, and commissioning).

5. Environmental, Social, Health and Safety Strategy [15%]

5.1. Environmental strategy demonstrated by the Bidder [5%]

This will assess Biodiversity, Waste Management, pollution, ESMP plans, oil handling/containment, PCB-free oils, spill prevention/response; SF₆ management for GCBs (leak detection, gas recovery/recycling, cylinder inventory and labelling, emissions reporting); noise design and management for transformers/reactors.

The Bidder shall outline a clear and detailed robust Environmental Strategy for each of the following:

- Biodiversity Impacts (Flora and Fauna):** Identification and management of impacts on both flora and fauna.
- Waste Management:** Identification and management of different types of waste streams.
- Pollution Prevention:** Identification and management of potential pollution impacts related to air, water, soil, and noise.
- Specific Management Plans:** Development and implementation of specific management plans as per ESMP for implementation of the environmental strategy. Specific management plans related to the

implementation of the environmental strategy should be outlined and described.

- v. **Compliance and adherence to Laws and World Bank ESF Standards:** Compliance and adherence to relevant environmental laws, regulations and World Bank ESF Standards for implementation of the environmental strategy. Relevant environmental laws, regulations, and specific World Bank ESF standards related to implementation of the environmental strategy should be outlined and described.
- vi. **Awareness and Training:** Environmental awareness training for workers and the community. List of training topics, modes of delivery, target groups, and frequency of training shall be outlined.
- vii. **Monitoring and Reporting on Environmental Management:** Monitoring tools, parameters to be monitored, mode and frequency of monitoring and reporting, and plans for corrective action shall be indicated.
- viii. **Oil handling, storage and treatment:** Fuel oil, PCB-free oils, clean and contaminated oil segregation, drip trays/bunds sized for transformers/reactors, spill prevention and emergency response, fire detection/suppression near oil areas; Waste management for oil filters, oil-contaminated materials.
- ix. **SF₆ management:** Leak detection, recovery/re-use, cylinder inventory and labelling, safe venting prohibition, emissions reporting); SF₆ hoses and seals.
- x. **Noise management:** Transformers and reactors – not only energization (no load) but also loading condition.

5.2. Social strategy demonstrated by the Bidder [5%]

This will assess Stakeholder engagement, GRM, GBV/SEAH, Traffic, Road safety (heavy-haul movements), Dust, and Sound.

The Bidder shall outline a clear and detailed robust Social Strategy for each of the following:

- i. **Stakeholder and Community Engagement:** Shall describe strategy for Stakeholder Identification and Engagement, Methods of Consultation, and Documentation of Engagement.
- ii. **Grievance Mechanism for Workers and Communities:** Shall describe strategy for Worker and Community Grievance Mechanism, including

Channels for submission of grievances, Process for management of received grievances, and plan for Monitoring of grievances.

- iii. **GBV and SEAH:** Shall present a strong strategy for managing Gender-Based Violence (GBV) and Sexual Exploitation Abuse and Harassment (SEAH), including clear response protocols and referral pathways for GBV/SEAH cases.
- iv. **Specific Management Plans:** Development and implementation of specific management plans as per ESMP and Labour Management Procedure for implementation of the Social Strategy. Specific management plans related to implementation of the Social Strategy should be outlined and described.
- v. **Compliance and adherence to Laws and World Bank ESF Standards:** Compliance and adherence to relevant labour laws and regulations, gender laws and regulations, and World Bank ESF Standards for implementation of the Social Strategy. Relevant laws, regulations, and specific World Bank ESF standards related to implementation of the Social Strategy should be outlined and described.
- vi. **Awareness and Training:** Strategy for Social awareness training for Workers and the Community on SEAH, GBV and other gender and social issues. A detailed training plan shall outline training topics, modes of delivery, target groups, and frequency of training.
- vii. **Monitoring and Reporting on Social Management:** Monitoring tools, parameters to be monitored, mode and frequency of monitoring and reporting, and plans for corrective action shall be outlined.
- viii. **Traffic and Transport Management:** Strategy for managing public safety and community disruption from heavy-haul transport of transformers and reactors, including route surveys, community notifications, and traffic management plans.

5.3. Health and Safety Strategy demonstrated by the Bidder [5%]

This will evaluate risk assessment, disease, vaccination, PPE, safety tools, hygiene, emergency response, and training.

The Bidder shall outline a clear and detailed, robust Health and Safety Strategy for each of the following:

- i. **Community and Occupational Health and Safety:** Shall describe a strategy for ensuring Community and Worker Health and Safety, identify

potential Health and Safety risks to the Community and Workers, and outline strategies for mitigating identified risks.

- ii. **Emergency Preparedness and Response:** Shall identify potential emergencies and outline strategies for response to identified emergencies.
- iii. **Incident Reporting and Investigation:** Shall outline the potential incidents, mode and frequency for reporting incidents, and the strategy for investigation and corrective action of incidents.
- iv. **Specific Management Plans:** Development and implementation of specific management plans as per ESMP for implementation of the Health and Safety Strategy. Specific management plans related to the implementation of the Health and Safety Strategy shall be outlined and described.
- v. **Compliance and adherence to Laws and World Bank ESF Standards:** Compliance and adherence to relevant occupational health and safety laws and regulations, and World Bank ESF Standards for implementation of the Health and Safety Strategy. Relevant laws, regulations, and specific World Bank ESF Standards related to implementation of the Health and Safety Strategy shall be outlined and described.
- vi. **Awareness and Training:** Strategy for Health and Safety awareness training for Workers and the Community. List of training topics, modes of delivery, target groups, and frequency of training shall be outlined.
- vii. **Monitoring and Reporting on Health and Safety Management:** Monitoring tools, parameters to be monitored, mode and frequency of monitoring and reporting, and plans for corrective action shall be indicated.
- viii. **Substation Specific OHS:** Methodology for substation construction, energized-yard work, lifting and crange, hot-oil operations, SF₆ safety, confined-space where applicable, live-line work (if necessary), emergency response (oil / fire / SF₆ incidents), training and reporting.

6. Adequacy of Resources (Equipment and Personnel) Allocation for Design and Construction Stage Activities [20%]

6.1. For Project Manager [5%]

PM will be assessed on CVs, certifications, resource allocation plan.

6.2. For the Rest of the Personnel [10%]

Personnel will be assessed on CVs, certifications, resource allocation plan.

The Bidder shall submit the proposed name and CVs for the Key Personnel in accordance with form PER-1 and PER-2. Proof of relevant qualifications will be required. For key personnel and proposed equipment, the evaluation will check that the bidder has assigned staff and tools appropriate for AIS substation works, oil processing of power transformers/reactors, SF₆ handling of GCBs, and secondary / SCADA integration, telecommunication/optical fibre integration, and not only for overhead line construction.

Table 10: Scoring Basis for Personnel

No.	Description	Percentage (Weightage)
1	Academic and professional qualifications	30%
2	Minimum years of relevant works experience	30%
3	Experience in similar works	30%
4	Working experience in the region (Zambia and the region)	5%
5	Knowledge of English language	5%

6.3. Proposed Equipment [5%]

This will assess the adequacy and deployment plan for key construction and testing equipment, especially specialized gear for transformer oil processing and SF₆ recovery.

The successful implementation of the works requires the utilization of design and construction approaches that consider specific project requirements and conditions and demonstrate a clear understanding of risks and risk mitigation strategies.

The Bidder shall also provide a list of major plants & equipment available, and the list of the equipment proposed for the project in accordance with Form EQU. List to include:

- Type of Equipment (owned or hired. e.g. heavy-lift cranes for transformers/reactors, transformer oil processing and filtration units, vacuum pumps, SF₆ gas recovery and handling carts, protection relay test sets)
- Quantity & Production rate, proposed numbers.
- Details of Owned/ Hired/ To be purchased.
- Present Location.
- Mobilization plan.
- Operations and Maintenance plan

Technical Proposal Scoring Methodology

The score for each sub- factor (i) within a factor (j) will be combined with the scores of sub- factors in the same factor as a weighted sum to form the Factor Technical Score using the following formula:

$$S_j \equiv \sum_{i=1}^k t_{ji} * w_{ji}$$

where:

t_{ji} = the technical score for sub- factor “i” in factor “j”

w_{ji} = the weight of sub- factor “i” in factor “j”,

k = the number of scored sub-factors in factor “j”

and
$$\sum_{i=1}^k w_{ji} = 1$$

The Factor Technical Scores will be combined in a weighted sum to form the total Technical Part Score using the following formula:

$$T \equiv \sum_{j=1}^n S_j * W_j$$

where:

S_j = the Factor Technical Score of factor “j”

W_j = the weight of factor “j” as specified in the BDS

n = the number of Factors

$$\text{and } \sum_{j=1}^n W_j = 1$$

3. Evaluation of Financial Part

The following factors and methods will apply:

(a) Time Schedule

Time to complete the Plant and Installation Services from the effective date specified in Article 3 of the Contract Agreement for determining time for completion of pre-commissioning activities is: 24 Months. No credit will be given for earlier completion.

(b) Life Cycle Costs

The price of recommended spare parts quoted in Price Schedule No. 6 shall not be considered for evaluation.

For this package, the evaluation of transformer and reactor losses shall be treated as part of the Life Cycle Cost (LCC) assessment, as these losses represent operational costs incurred during the project lifetime. The Bid Price shall be adjusted by adding the monetized value of (i) no-load losses and (ii) load losses, calculated using the values specified below.

Capitalization¹ Losses (Adjustment of Price for the Purpose of Evaluation)

TRANSFORMER

Capitalization of Transformer Losses/ Evaluated Price of Transformer Losses:

The evaluated price for each transformer unit shall be calculated based on the formula below:

$$TER(Tr) = BP(Tr) + N \times a + L \times b$$

TER(Tr): Total Evaluated Price of Transformer

BP(Tr): Bid Price of Transformer

$N \times a + L \times b$: Evaluated Price of Transformer Losses

N = No load loss (core-loss) at rated voltage in kW.

¹ Noise of transformer and reactor is not capitalized because it does not represent a continuous operational cost or energy inefficiency over the asset's lifetime. Therefore, it does not result in any direct financial impact.

L = Load loss (copper-loss plus auxiliary power losses) at 75 °C, 50 Hz maximum continuous rating in kW.

a = Cost/kW of no-load losses (core-losses) valued at USD 12,000/kW.

b = Cost/kW of load-losses (copper-losses plus auxiliary power losses) valued at USD 7,000/kW.

REACTOR

Capitalization of Reactor Losses/ Evaluated Price of Reactor Losses:

The evaluated price for each reactor unit shall be calculated based on the formula below:

$$\text{TER(Re)} = \text{BP(Re)} + T \times P$$

TER(Re) = Total Evaluated Price of Reactor

BP(Re) = Bid Price of Reactor

T x P = Evaluated Price of Reactor Losses

T: Reactor total loss (core and winding losses) at rated voltage in kW

P: Cost/kW of total reactor loss valued at USD 12,000/kW

The evaluated cost of the transformer and reactor shall be multiplied by the total number of transformers and reactors to arrive at the total evaluated cost.

The total capitalized cost of the losses will be added to the cost of transformers and reactors for comparing bids.

Any adjustment in cost that results from the procedure above shall be added to the bid price for the purpose of comparative evaluation only, to arrive at an "evaluated bid price". Bid prices quoted by Bidders shall remain unaltered.

If the bidder proposes transformers/reactor from more than one manufacturer, the values obtained from the manufacturer with the highest guaranteed/offered no-load and load losses will be used for the capitalization of the transformers and total load will be used for reactors.

(c) Functional Guarantees of the Facilities

Failure in Guarantees (During the Factory Acceptance Test), Transformer and Reactor Losses²**TRANSFORMER****No Load Losses**

If the no load losses of a transformer exceed the guaranteed value, by more than the margins specified hereunder, a penalty as specified for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **USD 12,000/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

On Load Losses

If the on-load losses (plus auxiliary power losses) of a transformer exceed the value guaranteed, by more than the margins specified hereunder, a penalty as indicated for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **USD 7,000/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

REACTOR

If the total loss a reactor exceeds the guaranteed value, by not more than the margins specified hereunder, a penalty as specified for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **USD 12,000/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

NOISE LEVEL

Should the noise level (at maximum power output and at U_{max}) for the transformer and reactor, at the specified distance according to IEC, exceed the guaranteed values

² The cost per kW for failure to meet the Functional Guarantees is higher than the cost per kW used for the capitalization of losses, as the former serves as a penalty if the bidder fails to meet the guaranteed values.

but not exceed 3 dB(A), the Contractor must pay liquidated damages (penalty) to the Employer.

The penalty will be **USD 12,000/dB(A)**. It is thereby understood that values of 0.5 dB(A) and above will be rounded up to the next full dB(A).

Rejection of the Transformers and Reactors

The Employer shall have the right to reject any transformer and reactor (after Factory Acceptance Test) if the actual values are in excess of the guaranteed values by more than the margins specified hereunder:

- No-load losses + 10%
- Load losses (forced cooling) + 10%
- Total losses + 10%
- Noise level + 3 dB (A)
- Temperature rise limit resulting in rated +0.0 K output

For all of the other values the margins stated in IEC standards are applicable, unless specified otherwise elsewhere in these Specifications.

The values for all insulation and test levels shall be obtained from the description of the general technical requirements of these Specifications.

The minimum (or maximum) requirements stated in the Specification for functional guarantees required in the Specification are:

Table 11: Functional Guarantees of the Facilities

Functional Guarantee	Minimum (or Maximum, as appropriate) Requirement
Kasama Substation	
1. 330kV Line Reactor – Load Losses (kW)	
2. 330kV Line Reactor – Noise Level (dB(A))	
3. Neutral Reactor – Load Losses (kW)	
4. Neutral Reactor – Noise Level dB(A)	
Nakonde Stepdown Substation	
5. 330kV Line Reactor – Power Losses (kW)	
6. 330kV Line Reactor – Noise Level (dB(A))	
7. Neutral Reactor – Load Losses (kW)	
8. Neutral Reactor – Noise Level dB(A)	
9. 330/(132)66/11kV 90MVA Transformer Load Loss (kW)	
10. 330/(132)66/11kV 90MVA Transformer No-Load Loss (kW)	

11. 330/(132)66/11kV 90MVA Transformer Noise Level dB(A)	

4. Combined Evaluation

The Employer will evaluate and compare the Bids that have been determined to be substantially responsive.

An Evaluated Bid Score (B) will be calculated for each responsive Bid using the following formula, which permits a comprehensive assessment of the evaluated cost and the technical merits of each Bid:

$$B \equiv \frac{C_{low}}{C} * X * 100 + \frac{T}{T_{high}} * (1 - X) * 100$$

where

C = Evaluated Bid Cost

C_{low} = the lowest of all Evaluated Bid Costs among responsive Bids

T = the total Technical Score awarded to the Bid

T_{high} = the Technical Score achieved by the Bid that was scored best among all responsive Bids

X = weight for Cost as **specified in the BDS**

The Bid with the best evaluated Bid Score (B) among responsive Bids shall be the Most Advantageous Bid provided the Bidder is qualified to perform the Contract.

5. Multiple Contracts

If permitted under ITB 37.3, will be evaluated as follows: **“Not Applicable”**

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Letter of Bid- Technical Part

INSTRUCTIONS TO BIDDERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Bidder must prepare this Letter of Bid on stationery with its letterhead clearly showing the Bidder's complete name and business address.

Note: *All italicized text is to help Bidders in preparing this form.*

Date of this Bid submission: *[insert date (as day, month and year) of Bid submission]*

RFB No.: *[insert number of RFB process]*

Alternative No.:*[insert identification No if this is a Bid for an alternative]*

We, the undersigned, hereby submit our Bid, in two parts, namely:

- (a) the Technical Part, and
- (b) the Financial Part

In submitting our Bid, we make the following declarations:

- (a) **No reservations:** We have examined and have no reservations to the bidding document, including Addenda issued in accordance with Instructions to Bidders (ITB 8);
- (b) **Eligibility:** We meet the eligibility requirements and have no conflict of interest in accordance with ITB 4;
- (c) **Bid-Securing Declaration:** We have not been suspended nor declared ineligible by the Employer based on execution of a Bid-Securing Declaration or Proposal-Securing Declaration in the Employer's country in accordance with ITB 4.7;
- (d) **Sexual Exploitation and Abuse (SEA) and/or Sexual Harassment (SH):** *[select the appropriate option from (i) to (v) below and delete the others].*

We *[where JV, insert: "including any of our JV members"]*, and any of our subcontractors:

- (i) *[have not been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations.]*

- (ii) [are subject to disqualification by the Bank for non-compliance with SEA/ SH obligations.]
 - (iii) [had been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations. An arbitral award on the disqualification case has been made in our favor.]
 - (iv) [had been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations for a period of two years. We have subsequently provided and demonstrated that we have adequate capacity and commitment to comply with SEA and SH prevention and response obligations.]
 - (v) [had been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations for a period of two years. We have attached documents demonstrating that we have adequate capacity and commitment to comply with SEA and SH prevention and response obligations.]
- (e) **Conformity:** We offer to provide design, supply and installation services in conformity with the bidding document of the following: *[insert a brief description of the Plant, Design, Supply and Installation Services]*_____;
- (f) **Bid Validity:** Our Bid shall be valid until *[insert day, month and year in accordance with ITB 19.1]*, and it shall remain binding upon us and may be accepted at any time on or before this date;
- (g) **Performance Security:** If our Bid is accepted, we commit to obtain a Performance Security in accordance with the bidding document;
- (h) **One Bid Per Bidder:** We are not submitting any other Bid(s) as an individual Bidder, and we are not participating in any other Bid(s) as a Joint Venture member, and meet the requirements of ITB 4.3, other than alternative Bids submitted in accordance with ITB 13;
- (i) **Suspension and Debarment:** We, along with any of our subcontractors, suppliers, consultants, manufacturers, or service providers for any part of the contract, are not subject to, and not controlled by any entity or individual that is subject to, a temporary suspension or a debarment imposed by the World Bank Group or a debarment imposed by the World Bank Group in accordance with the Agreement for Mutual Enforcement of Debarment Decisions between the World Bank and other development banks. Further, we are not ineligible under the Employer's country laws or official regulations or pursuant to a decision of the United Nations Security Council;

- (j) **State-owned enterprise or institution:** *[select the appropriate option and delete the other] [We are not a state-owned enterprise or institution] / [We are a state-owned enterprise or institution but meet the requirements of ITB 4.6];*
- (k) **Binding Contract:** We understand that this Bid, together with your written acceptance thereof included in your Letter of Acceptance, shall constitute a binding contract between us, until a formal contract is prepared and executed;
- (l) **Not Bound to Accept:** We understand that you are not bound to accept the lowest evaluated cost Bid, the Most Advantageous Bid or any other Bid that you may receive; and
- (m) **Fraud and Corruption:** We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf engages in any type of Fraud and Corruption.

Name of the Bidder: **[insert complete name of the Bidder]*

Name of the person duly authorized to sign the Bid on behalf of the Bidder: ***[insert complete name of person duly authorized to sign the Bid]*

Title of the person signing the Bid: *[insert complete title of the person signing the Bid]*

Signature of the person named above: *[insert signature of person whose name and capacity are shown above]*

Date signed *[insert date of signing]* **day of** *[insert month]*, *[insert year]*

***:** In the case of the Bid submitted by joint venture specify the name of the Joint Venture as Bidder

****:** Person signing the Bid shall have the power of attorney given by the Bidder to be attached with the Bid

Technical Proposal

- Guaranteed Technical Schedules as per Technical Schedule
- Project Management
 - Site Organization
 - Method Statement
- Mobilization Schedule
- Construction Schedule
- Environmental, Social, Health and Safety Strategy
 - Environmental strategy demonstrated by the Bidder
 - Social strategy demonstrated by the Bidder
 - Health and safety strategy demonstrated by the Bidder
- Adequacy of Resources
 - For Project Manager
 - For the Rest of the Personnel
 - Proposed Equipment
- Sustainable Procurement Proposal
- Risk Assessment and Proposed Management Plan
- Code of Conduct for Contractor's Personnel (ES)
- Plant
- Contractor's Equipment
- Personnel
- Proposed Subcontractors for Major Items of Plant and Installation Services
- Others

Method Statement

[Note to the Bidder: (i) As required in BDS 11.2 (i), also include method statement, management strategies, implementation plans and innovations, to manage cyber security risks; (ii) if there are assessed supply chain risks, the method statement must include proposed supply chain risks management plans.]

The method statement for Design, Procurement, Shipment and Construction shall as a minimum include the following;

- Pre-Execution Methodologies
- Testing and Supply Methodologies
- Execution and Commissioning Methodologies
- Supply Chain Risk Management and Quality Assurance Plan
- Methodology for Local Involvement

ES Management Strategies and Implementation Plans (ES-MSIP)

The Bidder shall submit comprehensive and concise Environmental and Social Management Strategies and Implementation Plans (ES-MSIP) as required by ITB 11.1 (j) of the Bid Data Sheet. These strategies and plans shall describe in detail the actions, materials, equipment, management processes etc. that will be implemented by the Contractor, and its subcontractors.

The bidders shall demonstrate strategies for maximizing local economic benefits, including voluntary targets for Zambian labor participation, subcontractor engagement with local SMEs, and community skills development programs (e.g., training for women/youth in line with ESF ESS2 Labor and Working Conditions).

In developing these strategies and plans, the Bidder shall have regard to the ES provisions of the contract including those as may be more fully described in the Employer's Requirements in Section VII.

Sustainable Procurement Proposal

*[Note to Bidder: In addition to submitting the **required** ES Management Strategies and Implementation Plans, the Bidder shall provide its proposal to demonstrate how additional sustainable procurement requirements, if any, specified in Section VII- Employer's Requirements would be addressed. The Bidder shall also provide its proposal, if any, for exceeding the sustainable procurement requirements.]*

Bidders are encouraged to outline opportunities for local content (e.g., employment, materials, training) and how these enhance project sustainability, without fixed quotas.

Risk assessment and Proposed Management Plan

The Bidder should submit a risk register identifying the hazards anticipated during the implementation of the contract.

For the key hazards ranked by impact, the risk register shall include a description of the hazard, an assessment of the potential impact on health and safety, environment, cost, program or other, and the proposed mitigation strategy for each hazard.

Code of Conduct for Contractor's Personnel (ES) Form

We are the Contractor, *[enter name of Contractor]*. We have signed a contract with *[enter name of Employer]* for *[enter description of the Facilities]*. The Plant for the Facilities will be installed at *[enter the Site]*. Our contract requires us to implement measures to address environmental and social risks, related to the Installation Services i.e. services ancillary to the supply of the Plant for the Facilities, such as inland transportation, site preparation works/ associated civil works, installation, testing, precommissioning, commissioning, operations and maintenance etc. as the case may require.

Note to the Bidder:

The minimum content of the Code of Conduct form as set out by the Employer shall not be substantially modified. However, the Bidder may add requirements as appropriate, including to take into account Contract-specific issues/risks.

The Bidder shall initial and submit the Code of Conduct form as part of its bid.

This Code of Conduct is part of our measures to deal with environmental and social risks related to the Installation Services.

All personnel that we utilize in the execution of the Contract, including staff, labor and other employees of us and of each Subcontractor, and any other personnel assisting us in the execution of the Contract, are referred to as Contractor's Personnel.

This Code of Conduct identifies the behavior that we require from the Contractor's Personnel employed for the execution of Installation Services at the Site (or other places in the country where the Site is located).

Our workplace is an environment where unsafe, offensive, abusive or violent behavior will not be tolerated and where all persons should feel comfortable raising issues or concerns without fear of retaliation.

REQUIRED CONDUCT

Contractor's Personnel employed for the execution of Installation Services at the Site (or other places in the country where the Site is located) shall:

1. carry out his/her duties competently and diligently;
2. comply with this Code of Conduct and all applicable laws, regulations and other requirements, including requirements to protect the health, safety and well-being of other Contractor's Personnel and any other person;

3. maintain a safe working environment including by:
 - a. ensuring that workplaces, machinery, equipment and processes under each person's control are safe and without risk to health;
 - b. wearing required personal protective equipment;
 - c. using appropriate measures relating to chemical, physical and biological substances and agents; and
 - d. following applicable emergency operating procedures.
4. report work situations that he/she believes are not safe or healthy and remove himself/herself from a work situation which he/she reasonably believes presents an imminent and serious danger to his/her life or health;
5. treat other people with respect, and not discriminate against specific groups such as women, people with disabilities, migrant workers or children;
6. not engage in any form of sexual harassment including unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature with other Contractor's or Employer's Personnel;
7. not engage in Sexual Exploitation, which means any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another;
8. not engage in Sexual Abuse, which means the actual or threatened physical intrusion of a sexual nature, whether by force or under unequal or coercive conditions;
9. not engage in any form of sexual activity with individuals under the age of 18, except in case of pre-existing marriage;
10. complete relevant training courses that will be provided related to the environmental and social aspects of the Contract, including on health and safety matters, and Sexual Exploitation and Abuse, and Sexual Harassment (SH);
11. report violations of this Code of Conduct; and
12. not retaliate against any person who reports violations of this Code of Conduct, whether to us or the Employer, or who makes use of the grievance mechanism for Contractor's Personnel or the project's Grievance Redress Mechanism.

RAISING CONCERNS

If any person observes behavior that he/she believes may represent a violation of this Code of Conduct, or that otherwise concerns him/her, he/she should raise the issue promptly. This can be done in either of the following ways:

1. Contact *[enter name of the Contractor's Social Expert with relevant experience in handling sexual exploitation, sexual abuse and sexual harassment cases, or if such person*

is not required under the Contract, another individual designated by the Contractor to handle these matters] in writing at this address [] or by telephone at [] or in person at []; or

2. Call [] to reach the Contractor's hotline (*if any*) and leave a message.

The person's identity will be kept confidential, unless reporting of allegations is mandated by the country law. Anonymous complaints or allegations may also be submitted and will be given all due and appropriate consideration. We take seriously all reports of possible misconduct and will investigate and take appropriate action. We will provide warm referrals to service providers that may help support the person who experienced the alleged incident, as appropriate.

There will be no retaliation against any person who raises a concern in good faith about any behavior prohibited by this Code of Conduct. Such retaliation would be a violation of this Code of Conduct.

CONSEQUENCES OF VIOLATING THE CODE OF CONDUCT

Any violation of this Code of Conduct by the Contractor's Personnel may result in serious consequences, up to and including termination and possible referral to legal authorities.

FOR CONTRACTOR'S PERSONNEL:

I have received a copy of this Code of Conduct written in a language that I comprehend. I understand that if I have any questions about this Code of Conduct, I can contact [*enter name of Contractor's contact person(s) with relevant experience*] requesting an explanation.

Name of Contractor's Personnel: [insert name]

Signature:

Date: (day month year): _____

Countersignature of authorized representative of the Contractor:

Signature: _____

Date: (day month year): _____

ATTACHMENT 1: Behaviors constituting SEA and behaviors constituting SH

ATTACHMENT 1 TO THE CODE OF CONDUCT FORM**BEHAVIORS CONSTITUTING SEXUAL EXPLOITATION AND ABUSE (SEA) AND
BEHAVIORS CONSTITUTING SEXUAL HARASSMENT (SH)**

The following non-exhaustive list is intended to illustrate types of prohibited behaviors.

(1) Examples of sexual exploitation and abuse include, but are not limited to:

- A Contractor's Personnel tells a member of the community that he/she can get them jobs related to the work site (e.g., cooking and cleaning) in exchange for sex.
- A Contractor's Personnel that is connecting electricity input to households says that he can connect women headed households to the grid in exchange for sex.
- A Contractor's Personnel rapes, or otherwise sexually assaults a member of the community.
- A Contractor's Personnel denies a person access to the Site unless he/she performs a sexual favor.
- A Contractor's Personnel tells a person applying for employment under the Contract that he/she will only hire him/her if he/she has sex with him/her.

(2) Examples of sexual harassment in a work context

- A Contractor's Personnel comment on the appearance of another Installation Services Personnel (either positive or negative) and sexual desirability.
- When a Contractor's Personnel complains about comments made by another Contractor's Personnel on his/her appearance, the other Contractor's Personnel comment that he/she is "asking for it" because of how he/she dresses.
- Unwelcome touching of a Contractor's Personnel or Employer's Personnel by another Contractor's Personnel.
- A Contractor's Personnel tells another Contractor's Personnel that he/she will get him/her a salary raise, or promotion if he/she sends him/her naked photographs of himself/herself.

Plant

[Note to the Bidder: This Bid form shall contain description of the Plant the bidder offers to supply. Plant (according to GCC) means permanent plant, equipment, machinery, apparatus, materials, articles and things of all kinds to be provided and incorporated in the Facilities by the Contractor under the Contract (including the spare parts to be supplied by the Contractor under GCC Sub-Clause 7.3 hereof), but does not include Contractor's Equipment].

Contractor's Equipment

Form EQU

The Bidder shall provide adequate information to demonstrate clearly that it has the capability to meet the requirements for the key Contractor's equipment listed in Section III, Evaluation and Qualification Criteria. A separate Form shall be prepared for each item of equipment listed, or for alternative equipment proposed by the Bidder.

Item of equipment		
Equipment information	Name of manufacturer	Model and power rating
	Capacity	Year of manufacture
Current status	Current location	
	Details of current commitments	
Source	Indicate source of the equipment ☐ Owned ☐ Rented ☐ Leased ☐ Specially manufactured	

Omit the following information for equipment owned by the Bidder.

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

Functional Guarantees

Form FUNC

The Bidder shall copy in the left column of the table below, the identification of each functional guarantee required in the Specification and stated by the Employer in para. 1.2 (c) of Section III, Evaluation and Qualification Criteria, and in the right column, provide the corresponding value for each functional guarantee of the proposed plant and equipment.

Required Functional Guarantee	Value of Functional Guarantee of the Proposed Plant and Equipment
Kasama Substation	
1. 330kV Line Reactor – Load Losses (kW)	
2. 330kV Line Reactor – Noise Level (dB(A))	
3. Neutral Reactor – Load Losses (kW)	
4. Neutral Reactor – Noise Level dB(A)	
Nakonde Stepdown Substation	
5. 330kV Line Reactor – Power Losses (kW)	
6. 330kV Line Reactor – Noise Level (dB(A))	
7. Neutral Reactor – Load Losses (kW)	
8. Neutral Reactor – Noise Level dB(A)	
9. 330/(132)66/11kV 90MVA Transformer Load Loss (kW)	

10. 330/(132)66/11kV 90MVA Transformer No-Load Loss (kW)	
11. 330/(132)66/11kV 90MVA Transformer Noise Level dB(A)	

Personnel

Contractor's Representative and other Key Personnel Schedule

Form PER -1

Bidders should provide the names of suitably qualified personnel to meet the specified requirements stated in Section VII. The data on their experience should be supplied using the Form below for each candidate.

Contractor' Representative and Key Personnel

1.	Title of position: Contractor's Representative	
	Name of candidate:	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
2.	Title of position: Project Manager	
	Name of candidate:	

	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
3.	Title of position: Construction Site Manager	
	Name of candidate:	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
4.	Title of position: Contract Manager	
	Name of candidate:	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>

5.	Title of position: Sub-Station Automation System/SCADA Engineer	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
6.	Title of position: Telecommunication Engineer	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
7.	Title of position: Civil/ Construction/ Structural/ Foundations Design Expert	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>

	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
8.	Title of position: Geotechnical/Foundations Design Expert: Geotechnical Engineer	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
9.	Title of position: Substation Electrical Engineer - Design	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
10.	Title of position: Substation Site supervision Engineer (Civil / Construction/ Structural)	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>

	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
11.	Title of position: Substation Site supervision Engineer (Electrical)	
	Name of candidate	
	Duration of appointment:	Duration of appointment:
	Time commitment: for this position:	Time commitment: for this position:
	Expected time schedule for this position:	Expected time schedule for this position:
12.	Title of position: Protection/Metering Engineer	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
13.	Title of position: Quality Control Engineer as QA/QC Manager	
	Name of candidate	

	Duration of appointment:	Duration of appointment:
	Time commitment: for this position:	Time commitment: for this position:
	Expected time schedule for this position:	Expected time schedule for this position:
14.	Title of position: Testing and Commissioning Engineer	
	Name of candidate	
	Duration of appointment:	Duration of appointment:
	Time commitment: for this position:	Time commitment: for this position:
	Expected time schedule for this position:	Expected time schedule for this position:
15.	Title of position: Environmental, Health and Safety (EHS) Manager (Team Management Level)	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
16.	Title of position: Environmental Officer	

	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
17.	Title of position: Health and Safety Officer (HSO)	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
18.	Title of position: Social Officer (Including Community Liaison & Gender)	
	<i>[Where Project SEA risks are assessed to be substantial or high, key personnel shall include an expert/s with relevant experience in addressing sexual exploitation, sexual abuse and sexual harassment cases]</i>	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>

	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
19.	Title of position: Biodiversity Expert	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>
20.	Title of position: Archaeologist	
	Name of candidate	
	Duration of appointment:	<i>[insert the whole period (start and end dates) for which this position will be engaged]</i>
	Time commitment: for this position:	<i>[insert the number of days/week/months/ that has been scheduled for this position]</i>
	Expected time schedule for this position:	<i>[insert the expected time schedule for this position (e.g., attach high level Gantt chart)]</i>

Resume of Proposed Personnel**Form PER-2**

Name of Bidder

Position											
Personnel information	<table border="1"> <tr> <td>Name</td> <td>Date of birth</td> </tr> <tr> <td colspan="2">Professional qualifications</td> </tr> </table>	Name	Date of birth	Professional qualifications							
	Name	Date of birth									
Professional qualifications											
Present employment	<table border="1"> <tr> <td colspan="2">Name of employer</td> </tr> <tr> <td colspan="2">Address of employer</td> </tr> <tr> <td>Telephone</td> <td>Contact (manager / personnel officer)</td> </tr> <tr> <td>Fax</td> <td>E-mail</td> </tr> <tr> <td>Job title</td> <td>Years with present employer</td> </tr> </table>	Name of employer		Address of employer		Telephone	Contact (manager / personnel officer)	Fax	E-mail	Job title	Years with present employer
Name of employer											
Address of employer											
Telephone	Contact (manager / personnel officer)										
Fax	E-mail										
Job title	Years with present employer										

Summarize professional experience over the last 20 years, in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

From	To	Company / Project / Position / Relevant technical and management experience

Proposed Subcontractors for Major Items of Plant and Installation Services

A list of major items of Plant and Installation Services is provided below.

The following Subcontractors and/or manufacturers are proposed for carrying out the item of the facilities indicated. Bidders are free to propose more than one for each item

Major Items of Plant and Installation Services	Proposed Subcontractors/Manufacturers	Nationality

Others - Time Schedule

(to be used by Bidder when alternative Time for **Completion is invited in ITB 13.2)**

Bidders Qualification without prequalification

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

**Bidder Information
Sheet****Form ELI 1.1**

Date: _____

RFB No.: _____

Page _____ of _____ pages

1. Bidder's Legal Name
2. In case of JV, legal name of each member:
3. Bidder's actual or intended Country of Registration:
4. Bidder's Year of Registration:
5. Bidder's Legal Address in Country of Registration:
6. Bidder's Authorized Representative Information Name: Address: Telephone/Fax numbers: Email Address:
7. Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of the legal entity named above, in accordance with ITB 4.4 ☐ In case of JV, letter of intent to form JV or JV agreement, in accordance with ITB 4.1 ☐ In case of state-owned enterprise or institution, in accordance with ITB 4.6, documents establishing: • Legal and financial autonomy • Operation under commercial law

- Establishing that the Bidder is not under the supervision of the Employer
8. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership. The successful Bidder shall provide additional information on beneficial ownership, using the Beneficial Ownership Disclosure Form.

**Party to JV Information
Sheet****12.15.1.1****Form ELI 1.2**

Date: _____

RFB No.: _____

Page _____ of _____ pages

1. Bidder's Legal Name:
2. JV's Party legal name:
3. JV's Party Country of Registration:
4. JV's Party Year of Registration:
5. JV's Party Legal Address in Country of Registration:
6. JV's Party Authorized Representative Information Name: Address: Telephone/Fax numbers: Email Address:

7. Attached are copies of original documents of

- ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or registration documents of the legal entity named above, in accordance with ITB 4.4.
- ☐ In case of a state-owned enterprise or institution, documents establishing legal and financial autonomy, operation in accordance with commercial law, and that they are not under the supervision of the Employer, in accordance with ITB 4.6.

8. Included are the organizational chart, a list of Board of Directors, and the beneficial ownership. The successful Bidder shall provide additional information on beneficial ownership for each JV member using the Beneficial Ownership Disclosure Form.

Historical Contract Non-Performance, Pending Litigation and Litigation History**Form CON – 2**

Bidder's Legal Name: _____

Date: _____

JV Member Legal Name: _____

RFB No.: _____

Page _____ of _____ pages

Non-Performed Contracts in accordance with Section III, Evaluation and Qualification Criteria

- ☐ Contract non-performance did not occur since 1st January *[insert year]* specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.1.
- ☐ Contract(s) not performed since 1st January *[insert year]* specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.1

Year	Non-performed portion of contract	Contract Identification	Total Contract Amount (current value, currency, exchange rate and US\$ equivalent)
<i>[insert year]</i>	<i>[insert amount and percentage]</i>	Contract Identification: <i>[indicate complete contract name/ number, and any other identification]</i> Name of Employer: <i>[insert full name]</i> Address of Employer: <i>[insert street/city/country]</i> Reason(s) for nonperformance: <i>[indicate main reason(s)]</i>	<i>[insert amount]</i>

Pending Litigation, in accordance with Section III, Evaluation and Qualification Criteria

- ☐ No pending litigation in accordance with Sub-Factor 2.3.
- ☐ Pending litigation in accordance with Sub-Factor 2.3 as indicated below.

Year of dispute	Amount in dispute (currency)	Contract Identification	Total Contract Amount (currency), USD Equivalent (exchange rate)
		Contract Identification: _____ Name of Employer: _____ Address of Employer: _____ Matter in dispute: _____ Party who initiated the dispute: _____ Status of dispute: _____	
		Contract Identification: Name of Employer: Address of Employer: Matter in dispute: Party who initiated the dispute: Status of dispute:	
Litigation History in accordance with Section III, Evaluation and Qualification Criteria			
☐ No Litigation History in accordance with Sub-Factor 2.4. ☐ Litigation History in accordance with Sub-Factor 2.4 as indicated below.			
Year of award	Outcome as percentage of Net Worth	Contract Identification	Total Contract Amount (currency), USD Equivalent (exchange rate)

<i>[insert year]</i>	<i>[insert percentage]</i>	Contract Identification: [indicate complete contract name, number, and any other identification] Name of Employer: <i>[insert full name]</i> Address of Employer: <i>[insert street/city/country]</i> Matter in dispute: <i>[indicate main issues in dispute]</i> Party who initiated the dispute: <i>[indicate "Employer" or "Contractor"]</i> Reason(s) for Litigation and award decision <i>[indicate main reason(s)]</i>	<i>[insert amount]</i>

Environmental and Social Performance Declaration

Form CON – 3

[The following table shall be filled in for the Bidder, each member of a Joint Venture and each Specialized Subcontractor]

Bidder's Name: *[insert full name]*

Date: *[insert day, month, year]*

Joint Venture Member's or Specialized Subcontractor's Name: *[insert full name]*

RFB No. and title: *[insert RFB number and title]*

Page *[insert page number]* of *[insert total number]* pages

Environmental and Social Performance Declaration			
in accordance with Section III, Evaluation and Qualification Criteria			
☐ No suspension or termination of contract: An employer has not suspended or terminated a contract and/or called the performance security for a contract for reasons related to Environmental or Social (ES) performance since the date specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.5.			
☐ Declaration of suspension or termination of contract: The following contract(s) has/have been suspended or terminated and/or Performance Security called by an employer(s) for reasons related to Environmental or Social (ES) performance since the date specified in Section III, Evaluation and Qualification Criteria, Sub-Factor 2.5. Details are described below:			
Year	Suspended or terminated portion of contract	Contract Identification	Total Contract Amount (current value, currency, exchange rate and US\$ equivalent)
<i>[insert year]</i>	<i>[insert amount and percentage]</i>	Contract Identification: <i>[indicate complete contract name/ number, and any other identification]</i> Name of Employer: <i>[insert full name]</i> Address of Employer: <i>[insert street/city/country]</i> Reason(s) for suspension or termination: <i>[indicate main reason(s) e.g., gender-based violence; sexual exploitation or sexual abuse breaches]</i>	<i>[insert amount]</i>
<i>[insert year]</i>	<i>[insert amount and percentage]</i>	Contract Identification: <i>[indicate complete contract name/ number, and any other identification]</i>	<i>[insert amount]</i>

		Name of Employer: <i>[insert full name]</i> Address of Employer: <i>[insert street/city/country]</i> Reason(s) for suspension or termination: <i>[indicate main reason(s)]</i>	
...	...	<i>[list all applicable contracts]</i>	...
Performance Security called by an employer(s) for reasons related to ES performance			
Year	Contract Identification		Total Contract Amount (current value, currency, exchange rate and US\$ equivalent)
<i>[insert year]</i>	Contract Identification: <i>[indicate complete contract name/ number, and any other identification]</i> Name of Employer: <i>[insert full name]</i> Address of Employer: <i>[insert street/city/country]</i> Reason(s) for calling of performance security: <i>[indicate main reason(s) e.g., for gender-based violence; sexual exploitation, or sexual abuse breaches]</i>		<i>[insert amount]</i>

Sexual Exploitation and Abuse (SEA) and/or Sexual Harassment Performance Declaration

Form CON – 4

[The following table shall be filled in by the Bidder, each member of a Joint Venture and each subcontractor proposed by the Bidder]

Bidder's Name: *[insert full name]*

Date: *[insert day, month, year]*

Joint Venture Member's or Subcontractor's Name: *[insert full name]*

RFB No. and title: *[insert RFB number and title]*

Page *[insert page number]* of *[insert total number]* pages

SEA and/or SH Declaration**in accordance with Section III, Evaluation and Qualification Criteria**

We:

- ☐ (a) have not been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations
- ☐ (b) are subject to disqualification by the Bank for non-compliance with SEA/ SH obligations
- ☐ (c) had been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations. An arbitral award on the disqualification case has been made in our favor.

[If (c) above is applicable, attach evidence of an arbitral award reversing the findings on the issues underlying the disqualification.]

Current Contract Commitments / Works in Progress

Form CCC

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

Name of contract	Employer, contact address/tel/fax	Value of outstanding work (current US\$ equivalent)	Estimated completion date	Average monthly invoicing over last six months (US\$/month)
1.				
2.				
3.				
4.				
5.				
etc.				

Bidder's Financial Situation

Historical Financial Performance

Form FIN – 3.1

Bidder's Legal Name: _____

Date: _____

JV Member Legal Name: _____

RFB No.: _____

Page _____ of _____ pages

To be completed by the Bidder and, if JV, by each member

Financial information in US\$ equivalent	Historic information for previous _____() years						
	(US\$ equivalent in 000s)						
	Year 1	Year 2	Year 3	Year ...	Year n	Avg.	Avg. Ratio
Information from Balance Sheet							
Total Assets (TA)							
Total Liabilities (TL)							
Net Worth (NW)							
Current Assets (CA)							
Current Liabilities (CL)							
Information from Income Statement							
Total Revenue (TR)							

Financial information in US\$ equivalent	Historic information for previous ____ () years (US\$ equivalent in 000s)						
	Year 1	Year 2	Year 3	Year ...	Year n	Avg.	Avg. Ratio
Profits Before Taxes (PBT)							

Attached are copies of financial statements (balance sheets, including all related notes, and income statements) for the years required above complying with the following conditions:

- a) Must reflect the financial situation of the Bidder or member to a JV, and not sister or parent companies.
- b) Historic financial statements must be audited by a certified accountant.
- c) Historic financial statements must be complete, including all notes to the financial statements.
- d) Historic financial statements must correspond to accounting periods already completed and audited (no statements for partial periods shall be requested or accepted).

Average Annual Turnover**Form FIN – 3.2**

Bidder's Legal Name: _____ Date: _____

JV Member Legal Name: _____ RFB No.: _____

Page _____ of _____ pages

Annual turnover data		
Year	Amount and Currency	US\$ equivalent
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
*Average Annual Turnover	_____	_____

*Average annual turnover calculated as total certified payments received for work in progress or completed, divided by the number of years specified in Section III, Evaluation Criteria, Sub-Factor 2.3.2.

Financial Resources**Form FIN – 3.3**

Specify proposed sources of financing, such as liquid assets, unencumbered¹ real assets, lines of credit, and other financial means, net of current commitments, available to meet the total cash flow demands of the subject contract or contracts as indicated in Section III, Evaluation and Qualification Criteria.

All financial resources shall be supported by **documentary evidence** issued by banks or other relevant financial authorities.

Source of financing	Amount (US\$ equivalent)
1.	
2.	
3.	
4.	

¹ Unencumbered – Assets that are not committed to any other financial liability.

Experience:

General Experience**Form EXP 4.1**

Bidder's Legal Name: _____ Date: _____

JV Member Legal Name: _____ RFB No.: _____

Page _____ of _____ pages

Starting Month / Year	Ending Month / Year	Years*	Contract Identification	Role of Bidder
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ —
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ —
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ —

Starting Month / Year	Ending Month / Year	Years*	Contract Identification	Role of Bidder
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ -
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ -
_____	_____		Contract name: Brief Description of the contract performed by the Bidder: Name of Employer: Address:	_____ -

*List calendar year for years with contracts with at least nine (9) months activity per year starting with the earliest year

Specific Experience**Form EXP – 4.2(a)**

Bidder's Legal Name: _____

Date: _____

JV Member Legal Name: _____

RFB No.: _____

Page _____ of _____ pages

Similar Contract Number: ____ of ____ required.	Information			
Contract Identification	_____			
Award date	_____			
Completion date	_____			
Role in Contract	Prime Contractor ☐	Member in JV ☐	Management Contractor ☐	Subcontractor ☐
Total contract amount	US\$ _____			
If member in a JV or subcontractor, specify participation of total contract amount	_____%		_____	US\$ _____
Employer's Name:	_____			
Address:	_____ _____ _____			
Telephone/fax number:	_____ _____			
E-mail:	_____			

Specific Experience (cont.)

Form EXP – 4.2(a) (cont.)

Bidder's Legal Name: _____ Page _____ of _____ pages

JV Member Legal Name: _____

Similar Contract No. __[insert specific number] of [total number of contracts] __required	Information
Description of the similarity in accordance with Sub-Factor 4.2a) of Section III:	
Amount	_____
Physical size	_____
Complexity	_____
Methods/Technology	_____
Physical Production Rate	_____

Specific Experience in Key Activities**Form EXP – 4.2(b)**

Bidder's Legal Name: _____

Date: _____

JV Member Legal Name: _____

RFB No.: _____

Subcontractor's Legal Name: _____

Page _____ of _____ pages

	Information		
Contract Identification	_____		
Award date	_____		
Completion date	_____		
Role in Contract	Prime Contractor ☐	Management Contractor ☐	Subcontractor ☐
Total contract amount	US\$_____		
If member in a JV or subcontractor, specify participation of total contract amount	_____ %	_____	US\$_____
Employer's Name:	_____		
Address:	_____ _____		
Telephone/fax number:	_____ _____		
E-mail:	_____		

Specific Experience in Key Activities (cont.)**Form EXP – 4.2 (b)(cont.)**

Bidder's Legal Name: _____ Page _____ of _____ pages

JV Member Legal Name: _____

Subcontractor's Legal Name: _____

	Information
Description of the key activities in accordance with Sub-Factor 4.2b) of Section III:	

Specific Experience in Managing ES aspects and any additional sustainable procurement aspects

Form EXP – 4.2(c)

Bidder's Legal Name: _____

Date: _____

JV Member Legal Name: _____

RFB No.: _____

Subcontractor's Legal Name: _____

Page _____ of _____ pages

1. Key Requirement no 1 in accordance with 4.2 (c): _____

Contract Identification				
Award date				
Completion date				
Role in Contract	Prime Contractor ☐	Member in JV ☐	Management Contractor ☐	Subcontractor ☐
Total Contract Amount	US\$ _____			
Details of relevant experience				

2. Key Requirement no 2 in accordance with 4.2 (c): _____

3. Key Requirement no 3 in accordance with 4.2 (c): _____

Bid Security – Bank Guarantee**Form of Bid Security**

[The bank shall fill in this Bank Guarantee Form in accordance with the instructions indicated.]

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[Employer to insert its name and address]*

RFB No.:*[Employer to insert reference number for the Request for Bids]*

Alternative No.: *[Insert identification No if this is a Bid for an alternative]*

Date:*[Insert date of issue]*

BID GUARANTEE No.:*[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____*[insert name of the Bidder, which in the case of a joint venture shall be the name of the joint venture (whether legally constituted or prospective) or the names of all members thereof]*(hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Bid (hereinafter called "the Bid") for the execution of _____ under RFB No. _____

Furthermore, we understand that, according to the Beneficiary's conditions, Bids must be supported by a Bid guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (_____) upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Bidder:

- (a) has withdrawn its Bid prior to the Bid validity expiry date set forth in the Applicant's Letter of Bid, or any extended date provided by the Applicant; or
- (b) having been notified of the acceptance of its Bid by the Beneficiary prior to the expiry date of the Bid validity or any extension thereto provided by the Applicant, (i) has failed to execute the Contract Agreement, or (ii) has failed to furnish the Performance Security, in accordance with the Instructions to Bidders ("ITB") of the Beneficiary's bidding document.

This guarantee will expire: (a) if the Applicant is the successful Bidder, upon our receipt of copies of the contract agreement signed by the Applicant and the Performance Security issued to the Beneficiary in relation to such contract agreement; or (b) if the Applicant is not the successful Bidder, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Bidding process; or (ii) twenty-eight days after the expiry date of the Bid validity.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758.

[Signature(s)]

Note: All italicized text is for use in preparing this form and shall be deleted from the final product.

Bid Security – Bid Bond

Form of Bid Security – Bid Bond

BOND NO. _____

BY THIS BOND _____ as Principal (hereinafter called “the Principal”), and _____, **authorized to transact business in** _____, as Surety (hereinafter called “the Surety”), are held and firmly bound unto _____ as Obligee (hereinafter called “the Employer”) in the sum of _____²(_____), for the payment of which sum, well and truly to be made, we, the said Principal and Surety, bind ourselves, our successors and assigns, jointly and severally, firmly by these presents.

WHEREAS the Principal has submitted a written Bid to the Employer dated the ____ day of _____, 20__, for the construction of _____ (hereinafter called the “Bid”).

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Principal:

- (a) withdraws its Bid prior to the Bid validity expiry date set forth in the Principal’s Letter of Bid, or any extended date provided by the Principal; or
- (b) having been notified of the acceptance of its Bid by the Employer prior to the expiry date of the Bid validity or any extension thereto provided by the Principal, (i) fails or refuses to execute the Contract Form, if required; or (ii) fails or refuses to furnish the Performance Security in accordance with the Instructions to Bidders;

then the Surety undertakes to immediately pay to the Employer up to the above amount upon receipt of the Employer’s first written demand, without the Employer having to substantiate its demand, provided that in its demand the Employer shall state that the demand arises from the occurrence of any of the above events, specifying which event(s) has occurred.

The Surety hereby agrees that its obligation will remain in full force and effect up to and including the date 28 days after the date of expiry of the Bid validity set forth in the Principal’s Letter of Bid or any extension thereto provided by the Principal.

IN TESTIMONY WHEREOF, the Principal and the Surety have caused these presents to be executed in their respective names this ____ day of _____ 20__.

² The amount of the Bond shall be denominated in the currency of the *Employer’s Country* or the equivalent amount in a freely convertible currency.

Principal: _____

Surety: _____

Corporate Seal (where appropriate)

(Signature)_____
(Signature)

(Printed name and title)

(Printed name and title)

Bid-Securing Declaration**Form of Bid Security Declaration**

Date: _____

RFB No.: _____

Alternative No.: _____

To: _____

We, the undersigned, declare that:

We understand that, according to your conditions, Bids must be supported by a Bid-Securing Declaration.

We accept that we will automatically be suspended from being eligible for Bidding or submitting proposals in any contract with the Employer for the period of time specified in Section II – Bid Data Sheet, if we are in breach of our obligation(s) under the Bid conditions, because we:

- (a) have withdrawn our Bid prior to the expiry date of the Bid validity specified in the Letter of Bid or any extended date provided by us; or
- (b) having been notified of the acceptance of our Bid by the Employer prior to the expiry date of the Bid validity in the Letter of Bid or any extended date provided by us, (i) fail or refuse to execute the Contract, if required, or (ii) fail or refuse to furnish the Performance Security, in accordance with the ITB.

We understand this Bid-Securing Declaration shall expire if we are not the successful Bidder, upon the earlier of (i) our receipt of your notification to us of the name of the successful Bidder; or (ii) twenty-eight days after the expiry date of the Bid validity.

Name of the Bidder* _____

Name of the person duly authorized to sign the Bid on behalf of the Bidder** _____

Title of the person signing the Bid _____

Signature of the person named above _____

Date signed _____ day of _____, _____

*: In the case of the Bid submitted by joint venture specify the name of the Joint Venture as Bidder

** : Person signing the Bid shall have the power of attorney given by the Bidder attached to the Bid

[Note: In case of a Joint Venture, the Bid-Securing Declaration must be in the name of all members to the Joint Venture that submits the Bid.]

Manufacturer's Authorization**Form of Manufacture's Authorization**

Date: _____

RFB No.: _____

To: _____

WHEREAS

We _____, who are official manufacturers of _____, having factories at _____, do hereby authorize _____ to submit a Bid the purpose of which is to provide the following goods, manufactured by us _____, and to subsequently negotiate and sign the Contract.

We _____, hereby guarantee that spare parts and technical support for the offered Goods [insert name of Goods] shall be available for purchase for a minimum period of ten (10) years from the date of Operational Acceptance.

In the event of discontinuation of production of such spare parts, we shall provide the Employer with: (a) Advance notification of at least twelve (12) months to permit the Employer to procure needed requirements; and (b) Following such discontinuation, furnishing at no cost to the Employer, the blueprints, drawings, and specifications of the spare parts, if requested.

We hereby extend our full guarantee and warranty in accordance with Clause 27 of the General Conditions, with respect to the goods offered by the above firm.

Signed: _____

Name: _____

Title: _____

Duly authorized to sign this Authorization on behalf of:

Dated on _____ day of _____, _____

Letter of Bid - Financial Part

INSTRUCTIONS TO BIDDERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Bidder must prepare this Letter of Bid on stationery with its letterhead clearly showing the Bidder's complete name and business address.

Note: All italicized text is to help Bidders in preparing this form.

Date of this Bid submission: *[insert date (as day, month and year) of Bid submission]*

Request for Bid No.: *[insert identification]*

Alternative No.: *[insert identification No if this is a Bid for an alternative]*

To: *[insert complete name of Employer]*

We, the undersigned, hereby submit the second part of our Bid, the Bid Price and Bill of Quantities. This accompanies the Letter of Bid- Technical Part.

In submitting our Bid, we make the following additional declarations:

- (a) **Bid Validity:** Our Bid shall be valid until *[insert day, month and year in accordance with ITB 19.1]*, and it shall remain binding upon us and may be accepted at any time on or before this date;
- (b) **Total Price:** The total price of our Bid, excluding any discounts offered in item (f) below is:
[Insert one of the options below as appropriate]

[Option 1, in case of one lot:] Total price is: [insert the total price of the Bid in words and figures, indicating the various amounts and the respective currencies];

Or

[Option 2, in case of multiple lots:] (a) Total price of each lot [insert the total price of each lot in words and figures, indicating the various amounts and the respective currencies]; and (b) Total price of all lots (sum of all lots) [insert the total price of all lots in words and figures, indicating the various amounts and the respective currencies];

- (c) **Discounts:** The discounts offered and the methodology for their application are:

- (i) The discounts offered are: *[Specify in detail each discount offered]*
- (ii) The exact method of calculations to determine the net price after application of discounts is shown below: *[Specify in detail the method that shall be used to apply the discounts];*
- (d) **Commissions, gratuities and fees:** We have paid, or will pay the following commissions, gratuities, or fees with respect to the Bidding process or execution of the Contract: *[insert complete name of each Recipient, its full address, the reason for which each commission or gratuity was paid and the amount and currency of each such commission or gratuity].*

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

Name of the Bidder: **[insert complete name of the Bidder]*

Name of the person duly authorized to sign the Bid on behalf of the Bidder: *** [insert complete name of person duly authorized to sign the Bid]*

Title of the person signing the Bid: *[insert complete title of the person signing the Bid]*

Signature of the person named above: *[insert signature of person whose name and capacity are shown above]*

Date signed *[insert date of signing]* **day of** *[insert month]*, *[insert year]*

*****: In the case of the Bid submitted by a Joint Venture specify the name of the Joint Venture as Bidder.

******: Person signing the Bid shall have the power of attorney given by the Bidder. The power of attorney shall be attached with the Bid Schedules

Schedule of Rates and Prices

See attached forms in Excel for Price Schedules, which include:

- Schedule No. 1. Plant and Mandatory Spare Parts Supplied from Abroad
- Country of Origin Declaration Form
- Schedule No. 2. Plan and Mandatory Spare Parts Supplied from Within the Employer's Country
- Schedule No. 3. Design Services
- Schedule No. 4. Installation and Other Services
- Schedule No. 5. Grand Summary
- Schedule No. 6. Recommended Spare Parts
- Price Adjustment

Price Adjustment

If price adjustment applies in accordance with ITB 17.9, the Bidder shall indicate the sources of indices and source of exchange rate (if applicable) and the base date indices in its Bid.

Item	Source of Indices	Base date Indices	Source of exchange rate (if applicable)

PACKAGE 4 PRICE SCHEDULES

Country of Origin Declaration Form

Item	Description	Code	Country

Schedule no 1 - Plant and Mandatory Spare Parts Supplied from Abroad

Item	Description	Code ¹	Qty. 1)	Unit	Unit Price ²		Total Price ² (1) x (3)
					Currency	CIP Nakonde	
					2)	3)	
1.1	330kV NAKONDE STEPDOWN SUBSTATION						
1.1.1	Conductors (Busbars and earth wires)						
1.1.1.1	AAC "Tarantula" Conductor or LGKK-600 Conductor		1	Lot			
1.1.1.2	ASCR "Bison" Conductor or LGJ 400/50 Conductor		1	Lot			
1.1.1.3	ACS 7/4.11 conductor		1	Lot			
1.1.2	Optic Fibre Cable						
1.1.2.1	48-core ADSS non-metallic approach fibre cable with trunking		1	Lot			
1.1.2.2	FC ODF Cabinet (complete with 18 patch panels with 12 FC Connectors each)		1	Lot			
1.1.2.3	FC-LC patch cords, SC-SC, LC-SC, LC-LC		1	Lot			
1.1.3	Circuit Breakers						
1.1.3.1	330kV Single Phase Circuit Breakers complete with supporting structure		30	Each			
1.1.3.2	330kV Single Phase Circuit Breakers complete with supporting structure as spare		6	Each			
1.1.3.3	SF6 Gas Cylinders for circuit breakers 20kg		5	Each			
1.1.3.4	132kV Three Phase Circuit Breakers complete with supporting structures		5	Set			
1.1.3.5	132kV Three Phase Circuit Breakers complete with supporting structures as spare		3	Set			
1.1.3.6	Drive motor for 330kV Circuit Breaker (spare)		1 no of each type	Lot			
1.1.3.7	Motor contactor of each type for 330kV Circuit Breaker (spare)		1 set of each type	Lot			
1.1.3.8	Fuses of each rating (spare)		1 set of each type	Lot			
1.1.3.9	Spring for 330kV Circuit Breaker (spare)		1 set of each type	Lot			
1.1.3.10	Drive motor for 132kV Circuit Breaker (spare)		1 no of each type	Lot			
1.1.3.11	Motor contactor of each type for 132kV Circuit Breaker (spare)		1 set of each type	Lot			
1.1.3.12	Fuses of each rating (spare) - 132kV		1 set of each type	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.3.13	Spring for 132kV Circuit Breaker (spare)		1 set of each type	Lot			
1.1.4	Disconnectors						
1.1.4.1	330kV Three Phase Disconnecter with supporting structure		30	Each			
1.1.4.2	330kV Three Phase Disconnecter with supporting structure as spare		2	Each			
1.1.4.3	132kV Three Phase Disconnecter with supporting structure		18	Each			
1.1.4.4	132kV Three Phase Disconnecter with supporting structure as spare		3	Each			
1.1.4.5	330kV Line disconnect switch, Motor Operated complete with supporting structures as spare		1	Each			
1.1.4.6	Support insulator column for 330kV Disconnecter as spare		1 set of each type	Lot			
1.1.4.7	Operating rod insulator for 330kV Disconnecter as spare		1 set of each type	Lot			
1.1.4.8	Drive motor for 330kV Disconnecter as spare		1 no of each type	Lot			
1.1.4.9	Motor contactor of each type for 330kV Disconnecter as spare		1 set of each type	Lot			
1.1.4.10	132kV Line disconnect switch, Motor Operated complete with supporting structures as spare		1	Each			
1.1.4.11	Support insulator column for 132kV Disconnecter as spare		1 set of each type	Lot			
1.1.4.12	Operating rod insulator for 132kV Disconnecter as spare		1 set of each type	Lot			
1.1.4.13	Drive motor for 132kV Disconnecter as spare		1 no of each type	Lot			
1.1.4.14	Motor contactor of each type for 132kV Disconnecter as spare		1 set of each type	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.5	Disconnectors with Earth-switch						
1.1.5.1	330kV Three Phase Disconnector with Earth-switch		11	Set			
1.1.5.2	330kV Three Phase Disconnector with Earth-switch as spare		1	Set			
1.1.5.3	132kV Three Phase Disconnector with Earth-switch		4	Set			
1.1.5.4	132kV Three Phase Disconnector with Earth-switch as spare		1	Set			
1.1.6	Instrument Transformers						
1.1.6.1	330kV Single Phase Current Transformer (7-core) complete with supporting structures		33	Each			
1.1.6.2	330kV Single Phase Capacitive Voltage Transformer complete with supporting structures		21	Each			
1.1.6.3	132kV Current Transformer (CT) complete with supporting structures		18	Each			
1.1.6.4	132(66)kV Capacitor Voltage Transformer (CVT), complete with supporting structures. Primary rated voltage (phase-to-ground) shall be interconnectable between 132/√3 kV and 66/√3 kV.		18	Each			
1.1.6.5	330kV Single Phase Current Transformer (7-core) as spare		3	Each			
1.1.6.6	330kV Single Phase Capacitive Voltage Transformer as spare		3	Each			
1.1.6.7	132kV Current Transformer(CT) as spare		9	Each			
1.1.6.8	132(66)kV Capacitor Voltage Transformer (CVT). Primary rated voltage (phase-to-ground) shall be interconnectable between 132/√3 kV and 66/√3 kV as spare.		5	Each			
1.1.7	Surge Arrestors (132 kV surge arresters are not required, as Nakonde will be initially commissioned as 330/66kV)						
1.1.7.1	330kV Single-Phase Surge Arrestor complete with supporting structures		27	Each			
1.1.7.2	66kV Surge Arresters complete with supporting structures		12	Each			
1.1.7.3	36kV Surge arresters (for neutrals of 3x10MVAR reactors to protect NCR against over-voltages) complete with supporting structures		2	Each			
1.1.7.4	330kV Single-Phase Surge Arrestor as spare		3	Each			
1.1.7.5	36kV Surge arresters (for neutrals of 3x10MVAR reactors) as spare		1	Each			
1.1.7.6	66kV Surge Arresters complete with supporting structures as spares		9	Each			
1.1.8	Post Insulators						
1.1.8.1	330kV Single Phase Post insulators complete with supporting structure		1	Lot			
1.1.8.2	132kV Single Phase Post insulators complete with supporting structure		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.9	Clamps and Insulators						
1.1.9.1	Clamps for AAC "Tarantula" or LGKK-600 Conductor		1	Lot			
1.1.9.2	Clamps for ASCR "Bison" Conductor or LGJ 400/50		1	Lot			
1.1.9.3	Clamps for ACS 7/4.11 Conductor		1	Lot			
1.1.9.4	330kV Tension Insulator set		1	Lot			
1.1.9.5	330kV Suspension Insulator set		1	Lot			
1.1.9.6	132kV Tension Insulator set		1	Lot			
1.1.9.7	132kV Suspension Insulator Set		1	Lot			
1.1.9.8	Clamps for AAC "Tarantula" or LGKK-600 Conductor (spare), 15 sets		1	Lot			
1.1.9.9	Clamps for ASCR "Bison" Conductor or LGJ 400/50 (spare), 15 sets		1	Lot			
1.1.10	Auxiliary Power & Control Cables						
1.1.10.1	4 core x 2.5sqmm		1	Lot			
1.1.10.2	7 core x 2.5sqmm		1	Lot			
1.1.10.3	12 core x 2.5sqmm		1	Lot			
1.1.10.4	24 core x 2.5sqmm		1	Lot			
1.1.10.5	7 core x 1.5sqmm		1	Lot			
1.1.10.6	14 core x 1.5sqmm		1	Lot			
1.1.10.7	19 core x 1,5sqmm		1	Lot			
1.1.10.8	27 core x 1.5sqmm		1	Lot			
1.1.10.9	4 core x 4sqmm		1	Lot			
1.1.10.10	4 core x 6sqmm		1	Lot			
1.1.10.11	4 core x 10sqmm		1	Lot			
1.1.10.12	4 core x 25sqmm		1	Lot			
1.1.10.13	4 core x 50sqmm		1	Lot			
1.1.10.14	4 core x 185sqmm		1	Lot			
1.1.10.15	11kV XLPE Power Cable 3x70 mm ² Cu conductor, incl. Cable Terminations		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.11	Earthing and Lightning Protection						
1.1.11.1	Earthmat conductor (High conductivity hard-drawn bare Copper)		1	Lot			
1.1.11.2	Earthmat joints and connectors		1	Lot			
1.1.11.3	Lightning Masts		1	Lot			
1.1.11.4	Earth rods		1	Lot			
1.1.11.5	Thermowelding tools and connection kits		1	Lot			
1.1.11.6	Drum of Copper Conductor (Earthing) 500m (70mm ²) as spare		3	Each			
1.1.11.7	Earth rods as spare		50	Each			
1.1.11.8	Substation earthing conductors (of each type) as spare		100	m			
1.1.11.9	Substation earthing conductor connecting bolts and clamps/lugs (of each type) as spare		15	Sets			
1.1.11.10	Thermowelding tool as spare		2	Each			
1.1.11.11	Thermowelding kits as spare		20	Sets			
1.1.12	Protection and Control - 330kV NAKONDE STEPDOWN SUBSTATION						
1.1.12.1	Nakonde-Tunduma Main 1 (NR PCS-931S-Direct Fibre connection) - Line Current Differential protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 2 and Backup, item 1.1.12.2. One panel at Nakonde and one panel at Tunduma complete with necessary interface for each circuit: 2 lots		2	Lot			
1.1.12.2	Nakonde-Tunduma Main 2 (SCHNEIDER P543-Direct Fibre connection) - Line Current Differential protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 1 and Backup, item 1.1.12.1. One panel at Nakonde and one panel at Tunduma complete with necessary interface for each circuit: 2 lots		2	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.12.3	Nakonde-Tunduma IEC61850 compliant Bay Control Units		2	Each			
1.1.12.4	Nakonde-Kasama Main 1 - Line Current Differential protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 2 and Backup, item 1.1.12.5		2	Lot			
1.1.12.5	Nakonde-Kasama Main 2 - Distance protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection IED. To be installed in Main 1 panel, item 1.1.12.4		2	Lot			
1.1.12.6	Nakonde-Kasama IEC61850 compliant Bay Control Units		2	Each			
1.1.12.7	Reactor Differential protection panel fully equipped with protection IED's, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection IED		3	Lot			
1.1.12.8	Reactor Bay IEC61850 compliant Reactors Bay Control Unit		3	Each			
1.1.12.9	330kV Bus-Coupler IEC61850 compliant Bay Control Unit		1	Each			
1.1.12.10	Transformer Differential protection panel fully equipped with protection IED's, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection IED		2	Lot			
1.1.12.11	Transformers IEC61850 compliant Bay Control Units		2	Each			
1.1.12.12	Transformers AVR		2	Lot			
1.1.12.13	Stand-alone 330kV and (132)66kV Disturbance Fault Recorders		2	Lot			
1.1.12.14	Nakonde-Nakonde Town Feeder Protection System		1	Lot			
1.1.12.15	Nakonde-Isoka Feeder Protection System		1	Lot			
1.1.12.16	132kV Line Feeders IEC61850 compliant Bay Control Units		2	Each			
1.1.12.17	132kV Bus-Coupler IEC61850 compliant Bay Control Unit		1	Each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.12.18	Complete 330kV and 132kV Busbar Protection systems fully equipped with protection IED's 18 bay input, panel wiring and all associated auxiliary equipment.		2	Lot			
1.1.12.19	Service Protection Laptop PC with all necessary softwares installed, configuration files, commissioning test files, and As- Built soft copy drawings (incl. O&M manuals)		4	Each			
1.1.12.20.1	Complete 330kV, 132kV and 11kV bays metering system panels for all bays including test blocks, terminal blocks and panel wiring. The meter type on the Tunduma 1&2 lines at Nakonde Stepdown shall be Microstar P2000-T or compatible equivalent to match with the meter type at Tunduma Substation and shall include necessary interface to the existing Nakonde 1 & 2 energy meters at Tunduma Substation The meter type shall be Landis + Gyr (E880) or CEWE Prometer 540 or Microstar P2000-T or equivalent and IEC 61850 compliant (Two meters per bay) for all bays except for the Tunduma line bays. Power quality meter as Unipower 2210 or equivalent (One meter).		1	Lot			
1.1.12.20.2	Metering management system/HMI with software and hardware		1	Lot			
1.1.12.21	Maintenance and interrogating Software with laptop for both configuration of energy meters and the remote meter reading system.		1	Each			
1.1.12.22	Complete Substation WAMPACS		1	Lot			
1.1.12.23	One (1) distance protection relay as spare		1	Each			
1.1.12.24	Two (2) line differential protection relays as spare		2	Each			
1.1.12.25	One (1) reactor differential protection relay as spare		1	Each			
1.1.12.26	One (1) transformer differential protection relay as spare		2	Each			
1.1.12.27.1	Meter as CEWE Prometer 540 , Landis & Gyr, or Microstar P2000-T or equivalent as spare		4	Each			
1.1.12.27.2	Meter as Microstar P2000-T as spare		2	Each			
1.1.12.28	Power quality meter as Unipower 2210 or equivalent as spare		4	Each			
1.1.12.29	NR PCS-931S relays complete with optic fibre coms interface as spare		2	Each			
1.1.12.30	SCHNEIDER P543 relays complete with optic fibre coms interface as spare		2	Each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.13	Telecommunication - 330kV NAKONDE STEPDOWN SUBSTATION						
1.1.13.1	Optical Transport Network (OTN) equipment with 4 directions with accessories		1	Lot			
1.1.13.2	10G & 100G Packet Transport Network (PTN) equipment complete.		1	Lot			
1.1.13.3	ZTE PCM P230 for data and voice communication		1	Lot			
1.1.13.4	Synchronous Digital Hierarchy (SDH) STM-64, with accessories		2	Lot			
1.1.13.5	Fox615 SDH multiplexer STM-16		1	Lot			
1.1.13.6	Alcatel PABX with accessories		1	Lot			
1.1.13.7	Alcatel PABX corporate wide networking license for digital trunk communication		1	Lot			
1.1.13.8	Analog telephone handsets with display		20	Each			
1.1.13.9	Analog telephone handsets without display		20	Each			
1.1.13.10	Digital telephone handsets		20	Each			
1.1.13.11	IP trunk license for VOIP		60	Each			
1.1.13.12	Patch cords LC/UPC-LC/UPC Single Mode for complete installation		1	Lot			
1.1.13.13	Patch cords FC/UPC-FC/UPC Single Mode for complete installation		1	Lot			
1.1.13.14	Patch cords SC/UPC-LC/UPC Single Mode for complete installation		1	Lot			
1.1.13.15	Patch cords SC/UPC-FC/UPC Single Mode for complete installation		1	Lot			
1.1.13.16	Patch cords SC/UPC-SC/UPC Single Mode for complete installation		1	Lot			
1.1.13.17	SFPs(PTN) electrical type (10/100/1000M, RJ45)		20	Each			
1.1.13.18	Laptops (processor shall have Intel core i9 or better CPU, 1TB HDD, 16GB RAM)		6	Each			
1.1.13.19	Optical splicing machine with accessors (90S or higher version)		2	Each			
1.1.13.20	Optical powermeter		4	Each			
1.1.13.21	Optical Time Domain Reflectometer (OTDR)		2	Each			
1.1.13.22	OTN analyser		2	Each			
1.1.13.23	Optical visual fault locator		4	Each			
1.1.13.24	Optical light source		4	Each			
1.1.13.25	Auxillary Power System (Charger, inverters Batteries)		1	Lot			
1.1.13.26	Free stand alone airconditioning unit 48000 BTU		2	Each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.13.27	Mandatory spares for SDH, PCM, IP-PABX, Power supply equipment, OTN and PTN as follows:						
1.1.13.27.1	EOBAH 2424		2	Each			
1.1.13.27.2	EONA 3120		2	Each			
1.1.13.27.3	SEOBA 2220		2	Each			
1.1.13.27.4	CSF		3	Each			
1.1.13.27.5	SEE card with optical interface		3	Each			
1.1.13.27.6	SEE card with electrical interface		3	Each			
1.1.13.27.7	ENCP		2	Each			
1.1.13.27.8	OL64 * 2 ports		2	Each			
1.1.13.27.9	OL16 * 4 ports		2	Each			
1.1.13.27.10	OPGW, 48 fibres (ITU-T G.652D)		5000	m			
1.1.13.27.11	ADSS cable, 48 fibres (ITU-T G.652D)		4000	m			
1.1.13.27.12	PABX power board		1	each			
1.1.13.27.13	PABX processor board		1	each			
1.1.13.27.14	ODU 40C		3	each			
1.1.13.27.15	OMU 40C		3	each			
1.1.13.27.16	WSUBM20D		1	each			
1.1.13.27.17	WASUBD9M8D		1	each			
1.1.13.27.18	WSUBA9P9D		1	each			
1.1.13.27.19	EOPM		1	each			
1.1.13.27.20	PDUB16		1	each			
1.1.13.27.21	C1K		2	each			
1.1.13.27.22	C2K		2	each			
1.1.13.27.23	C4K		2	each			
1.1.13.27.24	L4K		4	each			
1.1.13.27.25	CESM1		1	each			
1.1.13.27.26	SAMO2		1	each			
1.1.13.27.27	LEDS1		1	each			
1.1.13.27.28	TEPI1		1	each			
1.1.13.27.29	OPIC1		1	each			
1.1.13.27.30	LESU1		1	each			
1.1.13.27.31	LEXI1		1	each			
1.1.13.27.32	LEDE1		1	each			
1.1.13.27.33	ETOP1		1	each			
1.1.13.27.34	ELET1		1	each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.13.27.35	E2K		4	each			
1.1.13.27.36	SDH Analyser		2	each			
1.1.13.27.37	Optical SFP (1.25G, 2.5G, 10G, 100G)		20	each			
1.1.13.27.38	Electrical SFP (1.25G)		20	each			
1.1.13.27.39	DRA_P (H14) +EONA2520		2	each			
1.1.14	SAS						
1.1.14.1	GPS clock/time server complete with antenna accessories		2	Each			
1.1.14.2	Bay Control Units integration accessories		1	Lot			
1.1.14.3	Substation Automation System including redundant gateway servers and Redundant HMI servers.		1	Lot			
1.1.14.4	IEC61850 SAS LAN (Ethernet switches and cables)		1	Lot			
1.1.14.5	Common stations alarm panel complete with BCU		1	Lot			
1.1.14.6	(Deleted)		0	Lot			
1.1.14.7	DC to AC inverter panel complete with redundant inverters		2	Lot			
1.1.14.8	SAS Panels complete with HMI Server and Gateway in redundancy configuration		2	Each			
1.1.14.9	Operator Workstations in redundancy configuration		2	Each			
1.1.14.10	Engineering workstation (Desktop)		1	Lot			
1.1.14.11	Rugged Laptop (impact and water splash safe) computer pre-loaded with protection IED configuration software including all accessories for communication with the relays, meters and SAS with the following minimum Laptops with specs: Intel Core i7, Quad-core processor, 11 th Generation, 2.9GHz. 32GB Ram (DDR4 SDRAM), 1TB SSD, Dedicated Graphics card (Minimum 2GB GDDR5), Windows 11 pro, Microsoft 365, 14-inch screen (Minimum resolution of 1920 x 1080)		6	Lot			
1.1.14.12	Bay Control Unit as spare		2	Each			
1.1.14.13	Binary input cards of the type installed in the BCU as spare		2	Each			
1.1.14.14	Binary output cards of the type installed in the BCU as spare		2	Each			
1.1.14.15	AC analogue input card of the type installed in the BCU as spare		2	Each			
1.1.14.16	Power supply module of the type installed in the BCU as spare		2	Each			
1.1.14.17	Ethernet switches of the type installed in the BCU as spare		2	Each			
1.1.14.18	Complete set of Operator work station (computer) of the type installed as spare		1	Set			
1.1.14.19	Complete gateway (computer) of the type installed as spare		1	Each			
	Complete engineering workstation (computer) of the type installed as spare		1	Each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.15	Transformers						
1.1.15.1	Complete 330/(132)66/11kV Three-Phase 90/90/10 MVA ONAN/ONAF Power Transformer		2	Lot			
1.1.15.3	Fire Extinguisher 50kg		6	Each			
1.1.15.4	Sergi Fire Protection for the transformers or equivalent		2	Lot			
1.1.15.5	Sergi Fire Protection control system spares or equivalent						
1.1.15.5.1	Red leds (Control Box)		3	Each			
1.1.15.5.2	Green leds (Control Box)		10	Each			
1.1.15.5.3	Pilot green light (TP Cabinet)		2	Each			
1.1.15.5.4	Pilot red light (TP Cabinet)		2	Each			
1.1.15.5.5	Relay 24 VDC		5	Each			
1.1.15.5.6	Set of Fuses		2	Lot			
1.1.15.5.7	Electrical Actuator		2	Each			
1.1.15.5.8	Rupture Disk		1	Each			
1.1.15.5.9	Shock Absorber		1	Each			
1.1.15.5.10	Gasket		2	Each			
1.1.15.6	330kV transformer spares:		-	-			
1.1.15.6.1	330kV bushing		1	Each			
1.1.15.6.2	Neutral bushing		2	Each			
1.1.15.6.3	Dehydrating breathers		2	Each			
1.1.15.6.4	Buchholz relays		2	Each			
1.1.15.6.5	Oil level indicator		2	Each			
1.1.15.6.6	Silica gel		20	kg			
1.1.15.6.7	Gasket sheets		1	Each			
1.1.15.6.8	Filled Gas cylinders for Sergi fire suppression systems or equivalent for transformers		3	Each			
1.1.15.6.9	Drums Of Transformer Oil (200l) as spare		4	Each			
1.1.15.6.10	Winding temperature indicator		1	Each			
1.1.15.6.11	Oil temperature indicator		1	Each			
1.1.15.6.12	Transformer Oil calibration equipment		1	Each			
1.1.15.6.13	Sound level meters		3	Each			
1.1.15.7	500kVA 11/0.4kV Station Service Transformer		2	Lot			
1.1.15.8.1	100KVA 33/0.4kV Transformer complete with Protection equipment (HT and LV fuses) and accessories for Housing Complex on a structure of H-pole configuration		1	Lot			
1.1.15.8.2	Aerial bundled conductor 7 spans (350m)		1	Lot			
1.1.15.8.3	12m wooden poles for 7 spans (350m) and accessories		1	Lot			
1.1.15.B230:B2529	Kelman Online Dissolved Gas Analysis or equivalent		2	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.16	Reactors						
1.1.16.1	362/√3 kV 3x10MVar Single-Phase ONAN Reactors complete with accessories		3	Lot			
1.1.16.2	15kVar Neutral Compensating Reactors		2	Lot			
1.1.16.3	Fire Extinguisher 50kg		6	Each			
1.1.16.4	Sergi Fire Protection for the reactors (9x10MVar+ 2x15kVar) or equivalent		3	Lot			
1.1.16.5	330kV 10MVar single phase reactor spares:						
1.1.16.5.1	330kV bushing		2	Each			
1.1.16.5.2	Neutral bushing		2	Each			
1.1.16.5.3	Dehydrating breathers		2	Each			
1.1.16.5.4	Buchholz relays		2	Each			
1.1.16.5.5	Oil level indicator		1	Each			
1.1.16.5.6	Silica gel		20	kg			
1.1.16.5.7	Gasket sheets		1	Each			
1.1.16.7	Filled Gas cylinders for Sergi fire suppression systems or equivalent for reactors - (spare)		4	Each			
1.1.16.8	362/√3 kV Single-Phase 10MVar ONAN Reactor as spare		1	Each			
1.1.17	Junction boxes, terminal Boxes and Marshalling Kiosks						
1.1.17.1	Junction Boxes		1	Lot			
1.1.17.2	Terminal Boxes		1	Lot			
1.1.17.3	Marshalling Kiosk		1	Lot			
1.1.17.4	Splicing Box		1	Lot			
1.1.17.5	Outdoor Lighting Distribution Box		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.18	48V & 110V DC System						
	48V						
1.1.18.1	Battery Bank (1200AH)		2	Lot			
1.1.18.2	Battery Charger		2	Lot			
1.1.18.3	DC Cables		1	Lot			
1.1.18.4	AC Cables		1	Lot			
1.1.18.5	DC Distribution Panels		1	Lot			
1.1.18.6	AC Distribution Board		1	Lot			
	110V						
1.1.18.7	Battery Bank (800AH)		2	Lot			
1.1.18.8	Battery Charger		2	Lot			
1.1.18.9	DC Cables		1	Lot			
1.1.18.10	AC Cables		1	Lot			
1.1.18.11	DC Distribution Panels		1	Lot			
1.1.18.12	AC Distribution Board		1	Lot			
1.1.18.13	110V DC, 800AH Station Battery as spare		1	Each			
1.1.19	11kV Board						
1.1.19.1	Complete supply of metal clad indoor Air Insulated Switchgear (AIS) (Refer to E-330 kV Nakonde Stepdown Substation 11kV Aux SLD)		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.1.20	400V						
1.1.20.1	Complete supply of 400V board, metal clad indoor Air Insulated Switchgear (AIS) complete with feeder breakers. Refer to section 11.2 of Employers requirements		1	Lot			
1.1.20.2	Supply of 250kVA emergency Diesel generator		1	Lot			
1.1.20.3	250kVA emergency Diesel generator spares: Filters, radiator, brushes		1	Lot			
1.1.21	Structural Steelwork 132kV & 330kV						
1.1.21.1	Post Insulator Structures		1	Lot			
1.1.21.2	Steel Support structures for equipment, gantries and busbar support structures		1	Lot			
1.1.21.3	Steel support structures for outdoor lighting		1	Lot			
1.1.22	Civil Works - Imported Materials						
1.1.22.1	Geotextiles for Substation Retaining Wall		1	Lot			
1.1.22.2	Waterproofing for Liquid Retaining Structures (i.e. Oil Holding Dam, Transformer/ Reactor/ NR Oil Containment, etc) - Waterstops and Sealants		1	Lot			
1.1.22.3	Galvanised Steel Internal Cable Trench Covers		1	Lot			
1.1.22.4	Perimeter fence and gates		1	Lot			
1.1.22.5	Safety fence and gates		1	Lot			
1.1.22.6	Boundary fence and gates		1	Lot			
1.1.22.7	Galvanised Steel Water Tank Stands (2x8m High)		1	Lot			
1.1.22.8	Galvanised Steel Grating (Oil Holding Dam, Transformer/ Reactor/ NR Oil Containment)		1	Lot			
1.1.22.9	2 x Eyewash Station (Battery Rooms)		1	Lot			
1.1.22.10	Fire protection system for control building		1	Lot			
1.1.22.11	Surveillance and Access control		1	Lot			
1.1.22.12	Materials for External Access Road, 9m wide, (1.5km) (Asphalt)		1	Lot			
1.1.22.13	Air conditioning unit (as per employer's requirements)		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.	KASAMA SUBSTATION						
1.2.1	Conductors						
1.2.1.1	AAC "Tarantula" or LKGG-600 Conductor		1	Lot			
1.2.1.2	ASCR "Bison" Conductor or LGJ 400/50		1	Lot			
1.2.1.3	ACS 7/4.11 conductor		1	Lot			
1.2.2	ADSS						
1.2.2.1	48-core ADSS non-metallic approach fibre cable with trunking		1	Lot			
1.2.2.2	ODF Cabinet (complete with 18 patch panels with 12 FC Connectors each)		1	Lot			
1.2.3	Circuit Breakers						
1.2.3.1	330kV Single Phase Circuit Breakers complete with supporting structure		12	Each			
1.2.4	Disconnectors						
1.2.4.1	330kV Three Phase Disconnector with supporting structure		8	Each			
1.2.5	Disconnectors with earth switch						
1.2.5.1	330kV Three Phase Disconnector with Single Earth-switch complete with supporting structure		4	Each			
1.2.6	Post Insulators						
1.2.6.1	Post insulators complete with supporting structure		2	Lot			
1.2.7	Instrument Transformers						
1.2.7.1	330kV Single Phase Current Transformer complete with supporting structure		12	Each			
1.2.7.2	330kV Single Phase Capacitive Voltage Transformer complete with supporting structure		6	Each			
1.2.8	Surge Arrestors						
1.2.8.1	330kV Single-Phase Surge Arrestor complete with supporting structure		12	Each			
1.2.8.2	36kV Surge arresters (for neutrals of 3x10MVAR reactors to protect NCR against over-voltages) complete with supporting structures		2	Each			
1.2.9	Busbars & Clamps			Lot			
1.2.9.1	Clamps for AAC "Tarantula" or LGKK-600 Conductor		1	Lot			
1.2.9.2	Clamps for ASCR "Bison" Conductor or LGJ 400/50		1	Lot			
1.2.9.3	Clamps for ACS 7/4.11 Conductor		1	Lot			
1.2.9.4	330kV String Insulators		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.10	Auxiliary Power and Control Cables						
1.2.10.1	4 core x 2.5sqmm		1	lot			
1.2.10.2	7 core x 2.5sqmm		1	lot			
1.2.10.3	12 core x 2.5sqmm		1	lot			
1.2.10.4	24 core x 2.5sqmm		1	lot			
1.2.10.5	7 core x 1.5sqmm		1	lot			
1.2.10.6	14 core x 1.5sqmm		1	lot			
1.2.10.7	19 core x 1.5sqmm		1	lot			
1.2.10.8	27 core x 1.5sqmm		1	lot			
1.2.10.9	4 core x 4sqmm		1	lot			
1.2.10.10	4 core x 6sqmm		1	lot			
1.2.11	Earthing and Lightning Protection		1	Lot			
1.2.11.1	Earthmat conductor (High conductivity hard-drawn bare Copper)		1	Lot			
1.2.11.2	Earthmat joints and connectors		1	Lot			
1.2.11.3	Thermowelding tools and connection kits		1	Lot			
1.2.11.4	Earth rods		1	Lot			
1.2.12	Protection and Control - Kasama S/S						
1.2.12.1	Main 1 - Line Current Differential protection panel fully equipped with protection IED, panel wiring, multifunction meters (MFM) and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 2 and Backup		2	Lot			
1.2.12.2	Main 2 - Distance protection panel fully equipped with protection IED, panel wiring, multifunction meters (MFM) and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection IED. To be installed in Main 1 panel		2	Lot			
1.2.12.3	Reactor Differential protection panel fully equipped with protection IED's, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection IED		2	Each			
1.2.12.4	Busbar Protection integration		1	Lot			
1.2.12.5	IEC 61850 Compliant Line Bay Control Units Complete with accessories		2	Lot			
1.2.12.6	Reactor Bay Control Units Complete with accessories		2	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.12.7	Complete equipped Metering panel for both line and reactor, panel wiring, test blocks, terminals and all associated auxiliary equipment. The meter type shall be Landis + Gyr (E880) or CEWE Prometer 540 or equivalent and IEC 61850 compliant. Power quality meter as Unipower 2210 or equivalent .		2	Lot			
1.2.12.8	Ethernet switch for metering		1	Each			
1.2.12.9	Metering management system/HMI with software and hardware		1	Lot			
1.2.12.10	WAMPACS System		1	Lot			
1.2.12.11	Loose Main 1 - Line Current Differential protection relays as spare		1	Each			
	Loose Main 2 - Distance protection relays as spare		1	Each			
	Loose Line Backup Overcurrent & Earth Fault protection relays as spare		1	Each			
1.2.12.12	Loose Meter type Landis + Gyr (E880) or CEWE Prometer 540 or equivalent and IEC 61850 compliant as spare		4	Each			
1.2.12.13	Loose Power quality meter as Unipower 2210 or equivalent as spare		2	Each			
1.2.13	Telecommunication - Kasama S/S						
1.2.13.1	DWDM Optical Transport Networking (OTN) equipment with accessories and with subbracks in three directions		1	Lot			
1.2.13.2	DWDM Optical Transport Networking (OTN) equipment as spare		1	Lot			
1.2.13.3	10G & 100G Packet Transport Network (PTN) equipment		1	Lot			
1.2.13.4	ZTE PCM P230 for data and voice communication		1	Lot			
1.2.13.5	DDF, MDF cabinets		1	Lot			
1.2.13.6	Synchronous Digital Hierarchy (SDH) STM-64 with accessories		1	Lot			
1.2.13.7	Alcatel PABX with accessories		1	Lot			
1.2.13.8	Alcatel PABX corporate wide networking license for digital trunk communication		1	Lot			
1.2.13.9	Analog telephone handsets with display		20	each			
1.2.13.10	Analog telephone handsets without display		20	each			
1.2.13.11	Digital telephone handsets		20	each			
1.2.13.12	IP trunk license for VOIP		60	each			
1.2.13.13	Patch cords LC/UPC-LC/UPC Single Mode for complete installation		1	Lot			
1.2.13.14	for complete installation		1	Lot			
1.2.13.15	Patch cords SC/UPC-LC/UPC Single Mode for complete installation		1	Lot			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.13.16	Patch cords SC/UPC-FC/UPC Single Mode for complete installation		1	Lot			
1.2.13.17	Patch cords SC/UPC-SC/UPC Single Mode for complete installation		1	Lot			
1.2.13.18	SFPs electrical type(10/100/1000M, RJ45)		20	each			
1.2.13.19	Laptops (processor shall have Intel core i9 or better CPU, 1TB HDD, 16GB RAM)		2	each			
1.2.13.20	Optical splicing machine with accessors (90S or higher version)		2	each			
1.2.13.21	Optical powermeter		4	each			
1.2.13.22	Optical Time Domain Reflectometer (OTDR)		2	each			
1.2.13.23	Optical visual fault locator		4	each			
1.2.13.24	Optical light source		4	each			
1.2.13.25	Auxiliary Power System (Charger, inverters Batteries)		1	Lot			
1.2.13.26	Free stand alone airconditioning unit 48000 BTU		2	each			
1.2.13.27	Telecom spares						
1.2.13.28	EOBAH 2424		2	each			
1.2.13.29	EONA 3120		2	each			
1.2.13.30	SEOBA 2220		2	each			
1.2.13.31	CSF		2	each			
1.2.13.32	SEE card with optical interface		2	each			
1.2.13.33	SEE card with electrical interface		2	each			
1.2.13.34	ENCP		2	each			
1.2.13.35	OL64 * 2 ports		2	each			
1.2.13.36	OL16 * 4 ports		2	each			
1.2.13.37	OPGW		5000	meters			
1.2.13.38	ADSS		4000	meters			
1.2.13.39	PABX power board		1	each			
1.2.13.40	PABX processor board		1	each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.13.41	ODU 40C		1	each			
1.2.13.42	OMU 40C		1	each			
1.2.13.43	EOPM		1	each			
1.2.13.44	PDUB16		1	each			
1.2.13.45	WSUBM20D		1	each			
1.2.13.46	WSUBD9M8D		1	each			
1.2.13.47	WSUBA9P9D		1	each			
1.2.13.48	C1K		2	each			
1.2.13.49	C2K		2	each			
1.2.13.50	C4K		2	each			
1.2.13.51	L4K		2	each			
1.2.13.52	SDH Analyser		2	each			
1.2.13.53	Optical SFPs (1.25G, 2.5G, 10G, 100G)		20	each			
1.2.13.54	Electrical SFP (1.25G)		20	each			
1.2.13.55	8 x E2K x 10 ports board		8	each			
1.2.13.56	8 x E2K x 20 ports board		8	each			
1.2.13.57	EONA1820(with VOA)+ DRA_B (H14)		2	each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.2.14	SAS - Kasama S/S						
1.2.14.1	SAS Ethernet Switch		1	Each			
1.2.14.2	GPS clock/time server complete with antenna accessories		1	Each			
1.2.14.3	Extension of existing SAS Ethernet LAN		1	Lot			
1.2.14.4	Equipment for Integration of new line and reactor bays into the existing upgraded SAS		1	Lot			
1.2.14.5	Bay Control Unit as spare		2	Each			
1.2.14.6	Binary input cards of the type installed in the BCU as spare		2	Each			
1.2.14.7	Binary output cards of the type installed in the BCU as spare		2	Each			
1.2.14.8	AC analogue input card of the type installed in the BCU as spare		2	Each			
1.2.14.9	Power supply module of the type installed in the BCU as spare		2	Each			
1.2.14.10	Ethernet switches of the type installed in the BCU as spare		2	Each			
1.2.14.11	Complete set of Operator work station (computer) of the type installed as spare		1	Each			
1.2.14.12	Complete gateway (computer) of the type installed as spare		1	Each			
1.2.14.13	Complete engineering workstation (computer) of the type installed as spare		1	Each			
1.2.15	Reactors - Kasama S/S						
1.2.15.1	362/V3 kV 3x10MVAR Single-Phase ONAN Reactors complete with accessories		2	Lot			
1.2.15.2	15kVAR Neutral Compensating Reactors complete with accessories		2	Lot			
1.2.15.3	Fire Extinguisher 50kg		2	Each			
1.2.15.4	Sergi Fire Protection for reactor or equivalent		2	Each			
1.2.15.5	Sergi Fire Protection control system spares or equivalent						
1.2.15.5.1	Red leds (Control Box)		3	Each			
1.2.15.5.2	Green leds (Control Box)		10	Each			
1.2.15.5.3	Pilot green light (TP Cabinet)		2	Each			
1.2.15.5.4	Pilot red light (TP Cabinet)		2	Each			
1.2.15.5.5	Relay 24 VDC		5	Each			
1.2.15.5.6	Set of Fuses		2	Lot			
1.2.15.5.7	Electrical Actuator		2	Each			
1.2.15.5.8	Rupture Disk		1	Each			
1.2.15.5.9	Shock Absorber		1	Each			
1.2.15.5.10	Gasket		2	Each			
1.2.16	Junction boxes, terminal Boxes and Marshalling Kiosks - Kasama S/S						
1.2.16.1	Junction Boxes		1	Lot			
1.2.16.2	Terminal Boxes		1	Lot			

1.2.16.3	Marshalling Kiosk		1	Lot			
1.2.16.4	Splicing Box		1	Lot			
1.2.17	Structural Steelwork - Kasama S/S						
1.2.17.1	Steel Support structures for equipment, gantries and busbar		1	Lot			
1.2.18	Miscellaneous - Kasama S/S						
1.2.18.1	~~(Deleted)~~		0	Each			
1.2.18.2	Relay Room Air conditioners floor standing		5	Each			
1.2.18.3	Surveillance and Control System		1	Lot			
1.2.19	Civil Works - Imported Materials						
1.2.19.1	Fixtures and finishes for Control building as per employer's requirements		1	Lot			

1.3	Employer's Project Management						
1.3.1	Executive Chairs		10	Each			
1.3.2	Double door 541L upright Refrigerator		3	Each			
1.3.3	Filing Cabinets		4	Each			
1.3.4	Tables		5	Each			
1.3.5	Circuit Breaker Gas Filling Kits And Test Equipment		3	Sets			
1.3.6	Programma TM1800 Circuit Breaker Analyser System complete with CABA software, USB communication interface and transducers for motion, vibration, timing, contact resistance and DRM		2	Each			
1.3.7	Insulation Resistance Tester - up to 15kV		6	Each			
1.3.8	Earth Resistance Tester - accuracy from 0.1 ohms to not less than 2000 ohms		6	Each			
1.3.9	COMPROTware Testtool (Protocol Analyzer)		1	Lot			
1.3.10	SAS Integration Demo Kit complete with IEDs and Client		1	Lot			
1.3.11	Omicron StationScout IEC61850 Simulation and Testing tool for Substation Automation Systems (Complete with IEDScout IEC61850 Simulation and Testing tool for IEDs)		2	Lot			
1.3.12	100kV, Oil dielectric breakdown tester		3	Each			
1.3.13	Micro Ohm (low resistance) Tester for Switchgear – DUCTOR or similar		3	Each			
1.3.14	Mechanical and electrical tool box complete		10	Each			
1.3.15	CMC 500 Secondary injection test set Full package		2	Each			
1.3.16	Vacuum pump of adequate capacity for transformer insulation drying and oil filling		1	Each			
1.3.17	Oil pump and hoses, with a flow rate of at least 1.3 l/s (for oil filling of power transformers), should be portable and electrically operated		3	Each			
1.3.18	Transformer oil filtration streamliner, with a capacity of at least 5000 l/hr, complete with		1	Each			
1.3.19	CT Analyser equipment		2	Each			
1.3.20	SFRA Analyser		1	Each			
1.3.21	SF6 Gas Leakage Detector		2	Each			
1.3.22	CPC 100Transformer Analyzer		2	Each			
1.3.23	Handheld GPS type Garmin, or similar.		5	Each			
1.3.24	COMPROTware Testtool (Protocol Analyzer)		1	Each			

Item	Description	Code ¹	Qty.	Unit	Unit Price ²		Total Price ²
1.3.25	~~(Deleted)~~		0	Each			
1.3.26	GROUNDING STICKS SET : Type screw type contact clamp; Suitable conductor diameter 5mm - 60 mm; Maximum current capacity 23.9kA		1	Lot			
1.3.27	High Precision portable meter test set with voltage and current source complete with software and user license		1	Each			
1.3.28	Desk top computers for Nakonde Substation		3	Each			
	Laptop for AutoCAD 2026: Intel Core Ultra-series or AMD Ryzen 9 (9000 series or later) for high-performance multitasking, with a dedicated GPU, such as NVIDIA RTX 5070/5080/5090 or AMD Radeon Pro RX 8000 series, a minimum of 16GB RAM, Solid State Drive (SSD) minimum 1TB, high-resolution display with a minimum resolution of 1920 x 1080 (Full HD) , 64-bit Windows 11 or 10 version , adequate ports, including USB 3.X and Type-C		2	Each			
TOTAL (to Schedule No. 5. Grand Summary)							

¹ Bidders shall enter a code representing the country of origin of all imported plant and equipment.

² Specify currency. Create and use as many columns for Unit Price and Total Price as there are currencies.

Name of Bidder: _____

Signature of Bidder: _____

Schedule no 3 - Design Services

Item No.	Description	Estimated Quantity	Unit	Local Currency	Local Currency Portion	Foreign Currency (e.g. EUR or USD or ZAR, etc)	Foreign Currency Portion	Total Price Local Portion for Estimated Quantity	Total Price Foreign Portion for Estimated Quantity
		1)			2)		(3) Optional	(1) x (2)	(1) x (3)
3.1.	330kV NAKONDE STEPDOWN SUBSTATION								
3.1.1	Geotechnical Survey	1	Lot						
3.1.2	Insulation Coordination	1	Lot						
3.1.3	Switching Studies for neutral reactor sizing (Nakonde and Kasama)	1	Lot						
3.1.4	Conceptual designs.	1	Lot						
3.1.5	General Arrangement & Elevation Drawings for the 330kV Substation (overview and various sections)	1	Lot						
3.1.6	Design for Protection and Control Panels (Metering and Telecommunication included)	1	Lot						
3.1.7	WAMPACS studies and design	1	Lot						
3.1.8	Cable Block Diagram and Cable Termination schedule	1	Lot						
3.1.9	Protection and control Wiring Diagram	1	Lot						
3.1.10	Topographical Survey	1	Lot						
3.1.11	Civil Bulk Works Design (water, sewerage, earthworks, foundations, structural, earth retaining structures, roads/pavements, stormwater, etc).	1	Lot						
3.1.12	Structural steelwork designs	1	Lot						
3.1.13	Earthing and lightning protection Calculation and Designs	1	Lot						
3.1.14	Surveillance and Access Control Design	1	Lot						
3.1.15	SAS design	1	Lot						

Item No.	Description	Estimated Quantity	Unit	Local Currency	Local Currency Portion	Foreign Currency (e.g. EUR or USD or ZAR, etc)	Foreign Currency Portion	Total Price Local Portion for Estimated Quantity	Total Price Foreign Portion for Estimated Quantity
3.2	KASAMA SUBSTATION								
3.2.1	Geotechnical Survey	1	Lot						
3.2.2	Insulation Coordination	1	Lot						
3.2.3	WAMPACS studies and design	1	Lot						
3.2.4	Conceptual designs	1	Lot						
3.2.5	General Arrangement & Elevation Drawings for 330kV Substation extension	1	Lot						
3.2.6	Design for Protection and Control Panels (Metering and Telecommunication included)	1	Lot						
3.2.7	Cable Block Diagram and Cable Termination schedule	1	Lot						
3.2.8	Update all secondary system affected by the new 330kV line bays and the upgrade of SAS, Energy Meters, Telecom equipment, auxiliary power etc.	1	Lot						
3.2.9	Topographical Survey	1	Lot						
3.2.10	Civil Bulk Works Design (water, sewerage, earthworks, foundations, structural, earth retaining structures, roads/pavements, stormwater, etc).	1	Lot						
3.2.11	Structural steelwork designs	1	Lot						
3.2.12	Earthing and lightning protection Calculation and Designs	1	Lot						
3.2.13	SAS integration design	1	Lot						
3.2.14	Surveillance and Access Control Design	1	Lot						
3.2.15	Control Building Refurbishment Design	1	Lot						
TOTAL (to Schedule No. 5. Grand Summary)									

Name of Bidder: _____

Item No.	Description	Estimated Quantity	Unit	Local Currency	Local Currency Portion	Foreign Currency (e.g. EUR or USD or ZAR, etc)	Foreign Currency Portion	Total Price Local Portion for Estimated Quantity	Total Price Foreign Portion for Estimated Quantity

Signature of Bidder: _____

Schedule no 4 - Installation and Other Services

Item No	Description	Estimated Quantity	Unit	Foreign Currency(e.g. EUR or USD or ZAR, etc)	Foreign Currency Portion	Local Currency (ZMW)	Local Currency Portion	Total Foreign Currency Price for Estimated Quantity	Total Local Currency Price for Estimated Quantity
		1)			2)		3)	(1) x (2)	(1) x (3)
4.0	Preliminary and General								
4.0.1	Site Mobilization	1	Lot						
4.0.2	Contract Insurance, Stautory Regulation Requirements, Labour Act Requirements and Professional Registrations.	1	Lot						
4.0.3	Contractor's accommodation, transport, offices and other facilities; including that of Consultant and Employer as per employer's requirements with furnishing	1	Lot						
4.0.4	Employer's Housing (complete works)								
4.0.4.1	Three (3) 150 m2 Units	1	Lot						
4.0.4.2	Three (3) Type B Units	1	Lot						
4.0.4.3	Electrical Reticulation (inclusive of distribution box and mcb installation, wiring, and installlation of fittings and fixtures).	1	Lot						
4.0.4.4	One fully equipped borehole and four 5,000L tanks on 8m stand (to supply staff houses and guard house) including a pump room/ enclosure, all piping, connectors and water level sensors (inclusive of water quality testing)	1	Lot						
4.0.4.5	Residential wastewater drainage system including septic tank, leachpit/ soakaway, piping and manholes.	1	Lot						

4.0.4.6	Provide storm water drainage system at staff housing area to terminate at designated discharge point.	1	Lot						
4.0.4.7	Supply and install 80mm interlocking paving bricks for the yard including all layer works, edge restraints as per specification	1	Lot						
4.0.5	Site Establishment	1	Lot						
4.0.6	Site Demobilization	1	Lot						
4.0.7	Water, electricity and builders supply	1	Lot						
4.0.8	Provisional amount for services rendered by a specialist on request or instruction by the Employer or Consultant (equivalent of USD 50, 000.00).	1	Lot						
4.1.	330kV NAKONDE STEPDOWN SUBSTATION								
4.1.1	Preliminary and General								
4.1.1.1	(Deleted)	0	Lot						
4.1.1.2	Clearing of staff housing surface, excavations, sloping & back-filling, levelling, compacting, etc.	1	Lot						
4.1.1.3	(Deleted)	0	Lot						
4.1.1.4	(Deleted)	0	Lot						
4.1.1.5	Cable channels	1	Lot						
4.1.1.6	(Deleted)	0	Lot						
4.1.1.7	Staff housing Fencing (1.5m high diamond mesh - substation standard) and gates	1	Lot						
4.1.2	Conductors								
4.1.2.1	AAC "Tarantula" or LGKK-600 Conductor	1	Lot						
4.1.2.2	ASCR "Bison" Conductor or LGJ 400/50	1	Lot						
4.1.2.3	ACS 7/4.11 Conductor	1	Lot						
4.1.2.3	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.1.3	OFC Approach Cable								
4.1.3.1.	48-core ADSS non-metallic approach fibre cable with trunking	1	Lot						
4.1.3.2.	12 FC patch pane	1	Lot						
4.1.3.3.	FC-LC patch cords	1	Lot						
4.1.3.4.	Factory Acceptance Tests	1	Lot						
4.1.3.5.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.4	Circuit Breakers								
4.1.4.1	330kV Circuit Breaker complete with support structures	1	Lot						
4.1.4.2	132kV Circuit Breaker complete with support structures	1	Lot						
4.1.4.3	132kV and 330kV Factory Acceptance Testing	1	Lot						
4.1.4.4	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.5	Disconnectors								
4.1.5.1	330kV Disconnector complete with support structures	1	Lot						
4.1.5.2	132kV Disconnector complete with support structures	1	Lot						
4.1.5.3	330kV Line disconnect switch, Motor Operated complete with supporting structures as spare	1	Set						
4.1.5.4	132kV and 330kV Factory Acceptance Testing	1	Lot						
4.1.5.5	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.6	Disconnectors with Earth Switch								
4.1.6.1	330kV Disconnectors with Earth switch and support structures	1	Lot						
4.1.6.3	132/66kV Disconnectors with Earth switch and support structures	1	Lot						
4.1.6.4	132kV and 330kV Factory Acceptance Testing	1	Lot						
4.1.6.5	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.1.7	Instrument Transformers								
4.1.7.1	330kV Current Transformers (7-core) and support structures	1	Lot						
4.1.7.2	330kV Capacitive Voltage Transformers and support structures	1	Lot						
4.1.7.3	132kV Current Transformers(CT) complete with support structures	1	Lot						
4.1.7.4	132-66kV Capacitor Voltage Transformers (CVT) complete with support structures	1	Lot						
4.1.7.5	66kV, 132kV and 330kV Factory Acceptance tests	1	Lot						
4.1.7.6	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.8	Surge Arrestors								
4.1.8.1.	330kV Surge Arrestors and support structures	1	Lot						
4.1.8.2.	66kV Surge Arrestors and support structures	1	Lot						
4.1.8.3.	Surge Arrestors sized to protect NCR against over-voltages, incl. support structures	1	Lot						
4.1.8.4.	66kV and 330kV Factory Acceptance Testing	1	Lot						
4.1.8.5.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.9	Busbars, Clamps and Insulators								
4.1.9.1	Clamps for AAC "Tarantula" or LGKK-600 Conductor	1	Lot						
4.1.9.2	Clamps for ASCR "Bison" Conductor or LGJ 400/50	1	Lot						
4.1.9.3	Clamps for ACS 7/4.11 Conductor	1	Lot						
4.1.9.4	330kV Post Insulators complete with support structures	1	Lot						
4.1.9.5	330kV String Insulators	1	Lot						
4.1.9.6	132kV Post Insulators complete with support structures	1	Lot						
4.1.9.7	132kV String Insulators	1	Lot						
4.1.9.8	132kV and 330kV Factory Acceptance Testing	1	Lot						
4.1.9.9	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.1.10	Auxiliary Power & Control Cables								
4.1.10.1.	4 core x 2.5sqmm	1	Lot						
4.1.10.2.	7 core x 2.5sqmm	1	Lot						
4.1.10.3.	12 core x 2.5sqmm	1	Lot						
4.1.10.4.	24 core x 2.5sqmm	1	Lot						
4.1.10.5.	4 core X 25sqmm	1	Lot						
4.1.10.6.	7 core x 1.5sqmm	1	Lot						
4.1.10.7.	14 core x 1,5sqmm	1	Lot						
4.1.10.8.	19 core x 1,5sqmm	1	Lot						
4.1.10.9.	27 core x 1.5sqmm	1	Lot						
4.1.10.10.	4 core X 4sqmm	1	Lot						
4.1.10.11.	4 core X 6sqmm	1	Lot						
4.1.10.12.	4 core x 10sqmm	1	Lot						
4.1.10.13.	4 core x 25sqmm	1	Lot						
4.1.10.14.	4 core x 50sqmm	1	Lot						
4.1.10.15.	4 core x 185sqmm	1	Lot						
4.1.10.16.	11kV XLPE Power Cable 3x70 mm ² Cu conductor, incl. Cable Terminations	2	Lot						
4.1.10.17.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.11	Earthing and Lightning Protection								
4.1.11.1	Earthmat conductor (High conductivity hard-drawn bare Copper)	1	Lot						
4.1.11.2	Earthmat joints and connectors	1	Lot						
4.1.11.3	Earth rods	1	Lot						
4.1.11.4	Lightning Masts	1	Lot						
4.1.11.5	Thermowelding tools and connection kits	1	Lot						
4.1.11.6	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.1.12	Secondary Equipment - Nakonde								
4.1.12.1.	Protection system								
4.1.12.1.1	Factory Acceptance Testing	1	Lot						
4.1.12.1.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.2.	Metering system								
4.1.12.2.1	Factory Acceptance Testing	1	Lot						
4.1.12.2.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.3.	WAMPACS system								
4.1.12.3.1	Factory Acceptance Testing	1	Lot						
4.1.12.3.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.4.	Telecommunication systems								
4.1.12.4.1	Factory Acceptance Testing	1	Lot						
4.1.12.4.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.5.	SAS system								
4.1.12.5.1	Factory Acceptance Testing	1	Lot						
4.1.12.5.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.6.	AVR system								
4.1.12.6.1	Factory Acceptance Testing	1	Lot						
4.1.12.6.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.7.	Stand-alone 330kV and (132)66kV Disturbance Fault Recorders								
4.1.12.7.1	Factory Acceptance Testing	1	Lot						
4.1.12.7.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.8.	Surveillance and Access Control Systems								
4.1.12.8.1	Factory Acceptance Testing	1	Lot						
4.1.12.8.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.12.9.1	End-to-End tele-protection signaling tests for the 330kV Nakonde-Kasama, 400kV Nakonde-Tunduma, 132kV Nakonde-Nakonde town and 132kV Nakonde-Isoka lines	1	Lot						
4.1.12.9.2	Loop back tele-protection tests at Nakonde Substation for the 330kV Nakonde-Kasama, 400kV Nakonde-Tunduma, 132kV Nakonde-Nakonde town and 132kV Nakonde-Isoka lines	1	Lot						
4.1.13	Telecommunications Primary Equipment - Nakonde								

4.1.13.1.	Optical Fibre LinkSupply of optical fibre approach cables(ADSS) from the gantries on the Nakonde-Kasama 330kV bay, Nakonde-Tunduma 330kV bay, Nakonde-Isoka 66kV bay and New Nakonde-Old Nakonde 66kV bay at Nakonde substation to the telecoms equipment room.	1	Lot						
4.1.14	Transformers								
4.1.14.1	Complete 330/(132)66/11kV Three-Phase 90/90/10 MVA ONAN/ONAF Power Transformer	2	Lot						
4.1.14.2	Kelman Online Dissolved Gas Analysis or equivalent	2	Lot						
4.1.14.3	Fire Extinguisher 50kg	2	Lot						
4.1.14.4.1	100KVA 33/0.4kV Transformer complete with Protection equipment (HT and LV fuses) and accessories for Housing Complex on a structure of H-pole configuration	1	Lot						
4.1.14.4.2	Aerial bundled conductor 7 spans (350m)	1	Lot						
4.1.14.4.3	12m wooden poles for 7 spans (350m) and accessories	1	Lot						
4.1.14.5	500kVA 11/0.4kV Station Service Transformer	2	Lot						
4.1.14.6	Sergi Fire Protection for Transformers or equivalent	2	Lot						
4.1.14.7	Factory Acceptance tests - Power Transformers	2	Lot						
4.1.14.8	Factory Acceptance tests - Sergi Fire Protection or equivalent	2	Lot						
4.1.14.9	All Transformer Bays Installation, Site Acceptance Test and Commissioning	4	Lot						
4.1.15	Reactors		Lot						
4.1.15.1.	330kV Reactors	3	Lot						
4.1.15.2.	Neutral Compensating Reactors	2	Lot						
4.1.15.3.	Fire Extinguisher 50kg	3	Lot						
4.1.15.4.	Sergi Fire Protection for Reactors or equivalent	3	Lot						
4.1.15.5.	Factory Acceptance tests								
4.1.15.5.1	Factory Acceptance tests - Reactors	3	Lot						

4.1.15.5.2	Factory Acceptance tests - NCR	2	Lot						
4.1.15.5.3	Factory Acceptance tests - Sergi Fire Protection or equivalent	3	Lot						
4.1.15.6.	All Reactor Bays Installation, Site Acceptance Test and Commissioning	3	Lot						
4.1.16	All Station Junction boxes, terminal Boxes and Marshalling Kiosks								
4.1.16.1	Junction Boxes	1	Lot						
4.1.16.2	Terminal Boxes	1	Lot						
4.1.16.3	Marshalling Kiosk	1	Lot						
4.1.16.4	Outdoor Lighting Distribution Box	1	Lot						
4.1.16.5	Factory Acceptance Testing	1	Lot						
4.1.16.6	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.1.17	DC System								
	48V								
4.1.17.1	Battery Bank (1200AH)	2	Lot						
4.1.17.2	Battery Charger	2	Lot						
4.1.17.3	DC Cables	1	Lot						
4.1.17.4	AC Cables	1	Lot						
4.1.17.5	DC Distribution Panels	1	Lot						
4.1.17.6	AC Distribution Board	1	Lot						
4.1.17.7	Factory Acceptance Testing	2	Lot						
4.1.17.8	Installation, Site Acceptance Test and Commissioning	2	Lot						
	110V								
4.1.17.9	Battery Bank (800AH)	2	Lot						
4.1.17.10	Battery Charger	2	Lot						
4.1.17.11	DC Cables	1	Lot						
4.1.17.12	AC Cables	1	Lot						
4.1.17.13	DC Distribution Panels	1	Lot						
4.1.17.14	AC Distribution Board	1	Lot						
4.1.17.15	Factory Acceptance Testing	2	Lot						
4.1.17.16	Installation, Site Acceptance Test and Commissioning	2	Lot						
4.1.18	All Station Structural Steelwork								

4.1.18.1.	Surge Arrester Structures	1	Lot						
4.1.18.2.	Capacitive Voltage Transformer Structures	1	Lot						
4.1.18.3.	Current Transformer (7-core) Structures	1	Lot						
4.1.18.4.	Disconnecter Structures	1	Lot						
4.1.18.5.	Post Insulator Structures	1	Lot						
4.1.18.6.	Steel Support structures for equipment, gantries and busbar	1	Lot						
4.1.18.7.	Steel support structures for outdoor lighting	1	Lot						
4.1.19	All Project Civil Works including Material (the pricing shall be deemed inclusive for either option)								
4.1.19.1	Bulk Earthworks for Platform/ Terrace (stepped or single platform) Construction								
4.1.19.1.1	Bush Clearing	160000	m2						
4.1.19.1.2	Remove all vegetation, topsoil and rubble (up to 300mm below NGL) and dump at an approved site	1	Lot						
4.1.19.1.3	Break (i.e. by way of hole drilling, blasting, chemical breaking, mechanical breaking, e.t.c.) and remove rock outcrops to required design levels and dump at an approved site of at least 30km	1	Lot						
4.1.19.1.4	Cut to fill (and level to design grade)	1	Lot						
4.1.19.1.5	Import Material - G5 Gravel	1	Lot						
4.1.19.1.6	Backfill and compact imported G5 material in 150mm layers to 95% (to achieve min. CBR = 50%)	1	Lot						
4.1.19.1.7	Refer to Drawing F and C105 Option 1 (stepped): Construct reinforced concrete cantilever retaining wall between upper and lower terraces (complete with geotextile, weepholes, storm water drainage channels, safety barriers, signage, and stairs) Option 2 (single platform): Construct a single terrace platform (complete with geotextile, weepholes, storm water drainage channels, safety barriers, signage, and stairs) comprising of slope protection on both the cut face and the embankment	1	Lot						
4.1.19.2	Storm Water Management								
4.1.19.2.1	Provide temporary storm water drainage system for construction period.	1	Lot						

4.1.19.2.2	Provide permanent storm water drainage system on and around the substation terrace, including a berm on the upper side of the terrace. To terminate at designated discharge point.								
4.1.19.2.3	- Reinforced concrete channels (internal)	1	Lot						
4.1.19.2.4	- Reinforced concrete trapezoidal channels (external)	1	Lot						
4.1.19.2.5	- Reinforced concrete inspection chambers	1	Lot						

4.1.19.2.6	- 900mm Precast concrete culverts and head/wing walls	1	Lot						
4.1.19.3	Roadways and Pavements								
4.1.19.3.1	200mm thick by 6m wide heavy duty reinforced concrete road (complete with street lighting, kerbing, road markings, signage and storm water drainage channels). [Allow for lane widening for lay-bys.]								
4.1.19.3.1.1	- Internal Access Road	1.8	km						
4.1.19.3.1.2	- External Access Road	0.2	km						
4.1.19.3.1.3	- External access road (from gate 02 to proposed asphalt road, via staff housing area)	1.5	km						
4.1.19.3.2	200mm thick reinforced concrete internal pavement (between access road and around control building)	1500	m2						
4.1.19.3.3	300mm Thick Reinforced Concrete Slipway (around transformers and reactors)	1	Lot						
4.1.19.3.4	Supply and install 80mm interlocking paving bricks for the yard including all layer works, edge restraints as per specification	1000	m2						
4.1.19.3.5	Construct 9m wide (7m-main carriageway + 2m-shoulders) asphalt road from the main road complete with drainage on both sides. (This shall include street lighting, road markings, kerbing, reinforced concrete stormwater drainage channels & culverts, road markings, and any other road furniture required by the Road Development Agency.	1.8	km						
4.1.19.4	Switchyard Works								
4.1.19.4.1	Construction of Reinforced Concrete Outdoor Cable Trenches								
4.1.19.4.2	- Trench Channels	1	Lot						
4.1.19.4.3	- Covers	1	Lot						
4.1.19.4.4	- Galvanised steel brackets (wall mounted)	1	Lot						
4.1.19.4.5	- Galvanised steel trays (floor mounted)	1	Lot						
4.1.19.4.6	- Cable Trench ramp (building interface)	1	Lot						
4.1.19.4.7	- Cable duct bank (under roads and pavements)	1	Lot						

4.1.19.4.8	- Drainage	1	Lot						
4.1.19.4.9	- Pull pits/ manholes	1	Lot						
4.1.19.4.10	200mm Concrete Piping for cable sleeves	1	Lot						
4.1.19.4.11	Construct Firewalls (between transformers and reactors)	1	Lot						
4.1.19.4.12	Oil Containment System With Sumps, Manholes, Precast Concrete Pipes, Oil/Water Separator And Oil Holding Dam	1	Lot						
4.1.19.4.13	Sensing And Pumping System For Oil Containment System Including Sensors, Piping, Pumping Equipment And Electrical Installation With Control Box And Cabling	1	Lot						
4.1.19.4.14	Bund walls around Transformers Complete with rectangular galvanized steel grid all around the transformer (and crushed stone cover)	1	Lot						
4.1.19.4.15	Bund walls around Reactors Complete with rectangular galvanized steel grid all around the reactor (and crushed stone cover)	1	Lot						
4.1.19.4.16	Complete Installation of primary plant equipment foundations, lighting mast and gantry foundations, and busbar support foundations	1	Lot						
4.1.19.4.17	Complete installation of all steel support structures for equipment, lighting masts, gantries and busbar	1	Lot						
4.1.19.5	Fencing								
4.1.19.5.1	Substation Security Fencing (complete with main sliding gates, pedestrian gates, 600mm dia. Concertina razor wire, and reinforced concrete anti-dig barrier)	1	Lot						
4.1.19.5.2	Substation (Inner) Safety Fencing (inclusive of double-leaf gates, removable panels, and pedestrian gates)	1	Lot						
4.1.19.5.3	Property Boundary Fencing (inclusive of double-leaf gates and pedestrian gates)	1	Lot						
4.1.19.5.4	Install kerbing around substation fence	1	Lot						
4.1.19.6	Landscaping and Yard Cover								
4.1.19.6.1	Herbicide treatment of platform/ terrace (prior to stone coverage)	1	Lot						

4.1.19.6.2	Supply and install Crushed Stone Ground Cover (graded to Employer's Requirements)	1	Lot						
4.1.19.6.3	Supply and install of rubble masonry/ stone pitch paving on embankment anchored at base where embankment is higher than 1m (complete with geotextiles, weepholes, upper and lower (external) concrete stormwater drainage channels, and (internal) pipe drains)	1	Lot						
4.1.19.6.4	Seeding of embankment with indigenous grass where embankment is lower than 1m	1	Lot						
4.1.19.6.5	Insecticide treatment of excavated building trenches and backfill.	1	Lot						
4.1.19.6.6	Supply and Install External Lighting and Illumination for the Substation (inclusive of cable laying, earthing, and testing)								
4.1.19.6.6.1	- Foundations for outdoor light fitting support structures	1	Lot						
4.1.19.6.6.2	- Wall mounted lighting (on buildings)	1	Lot						
4.1.19.6.6.3	- Pole mounted lighting (street lights)	1	Lot						
4.1.19.6.6.4	- Mast mounted lighting (in switchyard)	1	Lot						
4.1.19.7	Substation Buildings								
4.1.19.7.1	Control Building (including plumbing, foundations, walls, floors, roof, concrete ceiling, gutters, final finishes, furnishing, cable racking, and cable trench covers)	1	Lot						
4.1.19.7.2	Two (02) Guard Houses (complete with furnishing, as per Employer's Requirements)	1	Lot						
4.1.19.7.3	Shelter for emergency diesel generator (as per Employer's Requirements)	1	Lot						
4.1.19.7.4	Shelter for oil drums (as per Employer's Requirements)	1	Lot						
4.1.19.8	Substation Facilities	1	Lot						
4.1.19.8.1	120 liter wheeled plastic bins marked Paper and Cardboard, Plastic, Metal and General Waste	4	Each						

4.1.19.8.2	One fully equipped borehole and two 5,000L tanks on 8m stand (to supply substation buildings) including a pump room/ enclosure, all piping, connectors and water level sensors (inclusive of water quality testing)	1	Lot						
4.1.19.8.3	Substation wastewater drainage system including septic tank, leachpit/ soakaway, piping and manholes.	1	Lot						
4.1.19.8.4	Provide substation utilities - Room signage/ labels, Notice board, White board, First aid kit, Danger notices, Primary equipment lables, Operating and maintenance manuals, Mounted single line diagram, Durable frame for emergency numbers, Key box, Wall mounted console desk for logbook	1	Lot						
4.1.19.8.5	Covered parking 3m wide, 11m long, 2.4m high (03 vehicles)	1	Lot						
4.1.19.8.6	Un-covered parking 40m wide, 50m long	1	Lot						
4.1.19.9	Quality Control for Civil Works								
4.1.19.9.1	Compaction Testing (at required frequency, as per the Employer's Requirements)	1	Lot						
4.1.19.9.2	Concrete Cube Testing (at required frequency, as per the Employer's Requirements)	1	Lot						
4.1.19.9.3	Materials Testing - Burrow Pit (Gravel)	1	Lot						
4.1.19.9.4	Materials Testing - Quarry (Yard Stone)	1	Lot						
4.1.19.9.5	Materials Testing - Concrete Mix Design	1	Lot						
4.1.19.9.6	Materials Testing - Concrete Mix Design (inclusive of aggregates)	1	Lot						
4.1.19.9.7	Materials Testing - Asphalt Design Mix	1	Lot						
4.1.19.9.8	(Deleted)	0	Lot						

4.2.	KASAMA 330 KV SUBSTATION								

4.2.1	Preliminary and General								
4.2.1.1	Excavations, decommissioning, dismantling, removal and disposal of all existing redundant material and equipment	1	Lot						
4.2.1.2.	Identify, and if required, relocate any visible and buried services	1	Lot						
4.2.1.3.	Identify, and demarcate safe area to work	1	Lot						
4.2.1.4.	Remove, and packaging of any decommissioned secondary equipment and auxiliary equipment	1	Lot						
4.2.1.5.	Remove, and packaging of any decommissioned primary equipment	1	Lot						
4.2.1.6.	Temporary barricading/fencing	1	Lot						
4.2.2	Conductors								
4.2.2.1.	AAC "Tarantula" or LGKK-600 Conductor	1	Lot						
4.2.2.2.	ASCR "Bison" Conductor or LGJ 400/50	1	Lot						
4.2.2.3.	ACS 7/4.11 Conductor	1	Lot						
4.2.2.4.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.3	OFC Approach Cable								
4.2.3.1.	48-core ADSS non-metallic approach fibre cable with trunking	1	Lot						
4.2.3.2.	12 FC patch pane	1	Lot						
4.2.3.3.	FC-LC patch cords	1	Lot						
4.2.3.5.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.4	Circuit Breakers								
4.2.4.1.	330kV Circuit Breakers With supporting structure	1	Lot						
4.2.4.2.	Factory Acceptance Test	1	Lot						
4.2.4.2.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.5	Disconnectors								
4.2.5.1.	330kV Disconnectors	1	Lot						
4.2.5.2.	Factory Acceptance Testing	1	Lot						
4.2.5.3.	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.2.6	Disconnecter with Earth switch								
4.2.6.1.	330kV Disconnectors with Earth switch	1	Lot						
4.2.6.2.	Factory Acceptance Testing	1	Lot						
4.2.6.3.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.7	Instrument Transformers								
4.2.7.1.	330kV Current Transformers (7-core)	1	Lot						
4.2.7.2.	330kV Capacitive Voltage Transformers	1	Lot						
4.2.7.3.	Factory Acceptance Test	1	Lot						
4.2.7.4.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.8	Surge Arrestors								
4.2.8.1.	330kV Surge Arrestors	1	Lot						
4.2.8.2.	Single Phase Surge arrestors sized to protect NCR from over voltage	1	Lot						
4.2.8.3.	Factory Acceptance Testing	1	Lot						
4.2.8.4.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.9	Busbars, Clamps & Insulators								
4.2.9.1.	Clamps for AAC "Tarantula" or LGKK-600 Conductor	1	Lot						
4.2.9.2.	Clamps for ASCR "Bison" Conductor or LGJ 400/50	1	Lot						
4.2.9.3.	Clamps for ACS 7/4.11 Conductor	1	Lot						
4.2.9.3.	330kV Single Phase Post Insulators	1	Lot						
4.2.9.4.	330kV String Insulators	1	Lot						
4.2.9.5.	Factory Acceptance Testing	1	Lot						
4.2.9.6.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.10	Auxiliary Power & Control Cables								
4.2.10.1.	4core x 2.5sqmm	1	Lot						
4.2.10.2.	7core x 2.5sqmm	1	Lot						
4.2.10.3.	12core x 2.5sqmm	1	Lot						
4.2.10.4.	24core x 2.5sqmm	1	Lot						
4.2.10.5.	27 core x 1.5sqmm	1	Lot						
4.2.10.6.	4 core x 4sqmm	1	Lot						
4.2.10.7.	4 core x 25sqmm	1	Lot						

4.2.10.8.	4 core x 6sqmm	1	Lot						
4.2.10.10.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.11	Earthing and Lightning Protection								
4.2.11.1	Earthmat conductor (High conductivity hard-drawn bare Copper)	1	Lot						
4.2.11.2	Earth rods	1	Lot						
4.2.11.3	Earthmat joints and connectors	1	Lot						
4.2.11.4	Thermowelding tools and connection kits	1	Lot						
4.2.11.5	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.12	Secondary Equipment - Kasama								
4.2.12.1.	Protection system								
4.2.12.1.1	Factory Acceptance Testing	1	Lot						
4.2.12.1.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.12.2.	Metering system								
4.2.12.2.1	Factory Acceptance Testing	1	Lot						
4.2.12.2.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.12.3.	WAMPACS system								
4.2.12.3.1	Factory Acceptance Testing	1	Lot						
4.2.12.3.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.12.4.	Telecommunication systems								
4.2.12.4.1	Factory Acceptance Testing	1	Lot						
4.2.12.4.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.12.5.	SAS system								
4.2.12.5.1	Factory Acceptance Testing	1	Lot						
4.2.12.5.2	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.13	Telecommunication - Kasama								

4.2.13.1	Optical Fibre LinkSupply of optical fibre approach cables(ADSS) from the gantries on the Nakonde-Kasama	1	Lot						
4.2.14	Reactors								
4.2.14.1	330kV Reactors	2	Lot						
4.2.14.2	Neutral Compensating Reactors	2	Lot						
4.2.14.3	Fire Extinguisher 50kg	2	Lot						
4.2.14.4	Sergi Fire Protection for Reactors or equivalent	2	Lot						
4.2.14.5	Factory Acceptance tests								
4.2.14.6	Factory Acceptance tests - Reactors	2	Lot						
4.2.14.7	Factory Acceptance tests - NCR	2	Lot						
4.2.14.8	Factory Acceptance tests - Sergi Fire Protection or equivalent	2	Lot						
4.2.14.9	All Reactor Bays Installation, Site Acceptance Test and Commissioning	2	Lot						
4.2.16	All Station Junction boxes, terminal Boxes and Marshalling Kiosks								
4.2.16.1.	Junction Boxes	1	Lot						
4.2.16.2.	Terminal Boxes	1	Lot						
4.2.16.3.	Marsahling Kiosk	1	Lot						
4.2.16.4.	Splicing Box	1	Lot						
4.2.16.5.	Outdoor Lighting Distribution Box	1	Lot						
4.2.16.7.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.17	DC System								
	48V								
4.2.17.1	Integration into existing 48V DC system	2	Lot						
4.2.17.2	Installation, Site Acceptance Test and Commissioning	2	Lot						
	110V								
4.2.17.3	Integration into existing 110V DC system	2	Lot						
4.2.17.4	Installation, Site Acceptance Test and Commissioning	2	Lot						
4.2.18	All Station Structural Steelwork								

4.2.18.1.	Steel Support structures for equipment, gantries and busbar	1	Lot						
4.2.18.2.	Substation Fencing	1	Lot						
4.2.18.3.	330kV Surge Arrestors structures	1	Lot						
4.2.18.4.	330kV Three Phase Disconnecter	1	Lot						
4.2.18.5.	330kV Current Transformers structures	1	Lot						
4.2.18.6.	330kV Capacitive Voltage Transformer structures	1	Lot						
4.2.18.7.	330kV Post Insulator Structures	1	Lot						
4.2.18.8.	Floodlights	1	Lot						
4.2.18.9.	Installation, Site Acceptance Test and Commissioning	1	Lot						
4.2.19.	Civil Works								
4.2.19.1.	Clearance of the working area, leveling , cutting and backfilling	1	Lot						
4.2.19.2.	Complete Installation of primary plant equipment foundations, gantry foundations and busbar support foundations	1	Lot						
4.2.19.3.	Complete installation of all steel support structures for equipment, gantries and busbar	1	Lot						
4.2.19.4	Levelling, compaction with slope suitable for drainage and installation of yard stone over the surface affected by the works	1	Lot						
4.2.19.5	Insecticide Treatment etc.	1	Lot						
4.2.19.6	Construct control cable trenches for new equipment	1	Lot						
4.2.19.7	Fire and bund Walls	1	Lot						
4.2.19.8	Trenches and Conduits	1	Lot						
4.2.19.9	Junction Boxes Foundations	1	Lot						
4.2.19.10	Terminal Boxes Foundations	1	Lot						
4.2.19.11	Marshalling Kiok Foundations	1	Lot						
4.2.19.12	All Drainage including subsurface and surface(Yard, perimeter, trenches, etc)	1	Lot						
4.2.19.13	(Deleted)	0	Lot						
4.2.19.14	Design, Supply and Install Substation lighting (inclusive of cable laying, earthing, and testing)	1	Lot						

4.2.19.15	Design, Supply and Install Perimeter lighting (inclusive of cable laying, earthing, and testing)	1	Lot						
4.2.19.16	Yardstone	1	Lot						
4.2.19.17	Oil Dam Construction, incl. Piping	1	Lot						
4.2.19.18	Decommissioning of existing water tank complete with the tank stand. Supply and installation of a new 10000litre tank, tank stand and accessories for a fully working water reticulation	1	Lot						
4.2.19.19	Control building works as per employer's requirements	1	Lot						
4.2.19.20	Surveillance and Access Control Systems								
4.2.19.20.1	Installation, Site Acceptance Test and Commissioning	1	Lot						

4.3.	MISCELLANEOUS								
4.3.1	C-ESMP impacts mitigations and enhancement costs	1	Lot						
4.3.2	Contractor's costs related to implementation of the SEP, LMP and ESCP.	1	Lot						
4.3.3	Engagement of external GBV service provider as per section 5.2.4 of the ESMP.	1	Lot						
4.3.4	Preparation of a GBV management plan including Development and printing of posters on GBV/SEAH, HIV/AIDS and empowerment of targeted citizens (including employment quotas) in English and translated into relevant local language(s) to be displayed at all work sites and project-affected communities as per ESMP requirements.	1	Lot						
4.3.5	Development and implementation of specific management plans as per ESMP requirements	1	Lot						

4.4.	Employer's Project Management								
4.4.1	Equipment familiarization training – Reactors and Transformers: 6 staff, includes local travel. Minimum 14 days.	1	Lot						

4.4.2	Equipment familiarization training – Protection system: 6 staff, includes local travel. Minimum 14 days.	1	Lot						
4.4.3	Training in configuring Energy Meters and the Energy Management System, fault finding and maintenance of three (3) Metering Engineers for fourteen (14) days • Understanding IEC 61850 standard • Metering communication systems • Substation automation of metering systems • Configuration and integration • Testing and conformance • Change management (Software configuration/multi vendor environment management)	1	Lot						
4.4.4	Hands on SAS Configuration Training: 6 staff, includes local travel. Minimum 4 weeks.	1	Lot						
4.4.5	Training in WAMPACS System; 4 staff, includes local travel. Minimum 14 days.	1	Lot						
4.4.6	Training in Stand-alone 330kV and (132)66kV Disturbance Fault Recorders, 4 staff, includes local travel. Minimum 14 days.	1	Lot						
4.4.7	Training in Omicron StationScout IEC61850 Simulation, Testing and commissioning tool for Substation Automation Systems for 6 staff for minimum 14 working days	1	Lot						
4.4.8	Equipment familiarization training – HV Switchgear (circuit breakers and disconnectors): 4 staff, includes local travel. Minimum 14 days.	1	Lot						
4.4.9	High Precision portable meter test set with voltage and current source complete with software and user license	1	Lot						
4.4.10	Telecoms Training;	1	Lot						
4.4.10.1	4 staff, 15 working days Training OTN	1	Lot						

4.4.10.2	4 staff, 15 working days Training PTN	1	Lot						
4.4.10.3	4 staff, 10 working days SDH and PCM training	1	Lot						
4.4.10.4	4 staff, 15 working days Training PABX	1	Lot						
4.4.10.5	4 staff, 10 working days, Power and Battery Charger Solutions Training	1	Lot						
4.4.10.6	4 staff, 15 working days Training FOX 615	1	Lot						
4.4.10.7	4 staff, 10 working days Training OPGW and ADSS fundamental and splicing techniques	1	Lot						
4.4.11	Local Training								
4.4.11.1	On-the-job training throughout the implementation of the project	1	Lot						
4.4.11.2	Equipment familiarization training – Protection system/metering: 6 staff, Minimum 14 days	1	Lot						
4.4.11.3	CCTV System Training for 10 ZESCO Engineers for 10 days	1	Lot						
4.4.11.4	Access Control System Training for 10 ZESCO Engineers for 10 days	1	Lot						
4.4.11.5	Security Operator (End User) Training for 20 trainees for 10 days	1	Lot						
4.4.11.6	Training in maintenance of the Metering system at the substation and the Power quality Software of three (3) Metering Engineers for 5 days	1	Lot						

4.4.11.7	Site-specific training shall be provided by the Contractor after successful commissioning of the control system for 15 ZESCO engineers, technicians and maintenance personnel for 4 weeks	1	Lot						
4.4.11.8	SFRA Training, 4 staff, Minimum 7 days	1	Lot						

TOTAL (to Schedule No. 5. Grand Summary)									

Name of Bidder: _____

Signature of Bidder: _____

Schedule 5 - Grand Summary

Item	Description	Total Price ¹	
		Foreign	Local
	Total Schedule No. 1. Plant, and Mandatory Spare Parts Supplied from Abroad		
	Total Schedule No. 2. Plant, and Mandatory Spare Parts Supplied from Within the Employer's Country		
	Total Schedule No. 3. Design Services		
	Total Schedule No. 4. Installation and Other Services		
GRAND TOTAL (To Letter of Bid)			

Name of Bidder: _____

Signature of Bidder: _____

¹Specify currency in accordance with ITB 18. Create and use as many columns for Foreign Currency requirement as there are foreign currencies

Schedule 6 - Recommended Spare Parts

Item	Description	Qty.	Unit Price		Total Price
			CIF or CIP (foreign parts)	EXW (local parts)	
		1	2	3	(1) x (2) or (3)
TOTAL (to Schedule No. 5. Grand Summary)					

Name of Bidder: _____

Signature of Bidder: _____

SCHEDULE No. 7 - Dayworks Rates (Not for Evaluation)

7.0	DAYWORK RATES	QTY	UOM	UNIT RATE
7.1	Standard Excavations (in dry soil)	m ³		
7.2	Rock Excavations: Mechanical	m ³		
7.3	Rock Excavations: Blasting - Chemical (Inclusive of all blasting consumables, safeguards, drilling, etc)	m ³		
7.4	Rock Excavations: Blasting - Explosives (Inclusive of all blasting consumables, safeguards, drilling, etc)	m ³		
7.5	Non-Standard Excavations: (Submerged soil)	m ³		
7.6				
7.7				
7.8				
7.9				
7.10				
7.11				
7.12				
7.13				
7.14				
7.15				
7.16				
7.17				
7.18				
7.19				

Name of Bidder: _____

Signature of Bidder: _____

Price Adjustment

If price adjustment applies in accordance with ITB 17.9, the Bidder shall indicate the sources of indices and source of exchange rate (if applicable) and the base date indices in its Bid

Item	Source of Indices	Base date Indices	Source of exchange rate (if applicable)

Name of Bidder: _____

Signature of Bidder: _____

Section V – Eligible Countries

Eligibility for the Provision of Goods, Works and Non-Consulting Services in Bank-Financed Procurement

In reference to ITB 4.8 and 5.1, for the information of the Bidders, at the present time firms, goods and services from the following countries are excluded from this Bidding process:

Under ITB 4.8 (a) and 5.1: **None**

Under ITB 4.8 (b) and 5.1: **None**

Section VI – Fraud and Corruption

(this Section shall not be changed)

1. Purpose

- a. The Bank's Anti-Corruption Guidelines and this annex apply with respect to procurement under Bank Investment Project Financing operations.

2. Requirements

2.1 The Bank requires that Borrowers (including beneficiaries of Bank financing); bidders (applicants/ proposers), consultants, contractors and suppliers; any sub-contractors, sub-consultants, service providers or suppliers; any agents (whether declared or not); and any of their personnel, observe the highest standard of ethics during the procurement process, selection and contract execution of Bank-financed contracts, and refrain from Fraud and Corruption.

2.2 To this end, the Bank:

- a. Defines, for the purposes of this provision, the terms set forth below as follows:
 - i. "corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;
 - ii. "fraudulent practice" is any act or omission, including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain financial or other benefit or to avoid an obligation;
 - iii. "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;
 - iv. "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;
 - v. "obstructive practice" is:
 - (a) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive, or collusive practice; and/or threatening, harassing, or intimidating any party to prevent it from disclosing its

knowledge of matters relevant to the investigation or from pursuing the investigation; or

- (b) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under paragraph 2.2 e. below.
- b. Rejects a proposal for award if the Bank determines that the firm or individual recommended for award, any of its personnel, or its agents, or its sub-consultants, sub-contractors, service providers, suppliers and/ or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract in question;
- c. In addition to the legal remedies set out in the relevant Legal Agreement, may take other appropriate actions, including declaring misprocurement, if the Bank determines at any time that representatives of the Borrower or of a recipient of any part of the proceeds of the loan engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices during the procurement process, selection and/or execution of the contract in question, without the Borrower having taken timely and appropriate action satisfactory to the Bank to address such practices when they occur, including by failing to inform the Bank in a timely manner at the time they knew of the practices;
- d. Pursuant to the Bank's Anti- Corruption Guidelines and in accordance with the Bank's prevailing sanctions policies and procedures, may sanction a firm or individual, either indefinitely or for a stated period of time, including by publicly declaring such firm or individual ineligible (i) to be awarded or otherwise benefit from a Bank-financed contract, financially or in any other manner;¹ (ii) to be a nominated² sub-contractor, consultant, manufacturer or supplier, or service provider of an otherwise eligible firm being awarded a Bank-financed contract; and (iii) to receive the proceeds of any loan

¹ For the avoidance of doubt, a sanctioned party's ineligibility to be awarded a contract shall include, without limitation, (i) applying for pre-qualification, expressing interest in a consultancy, and bidding, either directly or as a nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider, in respect of such contract, and (ii) entering into an addendum or amendment introducing a material modification to any existing contract.

² A nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider (different names are used depending on the particular bidding document) is one which has been: (i) included by the bidder in its pre-qualification application or bid because it brings specific and critical experience and know-how that allow the bidder to meet the qualification requirements for the particular bid; or (ii) appointed by the Borrower.

made by the Bank or otherwise to participate further in the preparation or implementation of any Bank-financed project;

- e. Requires that a clause be included in bidding/request for proposals documents and in contracts financed by a Bank loan, requiring (i) bidders (applicants/proposers), consultants, contractors, and suppliers, and their sub-contractors, sub-consultants, service providers, suppliers, agents, personnel, permit the Bank to inspect³ all accounts, records and other documents relating to the procurement process, selection and/or contract execution, and to have them audited by auditors appointed by the Bank.

³ Inspections in this context usually are investigative (i.e., forensic) in nature. They involve fact-finding activities undertaken by the Bank or persons appointed by the Bank to address specific matters related to investigations/audits, such as evaluating the veracity of an allegation of possible Fraud and Corruption, through the appropriate mechanisms. Such activity includes but is not limited to: accessing and examining a firm's or individual's financial records and information, and making copies thereof as relevant; accessing and examining any other documents, data and information (whether in hard copy or electronic format) deemed relevant for the investigation/audit, and making copies thereof as relevant; interviewing staff and other relevant individuals; performing physical inspections and site visits; and obtaining third party verification of information.

PART 2 - Employer’s Requirements

Section VII – Employer’s Requirements

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1 General Requirements

This Chapter covers the General Technical Requirements for the design, manufacture, shop testing, erection supervision and site tests of the equipment specified in the Employer's Requirements.

Special attention shall be paid to these General Technical Requirements, in which the general technical requirements applicable to materials, working stresses, workmanship, inspection, testing, surface treatment, corrosion protection, painting, packing, etc., are specified.

If the specifications and/or drawings of these documents do not contain particulars for materials or works which are obviously necessary for the proper and safe completion, operation and maintenance of the equipment in question, all such materials and works shall be deemed to be included in the supply.

In the event of any difference between the Drawings and the Specifications, the latter shall prevail.

In the event of any difference between scaled dimensions and figures on the drawings, the figures shall prevail.

If the Bidder finds discrepancies in, or omissions from, these Specifications or from the other documents, or should he be in doubt as to their meaning, he shall immediately contact the Employer for interpretation, clarification or correction thereof before submitting his Bid. Such action shall, however, in no case be considered as cause for altering the Bid opening date.

The Works shall comply with the technical guarantee data stated in the relevant Technical Schedules. The Contractor shall be responsible for any discrepancies, errors and omissions in the particulars and guarantees, whether such particulars and guarantees have been approved by the Employer or not.

1.1 General Information

The Governments of Zambia, Kenya and Tanzania signed in 2014 a tripartite IGMoU to carry out feasibility studies and implement the Zambia – Tanzania – Kenya (ZTK) Interconnector.

The techno-economic feasibility studies as well as the ESIA studies have been completed and following the completion of an operationalization study in 2018 under the SAPP Accelerating Regional Transformational Energy Projects (SAPP AREP) Program, funded by the World Bank, This project relates to Phase II of the Zambia – Tanzania portion of the interconnector.

The Zambia – Tanzania Interconnector Project (ZTIP) project is targeted to contribute to enhancing access to electricity and expanding and strengthening the electricity transmission

and distribution infrastructure. In addition, it will ameliorate the connectivity, quality and reliability of electricity supply in the region and open up for trade between connected countries.

The project embodies construction and extensions of substations and transmission lines in order to connect the cross-border connection from Tanzania to Pensulo substation via 330 kV Nakonde, Kasama and Mpika substations. Existing SCADA/EMS System and associated telecommunication systems are being extended. DVSD compensation plant shall be installed in 330 kV Nakonde new substation and existing Pensulo substation.

ZESCO is the Executing Agency for the implementation of the Project.

The main objectives of the Project are to improve and secure the supply of electricity to Zambia and able wheeling through the country. The Project shall increase the transmission capacity and the quality and reliability of supplied electricity and support ZESCO to meet unsatisfied electricity demands and provide wider access to electricity. The expected output of the project is to promote overall economic development in the whole region and foremost in Zambia. The project is expected to support the growth of industries promote trade and employment opportunities as well as social welfare for the population. Another factor this project will have is to reduce the poverty situation in the regions which is in line with the current strategy for Zambia. This project also shall prioritize sustainable materials and designs to minimize life-cycle carbon emissions.

Unless otherwise written in this document, the design follows the ZESCO standards and specifications.

The work includes detailed survey, Geotech, plant design, manufacture, test, delivery to site, civil works, erection, commissioning and guarantee and setting to work of the following but is not necessarily limited to the following:

1. Preliminaries

- a) All insurance etc. according to the Conditions of Contract.
- b) Establishment and operation of sites during the construction and defects liability period.
- c) Establishment of appropriate facilities and insurances for storage prior to installation.
- d) All designs necessary for approval and implementation of the Works including inspections of the sites in order to carry out detailed design of the Works.
- e) Site surveys and soil investigation, and climate risk assessments (for example flood-prone areas at Nakonde slope) per ESS1 (Assessment and Management of Environmental and Social Risks and Impacts) which includes climate change projections and adaptation measures including reporting.
- f) Power interruption/outage plan.

- g) Transportation to and within Zambia.
 - h) Participation in site meetings.
 - i) Status reporting.
 - j) Quality control of Works including reporting.
2. Implementation of the Sub-projects in the Schedules
 3. All Works necessary for a functional installation
 4. Liaise with the Engineer and the Employer's representatives during site visits and inspections of the Works
 5. Co-ordination of the Contract and the Works
 6. Factory Acceptance Tests and reporting from these tests
 7. Testing of the Works and putting into operation.
 8. Remedy of defects during the Defects Notification Period

All old installations replaced with new ones, such as poles, towers, cables, switchgears etc. should be physically removed from the site and all material that can be used as spare parts shall be handed over to the Employer, and all associated costs should be included in the Contract. The Contractor shall provide the Employer with a detailed list of items to be scrapped and the scrap value to be returned to the Employer.

All Works are to be carried out with a minimum of power interruptions, i.e. a careful planning regarding procedure and timing are needed and stand-by generators, etc. shall be used whenever necessary.

The Contractor shall plan his work in close co-operation with the Employer and the Engineer with the aim of limiting the number and duration of the power interruptions and shall prepare a detailed plan for power interruptions.

The plan for power interruptions shall be reviewed at each site meeting as a priority issue and the need for adjustments of the planned interruptions shall be agreed upon. The existing network in the project area is largely a radial system; Any planned outage on the transmission and subtransmission network in the project area implies a loss of supply to a wide customer base. Therefore, the contractor shall submit outage requests for works on existing plant not less than two (2) weeks before the proposed works date; however, actual outage lead times and approved windows shall remain subject to ZESCO System Operations requirements and may require longer notice for 330 kV network outages. The submission shall be subject to a review and approval by the system operator for the requested duration of outage. Liquidated damages shall apply if the contractor exceeds the agreed period of outage.

Included in the supply are also spare parts and tools as indicated in this document.

The Contractor shall provide his own transport and tools and quote his final price accordingly.

All surplus material imported in the name of this Project shall be handed over to the Employer after its completion.

The Contractor shall provide design, material and construction/installation in order to deliver a fully functional electrical system and equipment whether or not specified in this document. This clause shall be read in conjunction with the Drawings and Schedules. The Contractor shall make his own survey. The Contractor shall also quantify the Works out from the requirements in this document and his design.

Due to the extent of the Works several teams shall be scheduled to work in parallel in the different substations.

1.2 Introduction

This information is provided as guidance to Bidders in preparation of their Bids.

The Employer has provided the attached data to the best of its knowledge, but the Contractor is responsible for verification. Should significant deviations from this data be encountered that materially impact the works, appropriate adjustments will be considered under the contract variation procedures. It is the entire responsibility of the Bidders to check and validate the information provided and to obtain any further data that may affect their Bids and the Works prior to its preparation and submission.

Bidders shall be deemed to have inspected the Site, its surroundings and satisfied themselves as to the true nature of hydrological, physical and climatic conditions of the proposed substation sites; the ground, subsoil, form and nature of the substation sites and the works, the means and access to the sites, the accommodation which might be required and, in general, shall have obtained all necessary information as to risks, contingencies and other circumstances which may influence the Bid.

The Works Requirements contains functional and qualitative requirements, which shall be the base for detailed design by the Contractor. The Contractor may propose a solution of higher or equal quality to the once specified in this document, for the Engineers approval or rejection.

The Works Requirements defines the Scope of the Works, qualitative and quantitative requirements, but leaves the detailing of the Works to the Contractor, who has to carry out all the necessary design, works and supplies.

In case of discrepancy between documents, the most restrictive and/or recent shall be used.

1.3 Project Areas

The project main component comprises construction, upgrade and refurbishment of substations to interconnect Zambia with the 400kV network in Tanzania. This Package 4 includes work in the following substations:

1.3.1 Kasama Substation

The existing Kasama 330/66/11kV substation is located in the western part of Kasama Town, accessible via tarmac road M3.

The substation is connected to the 330kV system in Mpika substation. This package 4 includes extension of 330 kV double busbar with two equipped line bays and related line reactors to connect a double circuit overhead line to 330 kV Nakonde Stepdown substation. Necessary civil works shall be conducted at the existing control building and substation yard.

1.3.2 330kV Nakonde Stepdown Substation

The new greenfield 330KV Nakonde Stepdown Substation is located about 18km west of Nakonde Town.

The 330kV system shall be a double busbar configuration with two lines to Tunduma substation, two lines to Kasama substation complete with line reactor bays, two transformer bays, one busbar reactor bay, one unequipped STATCOM bay, a bus coupler bay and one unequipped future bay. There shall also be main and reserve busbar VTs.

The (132)66kV system shall be a double busbar configuration with one line bay to Nakonde Town substation, one line bay to Isoka substation, two transformer bays, a bus coupler bay and two unequipped future bays. There shall also be main and reserve busbar VTs. The 330/(132)66/11kV transformers shall be operated at 66kV with a provision of a 132kV switching for operation of the feeder bay line at 132kV. Therefore, the switchgear and transmission line bays with an exception of VTs and lightning arresters shall be designed at 132kV.

The station plot is in a slope and the works will include levelling and terracing works. There is also a small rocky hill that partly need to be brought down to common ground level.

1.4 Contractors’ facilities

1.4.1 Accommodation

The Contractor shall be entirely responsible for all accommodation of its personnel and for the provision of all other facilities related to accommodation and living conditions. The Contractor shall include in its Bid the provision, at each project site, of three rooms (each at

least 4m × 5m) for the sole use of the Employer and the Engineer. Each such room shall be furnished with, as a minimum, one bed, one table, and two chairs.

All dwellings and buildings, whether existing or erected by the Contractor for this purpose, shall comply with the Project’s Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP), applicable international good practice guidelines on workers’ accommodation (including IFC Performance Standards and associated guidance on labor and working conditions), and all relevant national and local regulations of Zambia with regard to construction, water supply, sanitation, health, safety, and environmental protection.

The Contractor shall prioritize the hiring of local personnel for non-specialized roles (e.g., site support, security, basic installation assistance, camp maintenance, and general labor) to maximize local economic benefits and skills transfer opportunities. The Contractor shall report monthly on workforce composition (percentage of local vs. expatriate workers, gender-disaggregated where applicable, and details of any training provided to local hires) in accordance with the metrics specified in Appendix C of Section VIII (General Conditions of Contract).

If the Contractor wishes to construct a camp (caravans, tents, etc.) to accommodate personnel on any property, it shall first obtain written permission from the Employer. It is recommended that the accommodation area be fenced and guarded.

Expensive permanent-type construction buildings in any camps are not mandatory, but all buildings erected in the camps shall be of reasonably attractive appearance and good construction. Proper sanitation shall be ensured by the Contractor at all accommodation facilities on site. Separate toilets and bathrooms for male and female employees shall be provided and adequately maintained during the construction period. All accommodation facilities shall support implementation of the Contractor’s Code of Conduct and SEA/SH Prevention and Response measures as required under the ESMP.

The location, construction, and operation of any camp shall be subject to approval by the Employer and shall comply with the Project’s ESIA and ESMP, applicable international good practice guidelines on workers’ accommodation, and all relevant national and local regulations of Zambia.

When camps are no longer required for the construction of the Works, and unless alternative arrangements have been agreed with the Employer, the Contractor shall remove all buildings, backfill all excavations with earth (including latrine pits), and leave the area in a clean and neat condition, to the approval of the Engineer. The issue of the Final Certificate of Completion, and any payments due, shall be withheld until the necessary clean-up has been completed.

No direct payment will be made to the Contractor for the construction or removal of camps, and the entire cost thereof shall be included in the Bid prices for the various Works.

1.4.2 Office Accomodation

The Bidder shall include in his tender for the provision, at his site office at each project area, of one room, at least 4m x 5m for the sole use of the Employer and the Engineer. The room shall be air-conditioned and shall be provided with four chairs, two desks, filing cabinets, a vertical drawing storage facility, a photocopier with paper, colour printer for connection with a PC, and stationery, all to be mutually agreed upon by the Employer and Engineer and the Contractor.

Toilet and washroom facilities shall include air extraction fans, western style WCs, urinals, washroom and shower and washbasins with hot and cold water. Water and effluent shall discharge into a suitably sized septic tank unless connected to a public sewer system. Ablution facilities should be separated according to gender.

Each office blocks shall also be provided with a kitchen, including 1 No hob and oven, refrigerator, water cooler, hot and cold water supply, sink, drainer, microwave oven, cupboards, and worktops.

The following equipment and furniture shall be supplied to each office block:

- Laser Jet colour printer (medium duty) A3 and A4 paper size
- Medium duty photocopier for A3 and A4 paper size
- Scanner machine for A3 and A4 paper size
- Projector, full HD incl. WiFi dongle
- Office tables
- Office chairs
- Shelves and bookcases
- Split type AC units
- Fire extinguishers

All equipment and consumables shall be stocked, maintained, and replaced by the Contractor on a regular basis for the duration of the Contract as necessary.

For all site services specified, all the associated costs for the full contract period are deemed to be included in the contract price.

During the construction period and time for completion of all outstanding items, the Contractor shall provide a daily refuse collection and disposal service to be loaded, transported, and dumped at areas where prior permission has been obtained from responsible authorities in order to keep the total offices and construction site areas clean and in safe condition.

Neglect of cleaning by the Contractor may lead to waste removal by others and the removal costs being deducted from payments to the Contractor.

1.4.3 Communication

Telephone and internet connections to the sites is the contractor's responsibility if deemed necessary by him.

1.4.4 Supplies

The Contractor shall be entirely responsible that proper services are available at the site for the administration offices, construction sites and camps, including a reliable electrical supply and distribution system, messing, food, beverages, potable water, ablution facilities and rubbish disposal. The provision of these services shall be the Contractor’s sole responsibility and cost, and no allowances shall be made in the tender for provision of these services by the Employer, either in whole or part.

The maintenance of these systems shall be such that undue failures do not occur, and that when unavoidable failures do occur, maintenance facilities are available to ensure their speedy return to service. Routine preventative maintenance is to be carried out frequently and regularly. All areas of the site are to be kept clean and tidy at all times. All rubbish, discarded packing material off-cuts etc. are to be removed to a single collection point for disposal off-site at regular intervals as directed by the Employer.

Ablutions shall be kept clean at all times to prevent a health hazard occurring.

1.4.5 First Aid

The Contractor shall maintain at the site a first-aid facility suitable for treating minor cuts and injuries not requiring specialist treatment. At least one member of the Contractor’s staff present at each site shall be trained in the administration of first aid and shall be able to give emergency treatment in case of an accident. A first aid trained person shall also be available to the Employer and Engineer free of charge, on request.

The Contractor shall ensure that comprehensive first-aid kits are carried by each site team and in each personnel-carrying vehicle. Such kits shall be replenished and renewed at frequent intervals.

1.4.6 Electricity

The contractor shall apply for electricity supply to the site camps and offices in the prescribed manner and bear the cost. The Contractor has to arrange at its costs the main connection to the AC supply system and install and maintain its internal distribution system. The Contractor shall pay ZESCO the usual electricity tariff for the consumed electricity as per installed energy

meter. At other sites, the Contractor is responsible for its own electricity supply at its own costs.

1.4.7 Water

The Contractor must provide water of acceptable quality for his own use and at his own cost.

1.4.8 Codes and Standards

The work is to be performed according to the most recent relevant codes, standards, accident prevention regulations and legal regulations (IEC 61936-1, IEC 62271-(1/100/200 series), IEC 60071-1/-2, IEC 60815, IEC 61869, IEC 60255 and the Zambia Grid Code. Please also reference ZESCO internal protection and substation design standards (e.g. Transmission System Design Principles and ZESCO Protection Philosophy). In case of any conflict, the hierarchy of application shall be IEC/IEEE → Statutory Requirements → Zambia Grid Code → ZESCO Standard Practices. All materials and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of goods, methods of inspection, constructional peculiarities of equipment and parts and acceptance of partial plants, as far as these are beyond the special requirements of partial plants and as far as they are beyond the particular requirements of the technical requirements shall comply in every respect with the technical codes of the International Organization for Standardization (ISO). IEC recommendations apply to the electrical equipment.

Other internationally accepted standards which ensure a quality equal to or higher than the standards mentioned above, but only if these are submitted in the English language edition and accepted by the Employer.

The Contractor must submit a list of standards to be applied for the equipment manufacturing testing installation and commissioning, for approval.

During the design stage the Contractor shall provide indexed lists (in English), of all referenced standards, codes and their referred associated standards, to which the Plant and Works are to be performed. It is the Contractor's responsibility to provide sufficient evidence that any national or other standard the Contractor proposes (other than those mentioned above) will ensure an equivalent or higher standard.

Further, equipment, components, tests and installations shall comply with relevant Zambian laws, by-laws, rules, recommendations as well as standards and specifications listed below. Applicable codes and standards will not only be limited to the ones stated in Table 1-1-1.

More other relevant, suitable, superior or better and applicable standards will apply where required.

Table 1-1-1 Applicable regulatory and specific requirements for the project

1. Electricity Act Cap 433 of the Laws of Zambia
2. Factories Act Cap 441 of the Laws of Zambia
3. Energy Regulation Act Chapter 436 of the Laws of Zambia
4. Engineering Institution of Zambia Act Chapter 432
5. Electricity (Grid Code) Regulations 2013, SI 79 of 2013
6. ZESCO Civil work standards
7. Project Specific requirements
8. ZESCO Transmission Protection Philosophy

Where the Project Specific Requirements and ZESCO specifications not are fully applicable the following codes and standards shall be applied as complimentary minimum requirements (Table 1). Where no standards exist, as in the case of patent or special materials, all such materials and workmanship shall be of the best quality, and full details of the material and any quality control tests to which they may be subject shall be submitted to the Engineer for approval.

Attention is drawn to the climatic and environmental conditions in the project area as well as the altitude above the sea level and, where applicable in the codes and/or standards, a suitable de-rating factor must be applied.

The Contractor shall prove that the equipment, components, tests and installations fully comply with the requirements in this subsection. This is done by successful meeting of tests and inspections witnessed by the Engineer and during review of documentation.

Table 1-1-2 Additional Acceptable standards

Standardisation by	Construction/Installation
IEC (International Electro-technical Commission), DIN (Deutsche Industrie Norm)	Electrical equipment and electrical installations
CEE (Commission Electrical Equipment)	
EN	
VDE (Verband Deutscher Elektrotechniker)	
IEEE (Institute of Electrical and Electronics Engineers)	
ITU (International Telecommunications Union)	Communication Network

CENELEC (Comité Européen de Normalisation Electrotechnique)	Electromagnetic Compatibility, cables
Eurocode, British Standards (BS)	Site Investigations, Testing Aggregates, Foundations, Civil Works, Earthquake
Eurocode and ASTM	Steel construction/structures
DIN/VDE	Galvanising

1.4.9 System of Units

The International System of Units (metric system) as specified in IEC shall be used throughout the Contract. The ISO system for units and delimitation of numbers and digits allows either a comma (,) on the line or a dot (.) on the line to be used as the decimal delimiters. A narrow space and commas may be used as the thousand delimiter.

(Ref. ISO 80000-1:2009: Quantities and units Part 1: General 7.3.2 Decimal sign p.27)

1.4.10 Hierarchy of Standards

Compliance with IEC standards is mandatory under this Contract. Where British Standards (BS) or other national standards are referenced, they shall be considered as guidance. The order of precedence shall be: (i) applicable laws and statutory/regulatory requirements; (ii) the Contract, including Section VII and the Technical Schedules; (iii) the Zambia Grid Code and identified ZESCO standards; and (iv) the referenced IEC/IEEE/ISO and other international standards. Where two requirements at the same level conflict, the more stringent requirement shall apply, provided it does not conflict with a higher-order requirement.

1.5 Work in Existing Substations and Connections to Existing Networks

All work in existing substations and at sites for connection of existing networks shall be planned in close cooperation with the Engineer and carried out by qualified personnel.

For work that will be carried out in live ZESCO substations, only short interruptions for temporary connections shall be permitted. Also, safety measures including provision of barriers shall be put in place. The Contractor shall arrange for all temporary connections and safety barriers, which shall be approved by the Consultant, and ultimately ZESCO System Operations.

Work on existing installations (switchgear, control panels and other equipment) shall be performed with special care. The existing equipment is often older and manufactured according to different standard. The Contractor’s personnel may need additional training before conducting such works. If necessary, the Contractor shall bring specialists to site to

supervise such works. To this end, strong involvement of relevant ZESCO staff shall also be facilitated.

All work in existing substations and at sites for connection of existing networks shall be planned in close cooperation with the Engineer and ZESCO and carried out by qualified personnel.

- The works shall be done in accordance with a specified plan submitted by the Contractor and which has been approved by the Engineer.
- The Contractor shall have an approved Health and Safety officer at site during all Works on site.

1.6 Reporting and Meetings

The Contractor shall submit for review, within 4 weeks of the starting date of the Contract, an outline design, manufacture, delivery, construction, and erection chart. Within a further period of 4 weeks the Contractor shall provide a detailed programme in a format to be agreed by the Engineer; this programme shall also include details of drawing submissions.

The Contractor shall submit to the Employer at monthly intervals, not later than the seventh day of the following month.

The Contractor shall prepare monthly reports divided by sites including:

- The progress and status of all activities (in %)
- Summary of the works planned for the upcoming month
- List of claims, if any
- List of invoices
- Summary of payments received
- Quality assurance issues
- Environment protection issues
- Community Liasons, Grievance Redress Mechanism (GRM) reported issues
- SEA/SH, GBV, and other gender issues including prevention awareness programs on including on HIV/AIDS issues

Site Meetings should be held weekly and other times as called for. The Engineer’s authorised site representative will chair the meeting and prepare brief minutes to be distributed to all participants by e-mail. The meeting shall cover planning for the coming work period, critical issues and issues to be carried out by the Employer, safety precautions etc.

Reports shall include a chart detailing plant manufacture, delivery, and erection. The chart shall indicate all phases of the work with provision for modification if found necessary during execution of the Works.

The design aspect of the progress report shall include a comprehensive statement on drawings and calculations submitted for review.

The section on manufacture shall indicate dates of arrival of material, the progress of manufacture and testing and shall state the date on which the material will be ready for transport. Any events which may adversely affect completion in the manufacturer’s works shall also be reported.

The shipping or transport of each order shall be monitored in the progress report and shall give the date when equipment is available for transport, the expected time of delivery to site and the dates actually achieved.

The Contractor shall forward two hard copies of each progress report to the Employer as well as submit digital format report via email/cloud service. If during the execution of the Contract the Employer considers the progress position of any section of the work to be unsatisfactory the Employer shall be at liberty to call progress meetings at site or in his office with a responsible representative of the Contractor.

1.7 Local Involvement

Contractor shall maintain verifiable records supporting local engagement reporting and a summary included in the monthly progress report. Employer may conduct periodic reviews of evidence and request corrective action plans where reported values are materially inaccurate or where KPIs trend negatively.

Contractor is encouraged to source locally where consistent with specifications, quality, and schedule (e.g., aggregates, concrete, rebar, site logistics).

Contractor is encouraged to increase the participation of women in the Project workforce and subcontracting chain and delivery of Social Awareness sessions including SEAH/GBV/HIV topics.

Contractor is encouraged to support local participation of non-mandatory base to cover local women’s participation, subcontracting to Zambian firms (including women owned).

Contractor must plan the implementation of onthejob training (OJT) for ZESCO staff during installation, commissioning and SAT, covering critical equipment and systems.

2 Contractor's Design

2.1 Suitability of the Design

The work shall include the Contractor's detailed design needed to manufacture, supply, erect, construct, test, commission, operate and maintain all equipment and plant, etc. in accordance with the functional requirements of this specification, drawings and schedules.

All design carried out by the Contractor is subject to the Engineer's approval, before manufacture of the equipment. The Engineer's approval shall, however, not relieve the Contractor of any of his obligations under the Contract.

In the design, particular attention shall be paid to the following points:

- Safety of operation and maintenance personnel
- Reliability and continuity in service
- Ease of inspection and maintenance
- Ease and clarity of operation
- Freedom from undue vibration and noise
- Exclusion of vermin, birds, animals and insects
- Precautions to minimise fire risk
- Long life of equipment
- Prevention of corrosion considering local environmental conditions
- Prevention of damages due to lightning and local climatic conditions

The Contractor shall prior to his design prepare a Design Manual. The Design Manual shall define all important design criteria which the Contractor intends to use in his design of the Works, as well as describe materials and work methodology, which are proposed by the Contractor in order to meet the design criteria. The design criteria shall be based on the Employer's Requirements. The design criteria shall be supplemented by the results of the Contractor's scrutinising of the relevant standards, information on local conditions, soil investigations, inspection of the site etc. The Contractor shall obtain the Engineer's consent of the Design Manual prior his design of the Works.

2.2 Interchangeability

To limit the required stock of spare parts, all equipment and parts performing similar functions shall be interchangeable where possible.

2.3 Design Temperature

The Contractor shall in his design account for the temperature rise deriving from installed equipment and from solar radiation in such a way that the rated performance and stability of the plant is guaranteed under the prevailing climatic conditions in Zambia.

2.4 Tropicalisation

All enclosures shall be designed to minimise condensation, with provision for ventilation and drainage as appropriate.

All electrical cubicles shall be equipped with suitable dimensioned electric heaters for automatic moisture control, mastered by a hygrometer in the cubicle.

All materials, which will be exposed to direct sun, shall be made of UV-resistant materials.

All equipment shall be designed to withstand attack from insects, vermin, rodents, etc. for instance by careful selection of materials, chemical preservation, mechanical termite barriers, etc. All enclosures containing electrical or mechanical equipment shall be provided with gaskets, steel mesh or similar effective protection against intrusion of insects, etc. Openings for ventilation and drainage must not give access to dust, vermin or termites.

2.5 Structures

All structures shall be designed to suit the service conditions specified, the load imposed to them, including any temporary load during erection and maintenance, and any appropriate mechanical and electrical clearance requirements. Suitable precautions shall be taken to prevent electrolytic corrosion between different metals.

2.6 Foundations

The Contractor has the responsibility for the design and construction, including excavation, of the foundations and shall submit design and construction drawings and information for approval within three months from the Commencement Date. The foundation design shall be based on the loads deriving from installation and normal conditions at the specific site. The Contractor shall supply template, anchor bolts and other components to be cast in the foundations.

2.7 Geotechnical Investigations

There is a geotechnical report available covering proposed 330 kV Nakonde Stepdown substation for bidding purposes. The Contractor shall be responsible, at costs included in the Schedule of Quantities, for ascertaining that the foundations to be employed are suitable for the sub-soils encountered at each proposed location of key equipment such as gantries, main

primary equipment switch gear, reactors, transformers and control Building. For this purpose, the Contractor will be responsible for the classifying of the sub-soils at each foundation location at an early stage of the Contract.

Consequently, the Contractor shall perform Geotech investigations at all substation sites and in case of larger foundations for building, reactors, transformers and gantries at specific locations to the depth and methods approved by the Engineer. The details of performing the tests, tools and equipment to be used shall be submitted to the Engineer for approval.

The minimum extent of geotechnical investigations shall be as follows:

- Geotechnical investigations shall include proposed location of key equipment such as gantries, main primary equipment switch gear, reactors, transformers and control Building.
- For Nakonde Stepdown substation, the geotechnical tests shall be done with a minimum of 18 pits x 4m deep, in relation to the key substation equipment points and 4 pits x 4m deep at the proposed STATCOM location including soil resistivity for earthing and slope stability analysis to avoid erosion during rains.
- For Kasama substation, the geotechnical tests shall be done with a minimum of 2 pits x 6m deep, including soil resistivity for earthing and slope stability analysis to avoid erosion during rains in relation to the key equipment points. Dynamic Probing Super Heavy (DPSH) and shallow test pit with soil classification.
- Standard Penetration Tests (SPT) or CPT for all points.
- Vane shear tests.

Further, the Contractor, using a reputable and locally registered firm (subject to the Employer’s approval), is to provide an interpretative geotechnical report for review by the Employer/Employer’s Representative to confirm the criteria to be used in the foundation designs. This report shall include at least the following information:

- a. A detailed record of all factual information obtained in the field and via laboratory testing, including detailed borelogs, description of the different layers, stability of side slopes etc.,
- b. Identification of all elements of contaminated material providing advice on their extent and the potential impact on personal health and durability of construction materials,
- c. Accurate logging of groundwater levels including global and perched,
- d. The results of the investigations into the soil resistivity and thermal resistance necessary for the design of the earthing rods,
- e. Foundation design parameters,

- f. Detailed recommendations regarding any specialist foundation solutions, including piling, soil improvement techniques etc.,
- g. Location of the site and Coordination of the substation,
- h. Boreholes (Trial pits) coordination and logs information,
- i. Depth of the Boreholes and trial pits,
- j. The Ground Water Conditions and specially the Ground Water Level,
- k. General geological Information of the region,
- l. Permeability and Consistency tests,
- m. Seismicity of the construction site,
- n. Earthquake acceleration coefficient,
- o. Results of the SPT (Standard Penetration Test),
- p. Soil Classification-Results of the Hydrometer test, Particle size analysis, Determination of Atterberg limits,
- q. Results of the Direct Shear Test,
- r. Chemical analysis of soil samples for determining soil properties and recommendations for the concrete criteria considering the Sulphate and chloride content of the samples and prevailing exposure conditions,
- s. Important characteristics of the soil layers like Cohesion coefficient (C), Angle of internal friction (ϕ),
- t. Immediate settlement and Consolidation settlement,
- u. Modulus of subgrade reactions (Ks),
- v. Coefficient of lateral earth pressure,
- w. Allowable slope of excavation,
- x. Depth of the poor soil,
- y. Recommendations for the foundation type,
- z. Cement type and water-cement ratio,
- aa. Allowable bearing capacity (q_{all}),
- bb. Soil Collapse potential,
- cc. Soil Liquefaction,
- dd. Earth resistivity test report,
- ee. Thermal resistivity test report,
- ff. Corrosion study report and
- gg. Conclusions and Guidelines.

The detailed programme shall be issued by the Contractor for the Engineer's approval. Additional borings may be ordered by the Engineer during the course of the work.

The sub-soil investigations shall be carried out under the supervision of a qualified soils engineer, who shall be subject to approval of the Engineer. Analyses of soil samples shall be

carried out by an approved soil test laboratory. All results together with geotechnical assessments and foundation recommendations shall be submitted to the Engineer as a soils report issued by a qualified geotechnical consultant.

Depending on the foundation type used, the Contractor shall be responsible for ascertaining that the sub-soil is not of a nature such as to cause corrosion of buried steelwork or deterioration of concrete.

The Contractor shall be responsible for any foundation settlement or failure due, in the opinion of the Engineer, to insufficient care having been taken in his investigation of ground conditions or in design or installation of the foundations.

Geotechnical investigations are deemed to be included in the Bid Price as well as soil resistivity tests. All mobilisation, demobilisation, general soil survey, transport and moving between tower sites, transport of samples, supervision, geotechnical assessments and reporting, etc. shall be included in the Bid Price.

The data obtained from each sub-soil test by the methods of test aforementioned shall include date of test, structure number, location, ground surface condition, test method, sample elevation, limit of strata, ground water level, expected maximum water level, soil classification and up to the depth of sub-soil test, and laboratory test data. The data thus obtained shall be prepared in final approved form to show the nature and extent of the soil strata over the area under consideration and recommended bearing capacities.

Selection of foundation type shall be made for each group of foundation with ground conditions. The Engineer reserves the right to make final selection of foundation type for each site based upon its judgement of the nature of sub-soil conditions or other factors affecting construction or operation.

Four copies of the final geotechnical report and foundation list in an approved form shall be submitted for approval of the Engineer. All sub-soil investigations and tests shall be made as soon as possible after award of the Contract. Field and laboratory test logs shall be submitted to the Engineer as agreed.

2.8 Basic Electrical System Design

Main electrical design data is shown in the Technical Schedules. Co-ordination of insulation shall be carried out according to the IEC 60071-1 and VDE 0210.

All design carried out by the Contractor shall consider all requirements of the Facilities. The Contractor shall be entirely responsible for all design carried out by him. All design calculations shall be subject to the review of the Employer and/or Consultant.

Table 2-1: Electrical system and design data for substations, corrected for altitude according to IEC 60071-2 (Altitude correction factor =1.13)**Main Design Data 330 kV, 2000 m.a.s.l**

Item	Description	Required	Unit
0.2.1	Nominal system voltage, U_n ;	330	kV r.m.s
0.2.2	Rated voltage, U_r ;	362	kV r.m.s
0.2.3	Rated short time current (1 sec);	40	kA
0.2.4	Rated short-duration power frequency withstand voltage	580	kV r.m.s
0.2.5	Rated lightning impulse withstand voltage	1,245	kVp
0.2.6	Rated switching impulse withstand voltage phase to earth	1080	kVp
0.2.7	Rated switching impulse withstand voltage, phase to phase ratio to the phase to earth peak value	1.50	-
0.2.8	Rated frequency, f ;	50 $\pm$ 2.5%	Hz
0.2.9	Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)	mm/kV
0.2.10	Minimum clearance, phase to phase;	3842	mm
0.2.11	Minimum clearance, phase to earth;	3390	mm
0.2.12	Safe working clearance (to the nearest live conductor in air);	5933	mm
0.2.13	Minimum height of support structure	2825	mm
0.2.14	Bay width;	21000	mm
0.2.15	Voltage quality	$\pm$ 5	%
0.2.16	Frequency quality	$\pm$ 2.5	%
0.2.17	System earthing;	Effectively grounded	-

Main Design Data 132 kV, 2000 m.a.s.l

Item	Description	Required	Unit
0.3.1	Nominal system voltage, U_n ;	66	kV r.m.s
0.3.2	Rated voltage, U_r ;	145	kV r.m.s
0.3.3	Rated short time current (3 sec);	31.5	kA
0.3.4	Rated short-duration power frequency withstand voltage	311	kV r.m.s
0.3.5	Rated lightning impulse withstand voltage	735	kV r.m.s
0.3.6	Rated switching impulse withstand voltage	356	kVp
0.3.7	Rated frequency, f ;	50 $\pm$ 2.5%	Hz
0.3.8	Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)	mm/kV
0.3.9	Minimum clearance, phase to phase;	1774	mm

0.3.10	Minimum clearance, phase to earth;	1398	mm
0.3.11	Safe working clearance (to the nearest live conductor in air);	4945	mm
0.3.12	Bay width;	12200	mm
0.3.13	Voltage quality	±5	%
0.3.14	Frequency quality	±2.5	%
0.3.15	System earthing;	Effectively grounded	-

Main Design Data 11 kV, 2000 m.a.s.l

Description	Required	Unit
Nominal system voltage, U_n ;	11	kV r.m.s
Rated voltage, U_r ;	12	kV r.m.s
Rated short time current (3 sec);	31.5	kA
Rated short-duration power frequency withstand voltage (phase to earth and between phases);	32	kV r.m.s
Rated short-duration power frequency withstand voltage (across open breaker gap and/or isolating distance);	32	kV r.m.s
Rated lightning impulse withstand voltage (phase to earth and between phases);	85	kVp
Rated lightning impulse withstand voltage (across open breaker gap and/or isolating distance);	85	kVp
Rated frequency, f ;	50 ±2.5%	Hz
Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)	mm/kV
Minimum clearance, phase to phase;	305	mm
Minimum clearance, phase to earth;	226.2	mm
Safe working clearance (to the nearest live conductor in air);	2938	mm
System earthing;	Effectively grounded	-
Voltage Quality	+/-10	%
Frequency Quality	+/- 2.5	%

Main Design Data 0.4 kV, 2000 m.a.s.l

The low-voltage systems shall be designed as TN-S system in accordance with IEC 60364.

Description	Required	Unit
Nominal system voltage, U_n ;	0.4	kV r.m.s
Rated voltage, U_r ;	1	kV r.m.s
Rated short time current (3 sec);	7.5	kA
Rated short-duration power frequency withstand voltage (phase to earth and between phases);	2.3	kV r.m.s
Rated short-duration power frequency withstand voltage (across open breaker gap and/or isolating distance);	2.3	kV r.m.s
Rated lightning impulse withstand voltage (phase to earth and between phases);	7.9	kVp
Rated lightning impulse withstand voltage (across open breaker gap and/or isolating distance);	7.9	kVp
Rated frequency, f ;	50 $\pm$ 2.5%	Hz
System earthing;	Effectively grounded	-
Voltage Quality	+/-10	%
Frequency Quality	+/- 2.5	%
Creepage Distance (IEC60815, USCD)	53.7	mm/kV

2.8.1 Pollution

The IEC 60815 (2008) standard defines five classes of pollution characterizing the site severity. Each class is associated with a minimum creepage distance.

Table 2-2: Pollution class and minimum Unified Specific Creepage Distance (USCD)

Class	Pollution	Minimum USCD* [mm/kV]	Minimum SCD [mm/kV]
e	Very heavy	53.7	31.0

Table 2-3: Electrical system and design data, not corrected for altitude

Nominal System Voltage, U_n	330 kV	132(66) kV	11 kV
Highest voltage for equipment, U_m	362 kV	145 kV	12 kV
Minimum Clearance			
Phase to Earth	3000 mm	1300 mm	200 mm
Phase to Phase	3400 mm	1650 mm	270 mm

Nominal System Voltage, U_n	330 kV	132(66) kV	11 kV
Safe Working Clearance	5.3 m	4.6 m	2.6 m

2.8.2 Design of Electrical Circuits

The Contractor shall comply with the requirements for earthing specified in the IEC60364 Standard.

Short circuit protection shall be included. All design carried out by the Contractor shall take into account all requirements of the Facilities. The Contractor shall be entirely responsible for all design carried out by him. All design calculations shall be subject to the review of the Engineer.

2.8.3 System Calculations

Phase and Neutral Reactor/Surge Arrester Sizing

The Contractor shall carry out all the phase and neutral reactor /neutral surge arrester sizing validation in order to show that the total system provides safety levels, power system protection and protection coordination, which meet the requirements in applicable IEC Standards and fits the existing power system protection. The neutral reactors technical requirements given in this bid are provisional. It shall be a responsibility of the Contractor to coordinate with the employer to get requisite switching studies information for the Kasama-Nakonde double transmission line and the due associated circuits for EMTP modelling simulations. The contractor shall be responsible for carrying out detailed switching studies for the Kasama and Nakonde stepdown phase and neutral reactors. Through these studies the contractor shall ascertain the arc recovery voltages and related neutral current for the Kasama and Nakonde line reactors and optimize the neutral reactor sizes for arc extinction and optimal dead times for High Speed Single Pole Auto Reclose (SPAR) dead times. Further, through these studies the Contractor shall validate the switching insulation requirements for the neutral and phase reactors. The software proposed by the Contractor for the power system calculations shall be presented to the Engineer for his consent.

The procedures for the design and approval of the designers shall follow the requirements in the Contract, e.g. this Employer's Requirements. The Contractor shall submit his design calculations including proposed settings of the power system protection to the Engineer for his consent.

The 3-phase fault levels for the project substations as per feasibility studies are as follows;

Table 2-4: Three phase fault levels

Substation	Voltage (kV)	Fault level (kA)
Kasama	330	5.01
Nakonde Stepdown	330	4.41

The standard ZESCO Limited short circuit capacities for the 330kV, 132kV, 11kV and 400V equipment given under Technical Schedules are higher than the simulated values and shall be used in the design.

Earthing Design Studies

The contractor shall carry out short circuit analysis in the project area (3-phase and ground faults). Ground fault analysis results shall be used for substation earthing design details that shall include site-specific soil resistivity measurements, step and touch voltage limits per IEEE Std 80, and uniform grid design.

2.8.4 Protection Philosophy

The applicable protection philosophy is as follows:

Transmission Lines

- **330kV transmission line**
 - i. Main 1 – differential protection system with an optic fibre link.
 - ii. Main 2 – line distance protection system with an optic fibre link and full scheme permissive under reach (3 forward zones and 1 reverse zone).
The mandatory features shall include breaker failure, auto-reclosing (single-pole high speed auto-reclosing 500-700ms and three-pole delayed auto-reclosing 10-15s), synchronization check, permissive directional earth-fault, power swing blocking, trip-circuit supervision, VT/Relay DC supervision and reverse & forward under/over power protection features in Main 1 and Main 2.
 - iii. Stand-alone bay control unit.
 - iv. Single pole segregated trip circuit supervision.
 - v. Main 1 and Main 2 station transformers, 400V AC supplies, DC chargers, DC and AC distribution board, DC batteries and breaker closing and tripping coils.
- **132kV transmission line**
 - i. Main 1 – line distance protection system with an optic fibre link and full scheme permissive under reach (3 forward zones and 1 reverse zone). The main features shall be breaker failure, auto-reclosing (three-pole delayed auto-reclosing 10-15s), synchronization check, permissive directional earthfault, power swing blocking,

- trip-circuit supervision, VT/Relay DC supervision and reverse & forward under/over power protection.
 - ii. Back-up protection – Overcurrent and earthfault protection.
 - iii. Stand-alone bay control unit.
 - iv. Three pole segregated trip circuit supervision.
 - v. One set of station transformers, 400V AC supplies, DC chargers, DC and AC distribution board, DC batteries and breaker closing and tripping coils.
- **11kV feeder**
 - i. 11kV indoor circuit breaker complete with overcurrent/earthfault protection.
 - ii. Bay control unit.

330/xxkV Transformer/330kV Reactor

- i. Main 1 – differential protection with the following features; restricted earthfault protection, phase differential, breaker failure protection, overcurrent and earthfault, Transformer Mechanical Protections (oil and winding temperature, Buchholz, pressure relief).
- ii. Main 2 – differential protection with the following features; restricted earthfault protection, phase differential, breaker failure protection, overcurrent and earthfault, Transformer Mechanical Protections (oil and winding temperature, Buchholz, pressure relief).
- iii. Stand-alone bay control unit.
- iv. Automatic Voltage Regulator with at least the following features:
 - Master/follower
 - Local/Remote
 - Circulating current/out of tap step
 - Independent/parallel

330kV and 132kV Busbar protection

The busbar protection schemes shall apply for 132kV and above substations. This shall be a low impedance scheme with zones defined by the number of sections of busbars and shall have inputs from all the bays. The tripping matrix shall be three pole and determined by the status of the main and reserve busbars isolators. The busbar protection scheme shall also be initiated by binary inputs of breaker failure from the bays.

2.8.5 Low-voltage Circuits

Each multi-core cable shall be used for one type of function only, e.g. power cables, control cables, instrument cables, etc. Conductor cross-sections shall be selected to conform to the expected current, the protection against overload and short circuits etc. However, for circuits operated at 220V and above, conductor cross-section shall not be less than 1.5 mm². The Contractor shall carry out all the necessary calculations in order to show that the total system provides safety levels, which meet the requirements in IEC Standards or IEE Wiring Regulations.

2.9 Interference

All electrical apparatus must be adequately designed in order to reduce interference with radio and other electronic communication equipment to a minimum, at least to the requirements in relevant EMC-standards. In case the Materials are manufactured in EU, they shall be provided with CE-marking according to EU directives 89/336/EEC, 92/31/EEC and 93/68/EEC.

2.10 Lightning and Over-voltage Protection

The station equipment and cables shall be protected by surge arresters installed at the end of the overhead line approaching the station and at all cable ends in open air.

2.11 Protection for Safety

The Contractor shall design the overall system of protection for safety in connection with the O&M works. Provisions shall be made to ensure easy access and adequate level of safety during inspections and maintenance operations.

2.12 Fire Protection

The design and construction of substations shall comply with the most restrictive of the following requirements and other requirements of this document:

- a) As a minimum, all new substation buildings (including floors, ceilings, conduits, roof supporting structural assembly etc.) shall be of non-combustible or limited combustible construction and material;
- b) Battery rooms or areas in control buildings shall be provided with adequate active ventilation to provide adequate diffusion of hydrogen and oxygen gases that evolve on battery charging;

- c) Penetration of conduits and cables through firewalls shall be provided with a fire break or seal conforming to requirements of the applicable standards, codes and ZS 791 at ceiling, wall and floor penetration;
- d) The provision of fire alarm and detection systems shall be required based on the size and hazard of the new buildings;
- e) For all new buildings within the Scope of Supply, a fire alarm Control Panel shall be included. There shall be an appropriate number and type of detectors for all rooms and spaces including access shafts, cable routes etc.
- f) The fire alarm control panel shall have indications for floors and zones and shall process required operation functions such as ventilation control, shut-downs and alarms (fire and system) to the station control system. Audible alarms and flashing lights shall be installed (types and quantities as required) and controlled by the fire alarm control panels.
- g) The automatic fire-suppression system shall be provided for power transformers for the purpose of personnel safety, asset preservation, and business continuity.
- h) The new Main transformers and Reactors within the Scope of Supply shall each be equipped with a SERGI fire detection and suppression system **or equivalent** as prescribed in the technical schedules.
- i) Substation buildings having mineral oil filled equipment or a travel distance of more than 30m to an exit shall have two or more exits located at opposite ends of the building. Doors shall open outwards with the direction of travel and be equipped with interior vertical panic hardware to allow exit even if locked. Exit doors shall not be padlocked, bolted, or physically impeded in any way to allow exit during a fire or other emergency condition.
- j) Portable fire extinguisher shall be installed in substations based on type of hazard(s) present at suitably identified locations.
- k) The substation designer shall provide for the oil-spill containment in order to achieve fire protection and environmental protection.
- l) Fire barriers (blast walls, fire trap doors etc.) shall be of suitable construction to maintain effectiveness throughout the duration of the expected fire. Fire barriers shall be designed to withstand wind loads, seismic loads, and blast pressures, as applicable. Note that where separation distance as tabulated in table below are met, fire walls are not required.
- m) Individual pieces of mineral-oil-insulated equipment (transformers, inductors, capacitors etc.) shall be separated from the anticipated flame fronts or one another by the minimum distances given in the table below. Separation distances to adjacent equipment should be measured from the edge of the postulated flame front to the nearest mineral-oil-filled component of the adjacent equipment.

Table 2-5: Minimum separation distance

Mineral oil volume (Litres)	Minimum separation distance (Meters)
1 000 to 18 000	8
> 18 000	15

2.13 IT Security

The new or adapted substation system for SCADA connection (Servers, MUX, Gateway, HMI, Switches etc.) shall be protected from attempted intrusions and cyber-attacks, unauthorized change of data or that unauthorized individuals gain access at the level of data communication network and control system controllers.

IT and information security need to comply with applicable parts of standards such as ISO/IEC 27001, IEC 62443, IEC 62351 or other applicable commonly accepted industry OT-security requirements, recommendations and guidelines.

Addressing IT and information security also means adhering to good practices like keeping information assets secure, keeping software up to date, utilizing segmentation by next generation firewalls, air-gapping Operation Technology systems from other system as much as possible, having a prepared incident response, performing training, and verifying backup systems and routines.

Switches will be the interface for a lot of services used in substations and therefore it is important to keep the security level on alert.

The Bidder shall in its solution ensure that IT security and IT security function is a vital part of the delivered solution for each substation and power plant. Furthermore, the bidder shall provide a cyber-security architecture (segmentation, access control, logging, patch management) for the SAS, metering and WAMPACS networks consistent with ZESCO policies and the Zambia Grid Code.

An IT Security Plan shall be delivered and approved by the Employer before any installation work begins. This shall be stated in the bid document and include, but not be limited to:

- Secure System Architecture: Individual components, project specific configurations and the entire system shall be designed and developed to support secure operations. This shall be documented in detail.
- The WAN must be hardened and there shall be functions such as ports that are not in use shall be blocked, account that are not in use shall be removed and services that are not in use shall be inactivated.
- All communication equipment on the WAN shall have authentication and no default passwords are allowed. Passwords cannot be sent as clear text.

- Authentication system shall be able to identify all human users due to IEC-62443-3-3. It must also be able to identify and authenticate all software processes and other equipment such as SCADA front end, surveillance and analysis systems.
- Authentication can be performed by passwords, pre-shared keys and certificates. All authentication privileges shall be limited in time and not last forever.
- Access-list shall be active. No default settings are allowed and all services that will not be used shall be blocked. Whitelisting shall be performed and approved by the employer.
- Protection against Denial of Service.
- Encryption shall be active. The solution shall not be based on proprietary (proprietary or closed) solutions for encryption or cryptographic technology.
- USB ports shall be blocked and other and/or other communication ports that is not in use shall not be active.
- Unauthorized attempts to log in shall be logged.
- Administration of user accounts and passwords. Default passwords are not allowed. There must be several grades of authorization such as Operator, Administrator etc.
- Whitelisting must be performed before commission of systems.

All components of the base system shall be permanently hardened according to recognized best practice guidelines and the latest service packs and security patches shall be installed. Unnecessary users, default users, software, network protocols and services shall be uninstalled or – where an uninstall isn’t possible – permanently deactivated and protected from accidental reactivation.

The entire system’s secure basic configuration shall be reviewed and documented.

3 Local Conditions

3.1 Project Area Altitudes

The sites spread as indicated on the map below.



Kasama substation

Kasama substation is located close to the town of Kasama at an altitude of 1335 m. Existing As-built documentation is corrected to a design site altitude of 2000 m. For the extension works, the Contractor shall harmonise all clearances for an altitude of 2000 m.

Nakonde Stepdown substation

The proposed substation location is close to the village of Barton and Longwani at an altitude of 1500 m. the contractor shall harmonise all clearances with the existing Kasama and Mpika substations and corrected for an altitude of 2000 m for easy inter-operability of spares.

3.2 Design temperature

The Contractor shall in his design account for the temperature rise deriving from installed equipment and from solar radiation in such a way that the rated performance and stability of the plant is guaranteed under the prevailing climatic conditions in the project area. The following temperatures apply:

- Minimum temperature of air -1°C
- Maximum temperature of air +45°C
- Maximum temperature of conductor +80 °C
- Maximum temperature of earth wire +50 °C

3.3 Solar radiation

The daily sunshine exposure is between 11 and 13 hours. Given the latitude and the altitude of the project area, a solar radiation of 1 035 W/m² is chosen.

3.4 Condensation and Tropical Protection

All enclosures shall be designed to minimise condensation, with provision for ventilation and drainage as appropriate. Openings for ventilation and drainage must not give access to sand, dust, vermin etc.

All electrical cubicles shall be equipped with suitable dimensioned electric heaters for automatic moisture control.

All materials, which will be exposed to direct sun, shall be made of UV-resistant materials.

All equipment shall be designed to withstand attack from insects, vermin, termites, rodents, etc. for instance by careful selection suitable resistant materials and design. All enclosures containing electrical or mechanical equipment shall be provided with gaskets, steel mesh or similar effective protection against intrusion.

3.5 Degree of Protection by Enclosure

Unless otherwise specified, all terminal boxes, cabinets, etc. shall have degrees of protection by enclosure, according to IEC 60529 as follows:

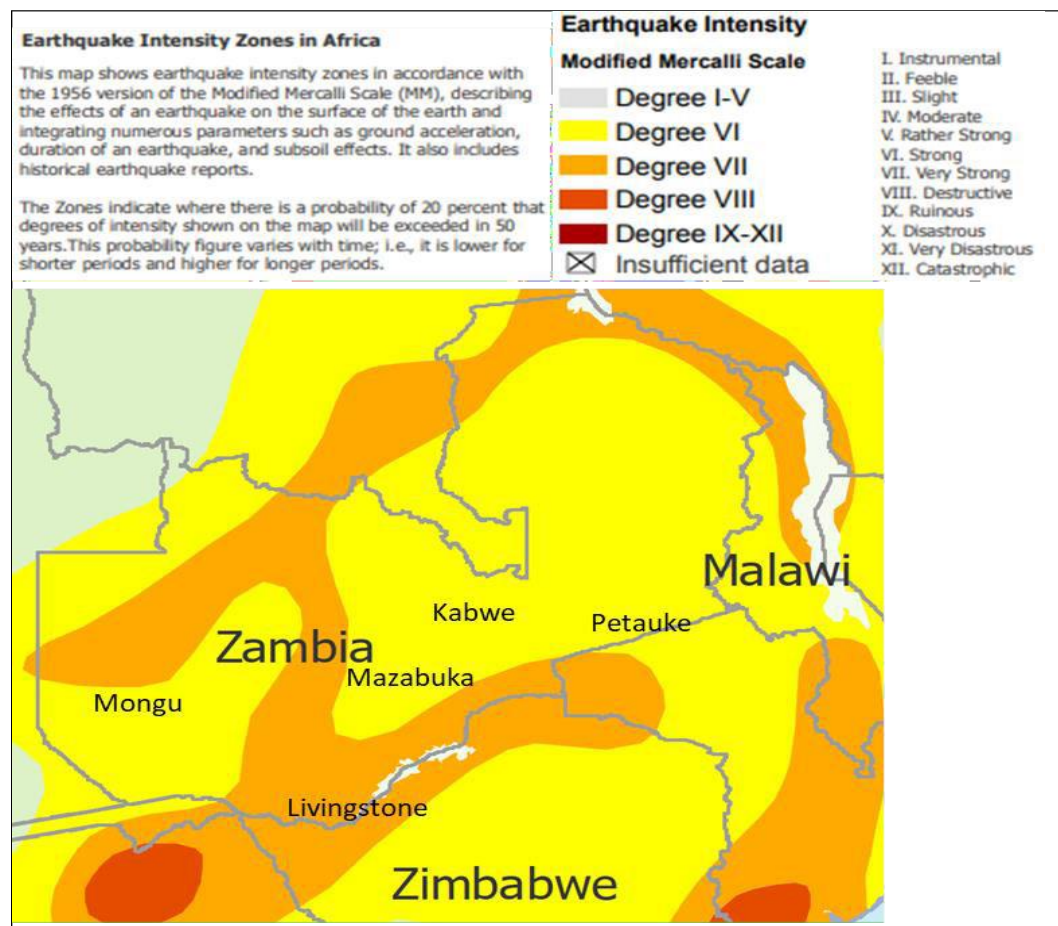
- Outdoor minimum IP 56
- Indoor minimum IP 54

3.6 Climatic Conditions

Climatic Conditions at Site are seen as given in the table below.

Table 3-1 General climate conditions in project area

Item	Unit	Ambient Conditions
Maximum outdoor temperature	°C	+45
Minimum outdoor temperature	°C	-1
Precipitation (rain)(Nominal)	mm/year	850-1200mm
Design wind speed (3 sec)	m/s	40
Lightning conditions	per/ km ² /Y	High, 10-16 flashes/km ² /year
Atmosphere pollutants		Medium/Dust
Relative humidity (min/max)	%	39/85
Maximum soil temperature (at 1 m depth)	°C	30
Maximum soil thermal resistivity	Km/W	1.2
Maximum solar radiation (insulation) on plan	W/m ²	1200
Exposed bare metal temperature	°C	+75
Altitude above sea level	m	1600
Seismic zone		Strong to Very strong (0.3 g)

Figure 1 Earthquake intensity map¹

3.7 Electrical Design Considerations

The insulation levels shall be valid at 2000 m above sea level, thus the withstand voltage values in the Technical Schedules are the calculated insulation levels according to IEC 60071-2 included recommended safety factor of 1.05.

Electrical System and Design Data according to Section 2.8 – Basic Electrical System Design and 16 Technical Schedule.

¹ OCHA Regional Office for Central and East Africa: Earthquake Risk in Africa: Modified Mercalli Scale. December 2007

4 Materials and Workmanship

All materials shall be new of the most recent models and of the highest quality.

The Contractor shall guarantee the availability of replacement components and equipment for a period of 10 years after Completion of Works.

Where corrosion due to atmospheric, electrolytic or other causes is likely to impair any part of the plant, suitable precautions shall be taken to prevent its occurrence.

The materials shall be free from any form for defects, cracks, scratches etc., and properly cleaned before installation and handing over.

The Contractor shall not make any work on material which has been treated for protection due to the environment, i.e. no machine or shop work, cutting, drilling, punching etc. is allowed unless agreed with the Engineer and provided that the protection can be restored to original level.

Repair of damaged material shall not be allowed if not agreed with the Engineer.

The Contractor shall submit test certificates in accordance with relevant standards, these Employer's Requirements and other parts of the Contract.

All materials used in the Works shall be subject to inspection and tests as the Engineer may direct from time to time as the Works proceeds.

The Contractor shall submit test certificated in accordance with relevant standards and these specifications.

Where particular manufactures are specified herein or in the Contract, no alternative makes shall be considered without the approval of the Engineer.

The Contractor shall be entirely responsible for all materials, apparatus, equipment, etc. furnished by him in connection with his work. Special precautions must be taken to protect the equipment from humidity during shipping, transport and storage.

All work, methods of work and workmanship, whether fully specified herein or not, shall be of the highest order. Competent workmen under skilled supervision shall carry out the work.

The Employer/Employer's Representative shall at any time have power to reject materials and workmanship not complying with this Specification or with the Drawings. Materials so rejected shall be immediately removed from site and replaced by materials of an approved standard at the expense of the Contractor. Rejected workmanship shall be broken out and replaced by work of an acceptable standard including the supply of new materials by the Contractor, at the expense of the Contractor, and without delay

The Contractor shall maintain a full and detailed inventory of all materials he delivers or has delivered to the site, and all manufacturers' labels, test certificates and documentation of the materials shall be maintained and presented to the Engineer on his request.

4.1 Corrosion Protection and Painting

Structures, conductors, fittings, equipment and other materials shall be treated to withstand the exposures from the atmosphere, during an expected lifetime of 25 years.

In general, hot dip galvanized items shall not be painted, except if damages to the galvanizing cannot otherwise be satisfactorily repaired or when specifically specified. All repair of galvanization shall be a subject to approval by the Engineer prior to such repair. Before any painting, the galvanised surfaces must be treated with an approved etching primer and an approved zinc primer.

All ferrous parts of the structures shall be effectively protected against corrosion by means of hot dip galvanising, if nothing else specified in the relevant clauses.

4.1.1 Galvanizing

Galvanizing shall be carried out by means of hot-dip galvanizing process according to the international standard ISO 1461, ASTM, A123, A153 and A767 resulting in the following minimum Zinc weight and corresponding surface cover (Zinc thickness):

The galvanizing process shall be carried out after complete manufacturing of parts to be galvanized. No manufacturing process shall be carried out after galvanizing, and no drilling, cutting or welding will be allowed at site of galvanized structures.

Zinc-coated steel wires (e.g. conductors) shall conform to IEC 60888, Regular steel grade and class 1 zinc coating. The zinc coating of the steel core shall be continuously smooth, of uniform thickness and adhere firmly to the steel. After galvanizing the wires shall not be subjected to any thermal process.

4.1.2 Painting

All steel parts, which shall not be galvanised, shall be treated effectively against corrosion after manufacturing. The treatment shall include sandblasting, anti-grease, primer and coating. The final coat of painting shall be homogenous and free for any kind of pores. The Contractor shall submit a certificate(s), which confirm that the proposed coatings are suitable for tropical climate.

Painting on cast iron and steel shall consist of four coatings with a total min. thickness of 160 µm. The two first coatings shall consist of primer, two-pack on epoxy-urethane base. Third and fourth coatings are finishing coatings with paint, two-pack on urethane base. Each coating shall have a min. thickness of 40 µm.

4.2 Structural Steel and Cast Iron

Structural steel shall be made by open-hearth basic oxygen or electric furnace process.

Only the following two strength classes shall be used:

- Low tensile steel with yield point from 220 to 260 N/mm²,
- High tensile steel with yield point from 300 to 350 N/mm².

The Contractor shall apply for the Engineer's approval of other steel qualities, if he intends to deviate from the specified two steel classes.

4.2.1 Bolts

Screws and nuts of property class 8.8 according to ISO 898-1 shall be used. Shortthreaded bolts with minimum tolerances and outlet of thread are especially applicable for high voltage poles and structures. M16 and M20 bolts are preferable in load carrying members. In secondary bracing a bolt size of M12 will be allowed. A washer DIN 7989 or equivalent approved by the Engineer apply under all nuts.

4.2.2 Cast Iron

Cast iron shall comply with the minimum requirements listed in 16 Technical Schedules.

5 DRAWINGS, DOCUMENTATION AND SAMPLES

5.1 Documentation

All drawings and documentation shall be in English language.

All drawings shall be to scale and comply in full of the Technical Specification and be fully detailed.

The contractor shall follow applicable drawing standard and forms that the Employer uses.

The electrical documentation shall be prepared in accordance with IEC 60617 and 61082.

The Contractor's Quality Assurance Manual shall show that the Contractor has a system ensuring that all documents, drawings, software programs, etc. are uniquely identified, designated and that it manages revisions.

The Contractor shall during the total project time maintain an up-to-date List of Documentation including date of original issue of the documents as well as dates of every revision. The list shall also indicate planned dates for submittal of documents.

The Employer is the owner of all documentation.

All drawings shall be drawn to one of the preferred scales quoted in Section 7 of BS Publication PD6031 or available on a standard ruler and on paper of the appropriate size from the International Series of A sizes.

All detail drawings submitted for review shall be to scale and of a size not less than 1/25 full size. All important dimensions shall be given and the material of which each part is to be constructed shall be indicated.

Except as otherwise specifically approved, all drawings shall be of size not greater than A0 (normally 841 mm x 1189 mm) not smaller than A4 (normally 210 mm x 297 mm). All prints shall be folded to A4 size and the title, drawing number and revision suffix shall remain visible.

All dimensions marked on the drawings shall be considered correct although measurement by scale may differ there from. Detailed drawings shall be acted on where they differ from general arrangement drawings.

All drawings submitted by the Contractor shall include the following particulars in a suitable format: Contractor's name, date, revision, scale, number and title of the drawing, contract number, and overhead line title and equipment description.

5.1.1 Documentation after Award of Contract

The Contractor shall prepare all documentation necessary for execution of the works. The documentation shall be prepared in such detail that not only can the works be executed on site, but also, in the opinion of the Engineer, sufficient for the Engineer's review and approval.

The Contractor shall submit all drawings or samples of materials for review in sufficient time to permit modifications to be made and the drawings or samples resubmitted without delaying the initial deliveries or the completion of the Contract Works.

Drawings marked RETURNED FOR CORRECTION shall be corrected by the Contractor and sent to the Engineer for further review. When a drawing is marked REVIEWED or REVIEWED AS AMENDED, the Contractor will be allowed to use the drawing for manufacture and erection. The Contractor shall, however, make corrections according to the remarks given by the Engineer. Manufacturing starting prior to receipt of "Reviewed" drawing is done at the Contractor's own responsibility.

All documents prepared by the Contractor shall be submitted in two sets to the Engineer and three sets to the Employer for review. Within twenty-one (21) days after receiving such documents, one copy of each document will be returned to the Contractor, dated, signed and commented where necessary. Documents for review shall also be included in the as-built documentation to a minimum as follows:

- Data specifications
- Routine certificates
- Data lists corresponding to schedules of this document
- Dimension drawings
- Detailed drawings as required by the Engineer
- List of components and details on the apparatuses, including dimensional sketches.

Manufacturing and/or ordering of material and equipment prior to the Contractors' receipt of returned documents marked Reviewed is done at the Contractors own risk.

The Contractor is responsible for ensuring that all inspections, tests etc. are carried out by authorised institutions in order to obtain required certificates.

Approval by the Engineer of working drawings shall neither relieve the Contractor of any of his obligations under the Contract, nor relieve him of correcting any errors found subsequently in the approved working drawings and in the work on the site or elsewhere associated therewith.

The documentation shall, as a minimum, consist of:

- Quality Assurance Manual for the project. Shall be submitted within two months after commencement date.
- Supervision Plan for works at the factory and on the site.
- Report on soil investigations.
- Design Manual.

- Foundation design, including calculations, quality requirements and construction drawings.
- Design and construction of major equipment.
- Design and construction drawings of earthing.
- Proposal on Contractor's facility area on the site.
- Calculation of electrical circuits.
- Detailed logistic plan defining the power shut down periods during implementation.
- Settings of protective relays.
- Site maps showing operation areas for erection equipment (cranes etc.) and for assembly.
- Substation specification as well as diagrams, drawings and tables of internal and external connections.
- Monthly reports including:
 - The progress and status of all activities (in %) based on the Price Schedules
 - Summary of the works planned for the upcoming month
 - List of claims, if any
 - List of invoices
 - List of personnel and equipment at site
 - Summary of payments received

The reports shall show the percentage completed works as per day 1 of every month. The Engineer shall receive the report within 10 days at the utmost.

- List of Content for Operation and Maintenance (O&M) Manuals.

During the execution of the works on the site, the Contractor shall record all information necessary for preparing as-built drawings. The drawings and other documents shall be available to the Engineer at any time during construction.

The Contractor shall keep the drawings up to date and keep on set at site including all changes made during the installation work.

The number of copies of each drawing or of any subsequent revision to be submitted to the Employer is given below. Following review, further copies of the reviewed drawing shall be supplied to the Employer for distribution to Employer and to Site.

Table 5-1: Number of drawing copies

	Prints	Electronic Copy by E-mail (see notes)	Electronic Copy – on media (USB)
<u><i>For approval</i></u>			
Calculations and drawings		2	
Other design documents		2	
Method statements		2	
Commissioning procedures		2	
<u><i>For construction</i></u>			
Calculations and drawings	3	2	
Other design documents	3	2	
Method Statements	3	2	
Commissioning procedures	3	2	
<u><i>Final records</i></u>			
Calculations and drawings	3	2	4
Other design documents	3	2	4
Method Statements	3	2	4
Commissioning procedures	3	2	4

5.1.2 Documentation before Test on Completion

One (1) month prior start of Tests on Completion, the Contactor shall propose a list of tests on completion to be carried out at the different equipment and complete primary and secondary systems, control, protection and communication systems. The documentation shall include but not be limited to:

- Certificates of already performed factory tests
- Detailed list and descriptions of tests for all equipment

- List of tests for whole systems
- Forms for detailed record of all types of tests
- Time schedule and sequence of tests
- Network calculations and protection coordination scheme including relay settings
- Setting for all control, protection and telecommunication equipment etc.

All the information in these manuals shall apply specifically to the equipment being supplied, and they shall be free from irrelevant matters and languages such as might be contained in the manufacturer’s general literature. Irrelevant languages are all other languages than English.

5.1.3 Documentation As-built

Two weeks prior starting test on completion the Contractor shall submit two (2) copies of as-built documentation in draft (one copy to the Engineer and one copy to the Employer).

Prior issuing of the Taking Over Certificate the Contractor shall supply six (6) copies of final As Built Documentation (five (5) to the Employer and one (1) to the Engineer). The Works shall not be completed for the purpose of taking-over until the Engineer has received the documents. Each copy shall be durably bound in a volume or volumes depending on bulk. All material except drawings shall have A4 size. Drawings shall be on international A-size sheets, preferably not exceeding 297 mm in height and shall be durably bound into the volume(s). Volume titles shall be clearly inscribed on the front cover and on the spine of the cover. Drawings and documents shall be marked AS-BUILT.

Together with the as-built documentation, the Contractor shall furnish two (2) sets of electronic copies of the manuals and drawings (drawings in AutoCAD format and documents in pdf format) on CD-ROM.

Technical particulars shall be delivered in a format compatible with the Employer’s network database software as listed below. The file format to be agreed with the Engineer.

- Transformer data
- HV/MV/LV cable data
- Conductor data
- HV/MV/LV equipment data

The following general manuals, covering the whole project shall be delivered as a minimum.

- A general description of the equipment of this contract
- Manuals shall include spare part lists and description of any special tools needed for maintenance of the equipment
- All other drawings and manuals which are not mentioned herein, but are deemed necessary for safe and proper handling of delivered equipment.

The following design documents shall be delivered as a minimum.

- All layouts, construction and installation drawings
- All calculations regarding civil, mechanical and electrical design
- Apparatus lists including all apparatuses installed, subdivided into voltage levels, type of apparatus and stations respectively
- Geographical maps showing location of lines, poles, joints, stations etc.
- Single line diagrams covering the Works, containing apparatus designations, cross sectional areas and types of cables and conductors.

All final as-built drawings and documents must be provided in PDF and native formats.

5.1.4 Drawing numbers

The Contractor will apply drawing numbers to all drawings, including those from sub-Contractors and those issued for information before they are submitted to the Employer. The Contractor’s drawing office will be expected to issue the numbers in batches that will cover broad subject areas. For instance, the Contractor might propose batches for primary equipment from OEMs, manuals and brochure of equipments, DC System drawings, protection drawings, metering drawings, telecommunication drawings, SAS drawings, low voltage AC system drawings, substation earthing drawings, civil & structural drawings and WAMPACS integration drawings, etc. The Contractor shall submit to the Employer for approval the subject areas he proposes to use prior to the issue of any drawing. The Contractor shall each month issue an up-to-date drawing list to the Employer.

5.1.5 Substation Drawings & Records

5.1.5.1 Drawings to be submitted during the contract period

- Single Line Diagram
- General Arrangement and Layout
- Earthing Layout
- Lighting Layout
- Procurement Documents
- Protection Drawings

5.1.5.2 Specific required Contractor’s Records

- As-built documents

5.1.6 Final Records

- As-builts documents
- Maintenance Plan

5.1.6.1 Final records - General Requirements

After completion of work on Site all Contract drawings shall be revised where necessary to show the equipment as installed and the number of copies of revised drawings as specified in this Section shall be submitted for review. A complete set of reviewed records shall be provided comprising, one full size reproducible copy and one full size print. Record drawings shall be endorsed “As Built” and shall be correctly titled and carry the Employer’s review number, Contractor’s drawing number and where appropriate Employer’s number allocated to the item.

After final review of the “As Built” record drawings the Contractor shall submit complete sets of records on compact discs, one of which is for Employer as detailed in Part 2. Electronic copies of the drawings shall be in electronic format suitable for reproduction on paper using Employer’s preferred software packages. Each disc shall provide a comprehensive drawing list containing the drawing number, sheet, revision, and title of every drawing. Each single file drawing record shall be self-supporting without referencing other files. Non-standard items such as fonts, line types, etc. should not be used. If compression techniques are applied to files, then any software necessary to decompress the files shall be included on the discs. The Contractor shall ensure that all information contained on the discs has been checked for virus contamination. Each compact disc shall be supplied suitably encased and accompanied with printed documentation describing the contents of the compact discs, the formats and software used to compile the discs and the print hardware required to reproduce the record drawings.

Final record copies shall be handed over before the issue of the Taking Over Certificate.

5.1.7 Installation and maintenance instructions

The Contract Price shall be deemed to include illustrated installation and maintenance instructions written in English.

Before commencement of substation works the Contractor shall submit to the Employer for review fully detailed operating and maintenance instructions for all new substation equipment. Also, to be included are instructions on the method of erection and installation of all key substation equipment and the methods to be used for the erection of all equipment together with the necessary tests and checks to ensure fitting has been successfully affected.

The instructions are to be as simple and clear as possible, fully illustrated with drawings and diagrams as necessary and detailed with part numbers for ordering of replacements. Two (2) copies are required for use of the Employer during erection work.

Further copies are to be reproduced as a book or books of approximately A4 size and bound into strong black durable imitation leather covers inscribed upon the front generally in the

form of the title page to this document except that the references to Specification, Conditions of Contract, drawings, etc, will be replaced by “Installation and Maintenance Instructions”. The name of Employer shall be inscribed upon the spine. The finished books are to be handed to the Employer not later than one (1) month before the Taking-Over Certificate is issued.

6 Packing and Transport

Where necessary, double packing shall be used in order to prevent damage and corrosion during transportation, unloading, reloading and during intermediate storage.

All parts shall be suitably protected against corrosion, water, sand, heat, any adverse atmospheric conditions, shocks, impact, vibrations, etc. for later transport and storage.

Tube ends and other similar open ends shall be protected against external damage and ingress of dirt and moisture during transit and while awaiting erection at site. Flanged pipes shall have their open ends protected by adhesive tape or jointing and then be covered with a wooden blind flange.

Spare parts shall be packed for long duration storage. Items such as gaskets and seals have to be vacuum sealed packed.

The contents of the cases shall be bolted securely to the case or fastened in position with struts or cross battens, and not wedged in place with wooden shocks, unless these are fastened firmly in place. All struts or cross battens are preferably to be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases shall be up-ended after packing to prove that there is no movement of contents.

All cases, packages, etc. shall be clearly marked on the outside to indicate the total weight, the position of the centre of gravity and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

All packing shall be included in the scope of delivery and the cost is included in the prices. The packing materials shall be disposed by the Contractor, unless required otherwise by the Employer. The costs for the transport and unloading in the storage place as well as disposal of the packing materials shall be deemed to be included in the Contract Price.

All items supplied shall be robustly packed for export shipment to tropical climates to a standard at least equivalent to that specified below. Notwithstanding these requirements, the Contractor shall be entirely responsible for the safe transport of all materials to site.

Each item shall be packed properly for sea shipment, and transport from the place of manufacture to the site.

Precautions shall be taken to protect materials and equipment where they rest on wooden or other supports likely to contain moisture. At such points, wrapping-impregnated with anti-rust composition or vapour phase inhibitors shall be used and shall be of sufficient strength to resist chafing and indentation due to any movement which is likely to occur in transit. The form of the protective wrappings and impregnation shall be suitable for a usable period of not less than twelve months, and shall be approved by the Engineer.

Lids and internal cross-battens of all packing cases shall be fixed by screws and not nails. Screws shall be of correct length, to ensure that no sharp end protrude into the cases.

Hoop metal bindings of cases shall be sealed where ends meet and, if not of rustles material, shall be painted.

Contents of cases shall be bolted securely or fastened in position with struts or cross-battens, and not with wood chocks wedged in place, unless they are fastened firmly in place. All struts or cross-battens shall preferably be supported by cleats fixed to the case above and below to form ledges on which the batten may rest. Cases shall be upended after packing to prove that there is no movement of contents.

Where parts are required to be bolted to the sides of the case, large washers shall be used to distribute the pressure, and the timber is to be strengthened by means of a pad.

Bolts and nuts shall be double bagged and crated suitable for sea shipment.

Crating together of components of dissimilar metals shall be avoided.

The Contractor shall be required to protect all steelwork suitably before shipment to prevent damage to galvanized surfaces. The Contractor must also note that the sending to site of untreated or non-impregnated drums is at the Contractor’s risk. If any evidence is found by the Engineer of deterioration in drums on site that, in his opinion, might lead to delays in erection work, he shall forthwith order all remaining drums to be suitably protected before shipment at the Contractor’s own cost.

All stencil marks on the outside of cases either shall be of a waterproof material or protected by shellac or varnish to prevent obliteration in transit and in subsequent storage.

Wood wool shall not be used for packing purposes.

Waterproof paper and felt linings shall overlap at seams at least 13 mm, with the seams secured together in an approved manner, but the enclosure is to be provided with screened openings to obtain ventilation.

Where practicable, all indoor items, such as switch and control gear, instruments and panels, matching components, etc. shall be “cocooned” or covered in polythene sheeting, sealed at the joints and the enclosures provided internally with approved desiccators.

Each crate or package shall contain a packing list in a waterproof envelope. All items of material shall be clearly marked for easy identification against the packing list.

All cases, packages, etc. are to be clearly marked on the outside to indicate the total mass; to show where the mass is weight bearing; the correct position of the slings; and an identification mark relating them to the appropriate shipping documents.

The Engineer may require inspecting and approving the packing before the items are sealed and despatched. This inspection shall not relieve the Contractor from his sole responsibility

for ensuring that the packing is suitable for transit and such inspection will not exonerate the Contractor from any loss or damage due to faulty packing.

6.1 Preparation for Shipment

The Contractor shall prepare and pack all goods, equipment and materials for moist tropical ocean shipment in such a manner as to protect them from moisture, rain, rust, corrosion and shock in transit and also from damage either during storage at the site or while en route to the site. The Contractor shall be held responsible for all damages due to improper preparation and packing for shipment and storage.

Dimensions of packages, crates etc. shall be suitable for road transport. Instructions for handling shall be clearly marked on all parts, packages, crates etc.

Silica gel must be used to absorb condensation.

If nothing else required by the Custom Authorities at the time of delivery, each individual package of each shipment shall be marked for identification as follows:

NAME OF THE EMPLOYER:

CONTRACT NO:

CONTRACT NAME:

SHIPPING MARKS:

DESTINATION:

CONSIGNEE:

NAME OF EQUIPMENT:

GROSS WEIGHT (KG):

NET WEIGHT (KG):

DIMENSIONS:

CASE NO/BALE NO:

The identification mark shall be located at a conspicuous place on the package and be durable to withstand moisture, rain, sun, shock in transit etc. during the transport and storage.

All packages must be marked consecutively from No 1 up-wards throughout all shipments until completion of the Contract without repeating the same number.

In each package the following documents, if nothing else required by the Custom Authorities at time of shipping, shall be enclosed:

- Detailed packing list in two copies.
- Quality certificate in two copies.
- Technical documents for relevant equipment in one copy.
- Two copies of the systematic drawings for the equipment which require assembling on site.

Each shipment shall be accompanied by thorough handling instructions to the personnel.

The Engineer retains the right to check and inspect all material, goods and equipment prior to shipment. The checking and inspection will in no case release the Contractor from his responsibility to effect complete shipment.

6.2 Shipping Documentation

Full conformity to the requirements of the Customs Authorities in Zambia is absolutely necessary. An acceptable format of the information to be included in the shipping and invoicing documentation shall be agreed upon before the first shipment. The Contractor will have full responsibility for custom clearance. In case of failure to comply with the requirements, making it impossible to effect prompt customs clearance of the goods, the Contractor shall be held responsible for any charges, storage charges and any other additional charges that may be imposed as well as any delays of the project and associated costs.

The custom procedures specified in these Documents are for guidance only and may be changed. The Contractor shall prepare his own procedures in co-operation with the Custom Authorities and undertake the Engineer's approval of these procedures.

Copies of all shipping documents shall be submitted to the Engineer.

6.3 Transport

The Contractor shall provide a site-specific transportation plan to ensure equipment is delivered to the relevant substation site safely and on time. This should include as a minimum:

- Freight instructions/specifications
- Pro-forma packing lists
- Nominated freighting and forwarding companies
- Procedures for shipping release
- Route of land transportation / transport survey
- Unloading procedures
- Heavy lifting plan for bulky consignments / cargo
- Timing of freight and delivery

As part of the transportation plan the Contractor shall conduct a pre-road survey for the delivery of the respective power transformers from the dock to site. This survey should

identify the entire route of transportation, any traffic restrictions for movement of large trailers, obstacles such as gantries, overhead lines and bridges, limitation of road and bridge widths, limitation of allowable axle load on bridges and the requirement of temporary road constructions at site. The survey shall be issued to ZESCO for approval prior to the completion of the transformer design.

The Contractor shall take reasonable steps to prevent any highways or bridges from being damaged by his traffic and shall select routes, choose and use vehicles and restrict and distribute load so that the risk of damage shall be limited as far as is reasonably possible. The Contractor shall immediately report to the Employer/ Employer's Representative any claims made against him arising out of alleged damage to a highway or bridge.

The Contractor shall be responsible for all costs including those incurred by ZESCO or the Employer/ Employer's Representative, arising from repair or replacement due to damage to equipment or materials during transport, off-loading or erection on site, until take-over by ZESCO.

The Contractor shall be responsible for obtaining from the relevant authorities all permissions necessary to use docking, off-loading, highway, and bridge facilities required for the transportation of contract materials and plant.

Shipment shall be made under deck except for such equipment and materials that for dimensional reasons cannot be stowed in the vessel's hold. In case equipment and materials cannot be stowed in the vessel's hold, permission shall be obtained from the Engineer prior to loading such equipment and materials on deck.

Shipment of all equipment by container system will be accepted however prior approval must be obtained from the Engineer and all incidental expenses arising in this connection shall be borne by the Contractor.

The Contractor shall be responsible for any loss or damage or expense arising from insufficiency or unsuitability of packing or preparation and non-navigable vessel or craft, unfitness of vessels or craft conveyance container or lift van for the safe carriage of the equipment. The cost of all damages to the equipment incurred due to improper packing, or due to improper storage in the vessel's hold, shall be at the Contractor's own expense.

All equipment shall be shipped on seaworthy ocean-going vessels not more than fifteen (15) years old. Vessels more than fifteen (15) years old shall not be used for shipment under this Contract unless they have been registered as A-class vessels in Lloyd's register or other equivalent register.

The Contractor must supervise transport and handling of equipment.

Any delicate equipment, materials, instruments and tools including but not limited to electronic parts, etc., shall be transported by airfreight.

The cost for all equipment needed for temporary fixing and supporting of the various parts of the Plant and the various packages, to cranes, during handling, transport, storage etc., including load distribution beams etc. whether they form part of the packing or crates or not, shall be deemed included in the contract price.

The available means of transportation of project cargo and personnel are Railway from Dar es Salaam to Nakonde Town at the Zambia-Tanzania border and then by road or by Road from Mozambique and South Africa. Air transport is possible to Lusaka and then further by road.

However, road conditions need to be taken into consideration by bidders while planning / arranging transport logistics to project sites including liaising with the Government for special load permit for out of gauge cargo in compliance with the prevailing laws and regulations of the Employer’s Country. The Contractor shall pay all fees related to the transports. The maximum wheel load must be adhered to.

The Bidder shall be entirely responsible for all transport of his personnel and all materials in connection with the works. The Employer take no responsibility for any scheduled service or change thereof.

6.4 Storage at Site

The Contractor is solely responsible for establishment and maintaining storage of the goods and equipment. Storage sites may need licensing by District or Province authorities due to storage and generation of hazardous waste, which it is the duty of the Contractor to obtain.

The Contractor shall establish storage facilities at the construction site where possible, and in close co-operation with the Employer. Storage sites shall adhere to the Environmental and Social Management Plan.

The storage area shall be fenced off from the construction site. Manufacturer's instructions for storage must be followed. For electrical / electronic parts special attention must be paid to temperature and humidity requirements. The Contractor must take adequate measures to avoid theft and spillage in the stores.

7 Contractor’s Quality Assurance

For the services to be rendered in connection with this project, a project quality manual based on ISO 9000 shall be prepared. This manual shall contain all the procedures, which are relevant and necessary to perform the activities. The Contractor shall prior to commencement of any work follow the quality requirements specified in these Bid Documents and his own Quality Assurance (QA) Manual.

7.1 Planning of QA

The Contractor shall plan all QA activities for the entire period of the Contract. The planning includes:

- Time, responsible person and extent of check of each main item of equipment and works to be inspected and/or tested
- Time and specification of factory acceptance tests
- Time and specification of supervision activities and site tests

The certificates, control forms etc. shall be submitted to the Engineer for his approval. If required by the Engineer, the inspection certificates, forms etc. shall be extended to the satisfaction of the Engineer.

The inspection certificates form etc. shall verify and document that production and installation procedures comply with the requirements according to the Contractor's Quality System and Approval Certificates.

7.2 Execution of QA

The Contractor shall plan, execute and document quality assurance throughout the project according to the project quality manual. The contractor's supervision activities are part of the quality assurance.

The quality assurance is to be specified in the bid.

When an installation is complete the Contractor shall provide a completion certificate to which is attached an inspection certificate to confirm that the completed work has been inspected and tested for compliance with the requirements. The inspection certificate shall list all items inspected and/or tested.

If the results of the inspection show that the installation or equipment does not comply with requirements, the variations found must be noted, and the time and content of corrective actions must be indicated.

Contractor shall modify the installation and prove that it complies with the Requirements if required by the Engineer.

The Engineer will undertake random spot control.

The Contractor shall render any assistance requested by the Engineer for his control. This assistance may comprise labour, materials and measuring equipment. Such assistance shall be included in the Contract.

7.3 Documentation of QA

The Contractor shall document the results of the quality assurance activities. The documentation shall as a minimum consist of:

- Completion Certificates
- Check forms
- Non-conformity reports

The QA documentation shall at any time be available to the Engineer and shall be handed over to the Employer at the final commissioning.

7.4 Erection, supervision and checking of work on site

The carrying out of all work on the Site included in this Contract shall be supervised throughout by a sufficient number of qualified representatives of the Contractor who have had thorough experience of the erection and commissioning of similar Works and are approved by the Employer and the Engineer.

The Contractor shall ascertain from time to time what portions of the work on the Site the Employer desires to check, but such checking shall not relieve the Contractor from the liability to complete the Works in accordance with the Contract or exonerate him from any of his guarantees.

The Contractor shall maintain an operational **Daily Construction Logbook** for each construction site (under separate control or site office).

This Logbook will reflect and register at least, but not limited to, the following data:

- i. all construction activities on respective site
- ii. delivery of material
- iii. number of staff on site
- iv. temperature and weather conditions
- v. minor operational design changes
- vi. site measurements undertaken
- vii. site tests undertaken and their results
- viii. record of daily H&S briefings and procedures
- ix. details of any HSE incidents which occurred in the review period

This logbook shall be submitted to the Employer in one original hard copy and as soft copy on a weekly basis. The Employer will then return the signed original to the Contractor with remarks/comments or with the status “NOTED”.

If at any time it appears to the Employer that the Contractor will be unable to complete any Section of the Works in the time stipulated, then the Contractor shall, if required by the Employer, carry on such work outside normal working hours and shall not make any claims

for any extra expense thereby incurred unless, in the opinion of the Employer, the delay is due to causes for which the Contractor would be entitled to an extension of time under the Conditions of Contract.

The Contractor shall satisfy himself as to the correctness of all connections made between the apparatus supplied under the Works and apparatus supplied under any other contract before any of the former is put into operation.

If the Employer shall certify that defects have shown themselves in the Works, the Contractor shall, for the purposes of maintenance after the completion of the Works provided for by the Conditions of Contract, keep on Site, supervisory staff of such numbers and for such periods as the Employer may require.

The Contractor is to keep the site, on which he erects or stores plant, reasonably clean removing all waste material resulting from the Works as it accumulates and as reasonably directed. On completion of the Works the Site is to be left clean and tidy to the satisfaction of the Employer. Any damage done to buildings, structures and plant or property belonging to Employer is to be made good at the Contractor's expense.

7.5 Tests and Commissioning

7.5.1 General

All type and routine tests required to prove that the plant and material meets the requirements of this specification should be carried out by the Contractor or by an approved testing authority at the Contractor's expense. Type tests may not be needed if type tests have been carried out on equipment to be supplied and are less than 5 years old at date of tender submission. Type tests shall be submitted with the tender. The Contractor shall include the costs of type tests, as optional items in the tender, for all equipment for which type tests have not been submitted with the tender (per item of equipment).

Prior to any test, the calibration of all measuring equipment shall be demonstrated by the Contractor to comply with the relevant Standard. Details of the test equipment and instruments used shall be noted in the test sheets in cases where the instrument or plant and material characteristics can have a bearing on the test results.

The passing of any inspection or test in the manufacturer's works or during erection and commissioning at site shall not prejudice the right of the Engineer to reject the whole or part of the plant if it does not comply with the requirements of the contract when placed in service at site.

7.5.2 Tests

Materials, components and equipment used in construction of lines and substations shall be subject to inspection and testing during manufacturing, as well as after completion at no extra cost to the Employer.

All materials shall be tested at the factory according to the relevant IEC/ISO/VDE standards.

No part of the substation shall be dispatched to the Site before it has passed all the tests and has been inspected and found to comply, in every respect, with the stipulations of the Specification to the satisfaction of the Engineer, who will issue the dispatch certificates, therefore.

A programme of all tests in the factory and at Site is to be mutually agreed upon between the Contractor and the Engineer.

All apparatus shall have at least the data specified in the technical schedules. The data shall be verified in reports of type tests performed by an independent authority in accordance with the IEC Standard or Equivalent National Standard acceptable to the Engineer. Such reports shall be submitted for the approval of the Engineer on request and in any event in the case of order.

7.5.3 Type Tests

The substation equipment (transformers, reactors, circuit breakers, CTs, VTs, SAS, metering, protection, WAMPACS relays and telecommunication equipment) offered for and supplied under this Contract shall be type tested. Bidders shall enclose in his Bid Type Test Certificates separately for each such main component and equipment offered.

Such Type Test Certificates shall be issued by internationally recognized testing organizations for type tests carried out on components and equipment which are, in the opinion of the Employer / Employer's Representative, of identical type or identical in all essential respects to the equipment offered. If any of the Type Tests Certificates submitted is not applicable to the component or equipment offered, the Employer / Employer's Representative reserves the right to require re-testing or the inclusion of additional tests in the routine test program.

The Bidder shall enclose in his Bid the reports for all type tests and additional type tests certificates as per technical specification along with equipment / material drawings separately for each such main component and equipment offered. The type tests conducted earlier should have been conducted in accredited laboratory based on ISO / IEC Guide 25 / 17025 and the test reports submitted shall be of the tests conducted within last 8 (eight) years prior to the date of bid opening (unless specially agreed with the purchaser). In case the test reports are of the test conducted earlier than 8 (eight) years prior to the date of bid opening, the Bidder shall repeat these test(s) at no extra cost to the Employer. In the event

of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

In case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

During manufacture, erection and after completion all materials, components and equipment supplied as well as works performed under this Contract may be subjected to inspection by the Employer / Employer's Representative, should they so require. The works may also be subjected to inspection and tests by any approved agencies of insurance or inspection companies, approved by the Employer / Employer's Representative, in accordance with the provisions of these technical requirements.

Type tests shall be made on one unit of each type of different equipment. Instead of carrying out the type tests the Contractor may submit suitable certificates of tests made on equipment of the same type; however, the Engineer reserves the right of accepting these certificates or to reject them partially or totally. The Contractor shall give a complete description of proposed test methods. The Contractor shall provide all instruments and equipment necessary for testing. The test reports shall be submitted to the Engineer for review in three copies.

Type tests establishing the performance detailed in this specification shall be carried out in accordance with the requirements of the relevant standard specification.

Type tests shall demonstrate the adequacy of a particular type, style, or model of plant and material to meet assigned ratings and to operate satisfactorily under specified operating conditions.

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This section contains general requirements for inspections and tests of material, parts, equipment and workmanship of the plant during manufacture, assembling and erection and upon completion to demonstrate compliance with General Technical Requirements/Particular Technical Requirements, codes and standards to ensure overall reliability of plant operation and performance.

All materials used in the Contract Works shall be made available for inspection and test by the Employer and the Employer’s Representative during manufacture and it is the Contractor's responsibility to advise ZESCO when equipment and materials are available for inspection.

All tests, inspections and examinations, as well as the results and finding established thereby shall be recorded and duly signed by the parties involved. The Contractor shall prepare complete test reports on all tests carried out in the factory or by the subcontractors. The reports shall include all measured and calculated data presented in tables and graphs. The reports shall demonstrate compliance of the Works with the requirements of the Contract. 3 copies of all reports shall be furnished to the Employer.

The Employer / Employer's Representative shall, at all reasonable times, be allowed free and ready access to the Contractor's premises and those of his suppliers for the purpose of inspecting the specified equipment components, and obtaining information as to the progress of the work. Failure on the part of the Employer / Employer's Representative, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Employer / Employer's Representative will not prejudice the right of the Employer to reject the Plant if it does not give complete satisfaction in service.

The Contractor shall submit an Inspection & Test Plan (ITP) to the Employer for approval. The ITP shall cover all items of equipment to be provided under this project through the manufacturing and erection stages of the project, and shall indicate the salient points of manufacture and/or erection at which the Employer/Employer's representative is required to attend. Stages of manufacture or erection where attendance is required by the Employer/Employer's representative is required, shall be Witness/Hold points in the process. Adequate advance notice shall be provided to the Employer by the Contractor of any forthcoming Witness/Hold points in the reports to be submitted by the Contractor as required. Formal written notification shall be given 28 days prior to any Witness/Hold point inspection to be performed.

Inspection and testing shall consist of:

- inspection and tests on raw materials
- factory tests and inspections
- routine tests
- type and special tests
- factory acceptance tests
- inspections and tests during construction
- inspections at the end of construction works (final construction checks)
- tests on completion

- performance verifications.

7.5.4 Routine Tests

Routine tests shall be performed in accordance with the relevant Standards and according to instructions by the Engineer. Routine tests shall demonstrate the integrity of the plant and material and its ability to operate satisfactorily under specified conditions.

The Contractor shall give a complete description of proposed test methods. The Contractor shall provide all instruments and equipment necessary for testing. The test reports shall be submitted to the Engineer for review in three copies.

Routine tests as per IEC-60076 shall be performed on all reactors.

7.5.5 Site Tests

The supplied equipment shall be completely tested by the Contractor at site.

The Contractor shall record the test results in an approved form in such a manner that the test reports can be used as the basis for future maintenance tests.

No tests in the agreed programme shall be waived except on the Engineer's written instruction.

Test methods and equipment shall be noted on the test sheets.

Test equipment shall be of satisfactory quality and condition and if found necessary, be calibrated by an approved authority.

All routine tests except power frequency voltage dry withstand test on main circuit breaker, reactor, relays etc shall be repeated on the completely assembled equipment at site.

7.5.6 Test Certificates

The Contractor shall provide three copies of test certificates (certified by the manufacturer) summarising all tests conducted on the plant and material. Where appropriate, latest logs and graphs for all tests and three copies of all such certificates, test logs and graphs shall be supplied for approval.

7.6 General

The Contractor shall comply with and meet the quality standards of ISO 9001.

The Contractor shall prepare and submit a Project specific Quality Plan and a Quality Manual based on ISO 9001 describing the quality related activities, procedures, steps and measures

(including Project organization, qualifications and expertise, documents control, quality audits, testing procedures etc.) implemented throughout the Project.

The same shall apply for any SubContractor, supplier or Manufacturer.

7.7 Quality Management System

The applicable quality management system shall be ISO 9001.

The Contractor shall submit its Quality Manual, Quality Plan and Policy for review and approval.

7.8 Quality Plan

The Contractor shall prepare a Project specific Quality Plan in accordance with ISO 9001.

The Quality Plan shall specify the relevant quality standards, practices, resources, specifications etc. and the sequence of activities relevant to the particular equipment, deliverables etc. in accordance with the contractual scope of the Contractor.

The Contractor's Quality Plan shall be submitted to the Employer for approval and shall, as a major section, address:

- type tests
- routine tests
- special tests
- tests during installation and commissioning.

In addition to the requirements of these ISOs, the Contractor shall:

- Establish procedures for adequate planning of all quality related activities including the preparation of quality plans.
- Establish measures for the identification and control of items throughout all stages of the Contract. This shall include measures to maintain traceability as identified in agreed quality plans.
- Arrange for the protection of the quality of the product to include delivery to the specified destination.
- Control their measuring and test equipment in accordance with established procedures for measurements and calibration systems and ensure that such equipment that may be used by subContractors to verify work is similarly controlled.

- Ensure adequate quality systems exist for compliance with the requirements of the Tender and Contract Documents.

7.9 Quality Monitoring and Inspection

The Employer/Engineer reserves the right to inspect the facilities of the Contractor (incl. facilities of Manufacturers, suppliers and sub-suppliers) at any time throughout the Project.

The Contractor shall provide assistance necessary regarding visa application, travelling and lodging reservations and other support necessary to enable the Employer/Engineer to visit the facilities and to participate in the tests and inspections as required.

The Contractor shall submit a Quality Inspection Plan scheduling the inspections and tests to be performed at the facilities as outlined above.

7.10 Factory and On-Site Testing

The Contractor shall submit a complete program and schedule describing the following:

- routine tests
- type tests
- other factory acceptance tests
- special tests (during construction and civil works)
- installation & pre-commissioning tests
- commissioning tests
- trial operation.

The Contractor shall also include other tests, inspections and quality arrangements the Contractor deems necessary based on its scope, design and other Project specifics to demonstrate compliance with the Contract requirements.

The tests etc. shall be based and conducted on international standards, best practices etc. and subject to review and approval by the Employer/Engineer.

A minimum of 30 days ahead of each test to be performed at the Contractor's facilities the Contractor shall provide final notification regarding the test schedule, commencement, arrangement, scheduled completion etc.

Test programs and reports shall be submitted by the Contractor in accordance with the current valid version of the Document Schedule.

7.11 Quality Assurance Requirements - Detailed

7.11.1 General

The Contractor shall have a well-organized Quality Assurance Program (QAP) based on ISO 9000, 9001 Series (Quality System Model for Quality Assurance in design / development, production, installation and servicing) to assure that items and services, including subcontracted items and services, comply with this specification.

All design, manufacturing, processing, testing and inspection operations affecting the equipment or material shall be governed by Quality Assurance procedures in accordance with the directives of the ISO 9001 standards while the production and installation shall be governed by quality assurance procedure in accordance with the directives of the ISO 9001 and 9002 standards. These may be subject to surveillance by the Employer or Employer’s Project Manager. A sample QAP shall be submitted together with the Bid.

Within thirty (30) days of the Effective Date of Contract, the Contractor shall submit one (1) hard copy and one e- version of his complete quality control and assurance procedures, manuals for review and approval by the Employer. The manual shall include pro-forma checklists for all requirements of the Contractor's quality control and assurance program and those called for in this Specification.

The Quality Control and Assurance Program to be submitted shall include but may not necessarily be limited to the following:

- Program requirements for Materials and Equipment Procurement and Manufacture with description on design control, purchased material control, quality verification tools, manufacturing control, materials and components selection, handling and packaging, etc.;
- Program requirements for Equipment Production with detailed description on Quality Assurance Organization of the Contractor, Quality Assurance Functions and Procedures and Performance Monitoring;
- Quality Assurance Program Tests with detailed description on the test procedures to be conducted;
- Quality Assurance Program requirements for installation and commissioning (for Design Supply and Install (DS&I) Contracts) with detailed description on Quality Assurance Organization of the Contractor, Quality Assurance Functions and Procedures, etc.).

Prior to manufacture, the Contractor shall submit to the Employer a fabrication sequence describing inspection and / or tests to be performed, for use in determining inspection points which the Employer may desire to witness. The Employer will advise the Contractor prior to manufacture of those fabrication steps and shop inspection points that the Employer desires to witness.

The Contractor shall give the Employer adequate notice, forty-five (45) calendar days minimum, prior to those fabrication steps and 8 weeks in advance for tests which the Employer desires to witness.

7.11.2 Quality Assurance Program

The Contractor shall, for all work covered by the Contract, establish and implement a quality assurance program which shall, as a minimum, meet the requirements set out in ISO 9001 and ISO 9002.

In addition to the requirements of these standards, the Contractor shall:

- Establish procedures for adequate planning of all quality related activities including the preparation of quality plans.
- Establish measures for the identification and control of items throughout all stages of the Contract. This shall include measures to maintain traceability as identified in agreed quality plans.
- Arrange for the protection of the quality of the product to include delivery to the specified destination.
- Control the calibration of measuring and test equipment in accordance with established procedures for measurements and calibration systems and ensure that such equipment that may be used by sub-Contractors to verify work is similarly controlled.
- Ensure adequate quality systems exist for compliance with the requirements of the Contract.

Where any site installation and / or test and commissioning work is involved, the Contractor shall prepare contract-specific quality assurance procedures in agreement with the Employer prior to commencements of such works.

The Contractor shall be responsible for specifying the quality assurance requirements to his sub-Contractors, for approving sub-Contractors' quality assurance program and for ensuring compliance with the requirements.

The Contractor shall ensure that all appropriate technical information is extracted from the Contract documents and specifications and passed on to the sub-Contractors.

The Contractor shall ensure that all computer systems and software to be utilized on the project is qualified for the application under consideration and such qualification is documented.

7.11.3 Quality Plans, Inspection and Test Schedules

Quality plans shall be prepared detailing the specific activities, design reviews, operations, control procedures, inspections, testing, approvals and certification requirements applicable. Quality plans shall be submitted to the Employer for review and approval.

Where inspection schedules are generated in support of a quality plan these are also required by the Employer for review and approval.

The format and content of schedules shall ensure that inspection operations are planned and performed in a systematic manner.

Documents referred to in quality plans shall be available to the Employer for review if required.

Specific quality plans shall be prepared for site work and submitted for review and approval by the Employer prior to commencement of such work.

The Contractor shall approve all quality plans, inspection and test schedules of its sub-Contractors and vendors.

The Contractor shall identify his verification requirements on the quality plans submitted to the Employer for review and approval and shall identify the following:

- Stages subject to random surveillance.
- Inspection that requires to be carried out or witnessed by the Employer or a third party following satisfactory verification and acceptance by the Contractor.
- Hold points beyond which work cannot proceed before completion of all operations, verifications and related activities identified after the previous hold point on the quality plan.

The Contractor shall be responsible for identifying and arranging any verification activities for statutory approval in the country of manufacture.

The Contractor shall adhere to the reviewed quality plan(s) and notify the Employer immediately of any deficiencies or difficulties should arise.

Where functional testing is required, functional test schedule(s) and / or procedures shall be prepared by the Contractor and submitted to the Employer for review and approval prior to the commencement of such testing.

7.11.4 Submission of Documents

The Contractor shall submit drawings and other documents for review and approval by the Employer as required in the Employer’s Requirements and Quality Plans.

A schedule of drawings and all documentation for review shall be submitted to the Employer in accordance with Work Program within 28 days from the Contract Effective date and shall

be maintained by the Contractor to show the up-to-date status and revision of each document.

The Contractor is not authorized to proceed with manufacturing until notified that the drawings are satisfactory to the Employer, unless the Employer waives this requirement in writing.

The Employer's general review of drawings and data or waiver of the same shall not in any way relieve the Contractor of any responsibility to meet all requirements of this specification or the Contract.

7.11.5 Monitoring by the Employer

Employer reserves the right to request, review for the duration of the Contract a copy of the Contractors Quality Manual.

During the course of the Contract, the Employer reserves the right to monitor the implementation of the Contractor's quality assurance program. Monitoring will be by means of surveillance of activities at the work locations and where appropriate by formal audits. Representatives of the Employer shall be afforded unrestricted access and facilities at all reasonable times to carry out this work to verify manufacturer's compliance with the established manufacturing, assembly, delivery, including installation and commissioning schedules .

The Employer reserves the right to monitor sub-Contractor's activities and the Contractor shall ensure that sub-Contractors are informed of these requirements.

7.11.6 Records

The Contractor shall generate records as required by the quality assurance system and quality plans. Records, including audit reports shall be available for inspection by the Employer.

All records shall be concisely compiled, indexed and cross-referenced to the project contract number and they were relevant subcontract numbers. They shall be clearly identifiable to the individual parts and assemblies to which they refer.

Those records required by the Employer, as defined in the contract specifications and quality plans shall be available at the time of delivery of the equipment. Such records shall include reports and certification in respect of pressure retaining components together with general traceability records for all items through certification and build documentation as a minimum. E-copies of these records shall be supplied to Employer with the exception of radiographic films where the original set of films shall be supplied.

All records generated during the course of the Contract, including those generated as evidence of effective implementation of the quality assurance program of the Contractor and his sub-Contractors, shall be retained by the Contractor for a minimum period of 8 (eight) years from the date of contract completion. These records shall be made available to Employer on request during the retention period.

7.11.7 Sub-orders

All orders for materials and equipment purchased by the Contractor specifically for this Contract are subject to inspection, tests and expediting. The Contractor shall advise the Manufacturer of any interventions received from the Employer or his authorized representative(s).

The QA program shall contain a detailed list of all sub-orders placed with sufficient information to enable the inspectorate to function properly, including order numbers, manufacturer's identity, equipment specifications, delivery and dispatch dates, etc.

7.11.8 Material and Test Certification

One (1) copy of all tests results recorded during an inspection visit shall be handed to the Employer or his authorized representative(s) on that day. In addition, one hard copy and one E-copy of the test certificates will be required fifteen (15) days thereafter.

In the event that the inspection of any item is waived, test certificates shall still be required.

7.11.9 Particular QA Requirements

7.11.9.1 General

As a supplemental document to the QA program, the Contractor shall submit for approval of the Employer a separate document with detailed particular requirements and specific acceptance criteria of all equipment.

7.11.9.2 At Shop

Corresponding to each major and minor component of transmission line equipment, the following data are required for submission to and approval by the Employer:

- Test and inspection procedure;
- Guaranteed technical rated or design data;
- List of hold points and / or routine tests;

- Acceptance criteria and reference standards;
- Test results / data in comparison to the guaranteed data. All allowable tolerances with respect to dimensional control of assemblies and sub-assemblies at shop shall be clearly indicated in the Manufacturer's drawings.

7.11.9.1 At Site

The tests at site shall be in accordance with the Manufacturer's recommendation as approved by the Employer.

The Employer or his duly authorized representative shall control said site tests, in collaboration with the Contractor's representatives.

7.11.9.2 Packing and Marking

Careful packaging of all materials supplied for this contract is of utmost importance and is subject to the control of the Employer, so that the following aspects are checked:

- Packaged design and markings;
- Protection of contents against damage by mechanical shock, moisture ingress and adverse atmospheric conditions, corrosion;
- Material quality workmanship and manufacturing of packages.

7.11.9.3 Reporting and Corrective Action

The Contractor's quality assurance program shall provide for prompt detection and correction of all conditions adversely affecting quality, including failures, malfunctions, incidents, trends, deficiencies, deviations, non-conformances, and defective materials. The Contractor shall establish and maintain methods for verifying and determining the cause of an adverse condition and for initiating necessary improvement and corrections to preclude repetition. Quality trends shall be analysed to furnish a basis for improvement in work performance. The Contractor's corrective action system shall extend to the performance of other participating sub-Contractors and shall provide for the interchange of corrective action information. Identification of the adverse condition, its cause, and the corrective action taken shall be recorded and reported to appropriate levels of management.

The Contractor shall establish and implement procedures for reporting, verifying, analysing, and correcting failures, including those that occur during development

and qualification testing. The procedure shall provide assurance that the cause and mode of each failure are determined, that potential safety and availability implications are evaluated, and that corrective action is taken.

A failure report shall be prepared to identify the failed item and its origin or source of manufacture and shall describe the failure, the test status at time of failure, the probable cause and mode of failure, and the recommended corrective action.

7.11.9.4 Design Revision and Substitution of Material

Any revision affecting the design and manufacturing of any transmission line component, as well as substitution of materials that is deemed necessary shall be notified by the Contractor to the Employer for the latter's review and approval prior to any implementation or order placement.

7.11.9.5 Contractor's Responsibility

Approval by Employer of the Contractor's quality assurance program, quality plans and inspection and test plans or of those of his sub-Contractors will not relieve the Contractor of his obligation to provide plant and equipment which meet the requirements of the Contract.

7.11.9.6 Information Required for Tender Evaluation

The following information is required in order to carry out a systematic evaluation of the Contractor's quality assurance program and should be compiled under the heading of Quality Assurance and structured as below:

- Statement of intent for the adoption of a documented quality system and acceptance of the requirements laid down in this specification.
- Details of any recent external assessments of the proposed quality system - through Second Party audit or Third-Party assessment. The results of such audits / assessments should be submitted together with details of any accreditation of the quality system.
- Details of the procedure for quality assessments of Contractors / Sub-Contractors together with recent assessments carried out. The list should include reference to the assessment standard, including the applicable part of such a standard.
- A contract specific quality plan together with supporting inspection and test schedules, as described in this Specification.
- Details of the procedures governing:

- Internal QA system audits.
- Project audits.
- Contractor / Sub-Contractor surveillance audits.
- Details of QA records produced and typical examples.
- Details of the facilities for inspection and test.
- A schedule of drawings and documentation for review and approval by Employer.

7.11.9.7 Sub-Contractors and Suppliers

For each Sub-Contractor the Contractor shall identify the relevant quality standard ISO 9001, 9002 or 9003 to be selected in accordance with the guidelines given in ISO 9000-1 and in ISO 9000-3. The Contractor shall assess Sub-Contractors' quality systems and their implementation to confirm adequate qualification standard.

The Contractor shall plan and carry out Quality Surveillance (QS) of his Sub-Contractors (ref. ISO 8402, Clause 3.11) at a level of detail sufficient to ensure fulfilment of the quality requirements of the Contract. The Employer shall have the right to participate as observer in such QS activities.

The Contractor shall submit his QS-plan(s) to the Employer for acceptance and keep the Employer informed of any change thereof.

7.11.10 Contactor’s Quality Plan

7.11.10.1 Quality assurance and quality control programme

The parts and components produced and the services provided in fulfilling the requirements of the Contract shall be performed in accordance with a Quality Assurance Program to be established by the Contractor. This Contractor's Quality Assurance Program shall be documented in sufficient detail to assure the Employer that the Contract requirements will be met during the design, procurement, manufacture, assembly, delivery, erection, installation, construction and test of all materials and components of the Works. The Contractor's Quality Assurance Program, as a minimum, shall provide the implementing details as given hereinafter.

7.11.10.2 Quality plan

The quality plan concerns the civil works and the electrical equipment.

General

The Quality Plan prepared by the Contractor with reference to his Quality Assurance Manual and as per ISO Standard shall be submitted to the Employer. This plan will reflect the know-how of the Contractor as well as the requirements of the Contract. Contractor's Quality plan shall include, but not be limited to, detailed procedures, instructions, or statement covering the following.

Organisation and procedures

The Quality Plan shall describe Contractor's Quality Assurance organisation and delineate the responsibility and authority of the various personnel and groups involved. The Quality Assurance Department's relationship with other departments shall be defined and their independence of Employer, construction, cost, and scheduling shall be stated. An organisational chart shall be included with lines of authority and communication.

Procedures of communications between the Contractor and the Employer will be established by the Employer. All documentation which is addressed to the Employer shall be copied to the Employers Project Manager.

Particular procedure will be established for communications on site.

Procurement Control

The Contractor's procurement process shall assure that purchased items, whether purchased directly or through the Contractor's sub-suppliers comply with the Employer's Requirements. This assurance shall be provided by the inclusion of the quality requirements into the Contractor's procurement documents and adequate inspection of the material at its source or upon receipt.

Prior to procurement, the Contractor shall furnish to the Employer, a list of Sub-Contractors and vendors with whom orders are to be placed for materials and equipment which will be incorporated directly into the Works. The Contractor shall also furnish such pertinent information as to capacities, efficiencies and sizes, and such other information as may be required by the Employer.

Copies of Contractor's unpriced orders of materials and equipment and list of his stock material or equipment shall be provided to the Employer. All orders and stock lists shall state the standard specification under which the material is to be furnished, pertinent drawing and the required delivery dates. They shall state that the materials and equipment are subject to inspection by the Employer.

Material Control

The Quality Plan shall provide assurance that procured and subsequently processed material complies with the Employer’s Requirements. Material identification shall be provided and maintained throughout the manufacturing cycle. Controls shall be provided for the documentation and quaranting of non-conforming material, parts or components, and their subsequent rework or repair and re-inspection. The program shall also provide for the prior notification to the Employer of proposed rework or repair or non-conformance, for the Employer’s evaluation and approval.

Special Processes

Special Processes such as welding, soldering, brazing, heat treatment, cleaning, non-destructive examination, etc., shall be performed in accordance with documented process procedures and by qualified personnel. The procedure shall describe the process sequence and methods, process pre-requisites, equipment, qualification of personnel and equipment, and acceptance criteria. The procedures shall also describe the preparation and retention of documents used to record the results of special processes.

Non-Destructive Testing

Non-Destructive Testing (NDT) shall be done according to written procedures prepared by the Contractor. The current edition of American Society of Mechanical Engineer (ASME), Section V shall be used as a guide for the NDT procedures. In addition, the specific requirements of the applicable Code and Standard shall be satisfied and the procedures shall be submitted to the Employer for review and approval prior to the initiation of the test.

The items to be non-destructively tested, the extent of testing, and the acceptance Standard shall be clearly defined in the procedures and in accordance with the referencing Code and Standard. NDT personnel shall be qualified and certified in accordance with the current edition of American Society of Non-destructive Testing (ASNT) Recommended Practice, number SNT-TC-1A or equivalent.

Inspection

The Quality Plan shall provide for the in-process and final inspection of material, equipment and activities to assure compliance with approved documents. Examination or measurements shall be performed at each applicable work operation. Inspection activities shall be performed by qualified individuals.

Calibration

Procedures shall be established to assure that test and measuring devices used to test, inspect, or accept material and components are calibrated at specified intervals to maintain the proper accuracy. Devices used shall be of the proper range, type, and sensitivity to reliably measure the parameters being evaluated. The calibration of such devices shall be documented and shall be performed using certified measurement Standards.

7.11.11 Approval of materials and equipment

7.11.11.1 General

All materials and equipment intended to be incorporated into the Works shall be subject to approval by the Employer prior to order by the Contractor.

Unless otherwise authorized by the Employer no material or equipment shall be shipped from its point of original manufacture or final shop assembly to the work site before it has been inspected and approved by the Employer.

7.11.11.2 Submission of samples and data

The Contractor shall submit for the approval of the Employer samples, drawings, catalogues, cuts, diagrams and other descriptive data for all structural, mechanical, electrical, architectural and such other materials and equipment as may be designated by the Employer and which the Contractor proposed to incorporate in the Works. For certain materials and equipment data may be required to be submitted in accordance with a detail form furnished by the Employer.

Items submitted by the Contractor shall be properly labelled to indicate the Project Contract number, Contractor, source of supply, Contractor Contract Item number, and other data required in the Employer’s Requirements.

All items shall be submitted in sufficient time, but not later than 90 days prior to purchase, to permit proper consideration and action thereon without delaying the construction schedule.

Items sent for approval shall be shipped prepaid by the Contractor and the Contractor shall give the Employer advance notice in written of all items shipped.

7.11.11.3 Assembly marking

All parts, or units of shop assemblies, shall be marked, or tagged with piece marks. Marks shall be in accordance with approved erection drawings, shall be clearly legible and so placed as to be readily visible when the part is being erected in the field. Before dismantling for shipment, connecting parts assembled in the shop shall be match marked to facilitate

erection in the field and marked so as to identify each part with the assembly to which it belongs. The location of the match marks shall be clearly indicated on erection drawings. All parts or assembly of parts shall also be so marked as to identify them with this Contract.

7.11.11.4 Quality of design, materials and manufacture

All items of the Plant shall be designed and manufactured in the most sound manner, using materials most suited to the particular service and giving due consideration to the most recent technical advances. All materials and components shall be new and unused. The design and materials shall be such as to enhance service life, operational reliability, freedom from wear and tear and ease of maintenance, inspection and adjustment.

7.11.12 Quality assurance and quality control

7.11.12.1 Introduction

The quality assurance programme and quality plan have been described in previous paragraph related to quality assurance programme and quality plan for all the works.

7.11.12.2 Test program

The Contractor's test program shall be suitably documented to assure that the required components or sub-components testing are properly performed. The test program shall address pertinent test pre-requisites, such as test instrumentation selection and calibration, acceptance criteria, documentation of test results, and evaluation of test results by qualified personnel.

7.11.12.3 Level of criticality and control

The level of quality control shall be adjusted to the importance of the equipment in terms of cost of repairs, personnel safety and loss of production as applicable. In respect of inspection and approval, the levels of criticality of the equipment and phases of construction will be divided into three categories as follows:

- **Type R (R for Record)** The Contractor shall send to the Employer the record of the tests or inspections. This generally applies to items whose failure would have no effect on production, personnel, ecology or environment. Replacement of equipment or spare parts would be readily available and treated as routine maintenance.
- **Type I (I for Invitation)** The Employer shall be invited to be present during the tests or inspection and the Employer will decide whether to assist in the tests

and to inspect the works or not. If the Employer decides not to be present, the works will go on.

- **Type S (S for Stop)** The works (manufacturing, erection, placing, construction, testing) shall be stopped and the work shall be resumed only after the Employer has given his approval. This generally applies to those items whose operability and reliability is vital for operation. Shutdown due to malfunction or failure of one of these items would result in loss of production and/or replacement costs, or pose potential hazard to personnel safety, and could cause damage to the environment.

7.11.12.4 Non-conformity

During manufacture and site works, after each assessment or measurement of quality, cases of non-conformity, identified either by the Contractor's quality control supervisors or by the personnel in charge of execution or by the Employer, will be divided into four categories:

- **NC.1** Minor defects which shall be repaired immediately, then recorded on standard follow-up documents.
- **NC.2** Defects which can be repaired according to a pre-established procedure. The repairs shall be carried out immediately and recorded on special documents.
- **NC.3** Defects which cannot be repaired according to a pre-established procedure. The decision to repair, modify or rebuild or remanufacture the item shall be proposed by the Contractor for the Employer's approval.
- **NC.4** Main defects on critical items. The Contractor shall propose a solution to the Employer. Then the Employer, after due consultation, will notify the Contractor of the final decision.

7.11.13 Documentation

The Quality Plan shall include a system to ensure that the documentation necessary to verify the completion of fabrication, erection, and installation, use of correct material ; completion of required inspections and tests and acceptability of results are generated, reviewed, maintained and issued to the Employer at the required time.

The system shall ensure that such documentation is reviewed by the Contractor for legibility, completeness, validity of data, traceability of document to activity or equipment and acceptability of results

Documentation to be generated and maintained during manufacturing and site works period as applicable, shall include at least:

- Raw material test report (mechanical, chemical, radioscopic, etc.) as per Standards. In the case of materials for which such practice is usual, the Employer may accept the Contractor's certified mill and laboratory certificate.
- Weld and weld repair procedure
- Inspection and test procedures
- Inspection and test reports
- If a demonstrable satisfactory service record is available for a material, certain specified tests may be waived by the Employer
- Vendor surveillance reports
- Heat treatment records
- Final inspection reports
- Packing and shipping procedure
- Certificates of compliance

In the case of Standard labelled stock products which have a record of satisfactory performance in similar works over a period of not less than 2 years, the Employer may accept a statement from the Contractor and verified by a certified laboratory certifying that the product conforms to the applicable specifications

7.11.14 Inspection and tests

The whole of the Works is subject to inspection and test by the Employer during manufacture, installation and completion at the Site where such tests or inspections are required in the Employers Requirements, or when it is impossible to certify that the performance conforms to the Employer’s Requirements

The Employer shall be given the opportunity to witness all tests, and the Contractor shall give adequate notice of all tests to be carried out, at least 8 weeks prior to scheduled tests.

The approval of the Employer or the passing of any inspection or test shall not prejudice the right of the Employer to reject equipment or material if it does not comply with the Specification when installed or incorporated into the Works.

The Contractor shall submit a "Quality Control, Inspection and Test Plan" to be reviewed by the employer, which shall describe the inspection and test procedure containing acceptance criteria for each component. The Inspection and Test Plan (ITP) shall include a test matrix for all primary, secondary, telecom, civil and E&S deliverables, with hold/witness points, acceptance criteria, and applicable IEC/IEEE clauses. The ITP shall have linkages to

commissioning sequence, energisation permits, and interface testing with existing Kasama plant.

If any component fails under test, such further tests, which are considered by the Employer to be necessary, shall be carried out by the Contractor as per GC 23 Test and Inspection.

7.11.14.1 Workshop inspection and tests

As far as practicable the quality of materials, workmanship and performance of all items and equipment to be furnished under the Contract shall be inspected and tested at the place of manufacture.

Factory tests shall be made by the Contractor on the following items:

- Transformer
- Shunt Reactor
- Protection
- 330 & 132 kV switching equipment
- 33kV SWG
- SCADA
- Telecom
- Auxiliary transformer
- Battery chargers
- LV Main SWG
- Support structures
- Conductors
- Earthwire
- Insulators
- Hardware / fittings
- Cables

7.11.14.2 Testing and Commissioning

The Contractor shall carry out the site/field tests as per the Specifications and the approved program which may be adjusted, when so directed by the Employer, according to the actual conditions prevailing on site. They include:

7.11.14.3 Tests and Checks prior to Pre-commissioning

In the course of erection of each item of the equipment all test will be done as per requirements Inspection & Testing and other equipment specific chapters. A commissioning ‘stage-gate’ sequence shall be as follows: (i) construction

completion; (ii) pre-commissioning functional checks; (iii) protection & SAS point-to-point; (iv) end-to-end (line differential / distance/ teleprotection); (v) energization; (vi) 72 [ZESCO to be confirmed]-hour reliability run; (vii) final acceptance. These shall be subject to review and approval by the employer.

7.11.14.3.1 Substation Inspection and Punch List compilation

On completion of the works, a final inspection of the substation works will be conducted in the presence of the Employer and the Contractor. The Employer’s Project Manager will prepare a list of minor defects and omissions (Punch list) will be issued to the Contractor to begin repairs immediately after receiving the same.

7.11.14.3.2 Notification of Pre-Commissioning Tests

Upon successful completion of final inspection of the line, the Contractor shall notify the Employer that the works are ready for Pre-Commissioning and the Pre-Commissioning Tests will then take place.

7.11.14.3.3 Pre-Commissioning

Tests Documentation

No later than 14 days prior to the commencement of the Pre-Commissioning tests, The Contractor shall provide to the Employer:

- Tools, appliances and spare materials required for maintenance of the transmission line as detailed in technical specifications
- All outstanding drawings and documentation to be provided under the Contract
- The Operating and Maintenance Manuals

7.11.15 Training

No later than 7 days prior to the commencement of Pre-Commissioning Tests, the Contractor shall train during one full week (5 working days) the Employer's staff to the extent where they are fully familiar with the technical aspects and the operation and maintenance requirements of the substation and its auxiliaries and that the duties can be assigned to the trained personnel on completion. Training shall include live line working.

8 Labelling of New and Existing Equipment

Main components shall be provided with a rating plate giving the type and serial number together with its ratings and service conditions. Each item shall be provided with labels and nameplates necessary to clearly identify the function and circuit designation of equipment. All cubicles and cabinets shall be labelled.

The durability of the marking shall as a minimum corresponds to the lifetime of the component.

The Contractor shall design and implement an item designation system for marking of the mechanical and electrical equipment. This system shall comply with IEC standard 61346.

All equipment shall be equipped with designation labels. Labels for outdoor use shall be of engraved stainless steel. For labels protected from solar radiation, fibreglass reinforced polyester with embedded colour layers can be used. All labels shall be fixed by stainless steel screws or rivets.

The Engineer shall approve the labelling system proposed by the Contractor.

Phase designation labels shall be R-Y-B and be coloured red-yellow-blue for phases L1-L2-L3.

Labels shall be in English language.

Warning labels shall have text in English and shall be approved by the Engineer. Warning labels shall have red lightning symbols.

Warning labels shall be mounted on all dangerous parts of the installation. This means:

- On low voltage distribution boards, a general warning label.
- On all cubicles where back voltage can appear after switches are opened, special warning labels shall be applied.
- Labelling, as is deemed necessary to prevent dangers arising from mal-operation of equipment.
- At all entrance doors of new buildings.
- At the fence of the new substation.
- At HV, MV and LV poles.

At the inside of the entrance doors of the substation and switching station buildings, a large sign of poster type, of durable design, shall be set up. It shall show steps and methods to be taken and used in case of electrical accidents where persons are hurt, i.e. first aid principles and how to proceed.

Marshalling boxes and control gear and units thereof, components mounted therein and wiring and cables, shall be labelled and marked as follows, the purpose of the labelling and

marking being to make possible the identification of switchgear and control gear and parts thereof and their relation to the relevant technical documentation in order to facilitate a rational and simple manner of installation, operation, trouble-shooting, maintenance and repair.

Apparatuses shall have labels or markings identifying the apparatus or units thereof (normally the relevant apparatus numbers used in the technical documents for the control gear). In some cases, this marking shall be completed with function marking in plain text. Apparatus labels shall be affixed by means of stainless-steel screws or rivets on the framework, so they remain in place when the apparatus is dismantled or changed.

Instruments, indicating devices and control devices shall have identification marking in plain text or simple symbols or colours. Control devices shall in addition have marking of control positions (e.g. Manual-Automatic, Open-Close), simple symbols or colours.

Internal wiring within control gear or apparatus units shall have all wire ends marked. The marking to include as a minimum the same marking as has the terminal to which the wire end is connected. The marking shall be carried out with sleeves or ferrules and shall be of white insulated material and be provided with glossy finish to prevent adhesion of dirt. They shall be clearly and durably marked in black and shall not be affected by damp or oil. Tape is not permitted.

Current and voltage circuits shall also have phase marking and, where necessary, polarity marking. Protective earth wires shall be marked with green-and-yellow.

9 Interfaces

9.1 HV Overhead Lines and Substations

The interface point between the overhead line package and the substation package is the line feeder gantry in the substation.

9.1.1 By the Substation Contractor

The line feeder gantry will be supplied and erected by the substation contractor, suitable for overhead line slack span, one overhead ground wire and one fibre optical ground wire (OPGW) with 48 fibres. With a maximum line angle of 45 degree and a span of less than 100 m.

The substation contractor shall arrange ground connection of the tower footing earthing to substation grounding system and installation of phase jumpers between the overhead line conductor and the substation conductor complete with all insulators and fittings.

The substation contractor shall also supply and install optical fiber approach cables (ADSS) from the gantries to the telecommunication terminal equipment.

9.1.2 By the Overhead Line Contractor

It is the overhead line contractor’s responsibility to terminate the slack span, phase, ground and OPGW wires to the gantry including supply of all necessary insulator strings and accessories etc.

The OPGW shall be terminated by the overhead line contractor in a splice box supplied and installed at the gantry by the transmission line contractor, suitable for termination of the OPGW and a fibre optical connection cable. The works of the transmission line contractor includes testing of the optical connection within the OPGW prior connection of the fibre optical connection cable (ADSS) to the telecommunication equipment.

9.1.3 Isoka / Nakonde Town / cross-border terminal interface scope

For avoidance of doubt, the Contractor's scope at the existing Isoka and Nakonde Town 66 kV substations is limited to the secondary-system interface works required to implement IF07 and IF08 in Table 91, namely:

- (i) . The Optical Transport Network (OTN) to be installed at Nakonde Stepdown shall interface with the terminal equipment at Nakonde Town and Isoka town;

No primary plant, switchgear or major civil works are included, except minor works strictly necessary for the above (e.g., cable penetrations, gland plates, panel mounting).

The Employer shall provide access, available asbuilt information and outage windows; the Contractor shall submit method statements and coordinate with ZESCO System Operations.

9.2 DVSD and Substation

The interface point between the DVSD package 5 and the substation package 4 is the 330kV double busbar in the substation.

9.2.1 By the Substation Contractor

The 330kV double busbar will be supplied and erected by the substation contractor. The substation contractor shall arrange for space for unequipped bay for the DVSD.

9.2.2 By the DVSD Contractor

It is the DVSD contractor’s responsibility to provide all bay equipment, support structures, accessories, foundations, installation and commissioning. The DVSD contractor shall also be responsible for bay equipment connection to the double busbar provided by the substation contractor.

Table 9-1: Interfaces

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
IF-01	330 kV Kasama S/S – 330 kV Kasama– Nakonde OHTL	Design, supply and erection of terminal towers outside Kasama S/S; stringing, downloads and jumpers from terminal towers to 330 kV gantries; terminations of conductors, OHGW and OPGW at gantry; line side earthing connection to S/S earth grid; provision of OPGW dome joints and	Design and construction of 330 kV line bays and gantries; foundations for gantries; S/S main earth grid and defined connection point for line earthing; underground fiber from OPGW joint box to ODF/telecom panels; bay equipment tests and integration into SCADA. Harmonise Nakonde line 1 & 2 phase	N/A	Terminal definitions as per ER “Description of 330 kV OHTL Kasama – Nakonde Stepdown S/S” and line terminal points.

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
		splicing at the gantry; OPGW tests up to first joint box. Phase sequence check at the gantry of Nakonde line 1 & 2.	sequence check to the substation phase sequence.		
IF-02	330 kV Nakonde Stepdown S/S – 330 kV Kasama– Nakonde OHTL	As per IF-01, at Nakonde end: terminal tower(s), jumpers and droppers, stringing, conductor / OHGW / OPGW terminations and line earthing up to gantry connection; provision of OPGW dome joints and splicing at the gantry; OPGW tests to joint box. Phase sequence check at the gantry of Kasama line 1 & 2.	330 kV Nakonde line bays and gantries; S/S earth grid and line earthing bonding point; underground fiber from OPGW joint box to ODF; integration of protection/telecom with OPGW fibers. Harmonise Kasama line 1 & 2 phase sequence check to the substation phase sequence.	N/A	Ensure tower spotting & gantry geometry coordinated in ICD; Package 4 to issue final gantry coordinates & elevations.
IF-03	330 kV Nakonde Stepdown S/S – 400 kV Nakonde–	400 kV terminal tower(s) outside Nakonde; stringing, downloads and jumpers to 330 kV gantry (insulation	330 kV line bays and gantries for the interconnector; S/S earth grid and bonding point; underground fiber from joint box to	N/A	Nominal operation at 330 kV (not 400 kV) at this stage; clear

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
	Tanzania Border OHTL	levels and arcing horn arrangement per ER); OHGW/OPGW terminations and line earthing; provision of OPGW dome joints and splicing at the gantry; OPGW tests to joint box. Phase sequence check at the gantry of Tunduma line 1 & 2.	ODF / protection & telecom equipment; any required VT/CVT interfaces for line differential or teleprotection. Harmonise Tunduma line 1 & 2 phase sequence check to the substation phase sequence.		insulation coordination responsibilities in ICD.
IF-04	Cross-border span – 400 kV Nakonde–Tanzania Border OHTL ↔ TANESCO 400 kV line	Design of Zambian terminal tower at border; mechanical & electrical design of cross-border span (final stringing of conductor, OHGW and OPGW across border); joint inspection and testing of span; provision of OPGW dome joints and splicing at the border crossing and all phase conductor jumpers and insulators including	None (substation-side only, except coordination on protection/telecom).	Design and construction of Tanzanian terminal tower; where TANESCO side is “second” contractor, responsibility for final stringing of conductors / OHGW / OPGW across border as per agreed sequence;	Sequence details to be frozen in ICD with TANESCO (tower coordinates, phase arrangement, tension/sag tables, safety rules).

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
		all connections. Coordination with TANESCO for joint inspection, testing, and commissioning/acceptance activities.		interface drawing approval; coordination of outages, work permits, and safety procedures.	
IF-05	Cross-border OPGW & telecom – ZESCO ↔ TANESCO	Supply and stringing of OPGW across and up to the border joint box; provision of OPGW dome joints and splicing; testing of fibers on ZESCO side up to joint; provision of OTDR test records and fiber allocation schedule.	None(substation side only, except integration to and coordination on protection/SCADA/voice/data systems(telecoms))	Supply and stringing of OPGW from Tanzanian terminal tower to border joint box; testing of fibers on TANESCO side; provision of compatible OTDR records and fiber allocation; onward termination to TANESCO ODF and systems.	ICD to include agreed fiber allocation (protection / SCADA / spare), connector type, test procedures and acceptance criteria, and which party leads cross-border end-to-end tests.
IF-06	132 kV Nakonde Stepdown	Terminal towers, stringing, downleads,	132 kV bays and gantries in Nakonde Stepdown S/S; earth	N/A	Note initial operation at 66 kV on

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
	S/S – 132 kV Nakonde–Isoka LI-LO OHTL (initially 66 kV)	droppers and terminations of conductors and OPGW at 132 kV gantries; line earthing up to gantry; provision of OPGW dome joints and splicing at the gantry; OPGW tests to joint box. Phase sequence check at the gantry of Isoka and Nakonde town lines	grid and TL bonding point; underground fiber from joint box to ODF; bay protection and telecom equipment. Harmonise Isoka and Nakonde town lines phase sequence check to the substation phase sequence.		132 kV design; any temporary equipment or settings (e.g. VT ratios, protection) to be covered in ICD and commissioning plan.
IF-07	Connection of new 132 kV line to existing Isoka–Nakonde Town 66 kV line (LI-LO)	New 132 kV LI-LO OHTL (towers, foundations, conductors, OPGW); T-junction tower and downloads to existing 66 kV line; ADSS/OPGW arrangement and new joint box on existing line, including 2.5 km ADSS option on wooden poles, if adopted.	Substation side only (Isoka and Nakonde Town 66 kV S/S) , protection changes, and ODF connections at both substations. No bay modifications and 66kV side other modification is expected.	N/A	ER gives both base arrangement and “Option” of using existing towers for OPGW; choice and detailed checks (mechanical utilization) to be documented by Package 3 and

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
					approved by Employer.
IF-08	OPGW / telecom interfaces at Kasama, Nakonde Stepdown, Isoka & Nakonde Town S/S	(Kasama and Nakonde Stepdown only)OPGW supply & stringing, downloads, joint boxes at each S/S gantry; fiber tests up to joint boxes; provision of as-built link diagrams and fiber schedules.	(Isoka and Nakonde town)Underground fiber between each joint box and substation ODF; termination hardware; telecom equipment (RTU, SCADA, teleprotection, voice etc.) and end-to-end testing inside the substation fence.	N/A	ER assigns joint box vs ODF responsibilities; this row simply consolidates them for the Interface Control Document.
IF-09	Earthing & step/touch potentials at line– substation interfaces	Line earthing design up to defined connection point on S/S earth grid; tower footing resistance and shield wire continuity; measurement and reporting at terminal towers; continuous counterpoise earthing for the first 1.5km on 400kV Nakonde Stepdown-border, 330kV Nakonde Stepdown -Kasama and	Design and installation of S/S earth grids (Kasama, Nakonde Stepdown); step/touch potential compliance inside the fence; definition and provision of earth grid connection points for each line.	For border span substations, TANESCO is responsible for its own S/S earth grid and connection to its terminal tower.	Interface drawings to show exact earth bonding details (conductor size, connection type, test points). Final earthing test responsibilities and methods to be described in ICD.

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
		Nakonde Stepdown 132kV- 66kV Isoka/Nakonde town lines and bonding to the substation earthing grid			
IF-10	Kasama and Nakonde Stepdown Substations	End to end OPGW optic fiber for Kasama – Nakonde on 330kV.	End to end telecoms terminal equipment at Kasama and Nakonde Stepdown substations for the Kasama- Nakonde 330kV OHTL	N/A	The package 3 and package 4 contractors shall collaborate to ensure establishment of a telecoms link between Kasama and Nakonde Stepdown substations
IF-11	Nakonde – Tanzanian border – Tunduma Substation 400kV	Line contractor for the Nakonde to the border section shall string and join the OPGW at the border	N/A	ZESCO & TANESCO line contractors end to end tests collaboration	
IF-12	Terminal Equipment at Nakonde Stepdown		Terminal equipment includes -Metering	ZESCO & TANESCO Nakonde Stepdown	

Ref	Interface location	Package 3 – Transmission Line Contractor	Package 4 – Substation Contractor (ZESCO side)	TANESCO / TANESCO Contractor	Notes / Key documents
	and Tunduma Substations		-Protection -Telecoms	and Tunduma Substation contractors	

10 Contractor’s Environmental and Social Management

The Contractor shall fully comply with, and implement throughout the Works, the project-specific Environmental and Social instruments, including but not limited to:

- Environmental and Social Impact Assessment (ESIA);
- Environmental and Social Management Plan (ESMP);
- Environmental and Social Commitment Plan (ESCP);
- Stakeholder Engagement Plan (SEP);
- Labour Management Procedures (LMP);
- Resettlement Action Plan (RAP) for relevant sections;
- Biodiversity Management Plan (BMP)

and any subsequent updates or addenda approved by the Employer and the Bank.

The Contractor’s Environmental and Social Management Plan (C-ESMP) shall incorporate and operationalize all mitigation, monitoring, and management measures from these instruments, tailored to the specific risks at Kasama Substation (brownfield extension) and Nakonde Stepdown Substation (greenfield). Non-compliance shall be grounds for suspension (GCC 41), performance deductions, or termination (GCC 42).

The Contractor shall prepare his Environmental and Social Management Plan (C-ESMP) for all his works and obtain the Engineer's approval of this plan within 30 days after contract effectiveness. There will be no mobilization and no start of site works until C-ESMP (including SEA/SH measures, traffic, waste, spill response, and stakeholder engagement actions) is reviewed and accepted by the Engineer/Employer. The Contractor shall implement the SEA/SH/GBV Action Plan, including mandatory training for all personnel within 30 days of mobilization, display of the Code of Conduct at all sites/camps, confidential grievance channels, and referral to survivor support services. All SEA/SH allegations shall be reported immediately to the Employer and investigated per the SEP and LMP. All works carried out by the Contractor in the field shall comply with the environmental protection requirements.

The C-ESMP shall be prepared with the aim to minimize environmental and social impacts of the Works to be carried out by the Contractor. The Management Plan shall be based on an assessment of environmental and social impacts likely to arise from the construction and operation of the works, as identified in the project Environmental and Social Impact Assessment (ESIA) and outlined in the Environmental and Social Management Plan (ESMP), and Labour Management Procedure(LMP)prepared for the project. The forestated safeguards documents (ESIA, ESMP, LMP, ESCP and SEP) are attached under the ZESCO LTD link for this tender. Note that all the compliance costs to the forestated safeguard instruments shall be deemed included in the Price Schedule submitted by the bidder.

10.1 Contractor’s environmental and social organisational requirements

The Contractor shall comply with all the requirements herein and the costs of compliance shall be included in the unit rates in the Schedule of Quantities. The Contractor shall carry out the specified environmental protection requirements to the approval of the Consultant. If instructed by the Consultant, the Contractor shall implement additional mitigation measures payable under the applicable rates in the Daywork Schedule.

The standard contract for the construction of electricity infrastructure contains general clauses that promote environmental protection during construction. The safeguards instruments (ESIA, ESMP, Biodiversity Management Plan etc.) provides the project with specific information on the potential impacts identified.

Efforts shall be made to avert adverse impacts as long as this is technically and economically feasible. Remaining impacts shall be mitigated within the context of the construction contract, hence the requirements in this chapter.

10.1.1 Administrative Institutions and regulatory framework

The Contractor shall comply with the conditions stated by, but not limited to the Zambia Environmental Management Agency (ZEMA), Water Resources Management Authority (WARMA), National Heritage Conservation Commission (NHCC), Energy Regulation Board (ERB), Factories Inspectorate, Forestry Department, Department of National Parks and Wildlife as well as respective Provincial and District Authorities, and the instructions of ZESCO through its appointed E/OHS supervisor. The Contractor shall abide by all Zambian statutory requirements, legal requirements, and other requirements as embodied in, but not limited to, the following acts, laws and guidelines:

- Environmental Management Act No. 12 of 2011
- Electricity Act of 2019
- Energy Regulation Act No. 12 of 2019
- Forestry Act of 2015
- Zambia Wildlife Act of 2015
- Water Resources Management Act of 2011
- Occupational Health and Safety Act of 2010
- Lands Act of 1995
- Urban and Regional Planning Act of 2015
- Water Supply and Sanitation Act of 1997
- National Heritage Conservation Commission Act (EMA) of 1989

- Employment Code Act No. 3 of 2019
- Public Health Act
- Anti-Gender-Based Violence Act of 2010
- Human Rights Commission Act of 1996
- Disaster Management Act No. 13 of 2010
- Factories Act
- Standards Act of 2017

The Contractor shall also adhere to all relevant ZESCO policies, guidelines and instructions, as well as other relevant national requirements in, but not limited to, the following areas:

Resettlement and Compensation

Contractor Management

Management of Personal Protective Equipment

Incident Reporting and Investigation

Waste Management Guidelines

Land Acquisition Guidelines

Substation construction ESHS/ESMP obligations (including waste, oil/SF6 management, dust/noise, community H&S) as per provisions of the ESMP and other relevant safeguards instruments provided.

In addition to the above, the Contractor shall abide by the requirements of the financiers as outlined as outlined in this chapter, in the ESMP of the Project ESIA, and in the following key Project Environmental and Social Safeguards instruments:

- Resettlement Action Plan
- Stakeholder Engagement Plan
- Labour Management Procedure
- Grievance Redress Mechanism
- Biodiversity Management Plan

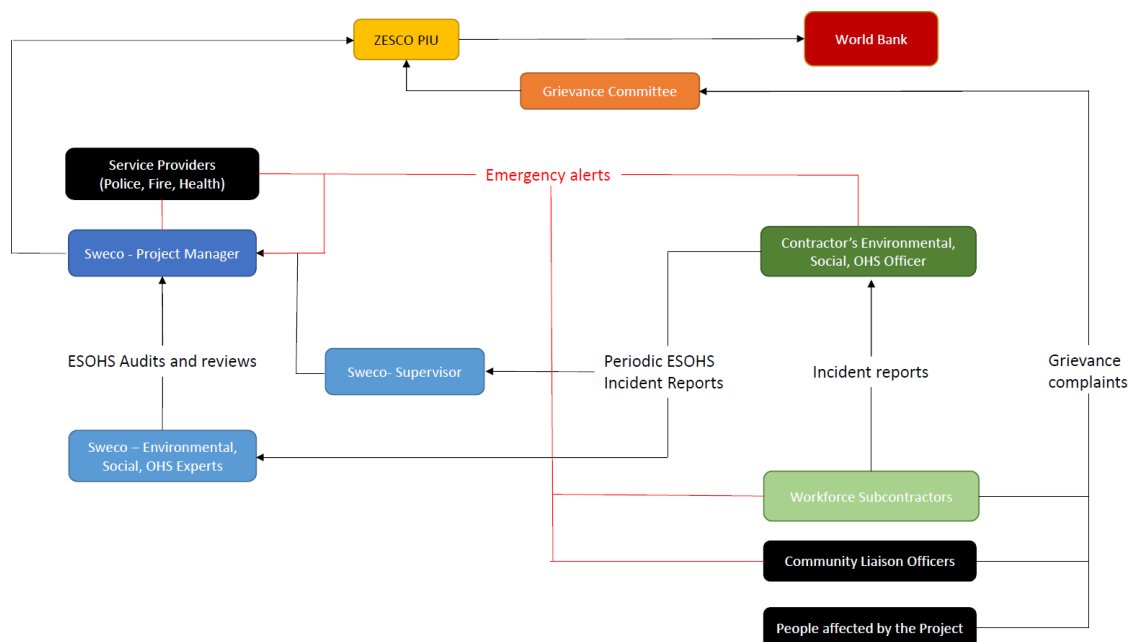
- Gender-Based Violence / Sexual Exploitation Abuse and Harrassment Action Plan

10.1.2 Environmental and Occupational Health and Safety Organization

The Contractor shall establish safety organisation for management of all safety related issues during the construction and operation of the Works, including safety of third parties. The safety requirements applicable in Zambia and ZESCO shall apply and cover Contractors as well as their sub-contractors and employees.

The Contractor's safety procedures shall be incorporated in his QA activities and specified in detail, in either a separate document or in his QA procedures. The procedures shall be subject to the Engineer's approval before the Contractor commences his works at the site. An outline of the organisation and functions of the occupational, health, safety and E&S organisation is provided in **Figure 2**.

Figure 2: Tentative Environmental, Social and Occupational Health and Safety Organization



10.1.3 Employment and Sub-Contracting

10.1.3.1 Employment

Contractors shall abide by the employment regulations according to the International Labour Organisation (ILO) and Zambian Law as provided for in the Employment Act and as per the Projects Labour Management Procedure. Each employee shall have an individual contract,

stipulating conditions for employment and remuneration. Employment shall be equal opportunity and gender sensitive. Each employee shall have the skills required for the tasks at hand or receive adequate training for undertaking the tasks. Employees shall be qualified to perform each task they are assigned. All electrical installations shall be performed by qualified staff. All employees shall be provided with PPE suitable for the work at hand, and free of charge.

There shall be a grievance mechanism by which employees can communicate concerns to the Contractor and ZESCO, preferably anonymously. This grievance mechanism shall also apply to and be available for subcontractors and their staff and shall be made known to all staff.

10.1.3.2 Sub-Contracting

The Contractor is encouraged to employ labour intensive techniques as much as possible. It is preferred that the Contractor and his Sub-contractors employ local residents of the area. The Contractor shall tighten controls on employment to ensure that people from outside the area are not employed at the expense of locals, except in the case of skilled or specialised tasks that are not available locally. The Contractor shall endeavour to engage local sub-contractors, particularly in areas not requiring specialist skills, such as:

- Bush clearing;
- Access road construction and maintenance;
- Excavation and/or concrete works for foundation footings;
- Haulage of materials;
- Watering of roads for dust abatement;
- Rehabilitation and maintenance of disturbed areas;
- Road Maintenance;
- Construction and maintenance of any buildings required for site establishment;
- Catering;
- Refuse disposal;
- Security.

It should be noted that some of the above may need certification or approval such as Public Health Regulation approval.

10.2 Environmental and Occupational Health and Safety Guidelines for Construction

In general, the Contractor shall conduct his activities to cause the least possible disturbance to existing amenities, whether natural or man-made, and to comply with all relevant statutory requirements. The relevant provisions of the ESMP, LMP and contractors’ standards shall apply.

10.2.1 Environmental Guidelines

The Contractor shall abide by the following general environmental guidelines while undertaking the works.

- The Contractor shall not establish or undertake any activities that, in the opinion of the Consultant, are likely to permanently affect the scenic quality of the works area. Where required, the Consultant may direct the Contractor to refrain from such activities or to take ameliorative actions to reduce the adverse effect of such activities on the scenic quality of the environment.
- Painting or marking of natural features shall not be permitted. Marking for surveying and other purposes shall be carried out only with pegs and beacons.
- No work shall be carried outside the defined area of the works without the prior written approval from the Consultant.
- The Contractor shall take all necessary actions to ensure that water quality in nearby rivers and streams is not adversely affected. The Contractor shall undertake a baseline and there after, periodic water sampling of the nearby rivers and streams to assess their water quality. Other than that, which must be there for operational reasons, no construction activity will take place within 50 metres of a riverbank, whether the riverbed is dry or wet.
- The effects of runoff and erosion within construction areas shall be minimised, for instance by use of sediment traps or other suitable and effective means.
- To minimise air and noise pollution, contractors shall use only equipment in good condition, which shall be properly maintained. The equipment shall have valid test certificates for the period operation.
- Blasting shall only be carried out when unavoidable. Where blasting must be carried out it shall be strictly controlled.
- On- or off-site, workers shall not wantonly kill or injure any creatures except those (such as rats, flies and mosquitoes) known to be vectors of disease.
- Accidents at a construction site shall be documented by the Contractor’s Health & Safety Officer and the Consultant. Safety rules and procedures shall be tightened in the light of that information to reduce the chances of recurrence.
- Contractors shall at all times exercise due care and diligence not to damage fences, walls, drains, roads, tracks, buildings, fields, pasture, hedges and trees. All damage shall be made good at the first opportunity, at the Contractor’s cost.
- Disturbance or disruption of the daily lives of local communities and their livelihood, including noise and dust pollution shall be minimised in as far as is practicable.
- The Contractor shall ensure that the Construction Site is always maintained in a neat and tidy condition.
- The Contractor shall employ as many locals as is practically possible for the execution of the Works.

10.2.2 Contractor’s Code of Conduct

In general, human beings are normally averse to invasion of privacy, regardless of status of society (modern or traditional). They expect an element of respect from outsiders. Therefore, the contractor shall prepare a code of conduct for the workforce for submission to ZESCO before commencement of work. The code shall be gender sensitive. The code of conduct shall

be discussed during the planning phase of the project and thereafter approved. It shall include, but not necessarily be limited to, the following:

- Workers will not dig holes, divert water, erect any structures or engage in any construction or excavation works unless so instructed by the site supervisor.
- All waste materials – comprising human waste and all spoiled and unwanted metal, paper, plastic, rubber, paint, batteries, bottles and other glass, chemicals, fuel and oily waste – will be deposited in bins and skips provided by the Contractor. All wastes to be segregated at source. Waste materials shall never be abandoned on the ground nor thrown into water.
- Workers may cook at the camp and may use woodstoves for cooking on clear ground within the designated project work areas at the discretion of the site supervisor. Workers will not light fires in any other place.
- Workers will not cut trees or branches of any tree except when so instructed by the site supervisor, and only after the specific trees to be cut have been clearly indicated.
- Wood, bamboo, fruit, vegetables, surface water, fish and farm animals may be bought from villagers bringing produce to the camp or selling it at a market; but such produce will not be taken by the workforce directly from the surrounding area.
- Workers will not hunt wild animals in the project area nor buy bush-meat from villagers.
- Workers will not put themselves at risk of contracting sexually transmitted diseases nor risk spreading disease among local communities.
- Workers shall be made aware that they are not allowed to disturb local communities.
- Workers will not bring visitors or dependants to any camp or any work-site without prior permission of the site supervisor. Any visitors or dependants who are permitted to visit the camp will abide by these rules and be inducted on site security, health and safety aspects prior to entering the site.
- Workers will carry identification cards issued by the Contractor and will show them to authorised personnel whenever passing through any site gate or at any other time when so requested by security personnel in uniform.
- Drivers will not take vehicles off-road or out of the designated work area without prior instruction by the site supervisor.
- Project vehicles will not be used for the carriage of any goods or passengers, other than project materials and personnel, without the express consent of the site supervisor.
- When asked about employment by members of local communities, workers will advise the enquirer to contact the site supervisor. Workers will not claim to be able to provide employment nor to influence the selection of temporary staff.
- Except when so instructed by the site supervisor, workers will not break or damage any wall, fence, hedge, drain, pipe or other structure existing at any work site prior to project operations.
- When any bones or other human remains, broken pottery or other evidence of burials or earlier human habitation of a site are uncovered during excavation, workers will

discontinue excavation and immediately inform the site supervisor. A Chance Find Procedure shall be developed and made known to workers.

- The Contractor shall ensure that each of their personnel and personnel under the employment of the sub-contractor receive and sign the approved Project Code of Conduct prior to commencement of works.

10.2.3 Temporary Works

The following specific environmental guidelines shall be observed and implemented by the Contractor in mitigation of potential environmental impacts in areas of activity, access roads, borrow areas, spoil disposal areas, labour camps and storage areas.

- Use of existing facilities such as access roads and site establishment sites and/or their improvement shall be preferred to the construction of new ones.
- A minimum of two toilets for temporary camps and full ablution facilities for permanent camps shall be provided. Latrines at camps will be closed and sealed after completion of works. There shall be hygiene facilities available for women as well as men.
- Camps and storage areas shall be located away from drainage courses and wetlands.
- Camps and work-sites shall be kept clean and tidy.
- Fuel, lubricants and other chemicals shall be stored in above ground storage facilities such that the entire surface area can be visually inspected. Tanks shall be inspected twice daily, and any leakage stopped immediately. There may be need for licensing for the management (importation, storage, use, disposal etc. as required) of hydrocarbons and chemicals through ZEMA, ERB, Zambia Metrology Agency, and Local Authorities.
- Sumps surrounded by low bounds and floored with impermeable material shall be constructed beneath all oil storage tanks and shall have appropriate volumes in place as per regulation (110% of tank capacity). Other than trivial amounts, oil spilled to sumps will be removed for recycling or safe disposal.
- Oil changes in machinery and equipment including vehicles shall take place only in depots (never in the field). Drip pans will be placed under the equipment throughout oil changes and lubrication to reduce spillages and hydrocarbon contamination to the environment.
- Construction workers are discouraged from wood cutting and fishing and shall be dismissed for unauthorised hunting. Contractors and their workforce may use local supplies of wood, within moderation, if there is no local shortage; but they should purchase wood from the local population rather than just taking it freely.
- Demobilisation from a site will include removal and safe disposal of all temporary structures and wastes. Stored top-soil shall be restored to site which will be planted with indigenous grasses, where instructed by the Consultant. No un-drained water will remain on site.

10.2.4 Traffic Management

The following traffic management guidelines shall be observed and implemented by the Contractor:

- Where work is carried out on or adjacent to a trafficked highway, the Contractor shall ensure that personnel shall, always, wear high visibility fluorescent garments.
- All proposals, details, execution, maintenance, removal and necessary reinstatement associated with traffic safety and management, temporary decking of heavy haulage of transformers, reactors, local escorts, road works near sites and other structures on public roads, shall be subject to the approval of the Roads Development Agency. The Contractor shall supply all information required for consultation with appropriate authorities, including the Local Authority and Police.
- All traffic safety and management measures necessitated by the Works shall be fully operational before the Contractor commences work which affects a highway.
- The Contractor shall provide suitable entry and exit signs, at points of access to and from the site, for vehicles and plant engaged on the works.
- The Contractor shall make all necessary arrangements including notices to relevant authorities for the provision, erection, maintenance, repositioning, covering and uncovering and final removal of all traffic signs as the progress of the works requires.
- Location of access roads/detours shall be done in consultation with the local community and relevant authorities where required, especially in important or sensitive environments. Access roads shall not traverse wetland areas or areas of environmental and cultural significance.
- Upon the completion of civil works, all access roads shall be ripped and rehabilitated.
- Access roads shall be sprinkled with water at least five times a day in settled areas, and three times in unsettled areas, to suppress dust emissions.
- Construction vehicles shall not exceed maximum speed limit of 40 km per hour.
- In carrying out construction of the Works, the Contractor, subcontractors and their suppliers of materials shall comply with the provisions of the relevant laws of Zambia.
- Where designated access routes are indicated in the Contract, the Contractor shall use no other without the approval of the Consultant.
- Where possible, medium-sized vehicles shall be used in transporting labour and materials in order to minimise noise and general wear of the roads.
- Where black cotton soils are prevalent, heavy construction vehicles and plant should not be used on access roads during the rainy season, unless the access roads are upgraded by laying suitable gravel and installing drainage to prevent the occurrence of quagmire conditions.

- All public and private roads used by the Contractor, subcontractors or suppliers for the construction of the Works shall be kept trafficable and free of excessive dirt and mud arising from the Works.
- Where existing gravel roads are used frequently by the project in any part of the works as access roads for transporting labour, plant and materials, the Contractor shall contribute towards the maintenance or upgrading of the roads in any one of the following ways:
 - Routine maintenance, consisting of gravelling and dust control by watering. The level of contribution, specific programme and equipment to be used shall be agreed with the Consultant, or
 - Negotiate a road maintenance/users “fee”, payable to the relevant authorities in lieu of road maintenance described above.
- The Contractor shall select his preferred option, formulate and implement the necessary administrative details with relevant parties, without any undue delay. Where there is delay for any reason, contingency plans shall be put in place, upon approval of the Consultant.
- Any area of public road which is closed because of the Works shall not be reopened until appropriate safety and traffic management measures have been completed and until the Consultant confirms that it is in a suitable condition for use by the public.
- The Contractor shall periodically water all gravel roads in the proximity of dwellings, where these are heavily used by construction traffic, to minimise dust emission.

10.2.5 Third Party Access

The following guidelines regarding third-party access to the work site shall be observed and implemented by the Contractor:

- The Contractor shall, at all times, maintain access for the authorised representatives of utility providers and allow emergency operations to be carried out on any utility or service facilities within the site.
- The Contractor shall not use public or private rights of way for depositing or storing plant or materials and shall maintain those parts of the public or private right of way not temporarily occupied by the Works in a clean, passable and safe condition at all times.
- The Contractor shall execute the Works in such a manner that safe access, (including disabled persons access, where they existed prior to site possession), to all properties is always maintained. Methods of construction and programming of the Works shall be such that vehicular access to properties affected by the Works is not restricted. Normal access shall be reinstated immediately after completion of the Works.
- The Contractor, his employees, subcontractors and their employees, in all instances shall exercise utmost driving control and driver care.

10.2.6 Refuse and Waste Control

The following refuse and waste control guidelines shall be observed and implemented by the Contractor:

- Littering shall be avoided. All refuse shall initially be separated at source and placed in bins or receptacles provided by the Contractor for such purposes, and subsequently disposed of in approved refuse disposal sites. No burning of waste shall be permitted.
- All hazardous wastes, materials soiled with hazardous wastes and non-biodegradable matter shall not be disposed of on the Site. All such waste shall be stored in an approved manner, on Site, and removed at regular intervals to off Site waste disposal facilities designed to handle such hazardous waste. Licensing by ZEMA and District authorities may be required. Where hazardous waste disposal facilities are unavailable, the waste shall be stored on site in manner as guided by respective environmental permit/license issued by the relevant authority.
- Wooden conductor drums, nails and other waste material deemed to be useful may be donated to the local communities on approval by the Consultant.

10.2.6.1 Disposal of Unusable Elements

The following guidelines on the disposal of unusable elements shall be observed and implemented by the Contractor:

- Unusable materials and construction elements such as electro-mechanical equipment, pipes, accessories and demolished structures will be disposed of in a manner approved by ZESCO, the Consultant, respective Local Authorities and in line with respective environmental permits/licences conditions where required. The Contractor has to agree with ZESCO/ Consultant which elements are to be surrendered to ZESCO’s premises, which will be recycled or reused, and which will be disposed of at approved landfill sites or in a manner approved by the relevant local authorities.
- As far as possible, abandoned pipelines shall remain in place. Where for any reason no alternative alignment for the new pipeline is possible, the old pipes shall be safely removed and stored at a safe place to be agreed upon with ZESCO/ Consultant and the local authorities concerned.
- AC-pipes as well as broken parts thereof have to be treated as hazardous material and disposed of as specified above.
- Unusable and demolished elements shall be dismantled to a size fitting on ordinary trucks for transport.

10.2.7 Water Pollution Control

The Contractor shall observe and implement the following guidelines on water pollution control:

- The Contractor shall design, construct, maintain and operate suitable temporary pollution control facilities necessary to prevent the discharge of polluting matter or visible suspended materials into private property, rivers, streams or existing drainage systems. Licensing by ZEMA and Local Authorities may be required.
- All diverted and pumped water shall be discharged at locations on the surface from which it cannot re-enter the Works, and in a manner which does not cause erosion, pollution or nuisance to landholders, other contractors employed by ZESCO, or other persons within or adjacent to the Site.
- Management of waste oil from workshops and other areas shall not cause pollution, and shall be done in accordance with conditions of respective waste/hazardous waste management licenses. Oil separators shall be employed, where necessary.
- The burning of plastic material shall not be permitted, and all such material shall be disposed of in a manner acceptable to the Consultant, and in line with environmental provisions as prescribed by relevant authorities.
- Soil contaminated by cement or other chemicals shall be removed and placed in approved disposal areas, identified by the Contractor.
- Before any work is carried out in any area of the site, all specified or directed or approved pollution control measures shall be in place and operational.

10.2.8 Water Resources Management

The following guidelines on water resources management shall be observed and implemented by the Contractor:

- The Contractor shall at all costs avoid conflicting with water demands of local communities.
- Abstraction of both surface and underground water shall only be done with the consent of the local community and after obtaining a permit from Water Resources Management Authority (WARMA).
- Abstraction of water from wetlands shall be avoided. Where necessary, authority must be obtained from relevant authorities.
- Temporary damming of streams and rivers shall be done in such a way avoids disrupting water supply to communities downstream and maintains the ecological balance of the river system.
- No construction water containing spills or site effluent, especially cement and oil, shall be allowed to flow into natural water drainage courses.
- Wash water from washing out of equipment shall not be discharged into water courses or road drains.
- Site spoils and temporary stockpiles shall be located away from the drainage system, and surface run off shall be directed away from stockpiles to prevent erosion.

10.2.9 Water Supplies

The following guidelines on community water supplies shall be observed and implemented by the Contractor:

- Where possible, the constructions shall be planned and located in such a manner that dams, boreholes, wells and pipelines and other water supply facilities are avoided.
- In the event of unavoidable disruption to water supplies, the Contractor shall provide alternative water supply to those communities whose supply is affected.
- The provisions in these technical specifications on water pollution control shall apply.

10.2.10 Wastewater Discharge from the Works

Wastewater quality standards of effluent from construction sites that shall be maintained for the general protection of public health and the ecosystem are outlined below.

- All water effluent discharge from the Works areas, whether from runoff or construction operations, shall be free from chemical and oil pollution.
- The waste water or effluent shall contain no other constituents in concentrations which are poisonous or injurious to humans, animals, fish or other forms of aquatic life, or which are deleterious to agricultural use.
- Wastewater testing, analysis and reporting shall be done on a regular basis as required by respective authorities.

10.2.11 Water Testing

Where there is a risk of pollution of water course from the Contractor’s operations, the Contractor shall arrange to take water samples at each discharge point as and when necessary, or as directed by the Consultant, and shall have the samples analysed for pollutants by an approved laboratory. Copies of the reports of analysed samples shall be submitted to the Consultant within fourteen days of the tests having been carried out. Water sampling at each discharge point shall be done in line with the conditions set in relevant permits.

In addition to samples from the discharge points, the Contractor shall take and have tested water samples from 500 m upstream and 500 m downstream of the Works. The suspended sediment concentration in the water course, 500 m downstream from the discharge point shall be limited to 10% above baseline conditions. The respective distances for sampling shall be confirmed with authorities prior to any sampling.

10.2.12 Fuel Storage and Workshop Areas

The following shall be adhered to in the management of fuels and poils from workshops and fuel storage areas:

- Drainage into water courses from fuel storage and machinery maintenance areas shall be treated to remove oil and/or fuel. Periodic testing of discharge shall be done in line with requirements from relevant authorities.
- Soil contaminated by fuel and oil leakage shall be removed and managed off site in a manner approved by relevant authorities i.e. ZEMA and Local Authorities.

10.2.13 Ablution and Toilet Facilities

The Contractor shall observe and implement the following guidelines on ablutions, toilets and sanitary facilities for the workforce:

- The Contractor’s labour force shall be provided with approved adequate ablution and toilet facilities within labour camps. All construction sites served by migratory site establishments shall have Blair type (pit latrine) or other approved toilet facilities which shall be properly rehabilitated upon demobilisation of the transit camp. Alternatively, transit camps may be provided with chemical toilets.
- Pit latrines and septic tank soak-ways shall be sited a minimum distance of 30 m down-slope from wells, boreholes and springs. Distances should be greater in sandy soils, or fissured material through which water can easily percolate.
- Washing utensils, vehicles and equipment in rivers and streams shall be strictly forbidden.

10.2.14 Groundwater

The following guidelines on groundwater management shall be observed and implemented by the Contractor:

- The Contractor’s working methods and systems shall be designed so as not to significantly affect groundwater around the Works. Abstraction of ground water shall not cause damage to the Works, nor to the property of third parties, and shall not cause nuisance. This may also require approval by relevant authorities such as ZEMA, WARMA and other local authorities.
- Permits and clearance shall be obtained from WARMA for groundwater abstraction where necessary. Ground water abstraction shall be done in such a manner as to avoid significant lowering of the natural groundwater table.
- Disposal of water taken from the works shall be in a safe and proper manner and shall fulfil the pollution control requirements specified in these specifications.
- Temporary works for the control of groundwater shall be removed and the ground reinstated when they are no longer required.

10.2.15 Worksite/Campsite Waste Management

The Contractor shall observe and implement the following guidelines on waste management at worksites and campsites:

- All vessels (drums, containers, bags, etc.) containing oil/fuel/surfacing materials and other hazardous chemicals shall be secured in order to contain spillage. This shall include the construction of their storage areas to be able to contain any possible spillages. All waste containers, litter and any other waste generated during the construction shall be collected and disposed at designated disposal sites in line with applicable waste management regulations.
- All drainage and effluent from storage areas, workshops and camp sites shall be captured and treated before being discharged into the drainage system in line with applicable water pollution control regulations.
- Used oil from maintenance shall be collected and managed appropriately as per ZEMA hazardous waste management regulations at designated sites or be re-used or sold for re-use locally.
- Entry of runoff to the site shall be restricted by constructing diversion channels or holding structures such as banks, drains, dams, etc. to reduce the potential of soil erosion and water pollution.

10.2.16 Air Pollution Control

The Contractor shall observe and implement the following guidelines on air pollution control in the work sites:

- The Contractor shall take measures, as necessary, to reduce the emission of particulate matter from blasting operations, excavations, road transport, rock crushing, material sieving, borrow areas, and other related construction activities.
- Equipment and vehicles that exhibit excessive emissions of exhaust gas due to poor engine adjustment or other inefficient operating conditions shall not be used.
- It is preferable that cleared trees and brush, combustible materials, construction materials and rubbish be used in slope stabilisation, erosion control works, site rehabilitation, or made available to local landowner or users.

10.2.17 Noise Pollution Control

Construction activities such as blasting, operation of plant and equipment, and heavy vehicles will result in noise nuisance to residents and animals in the project area. The following guidelines shall be followed to restrict noise levels to acceptable limits.

- The Contractor shall restrict any of his operations which result in undue noise disturbance to nearby communities and dwellings to between the hours of 06:00 and 18:00, unless otherwise approved by the Consultant.
- As far as is practicable, the Contractor shall bring to Site, and employ on the works, only environmentally acceptable and quietly operating plant and equipment, compatible with the safe and efficient construction of the Works.

- All plant shall be properly maintained, and relevant service records completed. All plant shall be provided with effective silencers and anti-vibration devices, and shall be operated according to the manufacturer’s recommendations, in such a manner as to avoid causing excessive noise emissions or vibrations.

10.2.18 Explosives

The following guidelines on the use of explosives during works shall be observed and implemented by the Contractor:

- The Contractor shall use explosives only in circumstances where it is safe to do so, having due regard to the safety of persons, third party property and the safety of the works.
- The Contractor shall obtain all necessary licences and shall provide and maintain a secure explosives store in accordance with the relevant Explosives Regulations and to the approval of the Consultant.
- Where explosives may damage existing foundations or structures, alternative methods, such as silent demolition, shall be employed using approved chemicals and methods.
- Blasting shall be carried out in accordance with the provisions of Zambian regulations.
- Blasting shall be carried out carefully to avoid loosening or shattering rock beyond the required line of excavation, and all loose or shattered rock shall be removed by scaling down or other means before personnel will be permitted to restart operations after blasting.
- Notices of blasting operations shall be posted on site and communicated to nearby communities giving them sufficient notice prior to blasting. Before each firing, the Contractor shall give audible warning, clear the area, and shall take positive measures to prevent personnel from entering the danger area.
- Where there is blasting in and close to rivers, no pollution of water courses resulting from the chemicals shall be permitted.
- Blasting activities shall not take place less than 2 km from settlement areas, cultural sites, or wetlands without the permission of ZESCO/ Consultant and relevant authorities.
- Blasting activities shall be done during working hours, and local communities shall be consulted on the proposed blasting times.
- Noise levels reaching the communities from blasting activities shall not exceed 85 decibels. When there is risk for such deviation, local communities shall be warned in advance. Noise measurements shall be taken periodically and records maintained as legally required to assess that the blasting levels fall within the required decibels.

10.2.19 Labour Camps

In establishing labour camps, the following gender sensitive guidelines shall apply:

- Camps shall be sited on naturally level ground and on deep soils suited to the construction of ablution and toilet facilities.
- Sites shall not impinge on scenic undisturbed areas or other areas used by the public and shall be screened from major roads.
- The provisions in these specifications for the protection of vegetation, wetlands, animals and pollution control shall apply.
- Drainage facilities shall be installed in and around the site to prevent storm water from flooding the site.
- Cutting of indigenous trees for firewood for cooking and warming shall be strictly prohibited. The Contractor shall supply the labour force with adequate firewood.
- Grass and forest fires shall be prevented by sound control of cooking and warming fires.
- Proper security measures shall be employed to ensure that public property in the vicinity of the site is not pilfered or damaged by the labour force.
- The Contractor shall provide own medical facilities so as to avoid over-stressing of existing local medical facilities. The Contractors medical facilities shall be subject to any required licenses, permits or clearance by respective relevant authorities.
- A First Aid post and portable chemical toilets shall be provided at each temporary labour camp.
- Adequate accommodation and ablution facilities shall be provided to avoid overcrowding.
- All non-migratory labour camps shall be fenced and gated. Access into and out of the camps shall ensure human and traffic safety, at all times.
- On demobilisation, the area shall be made good and re-vegetated in accordance with the provisions in these specifications.
- Permanent structures shall be handed over to local communities at the end of the Contract.

10.2.20 Borrow Areas and Quarry Sites

The Contractor shall obtain appropriate licenses/permits from relevant authorities to operate quarries or borrow areas. The location of quarries and borrow areas shall be subject to approval by relevant local and national authorities, including traditional authorities if the location on which the quarry or borrow areas fall in traditional land. Where available, existing borrow areas and quarry sites shall be utilized. Where these are unavailable, new extraction sites may be operated. The Contractor shall implement the Biodiversity Management Plan and Cultural Heritage Chance Find Procedure during all site clearance, quarrying, borrow pit operations, and rehabilitation. Chance finds shall trigger immediate stop-work, notification to the National Heritage and Conservation Commission, and follow-up measures per the approved plan.

New extraction sites :

- Shall not be located in the vicinity of settlement areas, cultural sites, wetlands or any other valued ecosystem component, or on high or steep ground or in areas of high scenic value, and shall not be located less than 1km from such areas.
- Shall not be located adjacent to stream channels wherever possible to avoid siltation of river channels. Where they are located near water sources, borrow pits and perimeter drains shall surround quarry sites.
- Shall not be located in archaeological areas. Excavations in the vicinity of such areas shall proceed with great care and shall be done in the presence of government authorities having a mandate for their protection.
- Shall not be located in forest reserves. However, where there are no other alternatives, permission shall be obtained from the appropriate authorities and an environmental impact study shall be conducted and approved by the relevant authority prior to excavation being done.
- Shall be easily rehabilitated. Areas with minimal vegetation cover such as flat and bare ground, or areas covered with grass only or covered with shrubs less than 1.5m in height, are preferred.
- Shall have clearly demarcated and marked boundaries to minimize vegetation clearing.

Further,

- Vegetation clearing shall be restricted to the area required for safe operation of construction work. Vegetation clearing shall not be done more than two months in advance of operations.
- Stockpile areas shall be located in areas where trees can act as buffers to prevent dust pollution. Perimeter drains shall be built around stockpile areas. Sediment and other pollutant traps shall be located at drainage exits from workings.
- The Contractor shall deposit any excess material in accordance with the principles of the general conditions, and any applicable EMP, in areas approved by local authorities and/or ZESCO/ Consultant.
- Areas for depositing hazardous materials such as contaminated liquid and solid materials shall be approved by ZESCO/ Consultant and appropriate local and/or national authorities before the commencement of work. Use of existing, approved sites shall be preferred over the establishment of new sites.

10.2.21 Rehabilitation of Work Areas

The Contractor shall rehabilitate disturbed areas of both Permanent and Temporary Works, including but not limited to quarries, borrow and spoil areas, the Contractor’s works and accommodation areas (including the areas designated for ZESCO’s use) and the areas required for the construction of temporary access roads, as well as such other areas as may be specified or instructed by the Consultant. Such rehabilitation shall comprise, where necessary, grassing and planting of trees and shrubs, and erosion protection, and shall be carried out at the

earliest opportunity during the Works. The following general guidelines for the rehabilitation of work areas shall apply:

- On slopes where the risk of erosion is likely, low ridges or beams parallel to the contours, or other approved erosion control features shall be made across the working width.
- Heavily compacted soils shall be lightly ripped to encourage re-vegetation in areas not prone to erosion.
- Where coarse substrate exists (e.g. rock waste, gravel etc.), a layer of subsoil from the stockpiles shall be placed to a minimum depth of 75 mm and lightly compacted. Top-soil shall then be placed preferentially on sites of greatest disturbance to a depth of 75 mm on top of the sub-soil layer. The natural seed store contained in the topsoil should be sufficient for natural re-vegetation over one to two years.
- Rehabilitation measures shall be at the latest carried out immediately following completion of construction of the permanent Works.
- Cut and fill slopes shall be shaped in a manner such that the final ground appears as a natural extension of the adjacent undisturbed ground profiles.
- Shaped surfaces shall be left slightly rough to facilitate binding with topsoil or the natural establishment

10.3 Contractor’s Environmental, Health and Safety Management Plan (EHS-MP)

Within 6 weeks of signing the Contract, the Contractor shall prepare an Environmental, Health and Safety Management Plan (EHS-MP) to ensure the adequate management of the health, safety, environmental and social aspects of the works, including implementation of the requirements of these general conditions and any specific requirements of an EMP for the works. The Contractor’s EHS-MP will serve two main purposes:

- i. For the Contractor, for internal purposes, to ensure that all measures are in place for adequate EHS management, and as an operational manual for his staff.
- ii. For the Employer, supported where necessary by an Engineer, to ensure that the Contractor is fully prepared for the adequate management of the EHS aspects of the project, and as a basis for monitoring of the Contractor’s EHS performance.

The Contractor’s EHS-MP shall provide at least:

- A description of procedures and methods for complying with these general environmental management conditions, and any specific conditions specified in an ESMP;
- A description of specific mitigation measures that will be implemented in order to minimize adverse impacts;
- A description of all planned monitoring activities (e.g. Sediment discharges from borrow areas) and the reporting thereof; and

- The internal organizational, management and reporting mechanisms put in place for such.

The Contractor’s EHS-MP will be reviewed and approved by the Employer/Engineer before start of the works. This review should demonstrate if the Contractor’s EHS-MP covers all the identified impacts and has defined appropriate measures to counteract any potential impacts.

10.4 EHS Reporting

As part of the monthly progress report, the Contractor shall prepare an EHS Report on compliance with these general conditions, the project ESMP, and his own EHS-MP. An example format for a Contractor EHS report is given below. It is expected that the Contractor’s reports will include information on:

- EHS management actions/measures taken, including approvals sought from local or national authorities;
- Problems encountered in relation to EHS aspects (incidents and near misses, delays, cost consequences, etc. as a result thereof);
- Details of all SEA/SH/GBV incidents/allegations (anonymized), resolutions, and follow-up;
- Sex-disaggregated data on workforce and training;
- Lack of compliance with contract requirements on the part of the Contractor;
- Biodiversity/CH monitoring results and any chance finds;
- Changes of assumptions, conditions, measures, designs and actual works in relation to EHS aspects; and
- Observations, concerns raised and/or decisions taken with regard to EHS management during site meetings, as well as community grievances per SEP/GRM, including resolutions.

It is advisable that reporting of significant EHS incidents be done “as soon as practicable”, and as prescribed by the Factories Act and Employers Incident reporting Procedures. Such incident reporting shall therefore be done individually. Also, it is advisable that the Contractor maintains his own records on health, safety and welfare of persons, and damage to property. It is advisable to include such records, as well as copies of incident reports, as appendices to the bi-weekly reports. Format of incident notification template shall be as agreed with the Consultant/Employer. Details of EHS performance will be reported to the Employer.

10.5 Training and capacity building of Contractor’s Personnel

The Contractor shall provide sufficient training to his own personnel to ensure that they are all aware of the relevant aspects of these general conditions, project ESMP, and his own EHS-MP, and are able to fulfil their expected roles and functions. The Contractor shall provide ES training to all personnel (including subcontractors) within 30 days of mobilization and ongoing refreshers, covering: Code of Conduct (ES), SEA/SH/GBV prevention, OHS in live substations,

biodiversity/CH protection, SF₆/oil handling, and emergency response. Training records shall be maintained and submitted monthly. Specific training should be provided to those employees that have responsibilities associated with the implementation of the EHS-MP. General topics should be:

- EHS in general (working procedures);
- Emergency procedures; and
- Social and cultural aspects (awareness raising on social issues).
- Gender Based Violence
- Sexual Exploitation Abuse and Harrassement
- Grievance Redress Mechanism

10.6 Cost of Compliance

It is expected that compliance with these conditions is already part of standard good workmanship and state of art as required under this Contract. No other payments will be made to the Contractor for compliance with any request to avoid and/or mitigate an avoidable EHS impact.

10.7 Grievance Mechanism and Public Liaison

The Contractor shall use the existing Project Grievance Redress Mechanism (GRM) developed and rolled-out by the Employer to the communities within the Project area, for Project related grievances arising from various stakeholders. The Contractor shall implement the approved Project GRM in line with its established reporting structures.

The Contractor shall develop and implement a workplace GRM to manage grievances within the Contractors operations. The Workplace GRM shall be communicated to, and easily accessed by, all contractor and sub-contractor employees.

10.8 Private Property, Schools and Institutions

Along roads to be upgraded, there may be several private properties, schools and other institutions that may be disrupted during construction. The following guidelines shall apply to mitigate the impacts on private property and institutions:

- Where possible, the work areas shall avoid houses and built up areas, plantations, cattle kraals, orchards, and other valuable private property.
- The siting of spoil dumps, borrow areas, access roads and labour camps shall avoid areas where valuable private property will be disturbed or destroyed.
- Where blasting is required, pre-blasting inspections of buildings falling inside the blast pressure zone shall be carried out by the Contractor, or qualified authority, to establish and record the status of the buildings.

- Where possible, the Contractor shall confine construction work through schools and institutions to periods during school holidays. Where this is not possible maximum care shall be taken when working in and around schools to avoid injuring children and damage to property.
- Where fences are breached or sports fields affected, the Contractor shall reinstate them immediately after completion of construction. Where it is required, alternative facilities shall be provided.
- The Contractor shall ensure that access to transport, services, fields, and water supply by private property owners is not disrupted.
- Any reasonable conditions demanded by the landowner shall be respected and complied with as far as it is practicable.
- Where any of the above cannot be avoided or is infringed upon, fair compensation shall be negotiated and paid by ZESCO.

10.9 Repair of Private Property

Should the Contractor, deliberately or accidentally, damage private property, he shall repair the property, at his own cost, to the owner's satisfaction. For each repair, the Contractor shall obtain from the owner a certificate that the damage has been made good satisfactorily in order to indemnify ZESCO from subsequent claims.

In cases where compensation for inconveniences, damage of crops etc. are claimed by the owner, ZESCO shall be informed by the Contractor. This compensation is in general settled under the responsibility of ZESCO before signing the Contract. In unforeseeable cases, the respective administrative entities of ZESCO will take care of compensation.

10.10 Respect for Cultural Values, Beliefs and Property Rights

Sacred sites may exist in the project area. Even if these sites do not fall within the line impacts zone, there is always a risk that members of the Contractor’s workforce might stray into them and desecrate the shrines therein. This could create unnecessary friction between the project and the local communities. With respect to contractor/community relations the following guidelines and rules shall apply:

- The Contractor and his sub-contractors shall conduct their operations in a manner that will not upset the socio-religious order of communities in the Project area. Local traditional beliefs shall be respected.
- In the interest of harmony and good public relations, the Contractor is strongly encouraged to develop rapport with local chiefs and traditional leaders through regular consultations and communications.
- The Contractor or his sub-contractors are prohibited from entering places considered to be sacred.
- Any chance finds of archaeological or cultural remains or artefacts shall be reported to the Consultant who shall contact the NHCC for evaluation.

11 SCOPE OF SUPPLY OF PLANT AND INSTALLATION SERVICES BY THE CONTRACTOR

The contractor shall consider complexity of wiring and interlocking systems, and the extra effort and risks involved in additional power outage work in live substations and interface with the DVSD works at Nakonde Stepdown substation that shall be done under Package 5.

11.1 330 kV Kasama Substation

Kasama substation is an existing 330/66kV substation located in the west outskirt of Kasama Town.

There will be two 330kV new line bays fully equipped with line reactors under this Package and are intended for the double circuit 330 kV transmission line to 330 kV Nakonde stepdown substation to be established under Package 3. The two 330kV Nakonde line feeder bay shall be established under this package by extending the busbar to the west of existing equipment and pointing north. The Design, supply and installation of the line bays complete with line reactors shall be coordinated with similar line bays equipment to be established at the 330kV Nakonde Stepdown Substation. Relevant 330kV Kasama – Nakonde double circuit lines switching studies shall be carried out accordingly.

The control building is located at the north side of the substation plot, next to the entrance gate and 66 kV switchyard, and shall house the equipment for all new 330 kV feeders.

Figure 3 Outline of Kasama Substation



Figure 4 Overview of Kasama and Lualua substations including the access road



The scope for Kasama substation mainly consists of the following;

- 330 kV outdoor switchgear and reactor bays towards Nakonde Stepdown Substation
- SAS, metering, protection, telecoms, WAMPACS, supervision and auxiliary systems for above
- Civil works

All works shall be performed in a live substation where to some extent working areas outdoors can be fenced off. Necessary outages must be coordinated with ZESCO System Operations Department. Two weeks prior notice to the Employer shall be required for any outages that the Contractor will require.

11.1.1 Entrance Road

The entrance road shall be adapted to necessary extent for the Contractor’s transport of new reactors and other bulky or heavy equipment.

11.1.2 330 kV Outdoor Switchgear

The 330 kV switchgear shall be designed as outdoor switchyard with the following general configuration:

- Extension of 330 kV double busbar with space for two equipped line bays.
- Two (2) 330 kV fully equipped line bays for 330 kV Nakonde 1 and 2 OHL’s
- Two sets of 330 kV line reactors, each rated at 30 MVAR and composed of three (3 x 10 MVAR) single-phase units. These shall be installed in the line reactor bays for the 330 kV Nakonde OHL circuits 1 and 2.

11.1.3 Primary Plant

Two 330kV main feeder bay primary plant equipment, each scoped as follows:

- One (01) three-phase 330kV disconnector for Busbar 1 (1M);
- One (01) three-phase 330kV disconnector for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- One (01) three-phase 330kV disconnector;
- Three (03) single-phase 330kV SF6 circuit breakers;
- One (01) three-phase 330kV line disconnector with single earth switch (line side);
- One (01) three-phase 330kV circuit breaker bypass disconnector mounted on gantry;
- Three (03) single-phase 330kV current transformers;
- Three (03) single-phase 330kV capacitor voltage transformers;

- Three (03) single-phase 330kV surge arrestors.

Two 330kV line reactor bay primary plant equipment each scoped as follows:

- One (01) three-phase 330kV disconnecter with single earth switch (reactor CB side);
- Three (03) single-phase 330kV SF6 circuit breakers;
- Three (03) single-phase 330kV surge arrestors;
- Three (03) single-phase 330kV post mounted current transformers
- Three (03) single phase 330kV 10 MVar ONAN Reactors fitted with SERGI 3000 fire protection or equivalent and bushing CTs on HV terminals and neutral terminals – refer to Technical schedule chapter 12.11.7 for more details on the CTs;
- One (01) single phase surge arrestor sized to protect NCR against over-voltages;
- One (01) neutral compensating reactor ONAN – 900 Ω with bushing CTs on HV terminal connected to neutral point of line reactors;
- Passive fire protection for reactors including fire walls (separating each unit including NCR) and bunded area with connection to emergency oil dam.

11.1.4 Auxiliary Power Supply

- AC Supply

Existing supply to cover the load
of the extensions.

- DC Supply

Existing supply to cover for the load of the extensions.

- Misc. auxiliaries

- Flood light for illumination of switchyard of the extensions,
- Lightning protection system covering all new equipment and connected to existing system.

11.1.5 Power and Control Cables

- One (1) set LV AC and DC power and control cables for the extension,
- Two (2) sets of fibre optical underground cable for connection of OPGW from 330 kV line terminal poles to the ODF in the communication panel.
- The contractor shall ensure that new control and protection cable schedules clearly identify all interfaces between existing Kasama panels and the new 330 kV bays, and that cable quantities are reconciled with the SLD and panel lists.

11.1.6 Substation Automation System

At Kasama substation, the contractor shall integrate protection, metering and WAMPACS using IEC 61850 station and process bus where applicable, with time synchronization from a common GPS time source for the Nakonde 1 & 2 line bays and associated line reactors. Further, the contractor shall ensure interoperability testing and cyber-security hardening (role-based access, secure engineering access, logging) of all IEDs and gateways between the new bays and the existing network equipment.

Care must be taken to ensure that all supplied Bay Control Units (BCU) and protection IEDs are of compatible firmware and software versions to achieve seamless integration into the SAS.

Extend existing Station and Process Communication LAN system complete with communication cables to allow for seamless connection and interface of the new IEDs with the existing LAN architecture.

The Contractor shall provide comprehensive signal lists and carry out point-to-point and functional tests for all added control and protection signals with dispatch centers.

11.1.7 Protection System

Protection for the 330 kV Kasama–Nakonde circuits shall be fully coordinated with the protection at Nakonde terminal (line differential and distance schemes, SPAR, tele-protection, communication channels) and shall comply with ZESCO Protection Philosophy and IEC 60255. The Contractor shall submit a coordinated protection study including trip logic, auto-reclose strategy and communication interfaces.

Single-pole auto-reclose (SPAR), inter-tripping and teleprotection schemes must be coordinated with the remote substation and verified by studies in accordance with IEC 60255 and applicable grid codes.

The Existing Line and Reactor Bay Relays at Kasama Substation are as follows:

- Shunt reactor Biased Differential Relay: Schneider P642
- Shunt and Neutral reactor backup protection: Schneider P142
- Line Main 1 Differential Protection relay: Schneider P543
- Line Main 2 Distance Protection relay: Schneider P443
- Line backup Protection relay: Schneider P142
- The existing Busbar protection relay is Schneider P746

11.1.8 330 kV Line Feeder Protection

The existing Control and Protection system for the 330 kV Line bays shall be extended to cater for the new Line bays. Necessary adaptive measures shall be included and follow existing station design/standard. The extension of the Protection and Control system for the

two line bays shall as minimum provide the following functionality/features for each bay:

- Differential Protection IED (main 1) on optic fiber converter to E1 electrical port on SDH, and auto-reclosing functions
- Distance Protection IED (main 2) on optic fiber- converter to E1 electrical port on SDH with Directional Earth fault and auto-reclosing functions.

- Bay Control Unit (BCU)Electrically and mechanically resettable tripping Relays
- Trip Circuit Supervision Relays
- Circuit breaker failure protection

11.1.9 330kV Reactor Protection

- The existing SAS and Protection system for the 330 kV Line Reactor bays shall be extended to cater for the two new Line Reactor bays. Necessary adaptive measures shall be included and follow existing station design/standard. Each reactor feeder on the extension shall as minimum provide the following functionality/features:2Nos Differential protection/ Restricted earth fault protection relays – Main 1 and 2
- Electrically and mechanically resettable tripping relays
- Over Current Protection, 50/51
- Earth Fault Protection
 - Solid earthed system – Neutral current protection, 67N
 - When resistance earthed system – Earth fault protection, 50N/51N
- Trip Circuit Supervision Relays
- Reactor Bay Control Unit

11.1.10 330 kV Busbar Protection

The two new line bays shall be integrated into the new low impedance phase segregated 330kV Busbar Protection system that shall be established under Package 2 contract.

11.1.11 WAMPACS

The two new 330kV Line bays shall be integrated in the existing Wide Area Monitoring, Protection and Control System (WAMPACS) installed in the Package 2 contract. Refer to the KASAMA WAMPACS drawings

The scope at Kasama S/S shall involve control strategy studies update, software updates, establishment of a complete NR substation WAMPACS system **or compatible equivalent** and relevant integration to the central system. The works shall include supply, installation and commissioning of due Analogue inputs from Relay panels and Marshalling kiosks of existing bays. The substation scope shall include the following equipment;

Table 11-1: WAMPACS Specifications

Table 1: 330kV KASAMA substation - Power Stability Control System Main Equipment List			
Item	Type	Description	Packag e Qty.

Stability Control Panel A	PCS-992M	Stability control host	1
	PCS-992S	Stability control slave	
	PCS-992S	Stability control slave	
	MD1701-01	Test Block (12 Sets)	
		OPTICAL FIBER DISTRIBUTION UNIT	
	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	
Stability Control Panel B	PCS-992M	Stability control host	1
	PCS-992S	Stability control slave	
	PCS-992S	Stability control slave	
	MD1701-01	Test Block (12 Sets)	
		OPTICAL FIBER DISTRIBUTION UNIT	
	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	
Communication Interface Panel C	MUX-22	Power Stability Control System A Communication Interface	1
	MUX-22	Power Stability Control System B Communication Interface	
	PCS-9882ED	Ethernet switch(12 RJ-45,12 Optic interface)	
		OPTICAL FIBER DISTRIBUTION UNIT	
	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	

➤ **Panels**

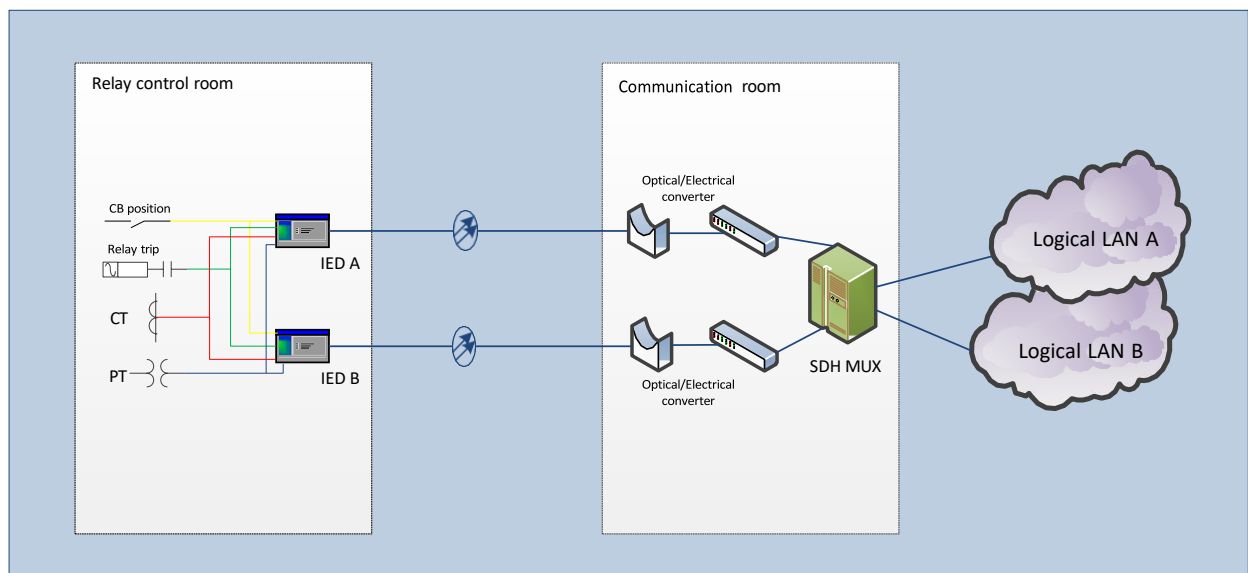
For the preliminary planning of the Kasama substation, it is considered to set up two WAMPACS Panels serving as System A/B sets. Each Panel will contain 1 PCS-992M device and 2 PCS-992S devices. Additionally, one WAMPACS Communication Panel will be installed, which includes 1 PCS-9882 ethernet switch and 2 MUX-22 communication interface devices.

➤ **Communication interfaces:**

For the WAMPACS devices within the Kasama substation to be integrated into the existing national WAMPACS network, it demands E1 (ITU-G.703 of 2048k bps) Channel between Substations, which could direct communication with each other. The connector type is BNC, 75 ohm characteristic impedance.

Two FE interfaces (two 100Mbps Ethernet interfaces) are required for each station and NCC

A typical arrangement is as follows;



➤ **Software upgrade:**

It is necessary to input the characteristic parameters of the Kasama substation and perform new simulation calculations and system analysis on the Zambia power grid structure. Based on the results, the master station program of WAMPACS will be adjusted and upgraded accordingly.

11.1.12 Energy Metering

Independent Tariff Meter and Power Quality Meter (on the OH Line bays only) shall be provided by the Contractor for the new 330kV OH lines and for the associated line shunt reactors at Kasama substation as required. The meter types shall be Landis + Gyr (E880) or CEWE Prometer 540 or Microstar P2000-T or equivalent IEC 61850 compliant meter.

- Two (2) number of Digital Programmable Energy import and export Meter for the new 330kV double circuit OH line to Nakonde Stepdown substation.
Class 0.2S (kWh/kVArh).

These meters are for statistical purposes and line performance assessments only.

- Two (2) number of Unipower power quality meters for the new 330kV double circuit OH line to Nakonde Stepdown substation. The PQ model should be UP2210 to match with the existing PQ meters on the network. Power quality meters should be connected to the remote Unipower server for purposes of preparing PQ reports.
- The AMI system for Kasama substation shall be established under Package 2. Integration of the two line bays and two reactor bays into the AMI system shall be the responsibility of the contractor for this Package 4. The system shall be able to read such values as load profiles, instrumentation measurements profiles, live line measurements, meter configurations and historical data from the meters.
- One (1) number of Maintenance/Analyze Software for both configuration of energy meters and the remote meter reading system.
- One (1) set of Cables, Fittings etc for the entire substation installations.
- Installation, Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc) of all above stated equipment.

11.1.13 Telecommunication Systems

The Contractor should note that the equipment offered is to form a part of a utility-WIDE AREA NETWORK (WAN) telecommunications system with remote monitoring, remote reconfiguration, and multi-service functionality. The Optical Transport Network (OTN) to be installed should have extra subracks to face in the direction of Nakonde Stepdown.

The optical terminal equipment shall have redundant communication features with automatic protection switching using 2-fibre pairs. The Bidder shall endeavor to supply multiplexers similar or of superior versions to the ones already installed on the ZESCO network through other projects. The existing DWDM/OTN and SDH multiplexers are of type ZXONE9700E and ZXMP S385 respectively and were supplied by ZTE Corporation of China.

The bidder shall also provide access multiplexers based on Pulse Code Modulation (PCM) for provisioning of user services like telephone, SCADA and low speed data units. The bidder shall also supply PCM multiplexers of make and type as the ones already installed on the ZESCO network. Current PCM multiplexer in use in our network are the ZXMP P230 from ZTE.

Of note is that the current ZESCO Telecommunication backbone network is based/anchored on the ZTE solution and products with limited interoperability. Subsequently additional telecommunications terminal equipment required for this project shall be based on the ZTE technologies or solutions. All equipment must have double supply voltage of -48VDC.

At Kasama 330kV substation, the existing fibre optic telecommunication equipment comprises the following:

FIBRE TRANSMISSION EQUIPMENT:

- ZXMP S385:
- ZTE SDH Multiplexer
- 10G (STM - 64)
- PCM AND ACCESS EQUIPMENT:
- ZTE PCM500:
- ZTE PCM Multiplexer

For the 2 new Nakonde - 330kV feeders, new Dense Wavelength Division Multiplexer (DWDM) equipment shall be provided. The proposed telecoms terminal equipment shall be able to reliably transfer telecommunication signalling through a distance of 226km without a repeater station.

Existing substation telecommunication system shall be extended for the connection with Nakonde Stepdown substation with the following components. Detailed description in technical requirements

Optical Fiber Link. Supply of optical fiber approach cable (ADSS) from the gantries on the Nakonde Stepdown bays at Kasama substation to the telecom’s equipment room.

- **Optical Transport Network (OTN) equipment with the following characteristics/requirements**
 - Not less than 4000G of transmission capacity in one (1) direction, Nakonde Stepdown
 - The proposed telecoms terminal equipment shall be able to reliably transfer telecommunication signalling through a distance of 226km without a repeater station.
 - The equipment must have cross connection capabilities
 - Must be open for integration and monitoring on the already operational ZTE Network Management System (NMS)
 - The equipment must be linked to the already operational ZXONE9700E equipment at Kasama

- **The Optical Transport Network (OTN) to be installed should have extra subracks to face in the direction of Nakonde Stepdown**

Service interface modules:

- 2 x 155M – 2.5G Modules/Cards with SFP’s
- 2 x 10G Modules/Cards with SFP’s (with 1310 nm and 1550 nm)
- 2 x Service cards with LAN capabilities
- 4 x 100G Modules/Card with SFP’s by four ports
- 4 x 4 port L4K Card or higher version
- 8 x E2K x 10 ports board
- 8 x E2K x 20 ports board
- The Optical Transport Network (OTN) to be installed should have extra subracks to face in the direction of Nakonde Stepdown.
- 2 x EONA1820(with VOA)+ DRA_B (H14)

- **One Packet Transport Network (PTN) equipment**

Transmission rate

- 10G
- 100G

Supported interfaces/rates

- 2Mbps
- 100Mbps
- 155Mbps
- GE
- 10G
- 100G

Line/Service Interface modules

- 3 x 100G
- 2 x 12 ports 10G module
- 4 x 16 ports GE module
- 1 x 4 port STM-1
- 1 x 63 TDM E1 processing module

- **One (01) Synchronous Digital Hierarchy (SDH) multiplexer with STM-64 optical transmission capacity**

Optical Transmission Modules:

- x 2 ports STM-64
- 4 x 4 ports STM-16

Service Interfaces:

- 63 x E1 ports
 - 1 x 8 ports STM-1
 - 8 x 100 Base TX ports (Fast Ethernet - Electrical)
 - 8 x 100 Base FX ports (Fast Ethernet – Optical)
 - 2 x Gigabit Ethernet ports x 4 control modules
 - Engineer’s Order Wire
-
- **One (1) PCM Access Multiplexer each with interfaces for SCADA, Speech and Data**
 - 8 ports for 2 wire subscriber lines
 - 4 ports for RS-232 (or V24/ V28) data channels
 - 4 ports for 64 kbps G.703 co-directional channels.
 - 4 ports for 2 Mbps G.703 (E1) channels.
 - 2 Ethernet ports
 - 8 Ports FXO
 - 4 Ports FXS

 - **The Contractor shall supply, test, install, commission and integrate one (1) ALCATEL PABX modern exchange which will be used for internal calls and also for external calls to the public switched telephone network**
 - Twenty (20) analogue telephone handsets
 - Twenty (20) digital telephone handsets
 - Twenty (20) VoIP telephone handsets (Alcatel compatible)
 - One (1) Optical Distribution Frame (ODF) with optical connectors (FC) and pigtails for complete multiplexer unit installation
 - One (1) Digital Distribution Frame (DDF) with electrical connectors and patch cables for complete installation.
 - One (1) Main Distribution Frame (MDF) with Krone type terminal blocks for terminating telephone.
 - One (1) lot Wiring for power cables and distribution blocks, data circuits, telephones, etc
 - One (1) lot Mechanical accessories, cabling, splice boxes and any other electrical, mechanical or optical parts required for a complete Optic Fiber Equipment installation
 - Installation of items above to the existing telecommunication system and the National Control Centre
 - Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc)

- The PDH/SDH PCM multiplexers shall be supplied with patch codes, power cables, and accessories for the complete installation and interfacing to the existing ZXMP S385 SDH multiplexer.

11.1.14 Surveillance and Access Control Systems

The Contractor shall design, supply, install, test and commission an integrated Closed-Circuit Television (CCTV) Surveillance and Access Control systems. The systems are required to monitor the substation critical infrastructure, perimeter of the site and all entrances into the Substation, Control Buildings and other critical areas.

In addition, the Contractor shall design and supply a standard Security Control Room, design to be approved by the Employer. The Security Control Room can be part of the Guard House at the substation entrance gate.

The access control system shall be installed in, but not limited to, the following areas:

- Control building
- Workshop
- Entrances to perimeters and buildings

Critical areas such control room, server room, battery room, etc.

11.1.15 Civil Works

Civil works shall follow ZESCO Specification SP-CSS-001 attached under Supplementary Information if not otherwise stated in this Section 7 Employers Requirements.

Kasama substations

- Perform soil bearing tests from a min of 14 pits x 6m deep for 330kV Kasama-Nakonde line bays and busbar extension,
- Preparation of areas for new equipment, such as removal of yard stone before any excavation,
- Excavation and filling works,
- Levelling and preparation of new switchyard areas,
- Improvement and extension of substation drainage system,
- Foundations for outdoor switchgear, gantries etc,
- Cable trenches and ducting,
- Finishing outdoor switchgear area with yard stone,
- Excavation and filling works for optical fibre cables to line terminal poles,
- Make good any affected areas after completion of works.
- Civil and electrical general arrangement for foundations, fire walls, oil containment, drainage and roads for the new line and reactor bays, reactors.

11.1.16 Control BuildingDemolition

- Carefully dismantle and remove the existing toilet partition, including disposal of debris off-site as per the Engineer’s instructions

Partitioning for water closet (WC)

- Construct a 100mm thick masonry wall using sand-cement blocks (minimum 3.5 N/mm² strength) laid in a 1:4 cement-sand mortar ratio (M6 mortar), ensuring proper bonding and alignment and make good any damages resulting from demolition and construction activities, ensuring proper surface preparation and finishing
- Apply 12mm thick cement-sand plaster in a 1:4 cement-sand ratio, ensuring a smooth finish.
- Prepare and paint all newly plastered walls with two coats of undercoat and two coats of high-quality washable emulsion paint as per the specifications.
- Refer to drawing A2-PP-ZTIP003-ODSS-C001

11.1.17 Sanitary Installations, Etc.

- Carefully remove and dispose of existing urinals, including associated plumbing fittings and concealed pipework.
- Supply and install new ceramic urinals (approved brand) complete with:
- Concealed piping using class 16 uPVC pipes for drainage and copper or PPR pipes for water supply, ensuring all pipework is chased into the walls and properly backfilled with mortar. Including flush mechanisms and all necessary plumbing accessories, ensuring proper connection to existing sanitary systems.
- Testing the system to ensure no leaks and proper drainage functionality before commissioning

11.1.18 Self-Leveling Epoxy Flooring, Etc.

- Supply and install 3mm thick industrial-grade self levelling epoxy resin flooring (light gray) for all the rooms of the control building (Refer to As-built drawing of Kasama S/S Control building), including:
- Refer to specifications below:

No.	Test	Description	Remarks
1	Abrasion Resistance	For systems exceeding 2 mm in thickness - BCA Abrasion Tester to EN 13892-4, or - Rolling Wheel tester to EN 13892-5 For systems less than 2 mm in thickness - Taber Abrasion Tester to DIN 53754	Depth of wear shall not exceed 0.1 mm - (Class AR1) Loss of volume shall not exceed 1.0 cm ³ - (Class RWA1) Loss in weight shall not exceed 100 mg (1000 cycles/CS10 wheels/1000g load)

2	Pull off strength to the substrate	EN 1542, using reference concrete to EN 1766 (type MC 0.40) as substrate	> 1.5 MPa: nature of failure to be reported.
3	Impact Resistance	EN ISO 6272, when bonded to a Reference concrete of EN 1766, (type MC)	Impact resistance > 4Nm with no cracking or de-bonding
4	Thermal compatibility to concrete	EN 13687-3 but with test conditions as +20°C dry to +80°C wet, for interior floorings EN 13687-2, for exterior floorings.	In either case, the bond of the flooring to a reference concrete substrate of EN 1766 shall not fail by cracking or detachment
5	Permeability to water vapour	EN 12086	The permeability shall be expressed as g/m ² /24 hours.
6	Chemical Resistance	EN 13529	Class I (3 days) or Class II (28 days): the nature of the chemicals to be tested to be agreed between the manufacturer and the potential user.
7	Electrical Resistivity	IEC 61340-5-1 or EN 1081	To meet customer's specification

11.1.19 Painting, Etc.

- Rate shall include for preparation of surface cleaning down, smoothing, knotting, stopping etc.
- Paint shall be from approved colour with approved manufacturer.
- Inspect all visible cracks on the external walls and repair using polymer-modified crack filler for minor cracks and epoxy resin or structural grout for larger cracks exceeding 5mm in width.
- Sand and smoothen the repaired areas before applying a primer coat and two coats of high-quality weather-resistant paint in ZESCO corporate colours as per the Engineer’s approval to: External Wall

11.1.20 External Ceiling, Etc.

Down takings

- Carefully remove the existing soffit, ensuring minimal damage to the structure
- Supply and install a new 9mm thick particle board soffit, including:
- Timber framing supports (50mm x 50mm hardwood battens, spaced at 600mm centers) with stainless steel screws, nails etc., and joint sealing with an approved filler

Fascia and Barge Board

- Supply and fix 225 x 22mm softwood timber fascia and barge board fixed to edges of rafters including necessary fittings, screws and nails etc., including wood preservative and painting with wood primer and gloss paint
- Painting with one undercoat and two coats of acrylic-based ceiling paint for a smooth finish.

11.1.21 Roof Rainwater Drainage

Supply and install new PVC gutters (150mm wide) and downpipes (110mm diameter), including:

150mm Gutters

- Secure fixing with galvanized steel/PVC brackets at 1m intervals, proper connection to existing drainage systems, ensuring effective stormwater management.

110mm Downpipes

- Secure fixing with galvanized steel/PVC brackets at 1m intervals, proper connection to existing drainage systems, ensuring effective stormwater management.

11.1.22 Office Chairs

- Supply and install four adjustable office chairs with ergonomic features i.e., height/incline adjustable, arm rests, etc.,

11.1.23 Airconditioners

- Supply and install new heavy-duty floor standing cabinet type air conditioner with automatic temperature control, 48 000 BTU capacity, including mounting of indoor, installation of insulated copper refrigerant piping (minimum 10m length) with proper insulation, electrical wiring and connection to the existing power supply, ensuring circuit breakers are installed for protection, proper drainage for condensate water discharge, testing and commissioning to ensure proper functionality

11.1.24 Relocation of the Water tank

The existing water tank complete with the tank stand shall be decommissioned and handled over to ZESCO. There shall be a new 10000litre tank, tank stand and accessories for a fully working water reticulation that shall be suitable located off the alignment of the double circuit Nakonde line..

11.2 330 kV Nakonde Stepdown Substation

11.2.1 General Comments

The substation shall include a 330kV and a 132kV switchgear. Additionally, a DVSD will be installed at the 330kV level in Package 5, therefore, the 330kV busbar shall be easy extendable for additional feeders.

The entrance road shall be upgraded to/constructed in bituminous standard from the main road.

11.2.2 330 kV Outdoor Switchgear

The 330 kV switchgear shall be designed as outdoor switchyard with the following general configuration:

Double busbar (A-C), Single phase breaker with bypass disconnecter.

- One (1) 330 kV double busbar for ten (10) bays,
- bus coupler,
- VT’s on each busbar,
- Four (4) 330 kV fully equipped line feeder bays,
- Two (2) 330 kV fully equipped line reactor bays 3 single phase units by 10 MVAR (30 MVAR) units for Kasama 1 and 2 OHL’s,
- Two (2) unequipped spare bay; one for OHTL and one for DVSD
- Two (2) 330 kV transformer bays,
- Two (2) 330/(132)66/11 kV power transformers 90/90/10 MVA incl. SERGI (or equivalent) fire suppress system and KELMAN (or equivalent) Online Dissolved Gas Analysis System
- One (1) 330 kV Bus Shunt Reactor 3 single phase units by 10 MVAR incl. SERGI (or equivalent) fire suppress system.

11.2.3 132 kV Outdoor Switchgear

The 132 kV switchgear shall be designed as outdoor switchyard with the following general configuration:

Double busbar (A-C), Three phase breaker. The 132 kV switchgear will be charged with 66 kV initially, however all VT’s shall be fitted for initially 66 kV. Surge arresters shall be designed for only 66 kV

- Two (2) 132 kV transformer bays,
- One (1) 132 kV double busbar for six (6) bays and with bus coupler and 66kV VT’s,
- Two (2) 132 kV fully equipped line feeder bays with switchgear and CTs designed for 132kV and VTs & surge arresters designed for 66kV,
- Space for Two (2) future line feeder bays.

The 132 kV switchgear will be charged with 66 kV initially. Voltage transformers/CVTs associated with the 132 kV yard shall be suitable for 66 kV initial energization and shall be interconnectable between 132/V₃ kV and 66/V₃ kV (phase-to-ground), unless otherwise specified.

11.2.4 Primary Plant

Two 330kV main feeder bay primary plant equipment for Kasama line 1 & 2 each scoped as follows:

- One (01) three-phase 330kV disconnecter for Busbar 1 (1M);
- One (01) three-phase 330kV disconnecter for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- One (01) three-phase 330kV disconnecter;
- Three (03) single-phase 330kV SF6 circuit breakers;
- One (01) three-phase 330kV line disconnecter with single earth switch (line side);
- One (01) three-phase 330kV circuit breaker bypass disconnecter mounted on gantry;
- Three (03) single-phase 330kV current transformers;
- Three (03) single-phase 330kV capacitor voltage transformers;
- Three (03) single-phase 330kV surge arrestors.

Two 330kV line reactor bays primary plant equipment for Kasama line 1 & 2 each scoped as follows:

- One (01) three-phase 330kV disconnecter with single earth switch (reactor CB side);
- Three (03) single-phase 330kV SF6 circuit breakers;
- Three (03) single-phase 330kV surge arrestors;
- Three (03) single-phase 330kV current transformers
- Three (03) single phase 330kV 10 MVar ONAN Reactors fitted with SERGI (or equivalent) fire suppress system and bushing CTs on HV terminals and neutral terminals – refer to Technical schedule chapter 12.11.7 for more details on the CTs;
- One (01) single phase surge arrestor sized to protect NCR against over-voltages;
- One (01) neutral compensating reactor ONAN – 900 Ω with bushing CTs on HV terminal connected to neutral point of line reactors;
- Passive fire protection for reactors including fire walls (separating each unit including NCR) and bunded area with connection to emergency oil dam.

Two 330kV main feeder bay primary plant equipment for Tunduma line 1 & 2 each scoped as follows:

- One (01) three-phase 330kV disconnecter for Busbar 1 (1M);
- One (01) three-phase 330kV disconnecter for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;

- One (01) three-phase 330kV disconnecter;
- Three (03) single-phase 330kV SF6 circuit breakers;
- One (01) three-phase 330kV line disconnecter with single earth switch (line side);
- One (01) three-phase 330kV circuit breaker bypass disconnecter mounted on gantry;
- Three (03) single-phase 330kV current transformers;
- Three (03) single-phase 330kV capacitor voltage transformers;

Three (03) single-phase 330kV surge arrestors.

Two 330kV transformer bay primary plant equipment each scoped as follows:

- One (01) three-phase 330kV disconnecter for Busbar 1 (1M);
- One (01) three-phase 330kV disconnecter for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- One (01) three-phase 330kV disconnecter;
- Three (03) single-phase 330kV SF6 circuit breakers;
- One (01) three-phase 330kV line disconnecter with single earth switch (transformer side);
- One (01) three-phase 330kV circuit breaker bypass disconnecter mounted on gantry;
- Three (03) single-phase 330kV current transformers;
- Three (03) single-phase 330kV surge arrestors.
- Passive fire protection for reactors including fire walls (separating each unit including NCR) and bunded area with connection to emergency oil dam.

One 330kV bus coupler bay primary plant equipment scoped as follows:

- One (01) three-phase 330kV disconnecter for Busbar 1 (1M);
- One (01) three-phase 330kV disconnecter for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- Three (03) single-phase 330kV SF6 circuit breakers;
- Two sets of Three (03) single-phase 330kV current transformers;

Two 330kV bus bars scoped as follows:

- Main Busbar 1 (1M);
- Reserve Busbar 2 (2M);

- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- Two sets of Three (03) single-phase 330kV capacitor voltage transformers;

Two 132kV transformer bay primary plant equipment each scoped as follows:

- One (01) three-phase 132kV disconnector for Busbar 1 (1M);
- One (01) three-phase 132kV disconnector for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- One (01) three-phase 132kV disconnector;
- One (01) three-phase 132kV SF6 circuit breakers;
- One (01) three-phase 132kV line disconnector with single earth switch (transformer side);
- One (01) three-phase 132kV circuit breaker bypass disconnector mounted on gantry;
- Three (03) single-phase 132kV current transformers;
- Three (03) single-phase 66kV capacitor voltage transformers;
- Three (03) single-phase 66kV surge arrestors.

Two 132kV Isoka and Nakonde Town main feeder bays primary plant equipment each scoped as follows:

- One (01) three-phase 132kV disconnector for Busbar 1 (1M);
- One (01) three-phase 132kV disconnector for Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- One (01) three-phase 132kV disconnector;
- One (01) three-phase 132kV SF6 circuit breakers;
- One (01) three-phase 132kV line disconnector with single earth switch (line side);
- One (01) three-phase 132kV circuit breaker bypass disconnector mounted on gantry;
- Three (03) single-phase 132kV current transformers;
- Three (03) single-phase 66kV capacitor voltage transformers;
- Three (03) single-phase 66kV surge arrestors.

One 132kV bus coupler bay primary plant equipment scoped as follows:

- One (01) three-phase 132kV disconnector for Busbar 1 (1M);
- One (01) three-phase 132kV disconnector for Busbar 2 (2M);

- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- Three (03) single-phase 132kV SF6 circuit breakers;
- Two sets of Three (03) single-phase 132kV current transformers;

Two 132kV bus bars scoped as follows:

- Main Busbar 1 (1M);
- Reserve Busbar 2 (2M);
- 1 Lot post insulators for connection from disconnectors to Busbars 1 and 2 respectively;
- Two sets of Three (03) single-phase 132kV capacitor voltage transformers;

11.2.5 Auxiliary Power Supply

The power for the substation’s auxiliary service shall be supplied from the tertiary windings of the main Power Transformers via 11kV cables and switchgear, two 500kVA, 11/0,4kV Station Transformers down to a Main 400V switchgear.

The 11kV switchgear shall be designed as a compact metal clad indoor Air Insulated Switchgear (AIS), for auxiliary services with the following main configuration:

- Two (2) 11 kV fully equipped panels from tertiary winding of main transformers to auxiliary transformers.
- One (1) 11 kV single busbar for four (4) feeders and a bus sectionaliser,
- Two (2) 11 kV fully equipped transformer bays (incoming),
- Two (2) 11 kV fully equipped auxiliary transformer bays,

An Emergency Diesel Generator shall be connected directly to the Main 400V switchgear and Automatic Switchover Logic shall be implemented to control the two ordinary incoming feeders and the Diesel Generator feeder.

The Main Distribution board shall be divided into Sub 1 and Sub 2 each fitted with all MCB’s and MCCB’s needed for the function of the complete installation plus 10% spare. Additionally, each sub shall be fitted with one MCB 250A for connection of equipment to be installed in a separate project Package 5. A buscoupler MCCB shall be installed between the two busbar halves. The 110V DC system shall be divided into two (2) physically and electrically separated

systems (SUB 1, SUB 2) with each battery charger supplied from different feeders in Main 400V switchgear.

Time-critical loads (protection, SAS, WAMPACS, telecoms, meters) require that battery and charger sizing calculations are submitted to demonstrate compliance with the 12-hour autonomy requirement under maximum DC load, in accordance with IEC 61936-1. The Contractor shall comply to this requirement.

The substation Auxiliary Power Supply services comprise mainly of the following:

- Two (2) Auxiliary Transformers 11/0,4kV, 500kVA, outdoor,
- One (1) Emergency Stand-by Diesel Generator, 250kVA, erected in a separate building,
- Two (2) 11kV Indoor Air Insulated Switchgear,
- One (1) Lot Main 400V AC Switchgear with three incomers and a bus section,
- 400/230V AC Sub-distribution Boards, number according to Contractor’s design,
- Two (2) 800Ah 110V DC battery banks,
- One (1) 800Ah 110V DC battery bank as spare,
- Two (2) 110V DC Battery Chargers and Main Distribution boards
- 110V DC Sub-distribution Boards, number according to Contractor’s design
- Installation, Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc).

11.2.6 Power and Control Cables

- One (1) set LV AC and DC power and control cables for the entire substation auxiliary power needs and apparatus control and signalling,
- Three (2) sets of fibre optical underground cable for connection of OPGW from 330 kV line terminal poles to the ODF in the communication panel,
- One (1) set communication cables,
- Provide cable schedules including all circuits associated with MOF and protection (including CT/VT metering cores, tele-protection and SCADA links) and the number of cores and routes are reconciled against panel and bay lists for Nakonde substation.
- Installation, Pre-Commissioning Tests and Checks (full documentation of test results, wiring diagrams etc).

11.2.7 Substation Automation System (SAS) and Protection Systems

The Contractor shall design, supply, install and commissioning a complete Substation Automation System (SAS) for the 330kV, (132)66kV switchgears and substations auxiliary and common service systems. Specifications as outlined in the detailed technical specifications.s

- Design, Supply, install, test, and commission a modern IEC-61850 based SAS complete with Bay Control Units (BCU) and other system requirements adequate to cater for all substation 330/132kV bays and monitoring systems in the new substation.
- Design, Supply, install, test, and commission SAS Panels housing Station Gateways, Common BCU, GPS Server, LAN Switches etc, as per approved design.
- Integrate protection, metering and WAMPACS using IEC 61850 station and process bus where applicable, with time synchronization from a common GPS time source.
- Conduct interoperability testing and cyber-security hardening (role-based access, secure engineering access, logging) of all IEDs and gateways
- The contractor shall assess if a separate dedicated PCM channel or multiplexed telecom communication channel is required, per IEC 60834-1, with TANESCO.

11.2.8 Protection Systems

Protection for the 330 kV Nakonde-Tunduma circuits shall be fully coordinated with the protection at Nakonde terminal (line differential and distance schemes, SPAR, tele-protection, communication channels) and shall comply with ZESCO Protection Philosophy and IEC 60255. The Contractor shall submit a coordinated protection study including trip logic, auto-reclose strategy and communication interfaces.

Single-pole auto-reclose (SPAR), inter-tripping and teleprotection schemes must be coordinated with the remote utility and verified by studies in accordance with IEC 60255 and applicable grid codes.

Each 330kV and 132kV bay’s SAS and Protection system shall be divided into two (2) sub-systems, SUB 1 and SUB 2. These two systems shall be electrically and physically separated, all from separate 110V DC batteries/supplies, cables, CT/VT-circuits, tripping circuits and tripping coils.

In general, each bay shall have two cabinets;

SUB 1 cabinet including BCU and Main 1 protection IED (e.g. Differential Protection relay).

SUB 2 cabinet including Main 2 protection IED (e.g. Distance Protection relay) and Backup Feeder Protection relay.

For details of all protection functions required in each IED, see Technical Specifications Chapter 12.19.

11.2.9 330kV Nakonde-Kasama Line Feeder bay

Two (2) nos of Line Protection and Substation Automation System (SAS) for the Kasama 330kV lines, each minimum consisting of:

MAIN 1

- Differential Protection Relay including Distance protection (Main 1) on optic fiber converter to E1 electrical port on SDH for complete interface with Kasama – Nakonde 1 differential relay
- Electrically and mechanically resettable tripping Relays
- Bay Control Unit
- Directional Earth Fault
- Auto reclosing

MAIN 2

- Distance Protection Relay (Main 2) on optic fiber- converter to E1 electrical port on SDH for complete interface with Kasama – Nakonde 1 distance relay
- Feeder Protection Relay (Backup)
- Electrically and mechanically resettable tripping Relays

11.2.10 330kV Nakonde-Tunduma Line Feeder bay

Two (2) Lots of Line Protection and Control System for the Tunduma 330kV lines, each minimum consisting of:

MAIN 1

- Main 1 (NR PCS-931S-Direct Fibre connection) - Line Current Differential protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 2 and Backup. The protection device on the Tunduma substation side is of the forestated type. The NR PCS-931S should be of the same variant and of the same telecommunication capability as the one installed at Tunduma end. Two panels shall be supplied: One for Tunduma and the other for Nakonde Stepdown substation complete with necessary end to end communication interfaces
- Electrically and mechanically resettable Tripping Relays
- Bay Control Unit
- Directional Earth Fault
- Autoreclosing

MAIN 2

- Main 2 (SCHNEIDER P543-Direct Fibre connection) - Line Current Differential protection panel fully equipped with protection IED, panel wiring and all associated auxiliary equipment complete with Line Backup Overcurrent & Earth Fault protection functions. Panel to also accommodate Main 2 and Backup. . The protection device on the Tunduma substation side is of the forestated type. The SCHNEIDER P543 should be of the same variant and of the same telecommunication capability as the one installed at Tunduma end. Two panels shall be supplied: One for Tunduma and the other for Nakonde Stepdown substation complete with necessary end to end communication interfaces
- Feeder Protection Relay (Backup)
- Electrically and mechanically resettable Tripping Relays
- Under/Over Directional Power Protection
- Power Swing Protection

11.2.11 330/(132)66/11kV Transformer bay

Two (2) nos of Transformer Protection and Control System for the Main 330/(132)66/11kV transformers , each minimum consisting of:

MAIN 1

- 3-winding Differential Protection Relay including Restricted Earth Fault protection (Main 1)
- Transformer Mechanical Protections (oil and winding temperature, Buchholz, pressure relief, etc);
- Electrically and mechanically resettable Tripping Relays
- Bay Control Unit

MAIN 2

- 3-winding Differential Protection Relay including Restricted Earth Fault protection (Main 2)
This IED shall be from a different manufacturer than MAIN 1 differential protection relay.
- Feeder Protection Relay (Backup)

11.2.12 330kV Reactor bay

Three (3) nos of Reactor Protection and Control System for each of the two Kasama 330kV line reactors and the busbar shunt reactor, each minimum consisting of:

MAIN 1

- Differential Protection Relay including Restricted Earth Fault protection (Main 1)
- Reactor Mechanical Protections (oil and winding temperature, Buchholz, pressure relief, etc);
- Electrically and mechanically resettable Tripping Relays
- Bay Control Unit

MAIN 2

- Differential Protection Relay including Restricted Earth Fault protection (Main 2) This IED shall be from a different manufacturer than MAIN 1 differential protection relay.
- Feeder Protection Relay as Backup protection
- Feeder Protection Relay as Neutral Reactor protection
- Electrically and mechanically resettable Tripping Relays

11.2.13 330kV and 132kV Busbar Protection

Two (2) Busbar Protection systems shall be supplied for the 330kV and (132)66kV busbars, each minimum consisting of:

A low impedance, phase-segregated, numerical busbar protection scheme with integral check zone and at least 2 unique protection zones (each switchgear is a double busbar design) and overall check zone.

11.2.14 132kV Line Feeder Protection

The protection system for each feeder shall consist of;

For the Nakonde Town Feeder

- Two sets of two (2) Basic Distance Protection Systems for (132)66kV
- Feeder Protection Relay (Backup)
- Electrically and mechanically resettable Tripping Relay
- Bay Control Unit

For the Isoka Feeder

- Two sets of two (2) Basic Distance Protection systems for (132)66kV.

- Feeder Protection Relay (Backup)
- Electrically and mechanically resettable Tripping Relay
- Bay Control Unit

11.2.15 WAMPACS

The Contractor shall supply, installation and commissioning a Wide Area Monitoring, Protection and Control System (WAMPACS) to be integrated into existing NR solution installed in other substations, for the entire New Nakonde Stepdown substation. This shall include integration into the existing ZESCO central systems. The Nakonde Stepdown WAMPACS drawing concept shall apply

WAMPACS (in addition to, SAS and SCADA) communications shall use IEC 61850 and ITU-T/IEC telecommunication standards already applied in existing ZESCO NR installations, including precise time synchronization via GPS/PTP (IEEE 1588).

Cyber-security and remote access arrangements shall comply with ZESCO’s telecom and information-security policies and be consistent between Kasama and Nakonde

The scope shall involve control strategy studies update, software updates, establishment of a complete NR substation WAMPACS system **or compatible equivalent** and relevant integration to the central system. The works shall include supply, installation and commissioning of due Analogue inputs from Relay panels and Marshalling kiosks of existing bays. The substation scope shall include the following equipment;

Table 11-2: WAMPACS specifications

Table 1: 330kV Nakonde Stepdown Substation - Power Stability Control System Main Equipment List			
Item	Type	Description	Package Qty.
Stability Control Panel A	PCS-992M	Stability control host	1
	PCS-992S	Stability control slave	
	PCS-992S	Stability control slave	
	MD1701-01	Test Block (12 Sets)	
		OPTICAL FIBER DISTRIBUTION UNIT	

	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	
Stability Control Panel B	PCS-992M	Stability control host	1
	PCS-992S	Stability control slave	
	PCS-992S	Stability control slave	
	MD1701-01	Test Block (12 Sets)	
		OPTICAL FIBER DISTRIBUTION UNIT	
	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	
Communication Interface Panel C	MUX-22	Power Stability Control System A Communication Interface	1
	MUX-22	Power Stability Control System B Communication Interface	
	PCS-9882ED	Ethernet switch(12 RJ-45,12 Optic interface)	
		OPTICAL FIBER DISTRIBUTION UNIT	
	Panel	IP 54, 2200x800x800(H*W*D),RAL-7035, MCBs, light, heating, terminals and inside cables	

➤ Panels

For the preliminary planning of the substation, it is considered to set up two WAMPACS Panels serving as System A/B sets. Each Panel will contain 1 PCS-992M device and 2 PCS-992S devices. Additionally, one WAMPACS Communication Panel will be installed, which includes 1 PCS-9882 ethernet switch and 2 MUX-22 communication interface devices.

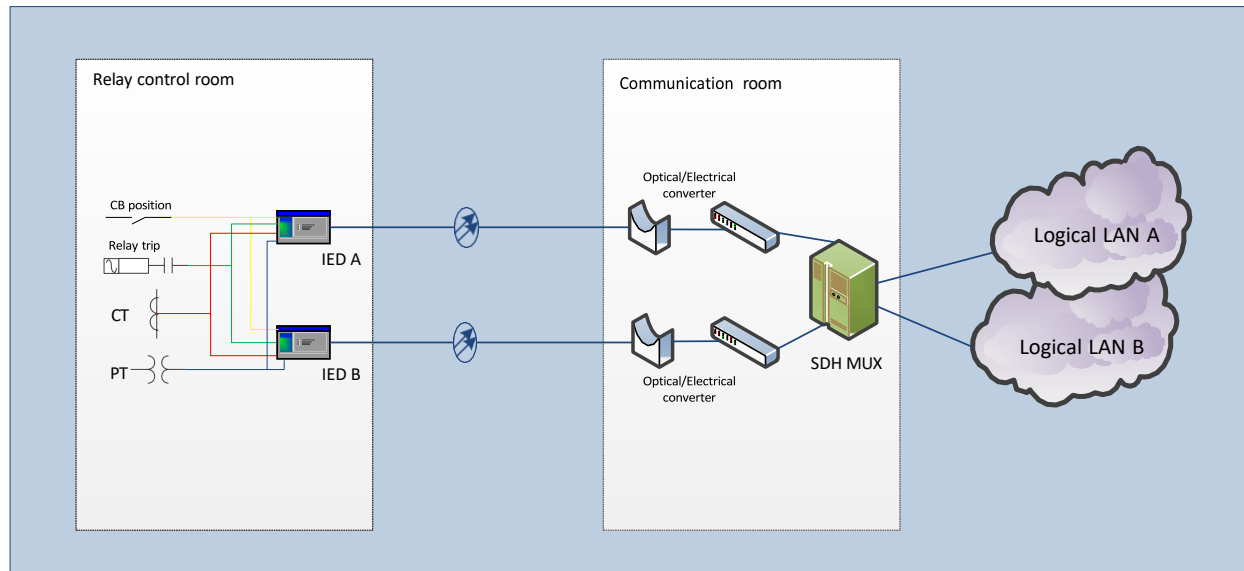
➤ Communication interfaces:

For the WAMPACS devices at the substation to be integrated into the existing national WAMPACS network, it demands E1(ITU-G.703 of 2048k bps) Channel between Substations,

which could direct communication with each other. The connector type is BNC, 75 ohm characteristic impedance.

Two FE interfaces (two 100Mbps Ethernet interfaces) are required for each station and NCC

A typical arrangement is as follows;



➤ Software upgrade:

It is necessary to input the characteristic parameters of the substation and perform new simulation calculations and system analysis on the Zambia power grid structure. Based on the results, the master station program of WAMPACS will be adjusted and upgraded accordingly.

Refer to the attached drawings of the Nakonde Stepdown substation WAMPACS. Stand-alone 330kV and (132)66kV Disturbance Fault Recorders

Design, supply, install, test of two (2) sets of Stand-alone Disturbance Fault Recorders, one for the 330kV system and one for the (132)66kV system.

All new switchgear bays shall be integrated.

11.2.16 Transformer Automatic Voltage Regulator (AVR)

Design, supply, install, test of two (2) sets of AVR and Tap Changer Control (TCC), one for each Main 330/(132)66/11kV transformer. The equipment shall be installed on an independent panel.

The AVR/TCC panel design and assembly shall be made by the same supplier as for the other control and protection systems. The two transformer AVR/TCC should be capable of auto/manual and local/remote operation.

11.2.17 Energy Metering

The contractor shall supply a complete 330kV, 132kV and 11kV bays metering system panels for all bays including test blocks, terminal blocks and panel wiring. The meter types shall be Landis + Gyr (E880) or CEWE Prometer 540 or Microstar P2000-T or equivalent IEC 61850 compliant meter.

The meter type on the Tunduma 1 & 2 lines at Nakonde Stepdown shall be Microstar P2000-T to match with the meter type at Tunduma Substation and shall include necessary interface to the existing Nakonde 1 & 2 energy meters at Tunduma Substation.

The Contractor shall supply the following for a complete energy metering system

- Two (2) number of Digital Programmable Energy import and export Meter for the 330kV Kasama lines.
- Class 0.2S (kWh/kVArh).
- The Contractor shall specify hardware such as defined burdens, test blocks, redundant settlement meters and GPS or PTP/IEEE-1588 time synchronization of metering data for settlement and dispute resolution purposes
These meters are for statistical purposes and line performance assessments only.
- Four (4) number of Digital Programmable, Bidirectional Energy Meters for the 330kV Tunduma lines.
- Class 0.2S (kWh/kVArh).
- Each line will have two meters, a main and check.
- The meters shall report to both NCC and the substation Metering System.
- Critical alarms shall be reported to Local HMI and NCC using IEC 61850 protocol.

These meters are for billing purposes.

Four (4) Unipower power quality meters to be installed on the 330kV Lines. The PQ model should be UP2210 to match with the existing PQ meters on the network. Power quality meters shall be connected to the remote Unipower server for purposes of preparing PQ reports

- Two(2) Digital programmable Bidirectional Energy meters for each Auxiliary Transformer.

- Class 0.2S (kWh/kVArh).

These meters shall be installed on the 11kV sides only.

- Two (2) Digital Programmable Energy import and export Meter for the (132)66kV lines
Class 0.2S (kWh/kVArh).

These meters are for statistical purposes and line performance assessments only.

- Two (2) Digital Programmable Energy import and export Meter for the 330/(132)66/11kV 90MVA transformers.
- Class 0.2S (kWh/kVArh).

These meters are for statistical purposes and line performance assessments only.

- One (1) Digital Programmable Energy import and export Meter for the 200kVA, 400VAC GenSet
Class 0.2S (kWh/kVArh).

These meters are for statistical purposes and line performance assessments only.

- One (1) Lot Work station for monitoring all substation meters.

- One (1) Lot Substation Remote meter reading system.

The system shall be able to read such values as load profiles, instrumentation measurements profiles, live line measurements, meter configurations and historical data from the meters, carry out summations and derive & record simultaneous maximum demand of multiple circuits over the billing period.

- One (1) Lot Maintenance and interrogating Software with laptop for both configuration of energy meters and the remote meter reading system.
- One (1) Lot Cables, Fittings etc for the entire substation installations.
- Installation, Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc).

The metering panels shall include test blocks, terminal blocks and wiring at Nakonde Stepdown which is typically required for commercial security. The panels shall include all hardware necessary for settlement metering, including CT/VT terminations, test links, communication interfaces and security features, and that they are costed separately from protection/SAS panels.

11.2.18 Telecommunication Systems

The contractor shall install and commission a new Wide Area Network (WAN) telecommunication system. The system will be used to monitor and control the substation. The WAN has very high capacity due to Dense Wavelength Division Multiplexing (DWDM); some capacity will be used for selling capacity to telecom operators. The WAN will consist of the following components:

The Contractor should note that the equipment offered is to form a part of a utility-WIDE AREA NETWORK (WAN) telecommunications system with remote monitoring, remote reconfiguration, and multi-service functionality. The Optical Transport Network (OTN) to be installed should have 4 subracks to face in the direction of Kasama, Nakonde Town, Isoka and Tunduma in Tanzania.

Telecoms shall provide redundant, secure channels for line protection (teleprotection), SCADA and metering data exchange with TANESCO, with latency and availability requirements suitable for distance and differential protection. Further, interfaces and protocols (e.g. IEC 60870-5-104, IEC 61850, IP/MPLS) shall apply on the interconnector and shall be tested end-to-end.

The optical terminal equipment shall have redundant communication features with automatic protection switching using 2-fibre pairs. The Bidder shall endeavor to supply multiplexers similar or of superior versions to the ones already installed on the ZESCO network through other projects. The existing DWDM/OTN and SDH multiplexers are of type ZXONE9700E and ZXMP S385 respectively and were supplied by ZTE Corporation of China.

The bidder shall also provide access multiplexers based on Pulse Code Modulation (PCM) for provisioning of user services like telephone, SCADA and low speed data units. The bidder shall also supply PCM multiplexers of make and type as the ones already installed on the ZESCO network. Current PCM multiplexers in use in our network are the ZXMP P230 from ZTE. All equipment must have double supply voltage of -48VDC.

New 48-core OPGW will be strung to surrounding substations from Nakonde stepdown substation. One 48-core fiber cable towards Isoka and Nakonde Town will be split into 24-cores to match the existing fibre cable on the 66kV Isoka-Nakonde line and the other two fibre

cables towards Tunduma and Kasama. The scope shall comprise but not limited to the following:

- Supply of optical fiber approach cables (ADSS) from the gantries on the Nakonde-Kasama bay, Nakonde-Tunduma bay, Nakonde -Isoka/Nakonde Town bay at Nakonde stepdown substation to the telecom’s equipment room.
- Optical Transport Network (OTN) equipment with the following characteristics/requirements:
 - Not less than 4000G of transmission capacity in each direction.
 - The Optical Transport Network (OTN) to be installed should have subracks to face in the direction of Kasama, Tunduma, Nakonde Town and Isoka. One Packet Transport Network (PTN)
 - The proposed telecoms terminal equipment shall be able to reliably transfer telecommunication signalling through a distance of 226km without a repeater station.
 - 2 x DRA_P (H14) +EONA2520
 - The equipment must have cross connection capabilities
 - Must be open for integration and monitoring on the already operational ZTE Network Management System (NMS)

11.2.19 Service interface modules

- 2 x 155M – 2.5G Modules/Cards
- 2 x 10G Modules/Cards with SFP’s (with 1310 nm and 1550 nm).
- 2 x Service cards with LAN capabilities
- 4 x 100G Modules/Card with SFP’s by four ports
- 6 x 4 port L4K Card or higher version
- 8 x E2K x 10 ports board
- 8 x E2K x 20 ports board

11.2.20 Line/Service Interface modules

One (01) Synchronous Digital Hierarchy (SDH) multiplexer with STM-64 optical transmission capacity each and the following interfaces:

- 2 x 2 ports STM-64
- 4 x 4 ports STM-16
- Service Interfaces
- Engineer’s Order Wire

Optical Transmission Modules:

- 2 x 2 ports STM-64
- 4 x 4 ports STM-16

Service Interfaces:

- 63 x E1 ports
- 2 x 8 ports STM-1
- 8 x 100 Base TX ports (Fast Ethernet - Electrical)
- 8 x 100 Base FX ports (Fast Ethernet - Optical)
- 2 x Gigabit Ethernet ports x 4 control modules
- Engineer’ s Order Wire
- One (1) Fibre optical frame (ODF) for connection of 1 x 48 fibre optical cables

One (1) FOX615 SDH MUX for communication with same equipment in Tanescos station Tunduma and NCC.

11.2.21 Packet Transport Network (PTN)

One Packet Transport Network (PTN) equipment with the following transmission rates:

- 10G
- 100G

Supported interfaces/rates

- 2Mbps
- 100Mbps
- 155Mbps
- GE
- 10G
- 100G

Line/Service Interface modules

- 3 x 100G
- 2 x 12 ports 10G module
- 4 x 16 ports GE module
- 1 x 4 port STM-1
- 1 x 63 TDM E1 processing module

One (1) PCM P230 access multiplexers for telephony and Ethernet services. Each unit shall have the following interfaces:

- 4 ports for distance protection channels, IEC 60834 - 1
- 4 ports for 64 kbps G.703 co-directional channels.

- 4 ports for 2 Mbps G.703 (E1) channels.
- 8 port FXO
- 4 Port FXS

One (1) PCM Access Multi plexer with the following interfaces:

- 8 ports for 2 wire subscriber lines
- 4 ports for RS-232 (or V24/ V28) data channels
- 4 ports for 64 kbps G.703 co-directional channels.
- 4 ports for 2 Mbps G.703 (E1) channels.
- 2 Ethernet ports
- 8 Ports FXO
- 4 Ports FXS
- The PDH/SDH PCM multiplexers shall be supplied with patch codes, power cables, and accessories for the complete installation

11.2.22 PABX modern exchange

The contractor shall supply test, install, commission and integrate one (1) ALCATEL PABX modern exchange which will be used for internal calls and for external calls to the public switched telephone network.

- Twenty (20) analogue telephone handsets
- Twenty (20) digital telephone handsets
- Twenty (20) VoIP telephone handsets (Alcatel compatible)
- One (1) Optical Distribution Frame (ODF) with optical connectors (FC) and pigtails for complete multiplexer unit installation
- One (1) Digital Distribution Frame (DDF) with electrical connectors and patch cables for complete installation.
- One (1) Main Distribution Frame (MDF) with Krone type terminal blocks for terminating telephone.
- One (1) lot Wiring for power cables and distribution blocks, data circuits, telephones, etc
- One (1) lot Mechanical accessories, cabling, splice boxes and any other electrical, mechanical or optical parts required for a complete Optic Fibre Equipment installation
- Installation of items above to the existing telecommunication system and the National Control Centre
- Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc)

- Laptops with Maintenance software for the OTN, PTN, SDH/PDH Multiplexers and PABX. The laptop processor shall have Intel core i9 or better CPU, 1TB HDD, 16GB RAM.
- At the National Control Centre (NCC) in Lusaka the bidder shall include in the scope of works the following equipment:

11.2.23 DC power charger and batteris

Two sets of 48V DC Systems (Charger and Batteries) each with the following characteristics/requirements:

- Three phase AC input
- Modular charger type
- Three phase AC input voltage range between 242V – 485V
- Input Current range between 6A – 600A
- Output DC voltage range between 42V – 58V
- Output high-off voltage range between 58V – 62V
- Able to handle 16 x 48VDC, 100Ahr Lithium batteries
- Must be open for integration and monitoring on the already operational ZTE Power Management System (PMS)
- Supply of 48V lithium batteries, 12 batteries with a minimum capacity of 1200Ah
- DC distribution board

11.2.24 Surveillance and Access Control Systems

The Contractor shall design, supply, install, test and commission an integrated Closed-Circuit Television (CCTV) Surveillance-and Access Control-, Systems. The systems are required to monitor the substation critical infrastructure, perimeter of the site and all entrances into the Substation, Control Buildings and other critical areas.

In addition, the Contractor shall design and supply a standard Security Control Room, design to be approved by the Employer. The Security Control Room can be part of the Guard House at the substation entrance gate.

The access control system shall be installed in, but not limited to, the following areas:

- Control building
- Entrances to perimeters and buildings
- Critical areas such as control room, server room, battery room, etc.

11.2.25 Civil Works

- The Package 4 consist of the greenfield 330/(132)66/11kV Substation including control building and six houses (Three (03) 150 m2 and Three (03) Type B) for operators.

- Refer to the drawing **PP-ZTIP-P04-ODSS-C109_Nakonde SS GA_R00_30062026** for an illustration of the extent of civil works
- All gantries, supports, foundations, trenches, associated earthworks, etc.
- Dismantling, of any facilities obstructing the works (those which have been deemed unsuitable for reuse or modification under the scope of this works). This includes, but is not limited to, concrete, obsolete material and equipment and construction waste. All such material shall be stockpiled at a designated location within the substation premises (to be advised at the time of construction);
- Wastewater reticulation system consisting of on-site treatment facilities (3-chamber septic tank and leachpit/ soakaway) and associated pipework and inspection chambers, sized to the following:
 - Substation (i.e. control building, guard house, etc) – 25 users
 - Guard house and staff houses – 50 users
- Perform geotechnical tests from a min of 22 pits x 4m deep (4 pits for the STATCOM area),
- Design and construction of reinforced concrete cantilever retaining wall to partition the upper and lower terraces, which shall span the entire length of the substation. Retaining wall shall be designed to sustain surcharge loading due to the passage of heavily loaded vehicles (i.e. during transformer/ reactor transportation).
- ,
- Construction of two (2) new Guard Houses at the entrance gates at the perimeter fence (500m by 1000m); Substation fencing shall be designed, supplied and installed, complete with gates (both fixed and removable, where appropriate) for the following:
 - Substation Land Extents – Boundary/ Perimeter fencing (500m x 1000m)
 - Substation Perimeter – Security fencing (310m x 250m)
 - Terrace Boundaries – Safety fencing (refer to Site Layout)
- Identify, and where necessary, relocate any buried services or facilities so as to accommodate the works.
- One (01) shed 100 m² for oil drums etc. on a concrete slab with oil collector connected to the common oil pit,
- One (01) shelter 25 m² on a slab with oil collector connected to the common oil pit, for the emergency diesel generator.

- Design, supply and installation of all infrastructure.
- Clearance of the working area, terracing, leveling, cutting and backfilling
- Installation of all primary plant equipment foundations, gantry foundations and busbar support foundations required for the scope.
- Design of all foundations, cable trenches, oil containment and buildings at Nakonde shall be based on the site-specific geotechnical parameters and design loadings carried out by the Contractor before detailed design. The civil works shall allow for future bay additions (e.g. spacing, road access, drainage) where consistent with the conceptual design
- Levelling, compaction with 0.5% slope suitable for drainage and installation of yard stone over the whole substation area;
- Storm water drainage channels and buried pipes;
- Construct control and power cable trenches according to cabling requirements and approved trench layout;
- Design, supply and construction of control building and six houses (three (03) 150 m² and three (03) Type B) for operators ;
- Supply and installation of:
 - i) Pole mounted transformer 100KVA 33/0.4 kV at existing 33kV OHL outside the substation plot on a structure of H-pole configuration,
 - ii) Accessories (PG clamps, insulators, 33kV jumper conductor ACSR 100mm²),
 - iii) protection equipment (HT and LV fuses) and
 - iv) with connection of LV (0.4kV) to the houses on overhead Aerial Bundled Conductor (100mm²) on 12m wooden poles with maximum 7 spans (350m) up to the point of metering.
 - v) The attached PMT drawing is T1 – Pole mounted transformer
- Complete Outdoor Lighting. The mounting of light fittings on gantry structures shall not be permitted. Standalone lighting masts shall be incorporated.
- Construction of reinforced concrete roads and pavements (inclusive of road markings, kerbing, and reinforced concrete stormwater drainage channels), as per the list below:
 - 6m wide concrete substation access road within the plot up to the switchyard fence of approximately 1 800 meters)
 - 1500m² of reinforced concrete paving from the access road up to the control building – same construction standard as the internal concrete road

- 6m wide concrete substation external access road of approximately 200 meters
- 6m wide concrete substation external access road from substation gate 2 via the housing complex to asphalt access road of approximately 1 500 meters
- Construct 9m wide (7m-main carriageway + 2m-shoulders) asphalt access road from the main road complete with drainage on both sides. (This shall include road markings, kerbing, reinforced concrete stormwater drainage channels & culverts, and any other road furniture which meet the standard requirements of the Road Development Agency - RDA). Road chainage length is approximately 1.8 km
- Supply and install two motorised sliding gates and a perimeter fence (with anti-climbing protection and cast into the anti-burrow beam at the bottom) around the whole substation plot (concrete poles with 4mm diamond wire mesh);
- Kerbs are required for all roads (internal and external, all types), as well as around substation security fencing. Yardstone shall extend 2m beyond the security fence and bound by kerbing. (All kerbing should be in accordance with SABS 927)
- For terracing, the Contractor shall include erosion control measures and biodiversity offsets per ESIA because this is critical for ESF (ESS6), and shall require GIS-based surveys for rocky hill impacts.
- Drill and equip a borehole for fresh water of acceptable quality and flow, and in accordance with the Water Resources Management Authority (WARMA) requirements;
- Water reticulation system consisting of an elevated water tank (min 8m high), placed on a hot-dip galvanized stand. This shall include all associated pipework, with connections to the ground water well (including necessary pump and piping between borehole and tank and to the control building). Water tanks/ reservoirs shall have the following capacities:
 - Substation – 2x5000L tanks (Total Capacity: 10 m³)
 - Guard house and staff houses – 4x5000L tanks (Total Capacity: 20 m³)
- Passive fire protection for transformers/reactors/NR as follows:
 - The local oil containment for each transformer/ reactor/ NR shall be separate and bund walling shall be constructed using reinforced concrete to project 300mm above platform level. The transformer/ reactor/ NR shall be fully contained within the extents of the bunded region, and sized with a depth sufficient to retain 50% of the total transformer/reactor/NR oil capacity;
 - A separating internal bund wall shall be installed to provide a separate catchment area for any potential oil cooler bank spillage if applicable;
 - Oil from the main unit can overflow into the cooler bank oil catchment area if necessary;
 - The total area of the bund shall be fitted with galvanized steel grating with the following minimum specifications:
 - Hot-dipped galvanized industrial grade steel bar grating (steel grade S355)
 - Main bearing bars: 50 x 6 (spaced at 30mm center to center)

- Cross bars: 50 x 6 (spaced at 100mm center to center)
- and covered in stone (should satisfy the requirements for ASTM C-33 No 1 aggregate) to provide a fire trap;
- Each transformer, reactor and NR will be separated by fire wall/head radiation barrier;
- A 50kg Portable Fire Extinguishers are to be included per transformer and reactor.
- Active fire protection for transformers and reactors is to be included such as SERGI 3000 System (Nitrogen Injection Fire Protection System "NIFPS");
- The transformer/reactor/NR oil bunds shall be connected to an underground oil reservoir fitted with an oil separator for overflow:
 - Each bund shall be connected to the oil dam via a minimum 300 mm diameter precast concrete piping system with a minimum fall of 1:200.
 - Manholes shall be provided at maximum 25 m intervals and at pipeline direction changes.
 - It shall be verified that the oil dam is sized to retain 120% of the combined oil volume of the connected transformer/reactor bank/NR combined oil volume (refer to Drawing No. NAK-R003-130).
 - The oil dam and associated pipework shall be separate from the standard substation storm water drainage system;
 - The overflow outlet shall be fitted with an oil separator;
 - The oil dam shall be easily accessible by truck for emptying.

Note: The land for the proposed substation possesses a steep grade which is unsuitable for construction without substantial earthworks. Therefore two options have been proposed;

- (i) To construct a retaining wall to create two levels for the substation yard.
- (ii) Cutting and filling the site to create a single level terrace/platform.

Note that the price proposed under the Price Schedules shall be deemed inclusive of either of the options that the bidder shall opt for during construction

- Control building shall be built on the east end of the substation plot. The available areas for the control building is approximately 44m x 20m. The roof structure shall be comprised of the following:
 - Reinforced concrete roof slab (2-hour fire rating)
 - Gable roof supported by steel trusses including 0.6mm IBR roof sheet cladding
- The building shall include the following rooms with minimum sizes.
 - 11kV Switch Room - 59m²
 - Storage - 15m²
 - Communication Room - 30m²
 - Control Room - 27m²

- AC/DC system Room - 30m²
- Relay Room - 127m²
- Superintendent's Office - 20m²
- Battery Room (x 2) - 26m² each
- Engineer's Office (x2) – 21m² each
-

- Dining/Kitchen - 21m²
- Service Room 5m²
- Men Bathroom – 9m²
- Ladies’ Bathroom – 9m²
- Meeting Room - 61m²
- Necessary corridors/hallways/passages

Air conditioning: - All the foretated rooms which house equipment (i.e. relay panels, telecoms panels e.t.c) shall have their air conditioning equipment sized adequately to meet climate control/operating temperatures as stated by manufacturers. With the exception of the meeting room and offices, air conditioning units shall be floor standing type. The meeting room and offices shall have split type air conditioning units

Ventilation: - All other rooms shall be equipped with wall mounted extractor fans specifically sized for the intended room.

The control building and guard house shall have but not limited to the following furnishing:

Table 11-3: Control building and Guard house furnishings

S/N	Room	Description	Qty	Remarks
01	Storage Room	Industrial Shelving - Open Style (~2200mm High x 1000mm Wide x 500mm Deep)	12	- Carrying Capacity: 300kg per shelf (for uniformly distributed loads).
02	Kitchen	Stool	4	Modern/ Metallic
03	Kitchen	Refrigerator	1	- Minimum Capacity: 650L - Style: Double Door
04	Kitchen	Kitchen Counter/ Eating Area (built-in)	1	Granite Stone
05	Kitchen	Four Plate Cooker Stove	1	Electric
06	Kitchen	Cabinetry with Countertop	1	High quality laminated wood with granite countertop.
07	Kitchen	1.7L Electric Kettle	1	
08	Office	Executive Chair	8	Leather
09	Office	4 Cubicle Workstation	2	- Material: Laminated wood (or better) - Geometry: ~1200mm x 700mm (per station)
10	Office	Vertical File Cabinet	2	- Material: Steel/ Sheet Metal - Geometry: ~1800mm High x 1200mm Wide x 800mm Deep

11	Superintendent's Office	Computer Chairs	2	Mesh material
12	Superintendent's Office	Executive Desk	1	- Material: Hardwood - Geometry: As per Ground Floor Plan

13	Superintendent's Office	Vertical File Cabinet	2	- Material: Steel/ Sheet Metal - Geometry: ~1800mm High x 1200mm Wide x 800mm Deep
14	Superintendent's Office	Executive Chair	1	Leather
16	Control Room	Console Desk	1	- Material: Hardwood - Geometry: As per Ground Floor Plan
17	Control Room	Executive Chair	3	Leather
18	Control Room	Vertical File Cabinet	2	- Material: Steel/ Sheet Metal - Geometry: ~1800mm High x 1200mm Wide x 800mm Deep
19	Guard House	Reception Area Chair	2	Leather
20	Guard House	Control Desk	1	- Material: Hardwood - Geometry: ~1400mm x 700mm
21	Guard House	Vertical Locker	1	- Material: Steel/ Sheet Metal - Geometry: ~1800mm High x 1200mm Wide x 800mm Deep
22	Guard House	Two Plate Cooker Stove	1	Electric
23	Guard House	Cabinetry with Countertop	1	High quality laminated wood.
24	Boardroom	14 Executive Conference Room chairs	14	Leather
25	Boardroom	Conference Table	1	- Material: Hardwood - Geometry: As per Ground Floor Plan
26	Boardroom	Video Conferencing System	1	

*Refer to "Furnishes Catalogue" for illustrations.

11.2.26 Lightning Protection and Earthing

- The earth mat (net) resistance shall not exceed 0.5 Ω . The Contractor shall be required to test the earth mat after installation. The Contractor shall also model the step and touch potentials using CYMGRD software to ensure the GPR does not exceed 5 kV under the most onerous fault condition. The Contractor will need to provide

supporting calculations showing the method of determining the three-phase and single-phase fault levels.

- All main earth mat connections will be done using Cadweld and tested for continuity to avoid high resistance connections.
- Connections above earth shall as a main rule be clamped and shall be easily accessible for inspection. All connections will be protected from various forms of corrosion including bi-metallic.

11.2.27 Additional Information Provided

A Soil Investigation report, Hydrological Meteorological Report and Topographic Maps are attached. Refer to Supplementary Information S1, S2, S3 and S4. The data should be used for reference only. The Employer has provided the attached data to the best of its knowledge, but the Contractor is responsible for verification. Should significant deviations from this data be encountered that materially impact the works, appropriate adjustments will be considered under the contract variation procedures.

The Contractor will be required to undertake detailed topographic surveys to locate and set out earthwork for terraces etc. Confirmation of the shall be subject to the approval of the Employer. The ground survey check shall be executed within the substation plot boundaries.

11.2.28 Terminal points for the overhead line

The Contractor shall coordinate with the Contractor of Package 3 regarding the connections of overhead lines to the substation, including the OPGW. The Contractor of Package 4 must be ready to accommodate this work when the Contractor of Package 3 is ready to make the connections.

The terminal points for both substations and circuits are defined as follows:

- a) The download connections of conductors, OPGW and earthwire, from the terminal towers to the substation gantry structures are included in Package 3, transmission line works. The droppers required to connect to the substation equipment and the connection itself are included in this scope of works.
- b) OPGW earthwire downloads will be terminated in a junction box capable of accommodating an underground fibre optical cable connection to be mounted on the substation/Cable Support & Entry (CSE) gantries. The transmission line contractor shall provide and install the joint box. ADSS from the junction boxes towards the substations optical distribution rack (ODR) are included in in this scope of works.

11.3 Interfaces and Co-ordination

The Contractor is required to manage and be responsible for the interfaces and coordinate with the other Contractors undertaking works related to the construction works as necessary. The primary interfaces between the Contractors or other parties are indicated below.

- Scheduling and coordinating of all required outages for the stringing within the substation and connection to existing busbars under the operational control of ZESCO Limited in Zambia.
- Scheduling and coordination of all heavy transport, workers’ accommodation campsites, storage areas and field offices with the local area councils and all other requisite authorities.
- Coordinating all design work while ensuring that all components of the overhead transmission system are compatible to permit the connection between each other in terms of dimensions and design loads.
- Scheduling and coordination of all substation works where there is more than one Contractor carrying out works on the same substation

The Contractor shall examine the interfaces of Works with others as indicated above and shall be responsible for any missing interface activities or works items supplied and/or executed as necessary to complete the works and shall not make any claims on the Employer in relation to interfaces above, whether specified or not

11.4 Training

Training shall be provided by the Contractor for ZESCO participants in English language. The objective of the training is to equip ZESCO engineers with the necessary skills to maintain, modify, troubleshoot and rectify system failures.

Training shall be conducted partly in the country of origin of materials and systems, and partly at installed material at site.

11.4.1 Foreign

Foreign training is mainly directed to engineers, technicians and administrators.

A Training Program and Schedule shall be availed to the Employer prior to the date of travel, no later than one (1) month, indicating the training period and training content by the Contractor. Training content shall be subject to Employer’s approval.

The Contractor shall include cost of training course and facilities in the Price Schedule for all training to be provided by the Contractor. The price shall also include local transportation

The Contractor shall be expected to provide the following proposed foreign trainings to the Employer’s personnel.

Table 11-3: International Trainings

Item	Description
1	Equipment familiarization training – Reactors and Transformers: 6 staff, Minimum 14 days.
2	Equipment familiarization training – Protection system: 4 staff, Minimum 14 days.
3	Equipment familiarization training – OPGW terminal equipment/telecoms; Minimum 15 working days. Proposed Staff as follows: a) 4 for OTN b) 4 for PTN and c) 4 for Power and Battery Charger Solutions d) 4 for PABX e) 4 for SDH and PCM P230 (10 working days) f) 4 for OPGW and ADSS fundamental and splicing techniques (10 working days) g) 4 for FOX 615 Training
4	Equipment familiarization training – HV Switchgear (circuit breakers and disconnectors): 4 staff, Minimum 14 days.
5	[Not used]
6	Hands on SAS Configuration Training: The control system database configuration will be done by six (6) ZESCO Automation Engineers under supervision of Contractor’s expert Engineers. These ZESCO engineers shall be trained in detail at Contractor’s Factory training facility for a period of four (4) weeks before undertaking these works. This to ensure transfer of skills and guarantee of adequate maintenance and troubleshooting of the substation control system long after the commissioning of this project. The training shall cover but not limited to the following: CONTROL SYSTEM GATEWAY TRAINING

Item	Description
	• Programming of Sequence of Events in Gateway • Programming of Command Outputs in Gateway • Programming of Measurands (Current, voltage, Power and Energy) in Gateway • Programming of Digital inputs in Gateway • Programming of Alarms in Gateway Configuration of NCC protocols (IEC60870-5-104)
	CONTROL SYSTEM HMI TRAINING • Station LAN configuration • Substation Data engineering (Database) • Programming of HMI Diagrams/Pictures • Programming of Sequence of Events in HMI • Programming of Command Outputs in HMI • Programming of Measurands (Current, voltage, Power and Energy) in HMI • Programming of Digital inputs in HMI • Programming of Alarms in HMI Integration of Protection signals in HMI
	CONTROL SYSTEM IED TRAINING • Programming of IED Mimic Diagram • Definition of Event and Alarm Lists in IED • Programming of Current, Voltage, Real Power, Reactive Power, Apparent Power and Energy in IED • Programming of Digital Inputs in IED • Programming of Digital Outputs in IED • Programming of Interlocking and Switching Functions in IED • Configuration of Substation Communication protocols (IEC61850, etc) • Loading/downloading of configuration settings Loading/downloading of firmware
7	Training in configuring Energy Meters and the Energy Management System, fault finding and maintenance of three (3) Metering Engineers for fourteen (14) days • Understanding IEC 61850 standard

Item	Description
	• Metering communication systems • Substation automation of metering systems • Configuration and integration • Testing and conformance • Change management (Software configuration/multi vendor environment management)
8	Training in Omicron StationScout IEC61850 Simulation, Testing and commissioning tool for Substation Automation Systems for 6 staff for minimum 14 working days
9	WAMPACS training for 4 engineers for 14 days
10	Training in Stand-alone 330kV and (132)66kV Disturbance Fault Recorders, 4 staff, includes local travel. Minimum 14 days.

11.4.2 Local

Local training is mainly directed to technicians and maintenance personnel. The training shall include both theoretical and practical components.

The Contractor shall be expected to provide the following proposed local trainings to the Employer’s personnel.

Table 11-4: Local Trainings

Item	Description
1	On-the-job training throughout the implementation of the project
2	Equipment familiarization training – Protection system/metering: 6 staff, Minimum 14 days
3	CCTV System Training for 10 ZESCO Engineers for 10 days
4	Access Control System Training for 10 ZESCO Engineers for 10 days
5	Security Operator (End User) Training for 20 trainees for 10 days
6	Training in maintenance of the Metering system at the substation and the Power quality Software of three (3) Metering Engineers for 5 days

Item	Description
7	Site-specific training shall be provided by the Contractor after successful commissioning of the control system for 15 ZESCO engineers, technicians and maintenance personnel for 4 weeks
8	SFRA Training, 4 staff, Minimum 7 days

12 SUBSTATION REQUIREMENTS

12.1 Design Data

Design data are detailed in section 2.0 Contractor’s design - Basic Electrical System design - Design of Electrical circuits and Technical Schedules.

12.15.1.2 General Design of Equipment

In complying with the requirements of the Specification, design shall conform to the best current engineering practice. Each component part of the Plant shall be to the maker's standard design provided that this design is in general accordance with the Specification. The essence of design shall provide simplicity and reliability in order to give long continuous service with high economy and low maintenance costs. Particular attention shall be paid to internal and external access in order to facilitate inspection, cleaning and maintenance.

Type test certificates of all major equipment and major material shall be submitted together with the Tender Documents as stated in the relevant specifications, failure to which the bid shall be considered to be non responsive. If necessary type test certificates shall be translated in all aspects to the English language by the issuing test institute. Type test certificates shall be properly issued to the manufacturer and to the manufacturer’s factory location.

Type test certificates/ type test reports are subject to the approval of Employer/ Employer’s Representative. Type-test certificates/ type test reports shall not be older than 8 (eight) years at the time of their submittal. Compilation of type test certificates/ type test reports shall be covered by a table of contents, clearly structured by equipment designation, the relevant standards, their sub clauses and designation of the relevant test.

Type tests shall have been performed by an internationally accredited independent testing laboratory not associated with the manufacturers. Also type tests performed at manufacturer’s laboratory and witnessed by accordingly accredited independent third party are acceptable. Accreditation to the testing laboratory/ third party shall be given by an according signatory member of International Laboratory Accreditation Cooperation (ILAC).

Upon submission of relevant type test certificates and proof that the equipment and material to be tested is identical to that covered by the test certificates, the Employer/ Employer’s Representative may waive the requirements for corresponding type tests called for in this Specification and/ or specified in the Standards.

On request of Employer/ Employer's Representative full type test report/ protocol shall be provided.

The design dimensions and materials of all parts shall be such that they will not suffer damage as a result of stresses under the most severe service conditions.

Fully detailed specifications of the component parts of the Plant shall be submitted describing particularly the materials to be used.

The materials used in the construction of the Plant shall be of the highest quality and selected particularly to meet the duties required of them. Mechanisms shall be constructed to avoid sticking due to rust or corrosion.

Workmanship and general finish shall be of the highest quality throughout.

All similar parts of the Plant shall be interchangeable.

All apparatus shall operate without undue vibration and with the least practicable amount of noise.

All equipment shall be designed to minimise the risk of fire and any damage which may be caused in the event of fire.

All apparatus shall be designed to obviate the risk of accidental short, malfunction or damage due to vermin. The use of materials which may be liable to attack by termites or other insects is to be avoided.

All items of equipment which may have to be lifted for erection or maintenance shall be provided with lifting eyes, jacking pads or alternative handling facilities.

The equipment is to be designed to prevent accidental contact with live parts.

Fixed installed maintenance platforms, where the height of the switchyard equipment necessitates them to perform operation and maintenance, shall be included in the delivery.

12.15.1.3 Steel Structures and Assembly Material

Steel structures are to be understood as substation gantries, equipment supports, with their body and leg extensions, additional crossarms if required, the foundation stubs, and stub setting templates.

Assembly material are to be understood as all bolts, screws, rivets, nuts, washers, locking devices which are necessary for the assembly of the steel structures and their accessories as well as, for the assembling and mounting of the equipment, insulator sets, conductor and earthwire / OPGW accessories.

12.15.1.4 Steel Structures

Generally, the design and stress calculation shall conform to a consecrated code or standard such as:

IEC 60826 Design criteria of overhead transmission lines

ISO 10721 Steel structures; calculation and construction

EN 1993 Design of steel structures.

The local climatic conditions, load calculation, description of loading cases, as well as the applicable design method and safety factors shall be as specified in these Bidding Documents.

The material to be used for the structures is high tensile - and mild steel sections and plates, according to internationally recognized standards (ISO 630, DIN 17100 or equivalent).

All structural steel shall be protected against corrosion by hot dip galvanizing.

12.15.1.5 Assembly Material

All necessary bolts, screws, rivets, nuts, washers and locking washers shall be included in the scope of supply of the Contractor with sufficient spare to cover for losses.

Members of lattice steel structures including stub setting templates shall be secured by means of bolts and nuts with approved spring washers and lock washers.

All bolts and nuts shall conform respectively to ISO 898 and/or to DIN 267 and shall have metric screwed threads. Nuts and the heads of bolts shall be of the hexagonal type. Nuts - except lock nuts - shall be full bearing on one side.

Minimum size of bolts for all structural connections shall be 16 mm diameter in mild steel or 12 mm in high tensile steel. The quality of bolts shall not be less than 5.6 according to ISO 898 and/or DIN 267.

All bolts and screwed rods shall be galvanized including the threaded portions. All nuts shall be galvanized with the exception of the threads, which shall be oiled.

Where for any type of tower high tensile steel bolts are employed then bolts of this type shall be used for all connections for every type of tower on that line in order to avoid the use of mild steel bolts in error where high tensile

12.2 Standard and Codes

The equipment, materials and labour employed in the fabrication, delivery, erection or installation and testing of the parts of the project shall comply with applicable and approved standards as stated in relevant sections and schedules.

The order of precedence shall be: (i) applicable laws and statutory/regulatory requirements; (ii) the Contract, including Section VII and the Technical Schedules; (iii) the Zambia Grid Code and identified ZESCO standards; and (iv) the referenced IEC/IEEE/ISO and other international standards. Where two requirements at the same level conflict, the more stringent requirement shall apply, provided it does not conflict with a higher-order requirement.

Where the equipment is specified to a particular standard, the Contractor may supply equipment of an equivalent standard, if approved by the Employer. If the equipment application does not fall within the scope of the above standards and codes, such equipment shall be provided in compliance with good Project Management practice, appropriate with the service required and approved by the Employer. Furthermore, in case of conflict between this specification and any of the referenced codes and standards, the above order shall be followed.

A complete tender list of the applicable codes, standards, and specifications shall have been submitted as part of the documents for review. English language copies of any such references shall be furnished by the Contractor as required by the Employer.

Reference Documents

The substation outdoor equipment shall be supplied in accordance with the detail requirements of this specification and in particular the latest issue of IEC standards. The characteristics of design and construction, ratings and testing procedures are concerned; the outdoor switchgears shall meet the following IEC standards. The following standards, and all standards quoted therein, shall be applicable:

Table 12.1: Standards

IEC 60028	International standard of resistance for copper
IEC 60034	Rotating electrical machines
-1	Part 1: Rating and performance
-5	Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) — Classification
IEC 60038	IEC Standard voltages.
IEC 60050	International Electrotechnical Vocabulary –
-151	Chapter 151: Electrical and magnetic devices.
-191	Chapter 191: Dependability and quality of service
-321	Chapter 321: Instrument transformers
-436	Chapter 436: Power capacitors
-441	Chapter 441: Switchgear, control gear and fuses.
-601	Chapter 601: Generation, transmission and distribution of electricity - General
-604	Chapter 604: Generation, transmission and distribution of electricity - Operation
IEC 60059	IEC Standard current ratings.
IEC 60060	High voltage test techniques
-1	Part 1: General definitions and test requirements
-2	Part 2: Measuring systems
-3	Part 3: Definitions and requirements for on-site testing
IEC 60068	Environmental testing

-2-11	Part 2: Tests – Test Ka: Salt mist
-2-14	Part 2: Tests – Test N: Change of temperature
-2-42	Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections
IEC 60071	Insulation co-ordination
-1	Part 1: Definitions, principles and rules
-2	Part 2: Application guide
IEC 60076	Power transformers
-1	Part 1: General
-6	Part 6: Reactors
IEC 60085	Electrical insulation - Thermal evaluation and designation
IEC 60099	Surge arresters
-1	Part 1: Non-linear resistor type gapped arresters for a.c. systems
- 3	Part 3: Artificial pollution testing of surge arresters
- 4	Part 4: Metal-oxide surge arresters without gaps for a.c. systems
- 5	Part 5: Selection and application recommendations
-10	Part 10: Determination of sound levels
-10-1	Part 10-1: Determination of sound levels - Application guide
IEC 60121	Recommendation for commercial annealed aluminium electrical conductor wire
IEC 60137	Insulated bushings for alternating voltages above 1 000 V.
IEC 60146	Semiconductor converters
IEC 60156	Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
IEC 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000V.
IEC 60214	Tap changers

IEC 60255	Electrical relays
-21-3	Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section 3: Seismic tests
IEC 60269	Low-voltage fuses
-1	Part 1: General requirements
-2	Part 2: Supplementary requirements for fuses for use by authorized person [fuses mainly for industrial application]
IEC 60270	Partial discharge measurements.
IEC 60273	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60296	Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchgear
IEC 60309-1	Plugs, socket-outlet and couplers for industrial purposes. Part 1: general requirements
-2	Plugs, socket-outlet and couplers for industrial purposes. Part 2: dimensional interchangeability requirements for pin and contact tube accessories
IEC 60354	Loading guide for oil-immersed transformers
IEC 60358	Coupling capacitors and capacitor dividers
IEC 60376	Specification of technical grade sulphur hexafluoride (SF ₆) for use in electrical equipment
IEC 60417	Graphical symbols for use on equipment.
IEC 60437	Radio interference test on high-voltage insulators
IEC 60439-1	Low voltage switchgear and control gear assemblies Part 1: Type tested and partially type tested
-5	Low voltage switchgear and control gear assemblies Part 5: Particular requirements for assemblies intended to be installed outdoors in public places – cable distribution cabinets [CDCs] for power distribution in networks
IEC 60480	Guidelines for the checking and treatment of sulphur hexafluoride (SF ₆) taken from electrical equipment and specification for its re-use

IEC 60507	Artificial pollution tests on high-voltage insulators to be used on a.c. systems
IEC 60529	Degrees of protection provided by enclosures (IP code).
IEC 60533	Electrical and electronic installations in ships - Electromagnetic compatibility (EMC) - Ships with a metallic hull
IEC 60551	Determination of transformer and reactor sound levels
IEC 60567	Oil-filled electrical equipment - Sampling of gases and of oil for analysis of free and dissolved gases - Guidance
IEC 60599	Mineral oil-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gases analysis
IEC TR 60616	Terminal and tapping marking for power transformers
IEC 60664-1	Insulation coordination for equipment within low voltage systems. Part 1: Principles, requirements and tests
-2	Insulation coordination for equipment within low voltage systems. Part 2-1: Application guide – dimensioning procedure, worksheets and dimensioning examples
-2-2	Insulation coordination for equipment within low voltage systems. Part 2-2: Interface considerations – Application guide
-3	Insulation coordination for equipment within low voltage systems. Part 3: Use of coating, potting and moulding for protection against pollution
-4	Insulation coordination for equipment within low voltage systems. Part 4: considerations of high frequency voltage stress
-5	Insulation coordination for equipment within low voltage systems. Part 5: A comprehensive method for determining clearance and creepage distances equal to or less than 2mm
IEC 60700	Thyristor valves for high voltage direct current (HVDC) power transmission
-1	Part 1: Electrical testing
-2	Part 2: Terminology
IEC 60715	Dimensions of low-voltage switchgear and control gear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and control gear installations

IEC 60721	Classification of environmental conditions –
-2-2	Part 2: Environmental conditions appearing in nature. Precipitation and wind
-2-4	Part 2-4: Environmental conditions appearing in nature - Solar radiation and temperature
IEC 60747	Semiconductor devices
IEC TS 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
-1	Part 1: Definitions, information and general principles
-2	Part 2: Ceramic and glass insulators for a.c. systems
-3	Part 3: Polymer insulators for a.c. systems
IEC 60870	Telecontrol equipment and systems
-5-101	Part 5-101: Transmission protocols - Companion standard for basic telecontrol tasks
IEC 60871	Shunt capacitors for a.c. power systems having a rated voltage above 1000 V
-1	Part 1: General
-2	Part 2: Endurance testing
IEC 60890	A method of temperature-rise assessment by extrapolation for partially type-tested assemblies (PTTA) of low-voltage switchgear and control gear
IEC 60947	Low-voltage switchgear and control gear
-1	Part 1: General rules.
-2	Part 2: Circuit breakers.
-3	Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.
-4-1	Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
-5-1	Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices

-5-2	Part 5-2: Control circuit devices and switching elements - Proximity switches
-6-1	Part 6-1: Multiple function equipment - Transfer switching equipment
-7-1	Part 7-1: Ancillary equipment - Terminal blocks for copper conductors
IEC 61000-4-2	Part 4-2: Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
IEC 61109	Composite insulators for a.c. overhead lines with a nominal voltage greater than 1 000 V – Definitions, test methods and acceptance criteria
IEC 61166	High-voltage alternating current circuit-breakers – Guide for seismic qualification of high-voltage alternating current circuit-breakers
IEC 61558	Safety of power transformer, power supply units and similar
IEC 61869	Instrument transformers –
-1	Part 1: General requirements
-2	Part 2: Additional requirements for current transformers
-3	Part 3: Additional requirements for inductive voltage transformers
-5	Part 5: Additional requirements for capacitor voltage transformers
IEC 61954	Static var compensators (SVC) - Testing of thyristor valves
IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC 62215	Integrated circuits - Measurement of impulse immunity - Part 2: Synchronous transient injection method
IEC 62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC 62271	High-voltage switchgear and control gear
-1	Part 1: Common specifications.
-100	Part 100: High-voltage alternating-current circuit-breakers
-101	Part 101: Synthetic testing
-102	Part 102: Alternating current disconnectors and earthing switches

-110	Part 110: Inductive load switching
-300	Part 300: Seismic qualification of alternating current circuit- breakers
-301	Part 301: Dimensional standardisation of terminals
IEC 62305	Protection against lightning
	Part 1: General Principles
	Part 2: Risk management
	Part 3: Physical damage to structures and life hazard
	Part 4: Electrical and electronic systems within structures
IEC	All Relevant IEC Standards on Power Electronic Switch Modules for STATCOM Applications
IEEE 80	IEEE Guide for safety in AC Substation Grounding
IEEE 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance & Earth Surface Potentials of a Ground System
SANS 10199	The design and installation of earth electrodes
SANS 10313	The protection of structures against lightning
IEEE 837	IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
ISO 8501	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness
-1	Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
ISO 8528:3	Alternating current generators for generating sets
ISO 15206:2010	Timber poles – basic requirements and test methods
SANS 32/EN 10240	Internal and/or external protective coatings for steel tubes – Specification for hot dip galvanized coatings applied in automatic plants.
SANS 121/ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
SANS 1091	National colour standard.

BS EN 22063	Metallic and other inorganic coatings – Thermal spraying – Zinc, aluminium and their alloys.
ISO 9001	Quality management system - Requirements
CIGRE WG14.01, TF2, REV. FEB 1994	Cigre guidelines for testing of Thyristor Valves for Static Var Compensators. (Draft document)
IEEE-32	Standard Requirements, Terminology and Test Procedure for Neutral Grounding Devices.
IEEE C37.06	IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis--Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V
IEEE C37.09	IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.10	IEEE Guide for Investigation, Analysis, and Reporting of Power Circuit Breaker Failures
IEEE C37.11	IEEE Standard Requirements for Electrical Control for AC High-Voltage (>1000 V) Circuit Breakers
IEEE C37.12	IEEE Guide for Specifications of High-Voltage Circuit Breakers (over 1000 Volts)

Note: Hierarchy of Standards - The order of precedence shall be: (i) applicable laws and statutory/regulatory requirements; (ii) the Contract, including Section VII and the Technical Schedules; (iii) the Zambia Grid Code and identified ZESCO standards; and (iv) the referenced IEC/IEEE/ISO and other international standards. Where two requirements at the same level conflict, the more stringent requirement shall apply, provided it does not conflict with a higher-order requirement.

12.3 Design and Standardisation

All apparatus shall be designed to ensure satisfactory operation under the atmospheric conditions prevailing at the Sites and under such sudden variations of load and voltage as may be met under working conditions on the system and short-circuits, including those due to faulty synchronizing, within the rating of the apparatus.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the Work and of associated existing equipment and previous designs.

All material used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

All apparatus shall operate without undue vibration and with the least practicable amount of noise.

Cast iron or cast aluminum shall not be used for chambers of oil-filled or gas-filled apparatus or for any part of the equipment, which is in tension or subject to impact stresses except where it can be shown that service experience has been satisfactory with the grade of cast iron, and the duty proposed.

Operating boxes, kiosks, cubicles, and similar enclosed compartments forming part of auxiliary equipment shall be adequately ventilated to restrict condensation. All contactors or relay coils and other parts shall be suitably protected against corrosion. Anti-condensation heaters of an approved type shall be provided inside each cubicle or where necessary each cubicle compartment. They shall be shrouded and located so as not to cause injury to personnel or damage to equipment. The thermostat equipment shall be arranged to switch off the heater supply when the internal temperature exceeds the required temperature. Means shall be provided at each unit for isolating the supply. A common switch with a neon gas type lamp labeled "**Cubicle heaters on**" shall be mounted at a convenient point such that it will not require relocation in the event of extension units being added. A Hygrostat switch shall be provided. The design of the heaters shall be such that when the equipment is in service with the heaters energized, the maximum permitted rise in temperature for the equipment shall not be exceeded.

All outdoor apparatus including bushing insulators and fittings shall be so designed as to avoid pockets in which water can collect.

The underside of all tanks shall be ventilated in an approved manner to prevent corrosion.

Accessible means shall be provided for the easy lubrication of all bearings and where necessary, of any mechanism or moving part. Grease lubricators shall be fitted with hexagon nipples.

The bus bars, connections, isolators, fuses, contacts, cable boxes, trucking connections, etc. which form part of the Work shall not exceed the temperature rise values specified in the relevant IEC publication or equivalent National Standard, when operating continuously and at the specified IEC rating or under short-circuit conditions and at the specified Site rating under the specified maximum design ambient conditions.

All connections shall be secured by bolts or set screws of ample size, fitted with locking devices of approved type and material.

All rubbing or wearing surfaces shall be machine surfaced. Joints employing a gasket material shall be so constructed that the packing is maintained under sufficient compression in all parts, so that an efficient joint can be made without the use of jointing compounds. Gasket material shall be of the minimum thickness necessary and of proven composition when operating under the environmental conditions prevailing at the Site. Neoprene and similar synthetic compounds, not subject to deterioration due to the climate conditions, shall be used for gaskets, sealing rings, diaphragms, etc. instead of the standard rubber - based materials.

All apparatus shall be designed to obviate the risk of accidental short-circuit due to animals, birds, and vermin. Openings in ventilated enclosures shall be so constructed to prevent the entry of vermin and insects.

Fabrics, cork, paper, and similar materials, which are not subsequently to be protected by impregnation, shall be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or varnishes shall not be used.

The use of wood in equipment shall be avoided so far as possible. When used, woodwork is to be thoroughly seasoned tek or other approved wood, which is resistant to fungal decay and shall be free from shakes and warp, sap and wane, knots, faults, and other blemishes. All woodwork shall be suitably treated to protect it against the ingress of moisture and from the growth of fungus and termite attack, unless it is naturally resistant to those causes of deterioration.

All joints in woodwork shall be dovetailed or tongued and pinned as far as possible. Metal fittings where used shall be of non-ferrous material.

Adhesives are to be specially selected to ensure the use of types, which are impervious to moisture, resistant to mould growth, and not subject to the ravages of insects. Synthetic resin cement shall be used for joining wood.

All equipment shall be designed to prevent ingress of vermin, dust and dirt. Where wiring, piping or ductwork passes through openings in equipment housings, such openings shall be

constructed to prevent ingress of vermin. Wiring and piping enclosures shall also be vermin proof.

12.4 Factory Acceptance Test (FAT)

FAT is mandatory for all substation equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on equipment to be supplied.

- The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers and one Consultant personnel . Prior to travelling, no later than one (1) month, the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer

The following equipment shall require FATs with duration estimates given in the Price Schedules

Table 12-2: Equipment FAT

S/N	Equipment	Duration (Days)	Standards
Secondary Equipment			
1	Metering	14	IEC 62053 series; IEC 61869-1
2	Protection	14	IEC 60255, IEC 60038, IEC 60068, IEC 60664
3	SAS	14	IEC 61850
4	WAMPACS	14	IEC 61850; IEC 60255
5	Telecommunication	14	IEC 61850
6	DC Chargers and batteries	7	IEC 61850-3
Primary Equipment			
7	Transformers	14	IEC 60076
8	Reactors	14	IEC 60076

9	Circuit breakers (330kV & 132kV)	14	IEC 62271-100
10	Disconnectors (330kV & 132kV)		IEC 62271-100
11	Sergi fire Protection or equivalent	7	IEC 60076
12	Voltage Transformers	7	IEC 61869-2
13	Current Transformers	7	IEC 61869-5
14	Surge arresters (330kV & 66kV)	7	IEC 60099
15	11kV Switchgear	7	IEC 62271-200; IEC 62271-1

12.5 Technical Specification for Substation Conductors

12.5.1 Scope

This specification covers the technical requirements of design, manufacture, testing at the manufacturer's works and the supply to site of stranded busbar and stringing conductors as well as earthwire. The specific requirements are covered in the technical data sheet.

In this document, the word “busbar” describes any conductor(s) used for the interconnection and termination of electrical connections to primary equipment within the substation yard.

12.5.2 Technical Details

The phase conductor shall be an all-aluminium conductor, conventional concentric-lay-stranded in accordance with IEC 61089. The stranded busbar and stringing conductor shall be either double AAC “Tarantula” or LGKK-600. Either ACSR Bison or LGJ 400/50 shall be used for inter-equipment connections. The shield wire and OPGW shall be strung up to the landing gantry by Package 3 contractor. Refer to Technical Schedules for data.

The bay conductor which aligns with the existing circuits of the Kasama substations is Bison. Physical properties are detailed in Technical Schedules.

The aerial earthwire conductor shall have the physical properties as detailed in Technical Schedules.

12.5.3 General Requirements

Aluminium wire used for AAC shall comply with the requirements of Technical Schedules. The aluminium shall be of the highest purity commercially obtainable, the copper content shall not exceed 0.04%.

12.5.4 Workmanship

Precautions shall be taken during the manufacture, storage, and delivery of conductors to prevent contamination by copper or other materials, which may adversely affect the aluminium.

Where permitted in IEC 61089 for aluminium wires the preferred method of jointing single wires is cold pressure welding. No more than one welded aluminium finished wire shall be used per drum length of conductor. The manufacturer must record the exact location of the weld.

The aluminium strands of the whole conductor delivery shall all be manufactured by one and the same manufacturing process.

12.5.5 Conductor Drums

The conductor shall be delivered on drums. The flanges and barrels of the drum shaft shall be made entirely of a suitable and seasoned wood, which shall be treated. If hardwood is used, it shall not form more than 40% of the total weight of wood making up the drum, neither shall it be used on the inside of the flanges and barrels, so that it shall not be in contact with the conductor. Spindle holes shall not be less than 60 mm in diameter. The surrounding of the holes shall be suitably reinforced.

The flanges and barrel shall be free from protruding material capable of damaging the conductor or the hands of the operator during rotation of the drum. The drum flanges shall be solidly secured with solid mild steel rods, nuts and square washers. The batons shall be secured with a minimum of two nails at each end and wrapped with a minimum of two steel bands or galvanized steel wire of minimum diameter 2.3 mm. The quality of the drums shall cope with at least 3 years of outdoor storage. The drum shall have a diameter of at least 700 mm.

12.5.6 Packing

The surface of the barrel and the inside of the flanges shall be lined with waterproof paper. The loose end of the conductor shall be firmly stapled to the inside of the flanges.

The drum number shall be branded or gauged onto the outside of one of the flanges. An arrow shall indicate the direction in which the drum shall be rolled. A label showing size, type and

length of conductor shall be firmly secured to the outside of one of the flanges. The label shall be suitably weatherproofed.

The gross mass of the drums for the various sizes of the conductors shall be between 1000 kg and 1300 kg.

12.5.7 Marking

The following information shall be marked on each package:

Manufacturer's name;

Trade mark, if any;

Drum or identification number;

Size and name of conductor;

Lengths of conductor;

Gross mass of drum;

Net mass of conductor;

Direction of rolling.

12.5.8 Installation of Conductors

Conductors shall be run out from drums mounted on trailers or drum stands.

The Contractor shall include within his Method Statement details of his proposal for installing and tensioning the busbar conductor spans.

During the erection of conductors and subsequently when any work is being carried out on the support above the anti-climbing device level, the Contractor shall ensure the conductors are adequately earthed at points not more than three spans apart, or such other spacing as may be necessary or directed by the Engineer.

The earthing equipment shall be approved by the Engineer and shall be designed to be clearly visible from the ground.

12.5.9 Conductor Cutting

Conductor joints shall be made over protective sheeting and waste materials shall be removed from site. Cutting of layers of conductors shall be carried out with tools designed to prevent damage to underlying strands.

12.5.10 Jointing

Before the conductor is inserted into compression type joints, clamps, connectors, compression spacers or repair sleeves, the Contractor will issue a method statement to the Engineer for approval.

The Contractor shall include within his Method Statement full details of his proposed jointing procedures, including where necessary appropriate diagrams.

Unless otherwise agreed with the Engineer who will take account of the degree of corrosion of the conductor, all the aluminium layers, after preliminary cleaning of the individual aluminium wires with a fine grade of abrasive paper or cloth, shall be coated with grease, wire brushed through the grease which shall be left on and assembled in the fitting after a further liberal application of grease. The innermost layer of aluminium wires should not be unlaid but treated on their external surfaces only. Care shall be taken to avoid damage to the wires especially by kinking or excessive removal of metal. If however, damage does occur, the whole conductor shall be cut clear of the damage and a fresh joint prepared.

12.5.11 Surface Greasing of Conductor

Except where specified to the contrary, the conductor shall be coated with approved grease and brushed at the point of attachment of fittings immediately before the final assembly of any fittings and all surplus grease shall be removed after assembly.

12.5.12 Greasing of Bolted Interfaces

For bolted jumper connections, non-tension joints, tee connectors and bonding leads, the lug and clevis contact faces shall be greased with approved grease, wire brushed through the grease liberally before assembly. All nuts and bolts shall be tightened to the supplier's recommended torque.

Where jumper or non-tension joint bolts are found to be loose, the Contractor shall dismantle and re-assemble the joint as above before re-bolting and tightening. All bolts shall face towards the centre line of each conductor bundle.

QUALITY CONTROL OF GREASE

In order to control the quality of the grease before been applied to the Conductor, The Contractor shall arrange to the manufacture of grease the tests of the grease before applied to the grease. The following tests but not limited shall be conducted as per requirements of EN 50326:

- i. Drop Point

- ii. High Temperature Stability Test
- iii. Penetrability
- iv. Adhesion
- v. Acidity/Alkalinity index
- vi. Ageing
- vii. Corrosion
- viii. Stability under steady state conditions
- ix. Stability under short circuit conditions

12.5.13 Electrical Resistance of Joints and Clamps

The maximum resistance, measured overall (primary measurement), of all joints shall not exceed 75% of the resistance of an equivalent length of conductor.

12.5.14 Measurement and Testing

The proposed conductor shall be subject to all electrical and mechanical sample tests in accordance with IEC 61089 and IEC 61395. All tests and inspection shall be made at an accredited facility prior to shipment of the conductor as per IEC 61089.

The proposed conductor shall be subject to all electrical and mechanical tests in accordance with IEC 61089, IEC 61395, and IEC 60889. These include both type tests and sample tests. The conductor should be accompanied with full type test certificates for electrical and mechanical properties. Additionally, these tests include creep tests on stranded conductors according to IEC 61395. All tests and inspection shall be made at an accredited facility prior to shipment of the conductor as per IEC 61089.

Sample tests are routine and include as a minimum are:

Appearance/Finish/Surface;

Diameter;

Resistivity;

Wrapping Test;

Lay Ratio and Direction of Lay;

Weight per meter;

Grease Weight per meter;

Breaking Strength and Resistance;

Torsion Test;

Stress Determination at 1% elongation;

12.6 Tensile Test. Technical Specification for the OFC

12.6.1 General

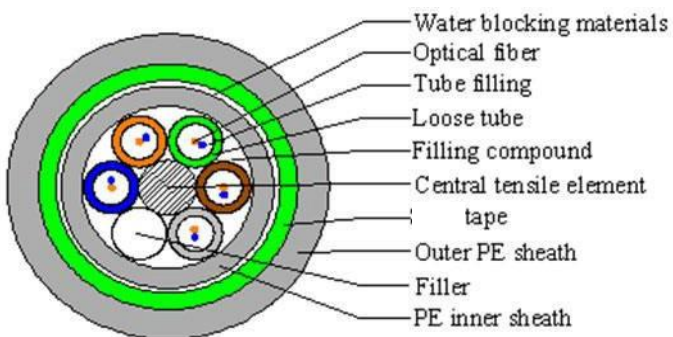
Armoured (non-metallic armouring) direct buried fibre optic cable shall be used to connect the OPGW splicing box in the substation yard, to the patch panel located within the Control Room. The OPGW shall be installed in HDPE piping or at cable ladders in cable trenches.

12.6.2 Technical Details

12.6.3 General requirements for optical fibre

Unless otherwise specified in this specification, all requirements for optical fibre shall be mainly in accordance with ITU-T G.652.D standards. The technical parameter of ITU-T G.652 D single-mode optical fibre shall be as stated in Technical Schedules.

12.6.4 Typical cross-section of outdoor optical cable



12.6.5 General

12.6.6 Colouring of fibre

The fibres should be coloured different colours for identification in loose tube. Colour-coding of fibre and tube will be clear, and not fade and move in temperature of working and installation.

12.6.7 Loose tube technique

The material of loose tube is PBT (Polybutylene terephthalate). Each loose tube contains fibres, which are loosely lying in the tube. The tube is filled with a non-hygroscopic, non-toxic, homogenous gel in order to prevent water penetration.

12.6.8 Reverse lay (SZ) stranding cable core

The loose tubes are stranded around the central strength member according to the reverse lay method, which means that the direction of stranding will reverse every several stranding pitches. Polyester binder is enlaced around the tube in order to retain them in the proper position.

12.6.9 Cable sheath

Direct buried cable: the MDPE-sheath is extruded on the cable core followed by a non-metallic armour tape and a water blocking tape longitudinally applied over the inner sheath, and the MDPE-sheath is extruded over the tape. Sheath shall contain Carbon Black for ultraviolet light protection and shall not promote the growth of fungus and shall be free of holes, splits and blisters.

12.6.10 Sheath mark

Unless otherwise required the sheath will be marked at intervals of 1m, containing:

- Indication in meters
- Quantity and type of fibre
- Factory name
- Date of manufacturing (year)
- Other requirements

The marks will be permanent and legible for the duration of the cable life. The precision of the length indication will be better than $10\text{m} \pm 2\text{m}$.

12.6.11 Delivery Lengths

OFC cables shall be delivered in agreed lengths suitable for the sections of the substation. A thermal pad shall be placed on the outer spirals and thermal protection shall be at least equivalent to that obtained with an aluminium sheet covered by 10 mm cellular polyethylene.

After factory inspection the inner end of the cable shall be fitted with a suitable cap to ensure water tightness. The outer end shall be fitted with a watertight head compatible with cable pulling.

The same precautions as for the line conductor shall be taken for OPGW with regard to reels, packing and shipment.

12.6.12 Packing and Drum

OFC shall be wound on a non-returnable wooden drum or iron-wooden drum. Both ends of OFC shall be securely fastened to drum and sealed with a shrinkable cap. The required marking shall be printed with a weather-proof material on the outsides of drum showing the fibre type, cable length and drum number.

12.6.13 Installation

Particular care should be given while carrying out the installation such as not to apply excessive bending or tension which could cause either damage to the OFC/Optical fibres or change fibres characteristics. In case damage occurs during the installation the Contractor will be is obliged to replace the damaged drum by a new drum.

12.6.14 Splicing and Termination

The splicing of the optical fibres should be carried out in all joint boxes and terminal boxes by well trained technicians for the Contractor and to be witnessed by the Employer. The methodology for jointing should be proposed by the manufacturer. The Contractor will be required to provide all required splicing equipment and tools for the execution of splicing and termination works. Splice loss shall be measured and shall not be more than 0.05 dB. Proper numbering shall be provided on each fibre core to facilitate identification.

12.6.15 Typical Installation at Splicing Structure

Detail arrangements must be supplied by the Contractor on how the splicing boxes must be installed on the gantry and Patch Panels. The minimum bending radius as recommended by the cable manufacturer must be adhered to at all times.

The splicing box must also be fitted with suitable stand-off insulators similar to those fitted to the down-lead clamps.

To allow sufficient slack for the joint to be brought to ground level for splicing, the OPGW down-lead length at a joint structure must equal to a minimum of the structure height plus 5m.

Should a duct cable or armoured direct buried optical cable be present at such a joint structure, then a minimum length of 10m should be allowed above the anti-climb guard.

For duct cables in substations, a minimum slack loop of 5m must be allowed. All slack to be taken up in a proper manner.

Splicing loss shall be measured and shall not be more than 0.05 dB. Proper numbering shall be provided on each fibre core to facilitate identification.

12.6.16 Joint / Termination Boxes and Splices

12.6.16.1 General

The boxes shall be small arms bullet-proof, insect-proof, waterproof and watertight with protection degree of IP67W (weather proof), made of rustfree metal and shall be designed such as to form an extremely rigid structure.

Junction box technology shall ensure only bottom cable entry, quick removal of box cover giving access to fibre splices, repair of fibre splicing at least three times during the overhead line's working life, accordingly sufficient fibre length should be left loose inside the box. All jointing materials, sufficient for all splices (equal to 1.2 times the number of fibres), including the splicing sleeves, heat shrinking protective tubes, splice holder and cable holder should be provided inside the box.

All joint boxes must be mounted as high on the structure as practical, to avoid theft. It must be ensured that the mounting height of the joint box is such that the safe working clearances from any of the phase conductors to the joint box are satisfied.

Joint boxes must be accepted by the Project Manager.

12.6.16.2 2-Way Joint Box for OPGW and OFC

This type of joint box is used for the connection of OPGW to OFC. These shall be in general similar to type A, except for the third cable entry and shall be installed at the structure about 5m above the structure foundation surface. This type of joint box shall be used to spur joint all fibres contained in two OPGW cables to OFC or one multi-core optical fibre cable at located terminal station, or other location, as detailed in the text or drawings elsewhere in this specification. The joint box will allow the installation of fuse splice fibre cassettes as well as FC/PC pigtail connectors mini distribution rack.

12.6.17 Measurements and Testing

OFC tests shall be in accordance with applicable standards or agreements between purchaser and manufacturer.

The OFC must be tested before and after installation according to the test specification in IEC 60793 and IEC 60794.

12.6.18 Test requirements.

The following table shows that the test items shall be carried out according to corresponding references.

Table 12-3 Test item references

No	Item	Reference
1	Attenuation coefficient	IEC 60793-1-40
2	Chromatic dispersion	IEC 60793-1-42
3	Mode field diameter	IEC 60793-1-45
4	Cladding diameter	IEC 60793-1-20
5	Cladding non-circularity	IEC 60793-1-20
6	Core/clad concentricity error	IEC 60793-1-20
7	Cable cutoff wavelength	IEC 60793-1-44

12.6.19 Joint testing

All joints must be type tested in accordance with the latest revision of IEC 60793 and IEC 60794.

12.7 Technical Specification for Busbars, Clamp, Accessories, and Insulators**12.7.1 Scope**

This specification covers the technical requirements of busbars, clamps, connectors, insulators and post insulators, complete with all hardware fittings for efficient and trouble-free operation for use in substations suitable for nominal system voltages greater than 1000 V. The specific requirements are covered in the technical data sheet.

12.7.2 General Requirements

All components of a busbar system shall meet the requirements of the standards under section 12.2 and the additional requirements stated in this specification. The main supplier shall produce installation, maintenance, and replacement procedures for the component, taking into consideration the Employer’s maintenance requirements.

12.7.3 Quality Assurance Plan and Inspection

A quality assurance plan shall be submitted for approval. As a part of the plan the scheduled date for factory inspection shall be included.

12.7.4 Compliance with Specification

If the technical requirements are not met or the performance of the equipment during test does not meet the guarantees stated in technical particulars, the Engineer shall have the right to reject the faulty component / equipment and the Contractor has to replace the same in full compliance with the specification, at no additional cost to the Employer.

12.7.5 Markings

The marking of the insulators shall fully comply with the relevant IEC requirements. The insulator shall be permanently and clearly marked with the following information:

Manufacturer's name or trademark;

Specified mechanical load or maximum design cantilever load;

Type or model number;

Batch number.

12.7.6 Packaging

The packaging shall protect the insulator from the normal handling that can be expected from the point of dispatch to the point of construction and shall be rodent resistant.

12.7.7 Drawings / Documents

Copies of the following drawings and documents shall be submitted for Client's approval before taking up manufacture:

General arrangement of String insulators completes with associated hardware;

General arrangement of post insulators with the technical characteristics;

General arrangement of clamps and connectors;

Schedule of clamps and connectors;

Manufacturing Schedule and test schedule;

Technical product catalogue and installation manuals shall be provided;

A copy of all type test certificates in English shall be provided and

A copy of the proposed routine test certificates in English shall be provided.

The technical data required for busbar components shall be included on drawings. The drawing shall confirm that the busbar components are to the specified tolerance and each general arrangement drawing of the insulator offered shall include:

Dimensions and tolerances, including end fittings;

Material description, mass and fabrication details;

The maximum working voltage, continuous current and short circuit levels;

Recommended installation torque(s) in Newton metres;

Specified mechanical load or maximum design cantilever load;

The safety factor for castings/forged materials shall be shown;

Supplier’s catalogue numbers and

Location and description identification markings.

12.7.8 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in Codes and Standards. In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer.

The Busbar hardware supplied shall satisfy all the requirements of Local Statutory authorities.

All insulators to be used in the substation shall meet the requirements of the following IEC standards:

Table 12-4: Insulators standards

IEC 60672-1	12-1. Ceramic and glass insulating materials - Part 1: Definitions and classification.
IEC 60672-2	12-2 Ceramic and glass insulating materials - Part 2: Methods of test.
IEC 60672-3	12-3. Ceramic and glass-insulating materials - Part 3: Specifications for individual materials.
IEC 60305	Insulators for Overhead Lines with nominal voltage above 1,000V – Ceramic or Glass insulator units for a.c systems – Characteristics of insulator units of the cap and pin type
IEC/TS 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: definitions, information and general

	principles.
IEC/TS 60815-2	Ceramic and glass insulators for a.c. systems.
IEC/TS 60815-3	Polymeric insulators for a.c. systems.
IEC 60372	Locking devices for ball and socket couplings of string insulator units – dimensions and tests.
IEC 60383-1	Insulators for Overhead Lines with nominal voltage above 1,000V – Part 1: Ceramic or Glass insulator units for a.c systems – Definitions, test methods, and acceptance criteria.
IEC 60383-2	Insulators for Overhead Lines with nominal voltage above 1,000V – Part 2: Ceramic or Glass insulator units for a.c systems – Definitions, test methods, and acceptance criteria.
IEC 60437	Radio interference test on High-Voltage insulators.
IEC 61211	Insulators for Overhead Lines with nominal voltage above 1,000V – Impulse puncture test in air.

12.7.9 Design Overview

The mechanical design of the busbar and conductor system shall be verified by calculation, and where necessary by test, by considering the limit states at which the components become unfit for their intended use.

The cross-sectional area of the conductors and tubes shall be chosen according to the electrical and mechanical requirements and shall be proposed by the Contractor and approved by the Engineer. The minimum factor of safety for busbars or other connections based on elastic limit shall be 2.5.

Only one size of cross-section area for each of the conductor and tubes shall be used for the phase conductors.

12.7.10 Technical Requirements

12.7.11 Connectors

The connectors and clamps shall be made of aluminium alloy casting, conforming to relevant IEC standards. The design of clamps shall be such as to minimise the number of parts and the possibility of incorrect assembly or installation. The need for special tools for installation or

removal of clamps shall be avoided if possible but where required they shall be submitted to the Engineer for assessment and approval.

The connectors and clamps shall be of such design that water or moisture cannot accumulate in the clamp.

All connectors joining dissimilar metals must be of the bimetallic friction-welded type or approved equivalent to prevent galvanic corrosion

All bolts, nuts and washers shall be of mild steel and shall be hot dip galvanised.

All castings shall be free from blowholes, surface blisters, cracks and cavities. All sharp edges and corners shall be burred and rounded off.

The bore of each connector clamp shall be of the correct diameter to suit the conductor size specified with required tightness.

The connection section shall be such that the contact surfaces are sealed from atmosphere and are not subjected to moisture and/ or weathering.

The connectors, clamps and accessories shall be such that the contact pressure is uniformly distributed over the entire contact surface and no stress concentration develops anywhere.

Suspension and tension clamps shall be designed to avoid any possibility of damage or deformation of the stranded conductor and separation of the individual strands and also prevent any damage to the equipment being connected.

All current carrying parts shall have minimum contact resistance.

All clamps and connectors used shall be certified corona free. For 175 kV and higher voltages, the maximum angle of angled clamps shall be no more than 45°.

12.7.12 Insulators and Fittings

12.7.13 Porcelain insulators

The string insulator units shall be of the ball and socket type.

The type of insulator and the characteristics of the discs and the number of discs per string shall be chosen according to the electrical and mechanical requirements and shall be proposed in the Tender.

Each insulator shall be marked with the initials or trademark of the manufacturer and with the guaranteed electro-mechanical strength. All markings shall be plainly legible and durable.

The insulators shall be free of laminations, cavities or other flaws affecting the mechanical and electrical strength, and shall be well vitrified, tough, and impervious to moisture.

The metal parts shall be designed to transmit the mechanical stresses to the porcelain by compression and to develop maximum and uniform mechanical strength of the insulator.

Socket and pin shall be of such design that they will not yield or distort under the specified mechanical loading in such a manner as to add undue stresses to the porcelain shells.

In general, the contours of the metal and porcelain parts shall be such as to eliminate areas or points of high electrical flux concentration.

All surfaces of metal parts shall be smooth with no projecting points or irregularities.

All ferrous material which is not made of stainless steel shall be hot-dip galvanised in accordance with the General Technical Specification.

The post insulators shall be dimensioned in accordance with IEC 60273. They shall comprise fully interchangeable units of either the pedestal or solid core cylindrical type and shall be designed so that they can be used either upright or inverted.

Minimum factors of safety shall be:

For complete insulators based on electro-mechanical failing load test (IEC 60383): 2.5;

For insulator metal fittings based on elastic limit: 2.5.

12.7.14 Electrical Design

The electrical characteristics of insulators shall be as stated in the Technical data sheets.

The total creepage distance and the protected creepage distance over the external surface of the insulators shall be as stated in the data sheet. The protected creepage distance refers to that part of the insulator which is protected against rain at right angles to the axis of the insulator. For insulators comprising standard units, the above requirements shall, unless otherwise specified, be met by the addition of approved number of additional units to the normal assembly.

If stated in the Technical data sheets insulators and accessories shall be designed with corona rings and/or arching horns so that, when installed, no visible corona discharges appear at the system voltage specified.

12.7.15 Mechanical Design

The strength of all insulators shall be such that, when supporting the maximum working load the factor of safety shall not be less than 2.5.

The insulators shall be secured in an approved manner with suitable clamping plates. They shall not engage directly with metal but shall be mounted with suitable interposing materials. All joint surfaces of porcelain shall be accurately ground. Where cement is used as a fixing medium, the method and materials used shall be approved by the Engineer.

The design shall be such that stresses due to expansion and contraction in any part of the insulator and fittings shall not lead to the development of defects.

The design of all insulators shall be such as to permit easy cleaning.

12.7.16 String Insulators

Suspension and tension insulators shall consist of a string of porcelain units with ball and socket fittings. Tension insulators shall consist of single strings unless otherwise specified.

Ball and socket connections shall be provided with cotter pins, which effectively lock the connection against accidental uncoupling without detracting from its flexibility. The cotter pin shall be of stainless steel or bronze.

The socket shall be galvanised malleable cast iron or ductile cast iron and the pin of galvanised steel.

The insulator sets shall be formed that under any condition, the retaining pin or locking device shall not allow separation of the insulator units or fittings. Their design shall be such as to allow for easy removal or replacement of insulator units or fittings without removal of the insulator sets from the structures. Retaining pins or locking devices when in position shall be incapable of rotation.

12.7.17 Post type Insulators

The post insulators shall be dimensioned in accordance with IEC 60273 and as specified in the data sheet.

Subunits of 132 kV and higher post insulators shall be interchangeable. Post insulators shall be sufficiently strong enough to withstand all shocks and jolts that may be met in operation. Post type insulators of uniform composition shall be of either the pedestal or solid core cylindrical type and designed so that they can be used for either upright mounting or under hung.

12.7.18 Suspension and Tension Clamps and Fittings

Clamps shall be as light as possible. Clamps shall be designed to avoid any possibility of deforming the stranded conductor and separating the individual strands.

Tension conductor clamps shall not permit slipping of, or damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate strength of the conductor.

Suspension clamps shall be free to move in the horizontal plane, and shall permit the complete conductor to slip before failure of the latter occurs. The mouth of the supporting groove shall be slightly flared in plan. The grooves in the clamping piece or pieces shall be bell-mouthed at each end. All conductor grooves and bell-mouths shall after galvanising, be smooth and free from waves, ridges or other irregularities.

Bolted type tension clamps shall be made smooth at the mouth, as specified for suspension clamps, and the above specified requirements for the conductor grooves shall be observed where applicable.

In clamps in which the conductor might be cut, approved means shall be taken to treat the cut ends of the conductors to prevent ingress of air or moisture. The mechanical efficiency of such clamps shall not be affected by methods of erection involving the use of “come along” or similar erection clamps before, during, or after assembly and erection of the clamp itself.

Clamps and fittings made of steel or malleable iron shall be galvanised. All bolts and nuts shall be locked with hump backed split pins. All bolt threads shall be greased before erection.

All humped back split pins for securing the attachment of fittings of insulator sets shall be of stainless steel and shall be backed by washers of approved size and thickness.

The factor of safety of the fittings when supporting the maximum working load shall not be less than 2.5 based on the elastic limit of the material.

12.7.19 Tests

All tests shall be carried out in accordance with relevant IEC standards. The Employer / his authorised representative reserve the right to witness the tests.

12.7.20 Routine / Acceptance Tests

The Contractor shall submit four copies of routine / acceptance test certificates, duly signed by the witnessing authority.

12.7.21 Type Tests

Type tests shall be performed on conductors, tubes, and connectors in order to demonstrate normal continuous current capability, short time withstand current capability and maximum radio interference voltage.

Tests of mechanical performance shall be undertaken which are representative of the intended application. The test arrangement shall be configured, as far as reasonably practicable, to expose the test sample(s) to load combinations that would be experienced in service.

The insulators, post, string or longrod, will be tested according to their relevant IEC specification. Test certificates indicating compliance with the IEC standards, from a recognised testing authority, must be submitted with the offer.

The Contractor shall furnish type test certificates during the Procurement Document process for the tests conducted on an item of identical design.

12.8 Technical Specification for Outdoor Circuit Breakers

12.8.1 General

The circuit breakers and accessories shall conform to IEC 62271-100, IEC 62271-1 and other relevant IEC standards except to the extent explicitly modified in the specification.

The circuit breakers used shall be only sulphur hexafluoride (SF6) type.

The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, interpole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform.

All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.

The support structure of circuit breaker as well as that of control cabinet shall be hot dip galvanized.

12.8.2 Introduction

This specification covers the technical requirements of design, materials, manufacture, performance requirements, testing at the Vendors works, installation and commissioning of high voltage, three- and single-phase, SF6 insulated alternating current Circuit Breakers for rated voltages from 66 kV to 400 kV. The specific requirements are covered in the Technical Schedules.

12.8.3 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in the table below.

Table 12-5: Circuit Breaker Standards

IEC 60071-1	Insulation coordination
IEC 62271-1	High voltage switchgear and controlgear - Common specifications
IEC 62271-100	High-voltage switchgear and controlgear - Alternating current circuit breakers
IEC 62271-110	High-voltage switchgear and controlgear - Part 110: Inductive load switching
IEC 62271-310	High-voltage switchgear and controlgear - Part 310: Electrical endurance testing for circuit-breakers above a rated voltage of 52 kV
IEC 60529	Classification of degree of protection provided by enclosures
IEC 60376	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment
IEC TS 60815-1, -2, and -3.	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The circuit breaker supplied shall satisfy all applicable statutes, regulations and safety codes of Local Statutory Authorities.

12.8.4 Technical Details

12.8.5 Specific Requirement

The single-phase circuit breakers shall be of the outdoor, single pressure SF6 type.

The outdoor breakers shall be mounted on steel structures.

The circuit breakers shall be suitable and completely equipped for single pole and three-pole rapid auto-reclosing.

The breakers shall be capable of handling the following operation cycle, according to the IEC recommendations:

O-t-CO-t'-CO $t = 0.3 \text{ sec}$ $t' = 15\text{s}$ for 330kV Circuit Breakers

The total breaking time (opening time plus duration of the arc) of the breakers shall be as short as possible, but in no case is it to be longer than 45 msec.

A system for continuously monitoring the gas density shall be provided. At a certain low density, a signal shall be given to indicate that refilling should take place. At the extreme low density, the circuit breaker should be automatically blocked against operation.

SF6 gas refilling equipment mounted on a trolley shall be provided for the substation.

The circuit breakers shall be provided with means to prevent contact pumping while the closing circuit remains energised should the circuit breaker either fail to latch or be tripped during closing due to the operation of the protective relays.

Each individual single pole of the 330 kV circuit breaker shall be provided with its own independent operating mechanism. Breakers for 132 kV and below may have one operating mechanism common to all three poles. Pneumatic operating mechanism is not accepted.

The mechanism shall be provided for electrical local and remote control.

The opening device shall be provided with two independent trip coils, which are to be fed from separate DC sources and connected to separate terminal blocks in the terminal cubicle, allowing for the connection of two independent opening command circuits.

A local position indicator, visible with the panel door closed, shall be mounted in the front panel of the operating mechanism cubicle.

A crank, lever or other similar suitable device shall be provided to permit charging the operation mechanism by hand in the event of a failure of the auxiliary supplies or in the event of a failure of the energy-storing device.

The stored energy shall for all types of operating mechanisms be sufficient to allow a complete O-C-O cycle. All circuit breakers shall be able to perform an O - CO switching cycle when the auxiliary voltage is lost. The rupturing capacity of the circuit breakers after unsuccessful auto-reclosing should not fall below the required minimum breaking capacity.

It shall be possible to determine the available operating energy stored by the mechanism prior to operating the circuit breaker. An alarm shall be given in the event of the stored energy falling below a minimum rated level.

If the stored operating energy is below a minimum rated level in one or more of the mechanisms, tripping, closing and auto- reclosing shall be blocked in all phases.

The complete operating mechanism, including the controls, shall be built in water-tight and dust-proof cubicles. All parts shall be easily accessible without dismantling other parts. Openings, covered with dust filters, shall allow a good ventilation of these cubicles. In order to avoid any moisture, hygostat-controlled heaters for 220 V AC shall be built-in. Push buttons for operating the breaker shall be located not more than 1.6 m above ground.

A local /off/remote control selector switch shall be provided in the cubicle. With the selector switch set to local control, operation from any remote source including the protective relays shall be inhibited. The switch shall have spare contacts for remote operation.

A sufficient number of DC auxiliary contacts, with at least 10 NO and 10 NC contacts for usage by the client. The contacts must be rated for 110 V DC for control and interlock purposes.

Motors shall be designed in accordance with valid IEC publication and shall be effectively protected by miniature circuit breakers, with alarm contacts.

All wiring shall lead to terminals. 20% of the terminals shall be spare.

12.8.6 Auxiliary Power Supply

Auxiliary electrical equipment shall be suitable for operation on the following supply system:

Table 12-6: Circuit breaker Auxiliaries

Power devices (like drive motors etc.)	110 V DC
AC control and protective devices like lighting fixtures, space heaters, HP Motor etc.	230 V AC, 1 Phase, 2wire 50 Hz AC supply with one lead grounded

12.8.7 Duty Requirements

The circuit breaker shall be re-strike free as per IEC under all duty conditions and shall be capable of performing its duties without opening resistors.

The breaker shall be capable of interrupting the steady state and transient magnetizing currents corresponding to power transformers.

The circuit breaker shall also be capable of clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

The circuit breaker shall satisfactorily withstand the high stresses imposed on it during fault clearing, load rejection and re-energisation of lines with trapped charges and be able to breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

12.8.8 Total Break Time

The total break time as specified under this Section shall not be exceeded under any of the following duties:

Test duties 1, 2, 3, 4, 5 (TRV as per IEC 62271-100/-1/-110);

Short line fault L75, L90.

The total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%), and arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, it shall be required to specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

The values guaranteed shall be supported with the type test reports.

12.8.9 Constructional Features

The gap between the open contacts shall be such that it can withstand continuously the rated phase to ground voltage at zero-gauge pressure of SF₆ gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously).

If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/test reports in support of the same shall be furnished. The thermal and voltage withstand of the grading elements shall be adequate for the service conditions and duty specified.

The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF₆ gas on the internal insulating surfaces of the circuit breaker.

All gasket surfaces shall be smooth, straight, and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF₆ media) shall have adequate seals. The SF₆ gas leakage should not exceed 1% per year. In case the leakage under the specified conditions is found to be greater than 1% after one year of commissioning of circuit breaker, the Supplier will have to replace the circuit breaker for one that fulfills the requirement.

In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as fully compatible with SF6 gas decomposition products.

Each pole shall form an enclosure filled with SF6 gas independent of two other poles, the SF6 density of each pole shall be monitored.

The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale, and it shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non-return valve coupling.

Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

Sufficient SF6 gas including that which will be required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition, separate cylinders shall be supplied as spare requirement.

Provisions shall be made for attaching an operational analyser after installation of circuit breakers at site to record contact travel, speed and making measurement of operating timings, pre-insertion timings of closing resistors if used, synchronisation of contacts in one pole. In case operation analyser is already available at a particular site, the Supplier shall have to supply a suitable adopter/transducer so that the offered circuit breaker can be used with the operational analyser.

12.8.10 Sulphur Hexafluoride (SF6) Gas

The SF6 gas shall comply with IEC 60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under the operating conditions.

The high-pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.

Test:

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides, and water content as per IEC 376, 376A and 376B and test certificates shall be furnished to the Engineer indicating all the tests as per IEC 376 for each lot of SF6 gas. Gas bottles shall be tested for leakage at site.

12.8.10.1SF6-Monitoring

The breaker shall be provided with a two-stage gas monitoring system. The first stage shall give an alarm while the second stage shall block the circuit breaker in the position in which the circuit breaker was at the moment when the gas pressure decreased below the level in question. All devices required for fail-safe operating during conditions of low gas pressure shall be provided.

The circuit breaker shall be designed on the puffer principle; i.e. the complete installation shall employ the single-pressure principle or an equivalent design. Replenishing of gas shall be possible while the circuit breaker is in service. Couplings for SF₆ gas filling shall be of self-sealing type preferably of Dilo.

12.8.11 Insulators

The insulators shall be of porcelain type.

The mechanical characteristics of insulators shall match with the requirements specified under this Chapter.

All insulators shall conform to IEC-61264 (for pressurised hollow column insulators). All routine and sample tests shall be conducted on the hollow column insulators as per these standards with requirements and procedures modified as under:

Pressure test as a routine test;

Bending load test as a routine test;

Bending load test as a sample test on each lot;

Burst pressure test as a sample test on each lot;

In addition to above, ultrasonic test shall be carried out as additional routine test.

Hollow porcelain for pressurised columns/chambers shall be in one integral piece in green and fired stage.

12.8.12 Operating Mechanism and Control

12.8.12.1 General Requirements

The Circuit Breaker shall be operated by spring charged mechanism. The mechanism shall be housed in a weatherproof and dust-proof control cabinet (IP 56).

The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance, for a man standing on ground.

The mechanism shall be anti-pumping and trip-free (as per IEC definition) under every method of closing.

The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

A mechanical indicator shall be provided to show open and close positions of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

Working parts of the mechanism shall be corrosion resistant and bearings that require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.

The Contractor shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions. The manual shall be written in the English language and where it is in any other language, a complete written translation into the English language shall be provided.

12.8.12.2 Control

The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

Each breaker pole shall be provided with two (2) independent tripping circuits, pressures switches and coils each connected to a different set of protective relays.

The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose, a local/off/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker central control cabinet

The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels

Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage.

However, even at 50% of rated voltage the breaker shall be able to operate. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules.

Density meter contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used, then fail-safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit breaker.

The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

12.8.12.3 Spring operated mechanism

Spring operated mechanism shall be complete with motor. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

Breaker operation shall be independent of the motor, which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 30 seconds for full charging of the closing spring.

Closing action of circuit breaker shall compress the opening spring ready for tripping.

When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote-control cabinet.

Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.

Potential free contacts for the spring charged and spring discharged feedback shall be provided. These potential free contacts shall be utilized for electrical interlocking so as to prevent closure of the circuit breaker when the spring is discharged.

The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

12.8.13 Support Structure

The structure design shall be such that during operation of circuit breaker, vibrations are reduced to minimum. If required, the Supplier shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility for monitoring the density/pressure of gas. The design of the platform must be approved by the Engineer prior to construction.

12.8.14 Terminal Connector Pad

The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium. The terminal pad shall have protective covers, which shall be removed before interconnections.

12.8.15 Interpole Cabling

The following shall be applicable:

All cables shall be armoured and shall be as per IS - 1554 (1100 Volts Grade). All cables within and between circuit breaker poles shall be supplied as part of the Project.

Only stranded conductor shall be used. Minimum size of the conductor shall be 2.5sq. mm. (Copper).

The cables shall be with oxygen index Min-29 and temperature index as 250°C as per relevant standards.

12.8.16 Fittings and Accessories

Following is a partial list of some of the major fittings and accessories to be supplied by Contractor in the Central Control cabinet:

Cable glands (Double compression type), Lugs, Ferrules etc;

Local/remote changeover switch;

Operation counter;

Pressure gauges;

Control switches to cut off control power supply;

Fuses as required;

The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use;

Anti-pumping relay;

Pole discrepancy relay;

DC Supervision relays;

Rating and diagram plate in accordance with IEC incorporating year of manufacture.

12.8.17 Document deliverables

Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position;

The temperature v/s pressure curves for each setting of density monitor along with details of density monitor;

Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site;

Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks;

The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time;

Sectional view of non-return couplings if used for SF6 pipes;

Details & type of filters used in interrupter assembly and also the operating experience with such filters;

Details of SF6 gas;

The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content;

Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas;

The precise procedure to be adopted by maintenance personnel for handling equipment who are exposed to the products of arcing in SF6 gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, methods of disposal of circuit breaker cleaning utensils and other relevant matters;

A complete catalogue on operation analyser satisfying all the requirements of this Chapter;

Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic/hydraulic pressure;

All duty requirements as applicable to CBs specified in this section shall be provided with the support of adequate test reports to be;

Field test report or laboratory test report in case of CB meant for reactor switching duty.

12.8.18 Recommended Spare Parts and Maintenance Equipment

The Contractor shall include under this project, spare parts and maintenance equipment. The calibration certificates of each maintenance equipment shall be supplied along with the equipment.

12.8.19 Tests and Commissioning

The circuit breaker along with its operating mechanism should have been successfully type tested as per IEC-56.

The test reports of the type tests and the following additional type tests shall also be submitted for the Engineer's review.

Corona extinction voltage test (as per Annexure-A of Chapter I.);

Out of phase closing test as per IEC-267 & IEC 62271-100/-1/-110;

Line charging breaking current;

Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure;

Seismic withstand test in unpressurised condition.

12.8.20 Type Tests

The Contractor shall furnish type test certificates along with the bid for the tests conducted on circuit breakers of identical design.

12.8.21 Routine Tests

Routine tests as per IEC 62271-100/-1/-110 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic/hydraulic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyser along with necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser exists, the Employer shall utilise the same. However necessary adopter and transducers etc. if required shall have to be supplied by the Contractor;

Measurement of Dynamic Contact Resistance for arcing and main contacts. Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts;

Measurement of trip and close coil current signatures shall be taken as reference for commissioning comparison and future maintenance.

12.8.22 Site Acceptance Tests (SAT)

All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site.

12.8.23 Factory Acceptance Tests (FAT)

The factory acceptance tests shall include, but not be limited to, the following.

Insulation resistance of each pole;

Check adjustments, if any suggested by manufacturer;

Breaker closing and opening time;

Slow and Power closing operation and opening;

Trip free and anti-pumping operation;

Minimum pick up voltage of coils;

Dynamic Contact resistance measurement;

Functional checking of SF6 plant and all accessories;

Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation;

Insulation resistance of control circuits, motor etc.;

Resistance of closing and tripping coils;

SF6 gas leakage check;

Dew Point Measurement;

Calibration of pressure switches and gas density monitor;

Checking of mechanical 'CLOSE' interlock, wherever applicable.

Pole discrepancy

12.9 Technical Specification for Outdoor Disconnectors

12.9.1 General Requirements

Live parts shall be designed as far as possible to eliminate sharp points, edges and other corona producing surfaces. The minimum clearances between the phases and between phase and the earthed parts shall be as specified in the data sheet.

Bolts, screws, and pins shall be provided with lock washer, keys or equivalent facilities and shall be manufactured from an approved material.

Factory adjustment shall be so made on each single pole so that field adjustments will not be required on the disconnector mechanism. When inter phase connections on the disconnector are installed in the field, all primary phase contacts shall make and break simultaneously.

Disconnectors shall be capable of withstanding the dynamic and thermal effects of the possible maximum short circuit current of the system in their closed position.

Disconnectors shall be constructed such that they cannot be dislodged or malfunction from their open or closed positions by gravity, wind pressure, vibrations, shocks, or accidental touching or snapping of the ganged connecting pipes attached to the operating mechanism and will not malfunction under influence of short circuit.

All disconnecter bases, operating mechanisms, phase coupling rods, bolts, pins, and other steel parts shall be hot dip galvanised as per ISO 1461 and technical schedules.

12.9.2 Quality Assurance Plan and Inspection

A quality plan shall be submitted for approval. As a part of the plan the schedule for inspection shall also be furnished.

12.9.3 Drawings

The Contractor shall furnish the following detailed dimensioned drawings to the Engineer for his approval:

Complete assembly drawing showing the plan and elevation views;

General arrangement of disconnecter, showing positions of Main Blades in open condition;

Wiring diagram;

Details of interlocking arrangement;

Details of operating mechanism box and operating handles;

Details of jaws and terminal ends;

Details of control box;

Details of auxiliary switches;

Manufacturing schedule and test schedule;

Structural support steel, including weights and all fixing details; and

Foundation drawing.

12.9.4 Manuals

The Contractor along with the despatch of equipment shall submit copies of the Commissioning Instructions, Operation and Maintenance manual.

12.9.5 Scope

This specification covers the technical requirements of design, materials, manufacture, performance requirements, testing at the Vendor's works, installation and commissioning of high voltage, three-phase, air-insulated alternating current disconnectors.

12.9.6 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with the standards listed in the table below.

Table 12-7: Disconnectors standards

IEC 60071-1	Insulation coordination
IEC 60071-2	Insulation coordination
IEC 62271-1	High voltage switchgear and controlgear - Common specifications
IEC 62271-102	High-voltage switchgear and controlgear - Alternating current disconnectors and earthing switches
IEC 60273	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60529	Classification of degree of protection provided by enclosures
IEC 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The disconnector supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

12.9.7 Technical Details

12.9.8 Constructional Features

The 330, 132 and 66kV disconnectors shall be of the conventional stand-alone AIS centre-break type, outdoor, gang operated, operating in the horizontal plane.

The disconnector shall be supplied complete with structural support steel and mounting bases, insulators, primary contacts, operating blades, auxiliary contacts in cable termination box, operating mechanism etc. Single-phase switches shall be mechanically interconnected to constitute one three-phase. Each pole unit of the disconnector shall be of identical construction.

The disconnecter shall be mechanically dimensioned to safely withstand the effects of temperature, wind load, tensile forces, and impact of blades, as well as short circuit forces.

The disconnecter blades and all conducting parts shall be manufactured from high conductivity copper or aluminium alloy. The design shall be such that no lubrication of any part is required at frequent intervals. All bearings shall be manufactured such that no lubrication or maintenance is required.

The main blades of all disconnectors shall have adequate strength and current carrying capacity conforming to the maximum rating. The disconnecter blade shall be so assembled that no part of the blade can move relative to the other.

All similar parts shall be interchangeable.

The disconnecter switch shall be completed with all parts that are necessary or essential for efficient & safe operation. These parts shall be deemed to be within the scope of supply, whether specifically mentioned or not.

The requisite clearance from live parts to plinth shall be considered while manufacturing of disconnectors and to decide location of operating mechanism box.

12.9.9 Contacts

The disconnecter shall be provided with high current carrying contacts, conforming to the maximum rating, on the hinge and jaw ends and all contact surfaces shall be of silver faced copper with a minimum thickness to be approved by the Engineer. The contact pressure shall be ensured by means of springs.

The current path shall not be through any springs or movable pin connection. The contact arrangement shall be designed to be adjustable, self-aligning high-pressure type. All contacts assemblies shall be easily removed and replaceable on site by an experienced person. The springs provided should not go out of alignment or get entangled with the male contact during operation. The details of springs shall be furnished on the G.A. drawing.

The moving contacts shall be capable of withstanding the highest short circuit current during service shall not lose their characteristics due to heating effect. The surface of the contacts shall be smooth, and silver plated, with the required thickness of silver plating.

12.9.10 Insulators

The porcelain insulators shall be of a solid core type. Porcelain used for the manufacture of insulators shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly

vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown colour, free from blisters, burns and other defects.

The insulators shall have creepage distances as specified in the data sheet. The porcelain and metal parts shall be assembled in such a manner that any thermal expansion difference between the metal and the porcelain part throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high-grade cast steel or malleable steel castings and shall be machine faced smoothly and galvanised.

In the event of insulators being chipped or damaged during installation, this shall be reported to the Engineer.

12.9.11 Operating Mechanism

Each three-phase disconnecter shall be equipped with its own operating mechanism suitable for manual and electrical operation of the disconnecter.

The operating mechanism for the disconnecter switches shall be provided for local and remote electrical operation. In the case of a complete failure of the operating mechanism, operation shall be possible by means of a lever or crank or another manual device. A local isolating fuse-switch unit for disconnection of power supply, a local/remote selector switch and a set of open/close push buttons shall be provided in the operating mechanism box for power operated disconnectors.

The disconnecter operating mechanism shall be so designed and fabricated that it will not cause excessive deflection to the operating arms to which it is attached. All disconnectors shall be self-locking in the open and closed positions independent of the control shaft restraint.

The height of the handle above the plinth shall be 1000 mm. The manual operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided, if necessary. Where a disconnecter is required to be connected to high level buses, the operating rod shall be provided with guide bearings at an interval of 3 metres. All members necessary for attaching the operating mechanism and operating handles to the supporting structure and foundations shall be supplied as an integral part of the disconnecter. Rust-proof pins and bearings of the bronze bushing, ball, and roller type, shall be furnished. All bearings shall be weather protected by means of covers and grease retainers.

Each operational function shall be indicated by means of a mechanical indicator showing the opening/closing status of the blade.

The operating mechanism shall be provided with sufficient adjustment to allow for final alignment of the disconnecter blades for simultaneous operation.

Springs shall be provided for counter-balancing the disconnectors to prevent impact at the end of travel both on opening and closing of the disconnector switch **where applicable**.

The disconnector shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for disconnector closing. They shall also be capable of withstanding all tensional and bending stresses due to the operation of disconnector.

It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced sufficiently at any point in the travel to allow improper functioning of the disconnector when the disconnector is opened or closed at any speed. All holes in cranks or linkages etc, having pins shall be drilled to accurately fit so as to maintain the minimum amount of slack and lost motion in the entire mechanism.

Motor operated mechanisms, if called for in the data sheet, shall be suitable for operational use with the voltage indicated and duty cycles as required for the disconnector. It shall be suitable for remote control and complete with motor starter, necessary contactor gear, position indicator etc.

A weatherproof stainless steel or cast aluminium cabinet, complete with hinged lockable doors, seals and padlock facility shall be provided to house the driving mechanism, motor starters, control valve solenoids, auxiliary switches etc., as applicable. The cabinets shall be designed and manufactured in accordance with the relevant enclosure ratings included in the technical data sheets. Consideration must be given to the omission of sand, dust, weather, and vermin proofing, but must allow for good ventilation of the cubicles. All enclosures and control cabinets shall have a degree of protection of IP56.

Hygostat controlled heaters shall be provided for each cubicle in order to prevent any moisture by condensation.

Suitable starters shall be provided for control of the motor.

Suitable reduction gearing shall be provided between the motor and the drive shaft of the disconnector. A quick acting electro-mechanical brake shall be fitted on the higher speed shaft to effect rapid braking.

Limit switches for motor control shall be fitted on the disconnector shaft, within the cabinet, to monitor the open and close positions of the disconnector.

12.9.12 Interlocking

Disconnectors shall be provided with padlocking facility to lock them in fully open or fully closed positions. Padlocks with three (3) keys shall be supplied with the disconnector.

All electrical interlocks shall function as to interrupt the supply to the operating circuits of the motorised mechanism. An approved system of interlock shall be provided between electrical and manual operation of disconnector. Failure of supply or connection to any electrical interlocking shall not produce or permit faulty operation. The interlocking gear shall operate satisfactorily between the specified ranges of rated auxiliary supply voltage.

Main switches of disconnectors shall be interlocked both mechanically and electrically with the corresponding feeder circuit breaker.

12.9.13 Auxiliary Switches

Each disconnector shall be provided with a mechanically driven auxiliary switch with all necessary contacts for control, indication and interlocking purposes.

All connections from the auxiliary switches shall be brought out to a terminal block housed in the mechanism box.

It shall be possible to change normally open contacts into normally closed contacts and vice-versa on site if required as well as the type, i.e. late or early make and break or transient operation.

Mechanically coupled auxiliary contacts shall not slip during the operation of the disconnector.

12.9.14 Nameplate

A weather-proof and corrosion-proof name plate shall be provided for each disconnector operating device. The name plates shall conform to applicable standards. The nameplates must be approved by the Engineer prior to manufacturing.

The nameplate shall be permanently fixed in position where a person with normal vision standing at ground level could easily read it. The nameplates shall contain the following necessary information as a minimum (or more where IEC standard definition overrides this requirement):

Order number;

Name and logo of the manufacturer;

Manufacturer's type designation;

Serial number and the rated characteristics; and

Year of manufacture.

If the switchgear and control-gear consist of several independent poles, each pole shall be provided with a nameplate. All the letters and figures on the nameplates shall be permanently marked. The nameplates shall be securely fastened to the equipment in a reliable manner, and the method of fastening shall be stated at the time of tendering.

The technical quantities and their symbols (which shall be displayed on the rating plate) shall be in accordance with IEC recommendations, and shall include the following as a minimum:

Rated voltage;

Rated lightning impulse withstand voltage;

Rated switching impulse withstand voltage;

Rated power-frequency withstand voltage;

Rated normal current;

Rated short-time withstand current and duration;

Rated peak withstand current;

Rated short-circuit making current;

Rated frequency;

Rated supply (auxiliary) voltage;

Contract number;

Standard to which tested (IEC, BSI, SANS, etc.);

Actual ratings to which the disconnector has been type-tested (and not merely the values specified in the Technical data sheet) shall be displayed. Labels associated with local operation of the switches shall be in English and shall provide the instructions for opening and closing the disconnector. Additional information required to perform any functions shall be referred to the Engineer.

Rating label inside the operating mechanism shall state at least the following:

Type designation; and

Motor voltage and current (starting peak current and nominal running current).

These shall be the nominal values (with tolerances) according to the routine test parameters. Rating labels shall be either engraved aluminium or stainless steel and are subject to approval by the Engineer.

12.9.15 Supporting Structures

Supporting structures for disconnectors shall be included in the Contractor's scope of supply.

12.9.16 Performance Requirements

The disconnector shall be self-cleaning so that when it is left in the closed position for long periods of time, binding does not occur. It shall be designed to operate satisfactorily even after being kept in one position for long periods.

The main disconnectors shall be capable of breaking the magnetising current of the associated power transformer.

12.9.17 Temperature Rise

The fixed and moving contacts shall be able to carry the rated current continuously without any appreciable rise in temperature.

The temperature rise of any part of the disconnector and associated equipment shall not exceed the maximum permissible temperature rise values as stipulated in the applicable standard of latest issue corresponding to design ambient temperature. The temperature rises of contacts due to the flow of rated short circuit current for the specified period shall not cause any annealing or welding of the contacts.

12.9.18 Testing and Commissioning

All tests shall be carried out in accordance with relevant IEC standards. The Employer / his authorised representative reserves the right to witness the tests.

12.9.19 Routine / Acceptance Tests

The Contractor shall submit copies of routine / acceptance test certificates duly signed by the witnessing authority.

12.9.20 Type Tests

The Contractor shall furnish type test certificates during the PD process for the tests conducted on disconnectors of identical design.

12.10 Technical Specification for Outdoor Disconnectors with Earth Switch

12.10.1 General Requirements

All requirements of Technical Specification for Outdoor Disconnectors are valid, with additional requirements related to the earth switch.

Disconnectors and earth switches shall be capable of withstanding the dynamic and thermal effects of the possible maximum short circuit current of the system in their closed position.

Earth switches shall have purposely made padlocking arrangement in both “Earth Switch Open” and “Earth Switch Closed” positions.

12.15.1.6 Drawings

The Contractor shall furnish the following detailed dimensioned drawings to the Engineer for his approval:

Complete assembly drawing showing the plan and elevation views;

General arrangement of disconnector/earth switch, showing positions of Main Blades and Earth Blade in open condition;

Wiring diagram;

Details of interlocking arrangement;

Details of operating mechanism box and operating handles;

Details of jaws and terminal ends;

Details of control box;

Details of auxiliary switches;

Manufacturing schedule and test schedule;

Structural support steel, including weights and all fixing details; and

Foundation drawing.

12.15.1.7 Manuals

The Contractor along with the despatch of equipment shall submit copies of the Commissioning Instructions, Operation and Maintenance manual.

12.15.1.8 Technical Details**12.15.1.9 Earth Switch**

Earthing switches, whenever specified in the technical data sheets, shall form an integral part of each pole of the disconnecter.

Short time current withstand capacity of earthing blades of Earthing switch shall be same as that of the main blades of Disconnector. The material of the blades of the Earthing switch shall be same as that of main blades of Disconnector. Each earthing blade shall be provided with flexible copper connections of adequate length and adequate cross-sectional area for connection between the operating shaft and the base frame. These copper connections shall have the same short time current carrying capacity as the earth blade.

Disconnector design shall be such as to permit addition of earth switches at a future date.

12.15.1.10 Operating Mechanism

Each three-phase earth switch shall be equipped with its own operating mechanism suitable for manual operation only.

The height of the handle above the plinth shall be 1000 mm. The manual operating handles shall be mounted on the base of supporting structure. Guide bearings shall be provided, if necessary. Rust-proof pins and bearings of the bronze bushing, ball, and roller type, shall be furnished. All bearings shall be weather protected by means of covers and grease retainers.

Each operational function shall be indicated by means of a mechanical indicator showing the opening/closing status of the blade.

The operating mechanism shall be provided with sufficient adjustment to allow for final alignment of the earth switch blades for simultaneous operation.

The operating pipes and rods shall be sufficiently rigid to maintain positive control under most adverse conditions and when operated in tension or compression for disconnector closing. They shall also be capable of withstanding all tensional and bending stresses due to the operation of earth switch.

It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced sufficiently at any point in the travel to allow improper functioning of the earth switch when the earth switch is opened or closed at any speed. All holes in cranks or linkages etc, having pins shall be drilled to accurately fit so as to maintain the minimum amount of slack and lost motion in the entire mechanism.

A weatherproof stainless steel or cast aluminium cabinet, complete with hinged lockable doors, seals and padlock facility shall be provided to house the mechanism and auxiliary contacts etc., as applicable. The cabinets shall be designed and manufactured in accordance with the relevant enclosure ratings included in the technical data sheets. Consideration must be given to the omission of sand, dust, weather and vermin proofing, but must allow for good ventilation of the cubicles.

Hygostat controlled heaters shall be provided for each cubicle in order to prevent any moisture by condensation.

12.15.1.11 Interlocking

For disconnect and earth switches, interlocking shall be provided between main disconnect and earth switch so that the earthing switch cannot be closed unless the disconnection switch is open. All interlocks shall be designed to prevent mal-operation. This may be achieved by means of mechanical interlocking etc.

Disconnectors and earthing switches shall be provided with padlocking facility to lock them in fully open or fully closed positions. Padlocks with three (3) keys shall be supplied with the disconnector/earth switch.

Earth switches shall be interlocked with the corresponding feeder equipment both mechanically and electrically.

12.15.1.12 Auxiliary Switches

Each disconnector shall be provided with a mechanically driven auxiliary switch with all necessary contacts for control, indication and interlocking purposes.

All connections from the auxiliary switches shall be brought out to a terminal block housed in the mechanism box.

It shall be possible to change normally open contacts into normally closed contacts and vice-versa on site if required as well as the type, i.e. late or early make and break or transient operation.

Mechanically coupled auxiliary contacts shall not slip during the operation of the earth switch.

12.15.1.13 Temperature Rise

The fixed and moving contacts shall be able to carry the rated current continuously without any appreciable rise in temperature.

The temperature rise of any part of the earth switch and associated equipment shall not exceed the maximum permissible temperature rise values as stipulated in the applicable

standard of latest issue corresponding to design ambient temperature. The temperature rises of contacts due to the flow of rated earth fault current for the specified period shall not cause any annealing or welding of the contacts.

12.15.1.14 Testing and Commissioning

All tests shall be carried out in accordance with relevant IEC standards. The Employer / his authorised representative reserves the right to witness the tests.

12.15.1.15 Routine / Acceptance Tests

The Contractor shall submit copies of routine / acceptance test certificates duly signed by the witnessing authority.

12.15.1.16 Factory Acceptance Tests (FAT)

The factory acceptance tests shall include, but not be limited to, the following;

- Withstand voltage test of axilliary and control circuits
- Insulation distance between phases
- Minimum electrical safety clearance to ground
- Mechanical operation tests
- Measurement of resistance of main circuit.

12.15.1.17 Type Tests

The Contractor shall furnish type test certificates during the PD process for the tests conducted on earth switches of identical design.

12.11 Technical Specification for Current and Voltage Transformers

12.11.1 General Requirements

The transformers shall be supplied complete with a weather-proof secondary terminal box. The substation yard marshalling boxes will be used for the interface point of the cabling between the instrument transformers and the control room. Facilities are to be provided within the yard marshalling box for the shorting and earthing of the current transformer secondary wiring and MCB’s for voltage transformers.

Terminals and polarity markings shall be clearly and indelibly marked on each current transformer at the associated terminals and the identification markings shall be in accordance with relevant standards.

Each transformer shall be provided with a rating plate showing the technical particulars as required by the relevant standard.

12.11.2 Introduction

This specification covers the technical requirements of design, manufacture, testing, supply to site, installation and commissioning of instrument transformers complete with all accessories for efficient and trouble-free operation. The instrument transformers shall be single-phase units as specified in the relevant data sheets, of the conventional stand-alone air-insulated (AIS) type. The specific requirements are covered in the technical data sheet.

12.11.3 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in section 1.5 and 12.2

In case of any conflict between the standards and this specification, this specification shall govern. The Instrument Transformers supplied shall satisfy all the requirements of Local Statutory authorities.

12.11.4 Design Overview

A standard transmission class multi-core, multi-ratio CT shall be used for all bay applications. All other CT applications and configurations are detailed in the technical data sheets.

12.11.5 Current Transformer

The thermal capability of the CT shall, per IEC 61869-2, be 120%.

12.11.6 Technical Details**12.11.7 Current Transformer (CT)**

CTs shall be oil immersed type.

Oil-insulated current transformers shall be equipped with an oil level gauge to be easily readable by a man standing on the ground. The current transformer oil shall be of the same type as for the power transformers. The oil of the current transformer shall be hermetically sealed against the ambient air. In order to compensate for fluctuations of the oil volume owing to temperature changes, flexible metal bellows or oil-resistant rubber covers shall be provided. The Contractor shall submit a description of the sealing method for review and acceptance before procuring the CT.

Current Transformers must have a minimum of seven (07) core for normal feeder protection and a minimum of five (05) cores for shunt reactors.

- Two (02) cores shall be dedicated to the dual protection relays (class PX).

- Two (02) cores shall be dedicated to BCU, main and check metering (class 0.2S) for feeders and one metering core for shunt reactors.
- One (01) core shall be dedicated to the busbar protection (class PX).
- One (01) core shall be dedicated to a non-unit protection relay.
- One (01) core shall be used as spare (class PX).
- Each core must be multi-ratio to facilitate standardization.

All secondary connections shall be connected to a terminal block, which shall be located in a dust-proof and watertight terminal box and shall be clearly labelled. An earth connection to the housing shall be provided.

The rated secondary outputs of the current transformers for measuring and protection purposes shall be determined according to the technical requirements but shall not be less than 125% of the overall computed (design) load of the connected apparatus including cables.

Earthing of secondary windings shall be done through a disconnectable terminal inside the low-voltage cabinet. Unused cores, if any, shall be wired to terminals and short-circuited in the low-voltage cabinet.

A legible circuit-diagram plate showing the transformer connection and terminal markings, shall be permanently fixed inside the low-voltage cabinet. The separate main data for the different cores shall be shown on the plate.

In the case of multi-core current transformers, it shall be possible to adjust the tap settings on any core independent of the settings on the other cores, for which purpose these tapings will have to be provided on the secondary windings.

Current transformers shall have a good transient response as specified in the relevant standards.

12.11.8 Capacitor Voltage Transformers (CVT) and Voltage Transformers (VT)

The CVTs and VTs (if applicable) shall be complete in all respects and shall conform to the modern practices of design and manufacture.

The CVTs and VTs shall be the outdoor, single pole, oil filled or self-cooled dry synthetic resin type, with silicone or porcelain bushings and associated sheds, suitable for a 50Hz power supply and operational use under the service conditions as specified.

A dedicated secondary core shall be provided for tariff metering (class 0.2S) as per the existing scheme. Measurements for SCADA can be shared with the class 0.2S, class 0.5/3P and class 3P cores and can be reported from either the protection IEDs or the BCU.

The CVTs and VTs shall be suitable for vertical mounting on steel structures, unless integral to compact (“live-tank” or “dead-tank”) GIS/AIS units and where applicable, shall preferably be suitable for horizontal transportation.

The CVTs and VTs shall be supplied complete with primary connection silver plated terminals where applicable to stand-alone AIS units, suitable weatherproof secondary terminal boxes, lifting lugs, grounding terminals, oil level sight glass, filling and draining plugs and name plate. All primary and secondary connections shall be clearly marked.

In the CVT (if applicable), the capacitor divider shall consist of primary and secondary capacitance. A dedicated class 0.5/3P secondary core shall be provided for protection relays (class 3P)-each feeder will be equipped with a Main “1” and Main “2” relay, the CVT supply to each relay will be provided with its own MCB. A class 3P core connected in star configuration shall also be provided this replaces the open-delta configuration in the existing arrangements. The secondaries shall be provided with miniature circuit breakers with alarm contacts. Each secondary winding shall be protected with individual MCB's mounted in the Marshalling box. To prevent false operation of relay protection, interlock system etc. a supervision device for the MCB's shall be provided.

For the Nakonde’s (132)66 kV system, the 132 kV switchgear will be charged with 66 kV initially. Voltage transformers/CVTs associated with the 132 kV yard shall be suitable for 66 kV initial energization and shall be interconnectable between 132/ $\sqrt{3}$ kV and 66/ $\sqrt{3}$ kV (phase-to-ground), unless otherwise specified.

12.11.9 General

All steel terminal boxes shall be finished hot-dip galvanized or be made of stainless steel. All terminals shall be clearly marked with identification number.

The earthing point on the instrument transformer tanks shall be provided each with two boltholes, which are to be used for the securing of the earthing conductor. Earthing of secondary windings shall be done through a disconnectable terminal inside the low-voltage cabinet. Earthing of the cores and the neutrals shall be done on the transformers and not on the terminal boxes.

12.11.10 Quality Assurance Plan and Inspection

Quality assurance plans, which shall include the testing procedure and the pass/fail criteria, shall be submitted for approval. As a part of the plan the scheduled date for factory inspection shall also be included.

12.11.11 Compliance with Specification

If the technical requirements are not met or the performance of the equipment during testing does not meet the guarantees stated in the technical particulars, the Employer shall have the right to reject the faulty component/equipment and the Contractor has to replace with the same equipment to comply fully with the specification, at no additional cost to the Employer.

12.11.12 Drawings

The following drawings shall be submitted for the Engineer's approval.

General arrangement of current transformer, capacitor voltage transformer/voltage transformer;

Magnetising characteristics for all current transformers;

Secondary terminal box arrangement;

Manufacturing schedule and test schedule;

Test certificates inclusive of type tests;

Nameplate diagram;

Instruction manual;

Structural steel supports;

Civil foundation drawing.

12.11.13 Manuals

The Contractor along with the despatch of equipment shall submit copies of the commissioning Instructions, operation, and maintenance manuals.

12.11.14 Testing and Commissioning

All tests shall be carried out in accordance with IEC 61869-5 standard. The Employer / his authorised representative reserves the right to witness the factory acceptance and site acceptance tests.

12.11.15 Factory Acceptance Tests

The Contractor shall submit copies of the Factory Acceptance test certificates duly signed by the witnessing ZESCO and Engineer's authorized personnel, for review and acceptance before dispatch of the equipment.

All instrument transformer ratios and windings shall be completely tested to prove compliance as specified in IEC 61869.

For each type of instrument transformer, thermal rating shall be proven under witness of the Employer and the Engineer during the FAT.

The factory acceptance tests for CVTs shall include, but not be limited to, the following:

- Capacitor-voltage divider test
- Power frequency withstand tests
- Partial discharge measurement test
- Capacitor-voltage divider test (after withstand voltage test)
- Measurement of capacitance and dielectric dissipation factor

The factory acceptance tests for CTs shall include, but not be limited to, the following:

- Insulation resistance test
- Measurement of direct current resistance
- Power frequency withstand tests on primary and secondary windings
- Power frequency withstand tests
- Measurement of capacitance and dielectric dissipation factor
- Partial discharge measurement test
- Excitation curve test
- Oil dielectric strength
- Inter-turn overvoltage test

12.11.16 Type Tests

The Contractor shall furnish type test certificates during the PD process for the tests conducted on instrument transformers of identical design.

12.12 Technical Specifications for Power Transformers 330/(132)66/11kV

The transformer shall constitute complete, independent unit with coolers, auxiliaries, accessories and spare parts. The supply shall include transport to the Site, erection and performance of test and commissioning of all delivered items.

The main power transformers shall be interconnectable between 330/132/11 and 330/66/11 kV by an easily accessible external change over switch.

- (a) The secondary winding shall comprise two identical halves connected in parallel for 66 kV and in series for 132 kV;
- (b) Reconnection shall be off-load via external change over switch;
- (c) FAT routine tests (ratio, losses, impedance, dielectric) shall be in both configurations;
- (d) Secondary winding and bushing insulation shall be rated for 132 kV BIL;

The Contractor shall be responsible for providing oil treatment device for necessary oil treatment before commissioning. Spare parts shall be included as listed under Spares and Tools section.

The power transformer shall incorporate and include the following:

- a. access ladder,
- b. Communication from the on line monitoring system and the DGA devices (The system shall be provided with the relevant software, which will be integrated in the overall SCMS using a protocol according to standards like IEC 60870, IEC 61850 or DNP 3.0 The system will have to allow the methods of following access.
 - i. direct access by RS232/485 port
 - ii. access by a commuted line to an optional modem by means of a phone line or of a mobile telephone network connection of communication using protocols corresponding to the standards of the industry and via footbridges to pass on the information to systems SCMS access via an internet connection or a router (route planner) / firewall to a waiter (server) of PC on internet.

12.12.1 Rating and design data of power transformers

The design data is specified in Scope of Works and Technical Schedules.

Table 12-8: Design specifications for Transformer

Specification	Guaranteed data	Unit
Rated power	90/90/10	MVA
Nominal primary voltage	330	kV

Specification	Guaranteed data	Unit
Nominal secondary voltage	interconnectable between 132 and 66	kV
Nominal tertiary voltage	11	kV
Highest system voltage	362/145/12	kV
Vector group	YNyn0+d1	
Cooling	ONAN/ONAF	
Power at ONAN, minimum of rated power	75	%
Colour	RAL7032 (Grey)	
Description	oil filled	
Type	Power transformer	
Type test	Authority, year, Doc.no	
Standards	IEC60076	
Transformer Class	Outdoor	
Single or three phase units	three phase	
Type of core	grain oriented silicon steel	
Type of tank	upper flange	
Tank fully vacuum proof	Yes	
Specification of oil (general)	IEC 60296, class II	
Oil corrosive sulfur free	Yes	
Oil PCB free (certification to be provided)	Yes	
Tap changer	On-load	
Tap changer make	MR Germany or comparable vacuum type	
Standard	IEC60214-1	
Tapping range	+10 / -15	%
Step range	1.25	%each
OLTC drive	Motor drive 3-ph 380- 415 VAC	
Operation contact life at rated through current	>300000	Nos.
Mechanical tap position indicator	Yes	
Impedance voltage at rated power, primary/secondary	14	%
Impedance voltage at rated power, primary/tertiary	24	%

Specification	Guaranteed data	Unit
Impedance voltage at rated power, secondary/tertiary	8	%
Zero sequence impedance at principal tapping	166 (shorted secondary)	Ω /phase
Temperature rise oil/top, maximum	60	K
Temperature rise winding, average, resistance method	65	K
Temperature rise winding, hot spot, resistance method	78	K
Bushing type	Porcelain	
Continuous overload for bushings	20	%
Minimum creepage distance (USCD)	53.7	mm/kV
Neutral bushing fully insulated at nominal voltage	Yes	
Neutral current transformer cores	1 x 5P20 1 x class X	
Insulation levels (prim/sec/tert) (not corrected for altitude):		
- Power frequency withstand voltage (phase and neutral)	570/275/28	kV
HV - neutral	85	kV
MV - neutral	140	kV
- Lightning impulse level (lines and neutral)	1300/650/95	kV
HV - neutral	185	kV
MV - neutral	325	kV
Tests:		
Routine tests according to IEC 60076	on each unit	
Type tests according to IEC 60076	on one unit	
All special tests according to IEC 60076	on one unit	
Auxiliary power, control	110	V DC
Auxiliary power, tap changer motor	3ph 400	V AC
Auxiliary power, heater	230	V AC
Noise level, Guarantee	<78	dB(A)

The transformer shall be capable of operating continuously at the specified outputs and at highest voltage for equipment at any tap. All goods delivered shall be in conformity with the standards but not limited to the following.

Table 12-9: Transformer Standards

IEC 60076-1	Power transformers - General
IEC 60076-2	Power transformers - Temperature rise

IEC 60076-3	Power transformers - Insulation levels, dielectric tests and external clearances in air.

IEC 60076-5	Power transformers - Ability to withstand short circuit.
IEC 60076-7	Loading guide for oil-immersed power transformers
IEC 60076-8	Power transformers – Application guide (For calculation format)
IEC 60076-10	Power transformers - Determination of sound levels.
IEC 60137	Insulated bushings for alternating voltages above 1000 V.
IEC 60214	On-load tap-changers.
IEC 60529	Degrees of protection provided by enclosures
NEMA TR1	Transformers, regulators and reactors [for audible sound levels]

12.12.2 Losses

The losses at rated data shall be those stated and guaranteed in the Technical Schedules.

These guarantees shall be interpreted as maximum values and shall not be exceeded.

During evaluation, transformer losses will be capitalized as follows:

Capitalization of transformer losses/ Evaluated price of Transformer Losses:

$N \times a + L \times b = \text{Evaluated Price of Transformer Losses}$

N = No load loss (core-loss) at rated voltage in kW.

L = Load loss (copper-loss plus auxiliary power losses) at 75 °C, 50 Hz maximum continuous rating in kW.

a = Cost/kW of no-load losses (core-losses) valued at USD 12,000/kW.

b = Cost/kW of load-losses (copper-losses plus auxiliary power losses) valued at USD 7,000/kW.

Evaluated Bid Cost = Bid Price of Transformer + Evaluated Price of Transformer Losses

The evaluated cost of the transformer shall be multiplied by the total number of transformers to arrive at the total evaluated cost.

The total capitalized cost of the losses will be added to the cost of transformers for comparing bids.

Any adjustment in cost that results from the procedure above shall be added to the bid price for the purpose of comparative evaluation only, to arrive at an "evaluated bid price". Bid prices quoted by Bidders shall remain unaltered.

If the bidder proposes transformers from more than one manufacturer, the values obtained from the manufacturer with the highest guaranteed/offered no-load and load losses (in kW) will be used for the capitalization of the transformers.

12.12.3 Parallel operation

The Transformers shall be equipped for operation in parallel with other transformers.

12.12.4 Short circuit withstand capability

The transformer shall be designed and constructed to withstand, at any tap, without damages, the thermal and mechanical effects of any short circuit (three-phase short circuits and solid line-to-ground short circuits, etc.) that can appear at the terminal of any winding.

The short circuit levels of the transformer are stated in The Technical Schedules. The asymmetrical peak value of the short circuit current in the windings shall be taken as not less than 2.5 times the over-current r.m.s. value derived for the appropriate short circuits specified above.

12.12.5 Overload

All items other than the windings, for example the on-load tap changers and the bushings, shall be designed for a continuous current of at least 120 % of the rated current, without exceeding the temperature rises prescribed in the relevant Standards. The overloading capacity of the complete transformer shall be according to IEC standard.

12.12.6 Frequency

The normal frequency will be 50 cycles per second. However, the transformer shall be suitable for continuous operation with frequency variation of plus or minus 2.5 per cent from the normal, without exceeding the temperature rise limit specified in the Technical Schedules.

12.12.7 Winding connections

The connection symbols shall be YNyn0+d1 as shown in the Technical Schedules.

The neutrals of the windings shall be brought out and earthed as stated in Technical Schedules.

12.12.8 On-load tap changer

On-load tap changer shall be provided on the HV winding. Tap changer of make MR-Germany or equivalent meeting IEC 60214 requirements is preferred. The OLTC control shall take into account of STATCOM voltage regulation without violating voltage control requirements. The short circuit impedance, number of taps, voltage per tap and the monitoring and control

designs and configurations shall be suitable for parallel operation of transformers. The details of the parallel operation regimes are given under the AVR section of the scope.

12.12.9 Voltage range

The voltage range for which the taps are to be designed, are specified in Technical Schedules and under the section - **Rating and design data of power transformers**. The tap power shall be equal to the rated power at power factor in the range 0.7-1 for connections on all taps and for power flow in both directions.

12.12.10 Current rating

The rated through-current of the tap changer shall comply with IEC 60214 standard.

12.12.11 Main contacts

The contacts for making and/or breaking the main contacts for making and breaking current shall use vacuum interrupter technology in accordance with IEC 60214-1. The main contacts shall be vacuum interrupters enclosed in hermetically sealed ceramic or glass envelopes within the diverter switch. The diverter switch shall be housed in a separate oil-filled compartment to provide insulation and cooling. This compartment shall be provided with valves for filling and emptying the oil as well as an oil level indicator, with alarm contacts.

If contacts other than those for making and breaking current are enclosed in separate compartments, these compartments shall be connected to a conservator through a gas and oil-actuated relay. The conservator shall be fitted with oil gauge and silica gel breather.

The design of the tap changers shall allow for easy inspection and repair.

12.12.12 Mechanism

The on-load tap changer shall be provided with a mechanism for both manual and electrical operation. When manual operation is selected, the electrical operation shall be blocked.

The operation mechanism shall be mounted in a cabinet supported by the main tank or its base, degree of protection IP56, with provision for pad-lock.

The motor shall operate on 3-phase 380-415V AC. The motor and auxiliary control supply shall be supervised. Alarm and blocking of parallel tap changer operation shall be made in case of supply failure.

A mechanical stop shall be provided to prevent over-running of the mechanism. Limit switches shall operate in the circuit of the operating motor or, alternatively, if an approved mechanical declutching mechanism is incorporated, in the control circuit.

The mechanism shall be provided with equipment for indicating the tap changer position by a mechanical indicator and a contact for each position to be used for indication in the control room.

A counter indicating the number of operations shall also be included. The mechanism shall be provided with a contact closed during operation, by which an alarm can be given at the remote-control point at incomplete or too slow operation and a tripping of the transformer circuit breakers if desirable. Modern systems that utilizes digital protocols (IEC 61850) for remote tap indications shall be included.

12.12.13 Control and operation

Electrical operation shall be performed locally from a cabinet mounted on the transformer, and remotely from the control board. Selection of local and remote control shall be made with a switch in the cabinet and also from the Automatic Voltage Regulating relay.

The on-load tap changer shall be designed for step-by-step operation, i.e. the impulse from the control switch shall cause one tap movement only and a new impulse shall be necessary for another movement. Once the impulse has been initiated, the operating mechanism shall complete the step by itself, independent of the length of the starting impulse. In the event of a power failure on either the drive motor or the control voltage, a change cycle already initiated must be in compliance with IEC 60214-1 through the completion of tap change after restoration of supply.

All relays, switches and fuses, thermal devices and associated items., necessary for local operation of the tap changer shall be mounted in the cabinet. The cabinet shall be vermin-proof (Degree of Protection IP56). The cabinet shall be placed at convenient height and it shall contain terminals for all incoming and outgoing cables.

All wiring shall enter the cabinet from the bottom through flanges provided with glands for each separate cable. Terminal blocks shall be in compliance with IEC 61439 for wiring and terminal arrangements.

12.12.14 Remote control apparatus

The following equipment , mounted in the control room, shall be included and have provision for SCADA integration and digital communication (IEC 61850 or Modbus):

- Raise/lower control switch,

- Tap position indicator,
- Tap changer in process indicator,
- Tap changer supply indicator,
- Motor MCB trip supervision,
- Automatic voltage regulator,
- Parallel operation control unit - compliant with IEC 60214-2 for automatic voltage control,
- Selector switch Manual-Automatic,
- Selector switch Master-Follower.

12.12.15 Cooling system

12.12.16 Cooling

The transformers shall be equipped with a self-cooled/ forced air-cooled type of cooling (ONAN/ ONAF). Unless specified otherwise in the Technical Data Sheets, the self-cooled capacity (ONAN) shall be at least 75 % of the forced-cooled rating (ONAF).

12.12.17 Fire Suppression Equipment

All line and neutral reactors shall be fitted with inbuilt active SERGI 3000 Fire suppression system or equivalent and to Engineer's approval.

12.12.18 Design

The cooling equipment shall be supplied complete with the following items:

At least two groups of detachable groups of radiators, equipped with lifting eyes, vent holes with plugs, plugs for filling and draining and with shut-off valves to permit the removal of any cooler without draining the oil from the transformer tank. Accumulation of air in the radiator heads must be avoided. The radiators shall be of the DIN type or equivalent, hot-dip galvanized provided with at least six cooling channels in each radiator fin. The radiators fins shall be welded with approved stiffening rods (horizontally and diagonally) to prevent vibration during operation of the transformers. The radiators shall be fully vacuum proof and pressure tested and shall be liquid tight.

The radiators shall be connected to the tank or external headers by butterfly valves in such a manner that each radiator can be removed without taking the transformer out of service, and without draining any oil from the tank and/ or common headers (if any). The lower radiator headers shall be connected to the transformer tank or common headers in an easily accessible height above floor level. The radiators shall be accessible for cleaning, to prevent accumulation of water on outer surfaces and to ensure against the formation of gas pockets during filling.

All butterfly valves shall be arranged in a vertical position and in such a manner that their position indications are clearly and freely visible and legible directly from tank cover and from ground level. Valve position indicators must not be arranged underneath the flange of the tank cover.

Where applicable, the following accessories shall be provided:

- 1 (one) butterfly valve each for inlet and outlet for each radiator, directly accessible from ground level and tank cover
- (two) isolation valves for connecting of each common header (if any) with the transformer tank and/ or cover
- 1 (one) drain plug (M12) with screwed cap at the outlets of each lower common header (min. two lower common headers, if provided) suitable for temporary installation of temperature sensors directly in the oil-flow during heat-run tests (subject to approval)
- 1 (one) air vent plug (M12) with screwed cap at the inlets of each upper common header (min. two upper common headers, if provided) suitable for temporary installation of temperature sensors directly in the oil-flow during heat-run tests (subject to approval)
- 1 (one) drain plug for each radiator at the outlet of each radiator suit-able for temporary installation of temperature sensors directly in the oil-flow during heat-run tests in case of radiators directly flanged onto the tank (subject to approval)
- Additional air vent plugs and drain plugs on common headers, if required
- 1 (one) air vent plugs each at the inlet of each radiator header suitable for temporary installation of temperature sensors directly in the oil-flow during heat-run tests in case of radiators directly flanged onto the tank.

12.12.19 ONAF Cooling

The ONAF cooling shall be provided by fan units mounted on the sides of the radiators. Minimum 2 (two) spare fans wired up to the starter units) shall be included. The fans shall operate on 400/230 V AC.

The fan units shall be fitted in an accessible position in a height of not less than 100 cm onto suitable non-corrosive steel structure/ framework, which shall be bolted rigidly onto the radiator groups (subject to approval). The fan units attached to radiator groups shall be mounted in a height not exceeding 1.4 m above floor level.

The fan units shall be preferably arranged in such a manner as not to protrude beyond the fins of one radiator. In no cases fan units shall protrude beyond the fins of one pair of radiators, and the overall diameter of the fan units shall not exceed 90 cm. Over-lapped arrangement of the fans with any fan(s) of other radiators must be avoided.

Each fan unit shall be individually removable without dismantling of any structure/ framework and without having to interfere with the operation of other fans. No fan units shall be attached to radiators arranged underneath the air-filled cable boxes, unless explicitly approved otherwise in exceptional cases.

The propellers shall be made of seawater proof aluminium alloy or stainless steel. Propellers made of any kind of plastics are not acceptable. Mechanical protection against touching of the fan blades shall be provided by round-wire mesh guards of stainless steel on both sides of the fan blades.

The fan motors shall be arranged underneath the fan blades and shall be accessible without removing of the guard. A nameplate made of stainless steel of top quality for each fan motor shall be provided clearly visible and legible on the outer housing of each fan unit at an accessible position.

Starting from the hot condition (100 % load at rated excitation) the transformer shall be capable of remaining in operation without exceeding hot spot temperature (windings) of 125°C at specified maximum ambient temperature after failure of forced cooling for not less than 60 minutes after outage of all forced cooling.

The control equipment for the cooling plant and all auxiliary devices shall be accommodated in a weatherproof cabinet (protection class IP56) mounted onto the transformer.

ONAN/ONAF

Where mixed cooling is specified, the natural (ONAN) rating shall generally not be less than 75% of the total specified forced-cooling capacity, unless otherwise specified.

The forced-cooling equipment shall be designed to operate automatically from winding-temperature relay control at predetermined temperatures recommended by the Contractor. The equipment shall be designed to start in two stages at pre-set temperatures.

Fans

All fans shall operate as a unit. Fan blades and fan ducting shall be of aluminium alloy, stainless steel, galvanised steel, or other corrosion-resistant metal and shall be designed to keep noise

and vibration to a minimum. All fans shall be provided with galvanised wire-mesh guards. It shall be possible to remove fan assemblies complete without dismantling other equipment.

Motors

All motors shall comply with IEC 60034 and dimensions with IEC 60072. They shall be capable of operating continuously under actual service conditions without exceeding the specified temperature rises, determined by resistance, at any frequency between 48 and 51 Hertz together with any voltage between ± 5 percent of the nominal value.

All motors shall be totally enclosed, and if situated in the open they shall be weatherproof and suitable for outdoor operation. They shall be provided with a suitable means of drainage to prevent accumulation of water due to condensation and with suitable means of breathing.

Motors operating in an ambient temperature not exceeding 40°C shall have Class 'E' insulation or better, but where the ambient temperature may exceed this figure or where the motor may be appreciably affected by conducted heat, Class 'B' insulation or better shall be used.

All motors shall be suitable for direct starting at full voltage as well as 10% over voltage.

Motors shall have sealed ball or roller bearings.

Motors shall be provided with starters, overload protection (three-phase where applicable) and in the case of three-phase motor, single-phasing protection. They shall be provided with manual push button start/stop in addition to the automatic start/stop from the winding temperature indicator.

Cooler Control Equipment

All the necessary automatic control, motor contactors, protective devices and switches for the forced-cooling equipment shall be assembled in a dust-proof, weatherproof and vermin-

proof cubicle. This cubicle shall be arranged for separate floor mounting in the proximity of the reactor. Hinged door(s) for front and rear access, handle(s), locking facilities, separately fused 220-volt single-phase heater and switch, and separately fused lamp with door switch shall be provided.

The cooler control equipment shall include:

An isolating switch rated to carry and break full-load current for each group of fan and pump motors.

A "Cooler Auto" - "Cooler-Manual" changeover switch.

Magnetic contactor for each group of fan motors. Contactor coil leads shall be wired to the terminal board. A set of normally closed contacts shall be wired to the terminal board. A set of normally closed contacts shall be provided on each motor contactor for alarm purposes.

Overload and single-phasing relays.

Fuses, links and terminal boards to approval to make a complete assembly.

12.12.20 Control of Cooling Units

The electrical supply for the control of the cooling units shall be provided by means of load-break switches with a rated current of at least 40 A, installed in the fan control cabinet and/or marshalling box as specified below. Circuit breakers shall be installed for manual switching of each cooling group. Fuses will not be accepted.

The fan motors or groups of motors shall be automatically controlled by a relay combination taking into consideration the winding and oil temperature. The criteria for automatic "on/ off" switching operations shall be the winding temperature (ON) and the oil temperature (OFF), respectively. Control shall be such that frequent start/ stop operation for small temperature differences must be avoided. A time delay relay shall be provided to prevent switching "off" the fans for at least five minutes after starting of the same.

WTI or OTI gauges shall have multiple contacts for cooler control, alarm and trip operation.

The fan motors shall be connected to the starting contactors by two groups. The first group shall come into operation at lower temperature (i.e. at 65°C hot spot temperature) and the second group at higher temperature (i.e. at 75°C hot spot temperature).

The control shall be such that, if the first group fails to come into operation on winding temperature reaching the set value on the contacts of winding temperature indicator, the second group when it comes into operation, consequently to winding temperature reaching higher set value, shall bring the first group of fans also into operation.

The fan groups shall not switch "off" on winding temperature falling to values set on winding temperature indicator for switching "on" of the groups, but they shall switch "off" when the top oil temperature falls below set values to switch "off" the groups. That is, the starting impulse for both the groups shall be given by the winding temperature indicators and stopping impulse by the contacts of the top oil temperature indicator (i.e. group 2 at 60°C and group 1 at 50°C oil temperature).

A group alarm shall be initiated if any fan fails; however, switching off of any further motor of the same group must be avoided.

The following alarm initiating devices having N.O. contacts shall be provided:

- Auxiliary supply failure,
- Cooling fan's failure for each fan group.

The following signal initiating devices having N.O. contacts shall be included:

- Cooling fans start for each fan group,
- Cooling system on automatic control,
- Cooling system on manual control.

12.12.21 Windings

Windings shall be of best modern design with conductors having constant cross-section along the whole windings. Electrolytic copper of a high conductivity and insulation material of high quality shall be used. The turns in coils shall be thoroughly treated to develop the full mechanical and electrical strength of the transformer and to get the highest through-fault capability.

The insulation material of windings and connections shall be free from insulation compounds subject to softening, shrinking or collapsing during service. Moreover, none of the material used shall disintegrate, carbonise or become brittle under the action of hot oil, under all specified load conditions.

The coils must be capable of withstanding movement and distortion caused by all operating conditions as specified in IEC 60076. Adequate barriers shall be provided between windings and core and between the windings. All leads or bars from the windings to the terminal boxes and bushings shall be rigidly supported. Stresses on coils and connections must be avoided.

All transformer windings for LI: 350 kV/ AC: 140 kV and below shall have uniform insulation. Transformer windings designed for higher insulation levels may have non-uniform insulation. In these cases, the rated AC insulation level for neutral points shall be at least 95 kV.

12.12.22 Core

12.12.23 Design

The core shall be made of high grade, non-ageing, cold rolled grain-oriented silicon steel with low losses and high permeability. Insulated packets of the core are to be connected so that no potential difference will exist between them. Flux distortion shall be minimized to reduce noise level.

Lifting lugs or other similar means shall be provided for conveniently lifting the complete assembly, with the windings. Provision shall be made for efficient arrangement of guides to prevent movement of the core and the windings during transport, installation or service.

The laminations shall be properly coated and annealed to reduce the losses to a minimum and to ensure sheets free from internal stresses. The cores shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength to support the windings and to reduce vibration to a minimum under operating conditions. The cores, framework, clamping arrangements, shall be capable of withstanding any shocks to which the equipment may be subjected.

The magnetic circuit shall be designed to avoid the production of flux components at right angles to the plane of laminations, which may cause excessive local heating. The core clamping arrangement and framework shall be efficiently insulated from the cores and the top main core clamping structure shall not be connected to the tank cover. The core shall be designed and built up to avoid accidental or slow development of short circuit paths through the iron and the framework.

Suitable axial cooling ducts shall be provided to ensure free circulation of oil and efficient cooling of the core.

The framework of the core shall be designed to prevent formation of oil pockets, which would prevent complete emptying of the oil from the tank through the drain valve.

12.12.24 Earthing

The magnetic core shall be earthed to the tank cover at one point only through removable links in an appropriate terminal box, placed in an accessible position on the tank cover and which, by disconnection, will enable to test the insulation between the core and transformer tank, applying 2.5 kV, 50 Hz during 1 minute.

12.12.25 Tank**12.12.26 Design**

The transformer tank shall be of the upper flange type with bolted on reinforced cover, and the complete transformer tank shall have rectangular shape.

The completely assembled tank shall be fully vacuum proof. The construction shall be of mild steel and shall be of sufficient strength and rigidity to withstand moving, shipping and handling without any de-formation. All seams and joints shall be welded both inside and outside to secure strong, leak-proof joints.

Tank stiffeners shall be provided as required, and these shall be designed to avoid water penetration.

The tank bottom shall be of one plane and shall be a heavy rigid base structure. The four tank walls shall be plane and of one piece each and shall be welded directly onto the tank bottom without steps and without any additional welded and/ or bolted flanges.

Special measures shall be taken to reduce the effects of stray flux resulting both from high current-carrying conductors and leakage flux with non-magnetic steel applied as necessary.

Double welding shall be provided where oil tightness is required. Prior to painting, all surfaces shall be thoroughly cleaned and shot-blasted to remove rust and mill scale.

The complete tank and its cover shall be designed in such a manner as to leave no external pockets in which water can accumulate, no internal pockets in which oil can remain when draining the tank and/ or in which air can be trapped when filling the tank.

Wherever possible, the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent any gas into the main expansion pipe.

Vent pipes shall have minimum inside diameter of 25 mm. Both ends of the tank cover shall be connected to the main expansion pipe.

12.12.27 Tightness test

After manufacturing, the transformer tank and oil conservator shall be tested for oil tightness by being completely filled with oil and subjected to overpressure of an oil column of twice the tank height and/ or exceeding 25 % over the maximum operating pressure, resulting from the system of oil preservation used (whatever is higher). This pressure shall be kept for a period of 24h.

12.12.28 Jacking, lifting and pulling

Plates for jacks shall be mounted under or at the sides of the tank, e.g. designed as consoles. The jack plates shall be reliably marked.

The tank shall be equipped with lifting devices such as eyes or hooks for lifting the transformer completely assembled and filled with oil and for lifting the core and coil assembly alone.

Where rails are provided, the supply shall also include one set of rollers for the transformer, capable to support the total weight of the transformer filled with oil and for longitudinal and lateral travel on rails. A set of supports for the transformer to be mounted instead of the rollers, after erection, shall also be supplied. The drilling plan for fixing the supports shall be the same as for the rollers. The tank shall be equipped with pulling eyes, for pulling in four perpendicular directions.

12.12.29 Centre of gravity

The centre of gravity both with and without oil shall be permanently marked on adjacent sides of the transformer.

12.12.30 Grounding terminals

Two grounding terminals shall be provided diagonally at the bottom of the tank, to suit for connection of earth wire with a cross-sectional area of at least 70 mm².

12.12.31 Valves

The transformer tank shall be equipped with the following valves (for filling and draining the oil, etc) and fittings:

- A drain valve suitably placed with screwed cap so that the tank can be completely drained from oil.
- Oil sampling valves accessible from ground level, one at the top of the main tank, one at the bottom of the main tank and one at the Buchholz relay
- Two diagonally placed valves (one at the top and the other at the bottom) with screwed caps for direct connection to an oil treatment plant.

The function and the operation position of all valves shall be clearly indicated.

12.12.32 Manholes

Power transformers shall be equipped with manholes and hand-holes of suitable size, subject to approval to facilitate installation and maintenance (i.e. tap changers, current transformers, bushings etc.). Manholes for tap changers shall have size of minimum 800 mm in height and 350 mm in width and shall be arranged in a convenient floor height (subject to approval). All openings in the cover of the transformer tank for bushings, manholes and terminal boxes shall be provided with adequate flanges. Covers for inspection openings, hand-holes etc. located on the tankcover shall be provided with adequate gas stoppers. All inspection covers etc. shall be provided with two lifting handles each.

12.12.33 Flanges

All joints in piping are to be flanged with smooth sealing surfaces. All connections bolted to the tank shall be fitted with suitable gas and oil resistant gaskets made of such a material that no serious deterioration occurs under service conditions. All gaskets shall be of closed design (without open ends) and shall be of one piece only. Rubber gaskets used for flange connections of the various oil compartments shall be laid in grooves or in groove-equivalent retainers on both sides of the gaskets throughout their total length. Care shall be taken to secure uniformly distributed mechanical pressure over the gaskets and retainers throughout the total length.

12.12.34 Thermometer pockets

The tankcover shall be provided with pockets for the hereinafter-stated thermometers, as well as with two extra pockets for control thermometers with a diameter of minimum 20 mm and a length of minimum 200 mm, with inwardly threaded openings closed by plugs.

12.12.35 Oil conservator

The transformer shall be provided with a conservator complete with all accessories, with a capacity of not less than 12 % of the total cold oil volume in the transformer.

The conservator shall preferably be of the diaphragm-sealed type, complete with necessary fittings. Breathing of the oil shall be made through the diaphragm to avoid any contact between the oil and the external air.

The drain valve shall be suitably placed so that the conservator can be completely drained when mounted as in service.

The conservator tank shall have a separate section for the on-load tap changer.

Each conservator vessel shall be equipped with one magnetic type oil level indicator with adjustable alarm contacts for min. and max. oil level, drainage valves and filter valves and suitable access to the interior of the conservator tank.

12.12.36 Oil

The transformer shall be filled at the Contractor's expense with mineral oil. The oil shall contain the inhibitor d-isobutyl-paracresol to the extent of at least 0.25 % by weight. It shall be acid-refined and pre-treated and shall have properties complying with IEC 60296 - class II. The oil shall be free from PCB.

Transformer Oil should comply as minimum to the applicable requirements of the following IEC Standards :

- IEC 60296 Specification for unused mineral insulating oils for transformers and switchgear
- IEC 60567 Guide for sampling of gases and oil from oil-filled electrical equipment and for the analysis of free and dissolved gases
- IEC 61181 Mineral oil-filled electrical equipment - Application of dissolved gas analysis (DGA) to factory tests on electrical equipment
- IEC 62535 Insulating liquids - Test method for detection of potentially corrosive sulphur in used and unused insulating oil

12.12.37 Online Dissolved Gas Analysis Monitoring System

The bidder shall supply, install and commission a Kelman Online Dissolved Gas Analysis (DGA) System or equivalent capable of continuous, real-time monitoring of transformer oil conditions. The system must utilize gas chromatography (GC) or equivalent advanced detection technology to accurately measure key gases, including H₂, CH₄, C₂H₂, C₂H₄, C₂H₆, CO, CO₂, O₂, and N₂, with detection limits complying with IEC 60567 and IEEE C57.104 standards. The system must feature automatic sampling, self-calibration, and fault diagnostics, with data accessible via a web-based interface supporting remote monitoring through Modbus, IEC 61850, or equivalent protocols. Additionally, it should integrate with existing SCADA/EMS systems and include cybersecurity protections for data integrity.

The system must operate on a 110-240V AC, 50Hz power supply with battery/UPS backup for uninterrupted operation. The supplier shall provide on-site installation, functional testing, and calibration by certified engineers, along with comprehensive operator training.

Compliance with IEC 60599, IEEE C57.104, and ISO 9001 is mandatory, and the system must carry CE, UL, or equivalent certification. Required documentation includes user manuals, calibration certificates, test reports statements. Bids must include detailed technical specifications, proof of compliance, delivery schedule, and cost breakdown.

12.12.38 Bushings

Winding leads shall be brought out through bushings. All bushings shall be so designed that there will be no excessive stressing of any parts due to temperature changes and adequate means shall be provided to accommodate conductor expansion.

The bushings shall be so installed that they are easy to check and remove without removing the tank cover and the pipework. High voltage (330 kV, and 132kV) bushings shall have capacitive taps for tan delta test. The low voltage (11kV) bushings shall be of condenser type (porcelain) bushing.

12.12.39 Insulation level

The insulation levels for bushings shall be at a voltage level higher than those specified for the windings.

12.12.40 Material

The bushings shall be of oil impregnated paper condenser type and shall be provided with taps for test purposes. The bushing shall be filled with transformer oil and there shall be no communication with the oil in the tank. They shall be provided with oil level indicators visible from ground level.

The porcelain shall be tested according to IEC 62155. The glaze shall be brown and shall cover all exposed parts of the insulator. Between the porcelain and surrounding metal, gaskets or cement is to be interposed. All porcelain clamping surfaces in contact with gaskets shall be accurately grounded and free from glaze.

The exposed surface of paper insulations shall be finished with non-hygroscopic varnish.

As an alternative for transformer voltages below 72.5 kV, solid porcelain bushings according to IEC 60137, DIN 42530, or similar may, be used.

12.12.41 Marking

Each bushing shall be marked with the manufacturer's identification mark, indicating the date of firing and other marks necessary for the tests. The markings shall be clearly legible and

visible after assembly of the fittings and be painted, for porcelain parts before firing and for paper bushings before varnishing.

12.12.42 Connections

Connections from the windings to the bushings shall have necessary flexibility.

Clamps and similar details made of steel or malleable iron shall be galvanized.

The fittings (lugs and rods) shall be made of copper or bronze.

Supply of all bushing clamps for connection of the transformer to the switchgear is included in the Scope of Works.

12.12.43 Current transformers

The bushing shall have built-in current transformers.

12.12.44 Vibration and sound level

Special attention shall be paid in order to avoid vibrations of the transformer. The transformer shall be capable of operating continuously at specified outputs and at a voltage corresponding to the highest voltage of equipment at any tap without undue vibration and noise.

The sound level shall not exceed maximum value, with and without cooling system in operation, indicated in Technical Schedules. Sound level shall be measured as specified in IEC 60551.

If the sound level is exceeding the required values for power transformers, the Employer will penalise the excess at a rate of USD 12,000 per dB(A).

Values of 0.5 dB(A) and above will be rounded up to the next full dB(A).

If the installed transformer exceeds the allowable noise level and no effective mitigation is implemented by the Contractor, the Employer reserves the right to require the Contractor to implement additional noise mitigation measures at the Contractor’s sole cost and responsibility. These measures may include, but are not limited to:

- Installation of sound-proof or acoustic barrier walls;
- Installation of noise enclosures or hoods;
- Use of vibration isolation pads or mounts;
- Any other effective noise reduction solutions approved by the Employer.

12.12.45 Rejection of the Transformers

The Employer shall have the right to reject any transformer (after factory acceptance test) if the actual values exceed the guaranteed values by more than the margins specified hereunder:

- No-load losses + 10%
- Load losses (forced cooling) + 10%
- Total losses + 10%
- Noise level + 3 dB (A)
- Temperature rise limit resulting in rated +0.0 K output

12.12.46 Accessories

The following accessories shall be provided for the transformer:

Gas-operated twin-float Buchholz relay with gas metal gassampling and testing device with side glass, to be operated from convenient floor height. The relay shall be mounted in the piping between the tank and the conservator and so located that it may be easily inspected. Valves and couplings shall be supplied so that the relay can be removed or replaced without service interruption. Suitable piping with valve and threaded cap at the sampling end, to permit gassampling from ground level.

Each conservator vessel shall be fitted with two parallel breathers in which only orange silica gel (transparent clear when wet) shall be used as dehydrating agent. The containers for the dehydrating agent and the oil trap shall not be of transparent plastics. The parallel breathers shall be connected to the air-expansion pipes via valves to allow closing of each breather separately for exchange/drying of silica gel but not allowing closing of both breathers to allow continuous ventilation.

In view of excessive humidity breathers shall be larger in size and shall be provided with oil trap. The silica-gel filling capacity of each breather shall be dependent on the size of the transformers with 0.5 kg/1500 l oil with minimum 4.5 kg for transformers up to 40 MVA per unit and minimum 6 kg for transformers above 40 MV and a minimum filling capacity of 3 kg for the OLTC conservators.

The silica gel breathers as well as all filling and draining devices shall be rigidly fastened at a convenient height above ground level. Furthermore, all breathers shall be rigidly fixed onto the tank by appropriate mounting brackets at their lower ends. A silica gel dehydrating breather designed for drying agents with a grain size of at least 2.5 mm. The required quantity

of silica gel shall be supplied. The dehydrator shall have an oil seal and shall be located at a convenient floor height.

- 1 (one) protective relay (oil-flow operated) with trip contact for diverter switch of OLTC. The pipes connecting the relay shall have slide valves on the conservator side (easily accessible from tank cover)
- 1 (one) pressure relief device of spring-loaded type (Qualitrol or equivalent) with pin-type operation indicator and trip contact for diverter switch of OLTC
- 1 (one) pressure relief device of spring-loaded type (Qualitrol or equivalent) with pin-type operation indicator and trip contact (for transformers above 63 MVA per unit two pressure relief valves arranged on opposite ends on the tank cover)
- 1 (one) thermal replica to be connected to each power winding via current transformer (for auto-transformers an additional CT is required in the lead to the primary terminal to give a true image of the temperature in the common/secondary winding).
- Winding temperature dial type thermometer with radial type maximum pointer and heating coil in thermometer pocket in tank cover for each thermal replica with remote indicator and four adjustable contacts for winding hot spot temperature alarm and trip and switching ON the cooling. The heating element for the device shall be located in an oil pocket not communicating with oil in the main tank.
- One (1) oil temperature indicator for the top oil with adjustable contacts for alarm and tripping and for switching off cooling groups. The oil temperature indicator shall be of the dial type with its sensing element located in the region of the hottest oil.
- Emergency vent to be mounted on the tank cover so as to relieve excessive pressure.
- Gas-pressure indicator to indicate pressure of inert gas during transport and storage.
- Separate filtering and drain connections for the on-load tap changer.

A vermin-proof marshalling box, degree of protection IP 56, with provision for pad-locking, of adequate size. The box shall be placed on the tank at convenient height and shall contain terminals for all incoming and outgoing cables. The box shall also be used for terminating all power and control cables to the transformer accessories, and contain fuses, motor starters, and switches for automatic and manual operations of the fans.

All wiring from the transformer auxiliaries and wiring to the transformer from the station control board, etc, shall enter the box from the bottom through flanges provided with glands for each separate cable.

The interphase between the transformer manufacturer and the switchgear Supplier shall be on the marshalling box.

All control and alarm functions required for complete operation shall be performed by the transformer manufacturer up to the marshalling box. The switchgear Supplier shall supply and execute all cable connections between the control room cabinets and the transformer marshalling boxes as well as supply all AC power for motors and DC voltage for control, indication and alarm purposes.

12.12.47 Cables and auxiliary equipment

12.12.48 Power and control cables

Power cables shall be of XLPE insulated, with steel armouring, rated voltage 1 kV, 50 Hz. The conductors shall be copper for cables ≤ 36 kV and of aluminium for cables >36 kV.

Control cables shall be PVC-insulated, rated voltage 300/500 V, 50 Hz and shall be steel armoured. The conductors shall be highly flexible stranded copper.

The minimum cross section area for current circuits shall be 2.5 mm^2 .

The screen of power and control cables shall be earthed at one end only.

Electrical connections between all fans, accessories etc. and the control and cabinets shall be supported throughout the total length, made of metal raceways, closed channels, solid steel conduits of corrosion-proof material or conduit wiring/ cabling. The raceways shall be rigidly fixed to the transformer to prevent mechanical damage or vibrations.

Flexible steel conduits may be provided throughout the total length for all cabling/ wiring other than laid in rigidly fixed race ways. Open cabling shall not be provided. All flexible steel conduits shall be rigidly fixed onto the tank etc. in an approved manner by ties of stainless steel throughout their total length in uniform distances not exceeding 50 cm. Any kind of plastic bands etc. are not acceptable.

Only steel armouring of cables is not considered to be sufficient protection and is not acceptable.

All cabling and/ or wiring to fan motors, oil pumps, measuring and monitoring devices etc. shall be designed for a conductor temperature of not less than 110°C .

12.12.49 Cubicle wiring

Auxiliary conductors in apparatus cubicles, such as control cubicles, etc, shall be stranded PVC cables with a minimum area of 1.5 mm^2 .

Conductors within cubicles and between terminal blocks and apparatus shall be laid in plastic ducts or covered with plastic bands.

Conductor ends not connected to compression-type terminal blocks shall be provided with approved claw washers, which neatly retain all strands. Wiring shall be arranged to give easy access to the terminal or relays and other apparatus.

Spare cores, if any, shall be connected to terminal blocks in cubicles and marshalling boxes.

All jointing and tying of wires shall be carried out only at the terminal points.

12.12.50 Boards and boxes

Boards and marshalling boxes shall be made of steel and designed for tropical conditions and be vermin-proof. Front doors of control and marshalling cabinets shall be of hinged type provided with locking devices for stopping of the front door. No electrical equipment shall be installed on the front door of these cabinets. Front doors shall be equipped with smooth action locking bars and with padlocking facilities integrated in door handle. In case of an inner door being provided, this door shall be hinged at the side opposite to the hinges of the outer door. A rigid pocket for storing the concerned circuit diagram shall be securely fixed on the inner side of the front door, be-sides a plate showing all circuit connections and terminal blocks.

To prevent impermissible temperature rise within the cabinets and/ or marshalling boxes, arising from sun radiation, they shall be protected by additional stain-less sheet steel rigidly fixed at a certain distance around the cabinet and onto the front door. Suitable ventilation mazes shall be provided at the side walls inside the cabinets.

Cables shall be mounted so that they are protected against damage and vibrations.

The cables shall enter through glands that shall protrude above the gland plate so as to prevent moisture from entering into the cables. There shall be one gland for each cable. Cables shall enter any board or marshalling box from the bottom.

Boards and marshalling boxes located outdoors or in damp surroundings shall have ventilation and drainage openings as well as a heater for connection to 230 V 50 Hz. They shall also be provided with lighting equipment.

All box openings shall be screened for protection against vermin and be so arranged that entry of water be prevented.

For screening of the holes, netting with at least 1 mesh/mm shall be used.

Boards and marshalling boxes and equipment installed in them shall be of corrosion-proof design.

All marshalling boxes shall be placed at normal working height and shall be sufficiently spacious to facilitate connection of leads. They shall be so designed as to make markings easily legible.

Only one core shall be connected to each side of a terminal block.

Each board and box, etc., shall be connected to the station earth system by a copper wire with a minimum area of 25 mm².

12.12.51 Terminals

All terminal blocks shall be equipped with visible isolating arrangements for testing purposes. They shall be provided with sockets for test plugs, at both sides. The terminal blocks shall be insulated for 500 V and shall have provisions for marking. The terminal blocks shall be of make Phoenix type RTK or of a comparable design.

The terminal blocks shall be mounted to give easy access to wires, terminations and ferrules. The terminal blocks shall also give a clear view of the arrangement of the cable tails.

Terminals connected to 400/230V shall be properly protected and separated from control circuits.

12.12.52 Electrical motors

Electrical motors shall fulfil the following requirements:

- Insulation Class F,
- Enclosure Degree of Protection IP 56,
- Cooling design IC 4.

They shall have protected drainage holes and be capable of operating continuously under equal service conditions without exceeding the specified temperature rises.

All motors required to operate in damp or humid conditions or located outdoors shall be supplied with electric heating equipment in order to protect the windings against moisture.

12.12.53 Marking

Marshalling boxes and control gear and units thereof, components mounted therein and wiring and cables, shall be labelled and marked as follows, the purpose of the labelling and marking being to make possible the identification of switchgear and control gear and parts thereof and their relation to the relevant technical documentation in order to facilitate a rational and simple manner of installation, operation, trouble-shooting, maintenance and repair.

Apparatus shall have labels or markings identifying the apparatus or units thereof (normally the relevant apparatus numbers used in the technical documents for the control gear). In some cases, this marking shall be completed with function marking in plain text. Apparatus labels shall be affixed by means of screws or rivets on the framework, so they remain in place when the apparatus is dismantled or changed.

Instruments, indicating devices and control devices shall have identification marking in plain text or simple symbols or colours. Control devices shall in addition have marking of control positions (e.g. Manual-Automatic, Open-Close), simple symbols or colours.

Internal wiring within control gear or apparatus units shall have slip over all wire ends marked, the marking to include as a minimum the same marking as has the terminal to which the wire end is connected. Tape is not permitted.

Current and voltage circuits shall have phase marking and, where necessary, polarity marking. Protective earth wires shall be marked with green-and-yellow. The marking shall be indicated with ferrules. The ferrules shall be of white insulated material and be provided with glossy finish to prevent adhesion and dirt. They shall be clearly and durably marked in black and shall not be affected by damp or oil.

Labels shall be permanently fixed to the switchboard and apparatus. Glued labels and marking tape will be rejected.

12.12.54 Spare parts and tools

Spare parts that shall be included in the supply is indicated in Price Schedules The supply will also include other spare parts proposed by the Contractor and approved by the Employer. The following shall be included:

- One 330kV bushing
- Two(2) neutral bushing
- Two(2) dehydrating breathers
- Two(2) Buchholz relays
- One (01) Oil level indicator
- Silica gel
- Gasket sheets
- Filled Gas cylinders for Sergi fire suppression systems or equivalent for transformers
- One Winding temperature indicator

- One Oil temperature indicator
- Transformer oil (200l x 250 drums)
- One Transformer Oil calibration equipment
- Three sound level meters

12.12.55 Tools

The Contractor shall provide all necessary lifting beams and frames, which may be needed for the erection of the transformer.

The Contractor shall provide a complete set of all tools, equipment, measuring instruments, for repair and maintenance of the transformer.

The following are expected to be provided by the contractor:

- Vacuum pump of adequate capacity for transformer insulation drying and oil filling
- Oil pump and hoses, with a flow rate of at least 1.3 l/s (for oil filling of power transformers), should be portable and electrically operated
- Transformer oil filtration streamliner, with a capacity of at least 5000 l/hr, complete with hoses and adapters.
- SFRA Analyser
- CPC 100 Transformer Analyzer
- 100kV, Oil dielectric breakdown tester

12.12.56 Inspection and testing

Full and complete testing of the transformer with accessories shall be carried out in accordance to IEC 60076.

The Contractor shall give a complete description of the proposed test methods. The Contractor shall provide all instruments and equipment necessary for testing.

12.12.57 Extent

Testing shall include all routine tests, type tests and special tests specified in IEC 60076. In addition, test certification protocols for equipment from sub suppliers mounted on transformer shall be included, and especially bushings and OLTC.

12.12.58 Routine tests

All routine tests as far as applicable shall be carried out according the IEC 60076.

The following routine tests shall be applied to all transformer:

- Resistance measurements of all windings for all tapings.
- Ratio tests for all tapings and vector relationship tests.
- Measurement of no-load losses and currents.
- Measurements of impedance voltages (at maximum, principal and minimum tapings), short circuit impedances and load losses. Load losses shall be measured at both rated currents when ONAN and ONAF cooling are specified.
- Determination of efficiencies at 50%, 75%, 100% and 120% load at maximum temperature of the winding and 0.8 power factor lagging and unity power factor for all ratings (ONAN, ONAF ratings).
- Zero sequence impedance measurement.
- Induced voltage and separate source voltage withstand power frequency, dielectric tests on all windings on all phases including neutral points.
- Full wave impulse withstand tests. The transformer shall be subjected to a complete series of tests. Such tests shall be applied to the HV winding line terminal of each phase as well as to the neutral points.
- Tests on on-load tap changers.
- Routine tests on all transformer accessories such as motors, contactors wiring, etc.
- Partial discharge measurements (corona testing) during the power frequency dielectric tests.
- Measurements of capacity between the windings and each winding and ground.
- Oil leakage test. The complete oil filled transformer with bushings and radiators fitted and any other attachment normally in contact with oil shall be tested at a positive pressure measured at the tank bottom of twice the column of oil in the transformer when the transformer is cold, but in any case not less than 70 kPa. Alternatively the radiators may be tested separately with the same pressure. The test period shall be not less than 12 hours.
- Core insulation test, 2 kV, 50 Hz for one minute.

12.12.59 Type tests

All type tests according to IEC 60076 shall be included.

The following type tests shall be carried out on one transformer of each type:

- Temperature rise test.

- Noise measurements.
- Chopped wave impulse test. The test shall be carried out in conjunction with the full wave test as described in IEC 60076-4.
- Vacuum test. The transformer tank and radiators filled with oil shall be subjected to a vacuum test to comply with IEC 60076. Bushings need not be fitted and the radiators and conservator may be tested as separate units.

12.12.60 Special tests

All applicable special tests according to IEC 60076 shall be included.

12.12.61 Bushing Test

Note shall be taken that the bushings shall have adequate insulation level for operating at 2000 m above sea level. It is not required to perform separate bushing tests if the Contractor selects bushings which have insulation levels compensated for the altitude. Nevertheless, the Contractor shall submit for approval test records and data for all bushings. These records shall show the test performed on the bushings including but not necessarily restricted to the following tests:

- Standard, one minute, 50 Hz dry withstand tests for all bushings.
- Type test of impulse withstand voltage.

All recorded test figures shall be given with the bushings serial number.

- For the 330 kV, 132kV and 11 kV bushings including any spare bushings:
- Internal pressure and terminal cap pressure. Power factor and capacitance measurements
- Power factor measurement
- Capacitance measurements between conductor and test tap and between the tap and earth.

12.12.62 Site Acceptance tests (SAT)

The site acceptance tests shall include, but not be limited to, the following:

- Dielectric oil test,
- Insulation dryness,
- Core to tank insulation,
- Winding insulation and/or measurement of dissipation factor,
- Resistance of windings,
- Ratio test,
- SFRA Test

- Function test of accessories.

12.12.63 Factory Acceptance tests (FAT)

- The factory acceptance tests for shunt reactor shall include, but not be limited to, the following: Measurement of voltage ratio and verification of vector group
- Winding resistance test
- Switching impulse and lightning impulse tests
- Insulation resistance and Tan delta tests
- Separate voltage withstand test
- Induced voltage test with PD measurements
- Measurement of No-load current and No-load loss
- Measurement of No-load current harmonics
- Measurement of short circuit impedance
- Zero sequence impedance measurement
- OLTC test
- Frequency response scanning analysis
- Oil dielectric strength

12.12.64 Transport

12.12.65 Dimensions

The dimensions of the transformers shall be such that when packed for transport, they will comply with the requirements of the authorities in charge of the applicable transport routes with respect to systems loading and clearance gauges if transported by road.

All shafts, bearings and machined surfaces exposed for transport to the site shall have a temporary protective coating to prevent corrosion.

If it is necessary to remove bushings or radiators for transport blanking-off plates and a spare set of gaskets shall be provided.

12.12.66 Oil content

If transport weight limitations permit, the transformers may be transported with sufficient oil to cover the core and windings. The tank shall be sealed for transport to prevent all breathing. The remainder of the oil to be supplied separately at the time of delivery shall be in 200 L drums.

12.12.67 Conservation gas

Alternatively, the transformers shall be transported filled with dry nitrogen under slight positive pressure. This pressure and the temperature at the time of filling shall be

communicated to the Employer and a pressure gauge suitably protected is to be fitted to each transformer to facilitate inspection of the gas pressure on arrival at site. Every precaution shall be taken to ensure that the transformers arrive at site in a satisfactory condition so that subsequent to oil filling, they may be put into service without the necessity for further drying out. Should the positive gas pressure disappear during transport and the transformer allowed to breathe, additional drying out at site if required shall be the responsibility of the Contractor.

12.12.68 Marking

All accessories and spares which are shipped separately must be clearly marked for identification with the transformer for which they are intended. All pipework and valves shall have further markings showing the correct points of assembly, which shall also be shown on assembly drawings to be supplied.

12.12.69 Oil filling

Full details must be supplied on methods of drying out the windings, if found necessary, on arrival and on the method to be adopted for oil filling and oil purification on site. Any special apparatus required for oil filling must be supplied as part of this contract.

Full details of the proposed methods of transport shall be submitted for approval.

12.12.70 Transport recorder

During transport, the transformers shall have impact recorders attached.

The recorders shall be sealed and working throughout the complete transport from manufacturers works to the Site.

12.12.71 Integrated Fire Suppression System

The TRANSFORMER PROTECTOR (TP) of make Sergi or equivalent shall be installed at all power transformers. It shall comply with the NFPA 850 Recommendation for Fast Depressurisation Systems for Substations.

The TP shall be a Mechanical Fast Depressurisation System and shall activate within 20 milliseconds, by the first dynamic pressure peak of the shock wave, avoiding transformer explosions before static pressure increases.

The bidder shall conduct comprehensive testing of the integrated fire suppression system for transformers to ensure compliance with IEEE 979, NFPA 15, and IEC 62305 standards. The testing process shall include the following phases:

1. Pre-Installation Testing

- Verification of material certifications (nozzles, piping, control panels) against approved specifications.
- Pressure and leakage tests on pipes, valves, and cylinders to ensure integrity.

2. Functional Testing (Post-Installation)

- Detection System Test: Simulate fire scenarios to validate smoke/heat detectors, gas sensors, and control unit response times.
- Activation Test: Manual and automatic triggering of the suppression system (e.g., water mist, foam, or gas-based) to confirm proper discharge.
- Fail-Safe Checks: Power failure simulations to verify backup power (UPS/generator) activation.

3. Integration Testing

- SCADA/EMS Interface: Validate alarms, remote shutdown commands, and data logging.

4. Performance Verification

- Full-scale live fire test (if required) to confirm suppression effectiveness.

5. Final Compliance & Documentation

- Submit test reports, calibration certificates, and as-built drawings.
- Provide operator training and emergency drill simulations.

Note: All tests must be witnessed by the client or third-party inspector. Non-compliant systems will be rejected.

12.13 Technical Specification for Reactors

12.13.1 Introduction

This specification covers the technical requirements of design, materials, manufacture, performance requirements, testing at the Vendors works, installation and commissioning of a high voltage, 3 by single-phase unit, Shunt Reactors and Neutral Compensating Reactors (NCR). The reactor specific requirements shall be supplied as specified in the relevant technical data sheets.

The reactors shall be suitable for continuous operation and switching under the envisaged voltage control regime.

12.13.2 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in section 1.4.8 and 12.2.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The line reactor supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory Authorities.

The design, manufacturing, testing, and commissioning of the reactors shall strictly follow the following standards:

IEC 60137	Insulating bushing for alternating voltages above 1000 V
IEC 60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
IEC 60282*	High-Voltage Fuses (* all applicable parts)
IEC 60296	Fluids for Electrotechnical Applications - Unused Mineral Insulating Oils for Transformers and Switchgear
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60815	Guide for the selection of insulators in respect of polluted conditions
IEEE C57.21	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 kVA
NEMA TR1	Transformers, Regulators and Reactors

ISO 9001	Quality Management Systems - Requirements
IEC 60076-1	Power transformers - General.
IEC 60076-2	Power transformers - Temperature rise.
IEC 60076-3	Power transformers - Insulation levels, dielectric tests and external clearances in air.
IEC 60076-5	Power transformers - Ability to withstand short circuit.
IEC 60076-6	Power transformers – Reactors.
IEC 60076-7	Loading guide for oil-immersed power transformers.
IEC 60076-8	Power transformers - Application guide (For calculation format)
IEC 60076-10	Power transformers - Determination of Sound levels.
BS 2765	Specification for dimensions of temperature detecting elements and corresponding pockets.

12.13.3 Design Overview

The design parameters for the required equipment are listed in Technical Details below.

12.13.4 Technical Details

Table 12-10: Reactor Technical Specifications

Description	Required	Unit
Description	Shunt reactor	
Type	Single phase	
Rated power	10	MVA
Nominal primary voltage (Un)	330	kV
Maximum continuous operating voltage (Um)	362	kV
Cooling	ONAN	
Colour	RAL7032 (Grey)	
Rated short-time current (3s)	40	kA
Type test	Authority, year, Doc.no	
Standards	IEC 60076	

Class	Outdoor	
Type of core	grain oriented silicon steel	
Type of tank	upper bolted flange	
Tank fully vacuum proof	Yes	
Specification of oil (general)	IEC 60296, class II	
Oil corrosive sulfur free	Yes	
Oil PCB free (certification to be provided)	Yes	
Supplier, type of oil	To be stated by Bidder	
Insulation levels (prim/sec/tert)(not corrected for altitude):		
- Power frequency withstand voltage (phase and neutral)	570/70	kV
- Lightning impulse level (lines and neutral)	1300/170	kV
Overvoltage withstand capacity continuously	1,1 x Un	
Overvoltage withstand capacity for 1 minute	1,25 x Um	
Overvoltage withstand capacity for 5 seconds	1,5 x Um	
Overvoltage withstand capacity for 1 second	1,75 x Um	
Positive internal pressure withstand capability	>70	kPa
Negative internal pressure withstand capability at empty tank	>50	mmHg
Temperature rise oil/top, maximum, at 1000masl	60	°C
Temperature rise winding, average, resistance method, at 1000masl	65	°C
Temperature rise winding, hot spot, resistance method, at 1000masl	78	°C
Bushing type	Porcelain	
Continuous overload for bushings	20	%
Minimum creepage distance primary side (USCD)	53.7	mm/kV
Minimum creepage distance neutral side (USCD)	53.7	mm/kV
Losses (75°C), Guarantee maximum at 35°C ambient temperature	To be stated by Bidder	kW
Capitalisation of losses	7000	USD/kW
Bushing current transformer primary side:		
Number of cores	5	Nos.
Turn ratio	1/800	
Secondary tapings turns ratios	1/100/200	
Class	0.2S / 4 x PX	
Rated burden protection core	10	VA

Rated burden measuring core	5	VA
Bushing current transformer neutral side:		
Number of cores	3	
Turn ratio	1/800	
Secondary tapings turns ratios	1/100/200	
Class	0.2S / 2 x PX	
Rated burden protection core	10	VA
Rated burden measuring core	5	VA
Dimensions total (length x width x height)	To be stated by Bidder	mm
Dimensions transport (length x width x height)	To be stated by Bidder	mm
Weight of oil	To be stated by Bidder	kg
Total weight of completely assembled reactor	To be stated by Bidder	kg
Auxiliary power, control	110	V DC
Auxiliary power, heater in control box	230	V AC
Noise level	<75	dB(A)

12.13.5 General Requirements

This specification covers the requirements for oil immersed HV shunt reactors and neutral reactor (single phase).

The line shunt reactor shall be designed for use on lines where single phase auto-reclosing is used, and the Contractor shall verify the shunt reactors and neutral compensating reactor sizing. The HV neutrals of the single phase line shunt reactors shall be connected to a neutral compensating reactor. The line reactor has a neutral point and neutral point is grounded through a neutral compensating reactor.

12.13.6 The busbar shunt reactor shall not be grounded through a neutral compensating reactor. Rated Power

The reactor shall operate at the values of rated power in MVar specified in schedules without exceeding the temperature rise limits specified in this specification.

12.13.7 Reactance

The tolerance on rated reactance at maximum operating voltage (U_m) and frequency shall be $\pm 5\%$.

The reactance in the three-phases when connected to a system of symmetrical voltages (U_m) shall not deviate from the average by more than $\pm 2\%$, but always remain within the above mentioned $\pm 5\%$ reactance.

12.13.8 Maximum Continuous Operating Voltage

The reactor shall be able to operate in this voltage continuously and without any limitation. No excessive gassing, excessive vibrations, or any other uncertain condition shall arise because of this voltage.

12.13.9 Maximum Temporary Overvoltages

Under switching conditions, the power frequency voltage may exceed the maximum system voltage (U_m). The reactors must be designed to withstand the over-voltages stated in Technical Schedules without harm.

The reactor shall also comply with the additional requirements in IEC 60076-3.

12.13.10 Earthing

The phase reactor shall be earthed through neutral reactors. The contractor shall carry out necessary sizing studies for the neutral surge arrester and neutral reactor.

12.13.11 Losses

The Contractor shall guarantee the reactor load losses in the Technical Schedules. The load losses of the reactor and cooling system shall be guaranteed at nominal voltage of 330kV, 50Hz and 35 °C ambient temperature.

The capitalised value of losses shall be added to the reactor tender price for the purposes of evaluation.

The evaluated price for each reactor unit shall be calculated based on the formula below:

$T \times P = \text{Evaluated Price of Reactor Losses}$

$\text{ReactT} = \text{Reactor total loss (core and winding losses) at rated voltage in kW}$

$P = \text{Cost/kW of total reactor loss valued at USD 12,000/kW}$

$\text{Evaluated Bid Cost} = \text{Bid Price of Reactor} + \text{Evaluated Price of Reactor Losses}$

The evaluated cost of the reactor shall be multiplied by the total number of reactors to arrive at the total evaluated cost.

The total capitalized cost of the losses will be added to the cost of reactors for comparing bids.

Any adjustment in cost that results from the procedure above shall be added to the bid price for the purpose of comparative evaluation only, to arrive at an "evaluated bid price". Bid prices quoted by Bidders shall remain unaltered.

If the bidder proposes reactors from more than one manufacturer, the values obtained from the manufacturer with the highest guaranteed/offered total load will be used

12.13.12 Current Transformers

Two current transformers shall be fitted on the reactor as specified in Technical Specifications above. The current transformers shall be bushing current transformer on the primary side and bushing current transformer on the neutral side of the Shunt Reactors.

12.13.13 Design Criteria

12.13.14 Service Conditions

The reactors shall be capable of operating continuously at its intended location during the ambient conditions.

If the ambient temperature specified under section 3.6 exceeds 45°C, the temperature rises shall be reduced in accordance with IEC Publication 60076, Part 2, Clause 2.3.

The design altitude for both substations is 2000 m.a.s.l., the temperature rise limits shall be adjusted in accordance with IEC Publication 60076, Part 2, Clause 2.3.

12.13.15 Rating

The reactors shall comply with the ratings specified in the scope of works and technical schedules under the stated service conditions without exceeding the temperature rise limits. If the voltage on the secondary (MV) side is reduced or raised by up to 5% from the rated voltage, the temperature rises of any part shall not rise by more than 5°C.

12.13.16 Noise

The reactors and supplementary cooling equipment shall operate without undue noise and every care shall be taken in the design and manufacture to reduce noise to the level of that obtained in good modern practice. To be tested in accordance with IEC Publication 60076, Part 10.

Should the noise level (at maximum power output and at U_{max}) for the reactors, at the specified distance according to IEC, exceed the guaranteed values but not exceed 3 dB, the Contractor must pay liquidated damages (penalty) to the Employer. It is thereby understood that values of 0.5 dB(A) and above will be rounded up to the next full dB.

Rejection of the Reactors

The Employer shall have the right to reject any reactor (after factory acceptance test) if the actual values exceed the guaranteed values by more than the margins specified hereunder:

- Load losses + 10%
- Noise level + 3 dB (A)
- Temperature rise limit resulting in rated +0.0 K output

12.13.17 Radio Interference

The design of the reactors shall be such that they will not cause any objectionable interference with radio reception near the reactors. Either by direct radiation or by transmission through the power-lines and system to which the reactors may be connected, when energizing at full rated voltage and when delivering any load up to the continuous maximum rating.

12.13.18 Insulation Levels

When assembled complete with connections as in service, electrical clearances in air shall be adequate to withstand the required impulse withstand voltage. The insulation level for bushings must be corrected for high altitude and particular reference is made to IEC Publication 60137, Clause 16 in this respect. Minimum bushing BIL insulation levels at sea altitude shall be at least one voltage class (according to IEC) higher than the corresponding winding insulation levels. Care shall be taken to ensure that no fittings are located to interfere with the external connections to the bushing terminals.

The windings for 220 kV and above shall have non-uniform insulation, the neutral points being solidly connected to earth. Windings of lower voltages shall have uniform insulation.

12.13.19 Short Circuit Performance

The reactor shall be capable of withstanding, without damage, the effects of a symmetrical three-phase short circuit and a phase to earth short circuit under conditions specified in IEC 60076 or in relevant sections of other approved standards.

It can be assumed that during a short circuit, nominal voltage will be maintained on one side of the reactor with a short on the other, the external impedance being zero.

12.13.20 Design**12.13.21 General Requirements**

The reactor shall be designed to carry 100% reactive current.

The HV and MV windings and all components shall be designed for the worst case maximum and minimum voltages that can occur during steady and dynamic operation.

The reactors shall be of the oil-immersed type suitable for outdoor use, they shall be dried out at the manufacturer’s works, and it should be possible to commission them without further dry out.

Particular attention shall be paid to the design of all equipment to ensure that no damage to working parts or insulation through the ingress of dust, moisture, insects, or vermin that are prevalent for long periods in the year.

An impact registration device shall be fixed to the reactor tank before transportation from the factory. The device shall record impacts in three axes and be properly sealed.

12.13.22 Cores

The reactor core shall be built up of laminations of the best quality non-aging cold-rolled grain oriented silicon sheet steel of high permeability and low loss coefficient. All joints between laminations shall be of the interleaved type and the laminations shall be clamped securely. Bolting of the core should be avoided to reduce losses. On no account shall butt joints be offered. The cross-section of the core shall form an approximate circle.

The laminations shall be separated by hot-oil proof insulation, and the clamping of the frame shall be firm to ensure even pressure over the whole of the core laminations to prevent undue vibrations or noises.

The core sheets shall be insulated with high-grade oil-proof insulation, for example magnesium-silicate-phosphate, instead of paper.

The magnetic circuit shall be designed to avoid the production of flux components at right angles to the plane of laminations, which may cause excessive local heating.

The core clamping arrangement and framework shall be efficiently insulated from the cores and withstand applying 2 kV, 50 Hz for 1 minute.

Each part of the core shall be electrically earthed to the reactor tank. The internal earth connection shall be of the detachable link type and shall be located in an accessible position.

The core, framework, clamping arrangements and general structure of the reactors shall be of robust design, capable of withstanding any shock to which they may be subjected during transport, installation or service.

Suitable axial cooling ducts shall be provided to ensure free circulation of oil and efficient cooling of the core. The ducts shall be proportioned so that the maximum temperature at any point will be within the prescribed limits of temperature rise.

Lifting lugs or other similar means shall be provided for conveniently lifting the complete assembly (with windings). The framework of the core shall be so designed as to prevent the presence of oil pockets, which would prevent complete emptying of the oil from the tank through the drain valve.

12.13.23 Windings

The windings shall be circular and consist of high-quality rectangular section copper, wound with age resisting paper of high dielectric strength. The current densities in the windings shall be stated in the technical schedules.

The amount of insulation between turns shall be determined not merely by normal volts per turn, but also by due consideration of the line voltages and the service conditions, under heavy lightning storms.

Adequate insulation and clearances between the windings shall be provided and all insulation and clearance between live parts must be adequate for operation at 5 per cent over the highest voltages on all the windings.

The insulation of the end turns of each winding adjacent to the reactor terminals shall be reinforced between turns to protect the windings satisfactorily against surges and transients.

The insulation of the reactor windings and connections shall be free from insulating material that may soften, ooze out, shrink or collapse during service. None of the materials used shall shrink, disintegrate, carbonise or become brittle under the action of hot oil, when the reactor is operated continuously at the maximum specified over loading.

The windings, connections and trappings of all reactors shall be clamped in position and braced to withstand shocks or undue stresses during transport, short circuit conditions, and other transient causes. No mechanical movement of the coils should be possible with dead short circuit on the reactors.

All windings and all fibrous and hygroscopic materials used in the construction of the reactor shall be dried under vacuum and impregnated with hot oil. Leads from windings to terminal board and bushings shall be rigidly supported to prevent injury from vibration and short circuit forces.

Adequate provision shall be made for the circulation of oil round and between the winding so that a low temperature gradient between the conductors and the oil is assured and any danger of excessive local heating is avoided.

The finished width of any duct and clamping arrangement shall be such as not to impede the free circulation of oil through the ducts.

It is essential that the windings shall be subjected to a thorough shrinking and seasoning process, so that no further shrinking of windings occur at site. However, the clamping arrangement shall be provided for taking up any possible shrinking of coils when in service.

The neutral points of star connected windings shall, unless otherwise specified in the technical schedules, be brought out to bushings located on the tank cover and connected to an earthing bus attached to the main reactor earth terminal.

12.13.24 Insulating Oil

The oil shall be of the inhibited mineral type and comply with IEC 60296 standard.

Oil shall preferably be supplied in bulk, dried, and cleaned on site. If oil is provided in drums, these shall have a volume of approximately 200 l and be full.

12.13.25 Current Transformers (where applicable)

Current transformers for winding temperature measurements shall be of the ring type mounted inside the reactors on the bushings.

Accuracy class 3 shall be used for temperature indication.

12.13.26 Tanks

Tanks shall be complete with all accessories and shall be designed to allow the complete reactor in the tank and filled with oil, to be lifted by crane or jacks, transported by road, rail and water without overstraining any joints and without causing subsequent leakage of oil. Corrugated tanks are not acceptable.

Each reactor shall be enclosed in a steel tank of welded construction with bolted top lid, suitably stiffened by means of channel or angle sections welded to the tank, for withstanding the stresses imposed during transit to site and subsequent operation with no signs of oil leakage. Bell type reactor tanks are not permitted.

The tanks must be so constructed as to be capable of withstanding an internal positive and vacuum as specified in Technical Schedules.

Guides shall be provided inside the tank to facilitate the lowering into the tank of the core and coils and their raising and correct positioning. The guides shall extend from the bottom of the tank to within 150 mm of the top of the tank.

The tank to covers shall be of adequate strength and shall not be distorted when lifted. Inspection openings suitably bolted shall be provided as necessary give easy access to bushings and earth connections. Each inspection opening shall be of ample size for the purpose for which it is provided. Manhole covers must be provided with lifting eyes where necessary. The tank cover and all inspection covers shall be provided with lifting eyes.

Detachable radiators shall have lifting eyes and be provided with drain plugs or valves at their lowest points and vent plugs in the headers. Isolating valves shall be provided adjacent to the main tank or headers to enable the radiators to be removed without interfering with the oil in the reactor tank.

All oil-pipe connections shall have flanged joints provided with gaskets, preferable set in grooves or held in position by stops to prevent over-compression of the gaskets.

The base of the tank shall be so designed that it shall be possible to move the complete reactor unit in any direction without damage when using rollers, plates, or rails. A design that necessitates rails being placed in a particular position shall not be used.

Lifting lugs shall be fitted, capable of lifting the reactor complete with windings and filled with oil.

Four jacking lugs shall be fitted 500 mm above ground level and four holes with a diameter of not less than 60 mm shall be provided on the jacking lugs in order to permit the reactor to be slewed in any direction.

The tank cover shall be fitted with pockets for a thermometer and for the bulbs of the winding temperature and oil temperature indicators specified. Protection shall be provided when necessary for each capillary tube. The thermometer pocket shall be fitted with a captive screwed cap to prevent ingress of water. The pockets shall be located in the position of maximum oil temperature, and it shall be possible to remove the instrument sensors without lowering the oil in the tank.

The tank cooling equipment shall be designed to permit vacuum treatment on site.

Two earthing terminals shall be provided, located at opposite sides of the tank. Provision shall be made at positions close to each of the four bottom corners of the tank for bolting the earth terminals to the tank structure to suit local conditions.

A rating plate shall be fixed to the tank at a height of not more than 1.55 m above ground level. A diagram plate shall also be fixed to the tank in an easily accessible position.

12.13.27 Gaskets

Oil-resisting synthetic rubber shall be used as a bonding medium for cork or similar material, or alternatively, where steel stops are provided to prevent over-compression of the gaskets.

The Contractor shall submit details of gasket material for approval.

Spare unused sets of gaskets shall be supplied for use on site for all positions where joints have to be made after transportation of the reactor.

12.13.28 Bushings

The reactor bushings shall withstand accidental arcing or flashover without seals or other vital parts becoming damaged. Stresses due to expansion and contraction in any part of the bushing shall not lead to development of bulges, hairline cracks or other defects. Suitable connecting clamps shall be able to absorb shocks due to vibration of the connecting jumpers. The bushings shall withstand internal vacuum in the reactor tank.

All terminals shall be marked to correspond with the markings on the diagram plate. Marking tags shall be securely fastened.

The HV bushing shall be of solid cast resin type or resin impregnated bushings (RIB) and rated in accordance with the standards listed in Design Overview and System Information.

The neutral ends shall be brought out externally via separate solid cast-resin bushings. The bushings terminals will be shorted to form the neutral connection, with a fully insulated conductor connected to the air-core neutral Compensating reactor.

12.13.29 Painting and Galvanising

Oil-filled reactors shall have their interior surfaces sandblasted and finished with two coats of anti-corrosive and oil-resistant priming paint. Exterior surfaces shall be sandblasted and have two priming coats and one filling coat with paint on zinc powder or urethane alkyd basis; three coats of weather and oil resistant paint. Minimum total thickness shall be 0.2 mm.

The tank interior surface shall be treated with varnish that is resistant to hot oil, and shall be white in colour.

The exterior finish of outdoor control cabinets and marshalling boxes shall be in the same colour as that for the reactors.

12.13.30 Accessories**12.13.31 Conservator**

The conservator for the reactor shall be mounted on the main tank.

The conservator shall preferably be of the diaphragm-sealed type, complete with necessary fittings.

The conservator shall be fitted with a removable end on which shall be mounted the oil gauge. The conservator tank shall be mounted to slope lightly downwards towards the drain valve, which shall be adjacent to the removable end.

The pipe connecting the conservator to the tank shall extend at least 50 mm into the conservator and shall be brought out from the highest point of the main tank cover. A valve shall be provided immediately adjacent to the conservator. All pockets and bushing turrets of the main tank shall be connected into this pipe between the reactor and the Buchholz relay.

The conservator shall be so dimensioned that it will permit all expansion over the working range of temperatures from no load with the reactor cold and at -10°C ambient air temperature to full load at maximum ambient air temperature while the sump pipe remains covered with oil and the oil level is visible or indicated. In any case, the volume of the conservator shall be at least 10% of the reactor oil volume.

The oil connections from the reactor tank to the conservator vessel shall be arranged at rising angle to the horizontal. The gas relay (see below) shall be fitted in this pipe in such a position that inspection, testing and dismantling is possible with the reactor in operation. A step valve shall be provided between the conservator and the relay.

The conservator shall be equipped with the following fittings:

- A sump that may be formed by extending the inlet pipe inside the conservator.
- A manhole formed by bolting one end plate of the conservator.
- A drain valve with flanged plug.
- A flanged filling plug.
- An oil level gauge.
- A filter valve.

12.13.32 Dial Type Oil Gauges

Dial-type oil gauges, where specified, shall be of the magnetically operated type, in which breaking of the gauge glass will not release any oil. The gauge shall be fitted with at least two circuit-closing, ungrounded, low-oil-level alarm contacts.

12.13.33 Silica Gel Breathers

Each conservator shall have a dehydrating breather assembly, complete with glass observation window fitted with silica gel, and necessary connecting piping to the conservator. The silica gel drum shall be easy to operate with regard to emptying and refilling.

The breather shall be provided with an oil cup or other device that prevents contact between the dehydrating agent and the air outside the reactor. If an oil cup is provided, the oil should be visible from the outside and the lowest oil level should be marked.

The weight of the dehydrating agent shall be not less than 0.5 kg per 1500 litres of oil in the reactor and cooler.

Unless the silica-gel container is transparent, the breathers shall have a window for inspection of the colour and condition of the silica gel and oil cup or other device to prevent continuous contact of the silica gel with the air outside the reactor.

12.13.34 Explosion Vents

Explosion-vent pipes shall have a diaphragm of approved material fitted at the upper end only. An equalising non-ferrous pipe shall connect the air space of the explosion vent with the air space of the conservator. Where this pipe would be unduly long or its presence affect electrical clearances, a small silica-gel breather may be fitted at ground level and connected to the upper end of the vent pipe by means of a small-bore non-ferrous pipe. If the explosion-vent pipe is connected to the top of the main tank, either it shall extend 50 mm into the main tank or be provided at the lower end with a gas deflector.

The explosion-vent shall be provided of sufficient size for the rapid release of any pressure that may be generated within the tank and that might result in damage to the equipment. The device if used shall be so placed that any discharge from it will not be deposited on any part of the reactor or its associated equipment.

The diaphragm shall be of approved design and material and shall be provided with a protective cover during transport.

If an over-pressure device of the spring release type is used in place of an explosion-vent, this shall be approved by the Engineer.

12.13.35 Temperature Indicators

Temperature detectors of the resistance type shall be Pt 100 DIN or similar type.

The local temperature indicators shall be of the dial-type graded in °C with a manually resettable pointer to register the highest temperature reached. The local indicators shall be mounted on the reactor preferably tank in a suitable weatherproof steel cabinet with a lockable door. The cabinet shall be so positioned as to allow easy access to and readability of the gauges.

The indicators shall be provided with two sets of alarm/trip contacts, adjustable to close at any temperature between 60°C and 120°C such adjustment being possible without dismantling the instrument. Where supplementary forced cooling is specified, two additional set of contacts shall be provided on the winding temperature indicator, also adjustable within the above temperature range for automatic start of the cooling fans in two stages. The differential between "switch on" and "switch off" temperatures must also be variable.

One temperature indicator of the capillary type for measurement of the top oil temperature shall be provided for each reactor.

Each reactor shall be provided with two winding temperature indicators of the "thermal image" type, one for each main winding, compensated for changes in ambient temperature. The indicator shall have a load - temperature characteristic approximately the same as the hottest part of the windings. The primary current reactors for operating the indicator shall be built into the reactor tank on the bushings. Information shall be included in the maintenance instructions in the form of either a graph or table showing the relationship between current injected into the heater coil and the corresponding temperature reading.

12.13.36 Alarm and Trip Contacts

All alarm contacts shall have ample inductive making and breaking at the specified alarm and tripping voltage.

Any auxiliary relays associated with the trip circuits shall be 110 VDC - operated and suitable for the specified alarm and tripping voltage.

Alarm and trip contacts shall be provided with independent potential free contact.

12.13.37 Control Cabinet and Auxiliary Wiring

The reactor shall be equipped with a weatherproof control cabinet made of corrosion resistant material with terminal blocks for all external low-voltage power and control cable connections. The control cabinet shall be situated at convenient height on the reactor.

The control cabinet shall contain:

- Motor starters for cooling fan motors.
- Heating element for prevention of condensation.
- Disconnectable terminal blocks with testing facilities for external cable connections.
- Change-over switch for remote/manual operation of the OLTC.

All sensors, motors etc. shall be connected to the terminal block in the control cabinet. All auxiliary wiring used on each reactor shall be carried in suitably supported steel conduits or metal protective sleeves and brought to the terminal blocks through compression type glands.

All wiring shall be stranded conductor with oil resistant insulation.

12.13.38 Drain, Filter and Sampling Valves

All valves shall be attached by bolted-on flanges and shall not be screwed or welded to the tank. Drain valves or isolating valves larger than 101.6 mm (4"B.S.P.) and of the double-flanged gate-type, construction may have bodies of cast iron or cast steel. All valves shall be opened by turning counter-clockwise when facing the hand wheel.

Every valve shall be provided with an indicator to show clearly the position of the valve.

Means shall be provided for padlocking the valves in their open and closed position.

All valves shall be suitable for operation in conjunction with reactor oil as specified in IEC Publication 60296 at temperatures up to 115°C.

Oil sampling valves shall be arranged to permit sampling of oil from top and bottom of the reactor tank and from the gas relay(s). The sampling valves shall be of the screwed globe type, designed to prevent any sudden release of oil. Valves for sampling of oil from top of the tank and from the gas relay(s) shall be placed at 1.5 m above ground. The outlet side of the valves shall be equipped with a spout for connecting a hose or tube during filling of the test bottles.

12.13.39 Rating and Diagram Plates

Rating and diagram plates shall be to IEC 60076, BS 171 or equivalent specification stamped or embossed on brass, or stainless steel. They shall show the Employer's Order Number and shall have a blank space for the Employer's Serial Number. The diagram plate shall show the internal connections and the voltage vector relationship of the windings in addition to a plan view of the reactor giving the correct physical relationship of the terminals.

Where applicable, rating or diagram plates shall show locations, ratio, rating and accuracy class of current reactors. Rating and diagram plates shall be approved by the Engineer.

12.13.40 Skid Underbase

Skid under base, where specified, shall be reinforced to permit moving the reactor in a direction perpendicular to the base. Hauling eyes shall be provided on the under base.

12.13.41 Wheels

Wheels, where specified, shall be plain, flanged uni-directional or bi-directional, whichever is specified in the technical schedules.

Wheels fitted to the reactors shall be provided with grease nipples or cups for lubricating the wheel bearings.

Bi-directional wheels shall be designed so that it is possible to change the direction of the wheels without removing them from the reactor, and provision shall be made for locking the wheels parallel or at right angles to the major axis. Grease nipples or cups shall be provided for lubricating the swivel bearings.

12.13.42 Cooling**12.13.43 Declaration of Ratings**

The Bidder shall declare in the schedule of technical guarantees the rated power available under the operating conditions ONAN and the ratings shall be indicated on the rating plate.

12.13.44 Radiators

Where detachable radiators are fitted, suitable valves, with blanking plates shall be provided at the inlet and outlet of each radiator so that it may be removed without draining oil from the tank. Inlet and outlet valve "OPEN" and "CLOSED" positions shall be clearly marked. The valves shall be readily accessible and easy to operate. Lifting facilities, a drain cock and an air release vent shall be provided on each radiator.

Radiators shall be designed so that it is possible for the whole of the cooling surface to be cleaned and, if necessary, subsequently painted by brushing and spraying. They shall also be designed so that they shall withstand dry-out vacuum without distortion or causing leakage of hot oil.

12.13.45 Fire Suppression Equipment

All line and neutral reactors shall be fitted with inbuilt active SERGI 3000 Fire suppression system or equivalent and to Engineer's approval.

12.13.46 Neutral Compensating Reactor

The neutral reactors technical requirements given in this bid are provisional. It shall be a responsibility of the contractor to coordinate with the employer to get requisite switching studies information for the Kasama-Nakonde double transmission line and the due associated circuits for EMTP modelling simulations. The contractor shall be responsible for carrying out detailed switching studies for the Kasama and Nakonde stepdown phase and neutral reactors. Through these studies the contractor shall ascertain the arc recovery voltages and related neutral current for the Kasama and Nakonde line reactors and optimize the neutral reactor sizes for arc extinction and optimal dead times for High Speed Single Pole Auto Reclose (SPAR) dead times. Further, through these studies the contractor shall validate the switching insulation requirements for the neutral and phase reactors.

The Neutral Reactor (NR) will be of the oil immersed type to match the existing units installed at Kasama substations. The standards and requirements will be the same as for the line reactors, with the exception of an off-load tap setting.

Neutral reactors will have the Direct impedance at rated voltage N-X1, X2, X3 as 997/904/815 respectively. The neutral reactor will have three taps with different impedances thus X1, X2 & X3.

Neutral Reactors shall include the following integral supervisory devices as a minimum:

Buchholz Surge Relay;

Tank Over-pressure Sensor;

Oil Level Low/High sensor;

Winding temperature sensor;

Neutral Bushing CT on the Earth Side bushing, type class PX, to match the CT used for reactor differential protection.

Table12-11: Technical Specifications of Neutral Compensation Reactor

Description	Required	Unit
Description	Neutral reactor	
Type	Single phase	
Rated power	15	kVAr
Nominal primary voltage	35	kV
Maximum continuous operating voltage	42	kV
Core type	Core	

Description	Required	Unit
Cooling	ONAN	
Colour	RAL7032 (Grey)	
Rated short-time current (3s)	40	kA
Type test	Authority, year, Doc.no	
Standards	IEC60076, 60137	
Class	Outdoor	
Type of core	grain oriented silicon steel	
Type of tank	upper flange	
Tank fully vacuum proof	Yes	
Specification of oil (general)	IEC 60296, class II	
Oil corrosive sulfur free	Yes	
Oil PCB free (certification to be provided)	Yes	
Supplier, type of oil	To be stated by Bidder	
Magnetizing linearity	140	% Vn
Current density at maximum load and rated voltage and rated voltage tap	To be stated by Bidder	A/mm ²
Direct impedance at rated voltage N-X1, X2, X3	997/904/815	Ω
Zero-sequence impedance at rated voltage	To be stated by Bidder	Ω
Tolerance to be applied to the reactor impedance	5	%
RIV max. Voltage level (IEC 62271-1) at 0.5 MHz and 230 kV test voltage (1.1 ur/√3) Maximum	2500	mV
HV bushing rated current	362	A
Neutral busching rated current	123	A
Lightning impulse level HV winding	200	kV
Lightning impulse level neutral	75	kV
Rated short-duration AC withstand voltage HV winding	95	kV
Rated short-duration AC withstand voltage neutral	28	kV
Temperature rise oil/top, maximum, Guarantee	60	K(G)
Temperature rise winding, average, resistance method, Guarantee	65	K(G)
Temperature rise winding, hot spot, resistance method, Guarantee	78	K(G)
Bushing type	Porcelain	
Continuous overload for bushings	20	%

Description	Required	Unit
Minimum creepage distance (USCD)	53.7	mm/kV
Total losses (75°C)	To be stated by Bidder	kW
Current transformers:		
<u>HV neutral</u>		
Number of cores	3	Nos.
Accuracy class	PX	
Burden	30	VA
Rated current ratio	100/1	
Dimensions total (length x width x height)	To be stated by Bidder	mm
Dimensions transport (length x width x height)	To be stated by Bidder	mm
Weight of oil	To be stated by Bidder	kg
Total weight of completely assembled transformer	To be stated by Bidder	kg
Auxiliary power, heater	230	V AC
Noise level, Guarantee	<78	dB(A)

12.13.47 Integrated Fire Suppression System

The TRANSFORMER PROTECTOR (TP) of make Sergi or equivalent shall be installed at all reactors. It shall comply with the NFPA 850 Recommendation for Fast Depressurisation Systems for Substations.

The TP shall be a Mechanical Fast Depressurisation System and shall activate within 20 milliseconds, by the first dynamic pressure peak of the shock wave, avoiding transformer explosions before static pressure increases.

The bidder shall conduct comprehensive testing of the integrated fire suppression system for transformers to ensure compliance with IEEE 979, NFPA 15, and IEC 62305 standards. The testing process shall include the following phases:

1. Pre-Installation Testing

- Verification of material certifications (nozzles, piping, control panels) against approved specifications.
- Pressure and leakage tests on pipes, valves, and cylinders to ensure integrity.

2. Functional Testing (Post-Installation)

- Detection System Test: Simulate fire scenarios to validate smoke/heat detectors, gas sensors, and control unit response times.
- Activation Test: Manual and automatic triggering of the suppression system (e.g., water mist, foam, or gas-based) to confirm proper discharge.
- Fail-Safe Checks: Power failure simulations to verify backup power (UPS/generator) activation.

3. Integration Testing

- SCADA/EMS Interface: Validate alarms, remote shutdown commands, and data logging.

4. Performance Verification

- Full-scale live fire test (if required) to confirm suppression effectiveness.

5. Final Compliance & Documentation

- Submit test reports, calibration certificates, and as-built drawings.
- Provide operator training and emergency drill simulations.

Note: All tests must be witnessed by the client or third-party inspector. Non-compliant systems will be rejected.

12.13.48 Inspection and testing

Full and complete testing of the reactor with accessories shall be carried out in accordance to IEC 60076.

The Contractor shall give a complete description of the proposed test methods. The Contractor shall provide all instruments and equipment necessary for testing.

12.13.49 Extent

Testing shall include all routine tests, type tests and special tests specified in IEC 60076. In addition, test certification protocols for equipment from sub suppliers mounted on reactor shall be included, and especially bushings.

12.13.50 Routine tests

All routine tests as far as applicable shall be carried out according the IEC 60076.

The following routine tests shall be applied to all reactors:

- Winding resistance.
- Insulation resistance & Polarization index
- Loss measurement.
- Induced voltage and separate source voltage withstand power frequency, dielectric tests on all windings including neutral points.
- Full wave impulse withstand tests. The reactor shall be subjected to a complete series of tests. Such tests shall be applied to the HV winding as well as to the neutral points.
- Routine tests on all reactor accessories such, contactors wiring, etc.
- Partial discharge measurements (corona testing) during the power frequency dielectric tests.
- Measurements of capacity between the windings and each winding and ground.
- Oil leakage test. The complete oil filled reactor with bushings fitted and any other attachment normally in contact with oil shall be tested at a positive pressure measured at the tank bottom of twice the column of oil in the reactor when the reactor is cold, but in any case not less than 70 kPa. The test period shall be not less than 12 hours.
- Core insulation test, 2 kV, 50 Hz for one minute.

12.13.51 Type tests

All type tests according to IEC 60076 shall be included.

The following type tests shall be carried out on one transformer of each type:

- Temperature rise test.
- Noise measurements.
- Chopped wave impulse test. The test shall be carried out in conjunction with the full wave test as described in IEC 60076-4.
- Vacuum test. The reactor tank filled with oil shall be subjected to a vacuum test to comply with IEC 60076. Bushings need not be fitted and conservator may be tested as separate units.

12.13.52 Special tests

All applicable special tests according to IEC 60076 shall be included.

12.13.53 Bushing Test

Note shall be taken that the bushings shall have adequate insulation level for operating at 2000 m above sea level. It is not required to perform separate bushing tests if the Contractor selects bushings which have insulation levels compensated for the altitude. Nevertheless, the

Contractor shall submit for approval test records and data for all bushings. These records shall show the test performed on the bushings including but not necessarily restricted to the following tests:

- Standard, one minute, 50 Hz dry withstand tests for all bushings.
- Type test of impulse withstand voltage.

All recorded test figures shall be given with the bushings serial number.

- For the 330 kV bushings including any spare bushings:
Internal pressure and terminal cap pressure. Power factor and capacitance measurements
- Power factor measurement
- Capacitance measurements between conductor and test tap and between the tap and earth.

12.13.54 Site Acceptance tests (SAT)

The site acceptance tests shall include, but not be limited to, the following:

- Dielectric oil test,
- Insulation dryness,
- Core to tank insulation,
- Winding insulation and/or measurement of dissipation factor,
- Resistance of windings,
- Ratio test,
- Function test of accessories.

12.13.55 Factory Acceptance tests (FAT)

The factory acceptance tests shall include, but not be limited to, the following:

- Winding resistance test
- Switching impulse and lightning impulse tests
- Separate voltage withstand test
- Short duration induced voltage withstand test
- Long duration induced AC voltage withstand test
- Measurement of loss and impedance
- Excitation test
- Sound and vibration test
- Measurement of radio interference levels
- Oil tank and conservator hermetic tests
- Mechanical strength test of the tank

- Temperature rise test
- Measurement of frequency response characteristic
- Bushing test
- Build-in current transformer test
- Oil dielectric strength test

The factory acceptance tests for neutral reactor shall include, but not be limited to, the following:

- Winding resistance test
- Insulation resistance and dielectric loss factor
- Lightning impulse test
- Separate source voltage withstand test
- Short duration induced voltage withstand test
- Excitation Test
- Loss and impedance measurement test
- Mechanical strength test of tank
- Measurement of frequency response characteristics
- Built-in current transformer test
- Temperature rise
- Insulation oil test
- Sound and vibration level tests

12.14 Technical Specification for Surge Arrestors

12.14.1 Scope

This specification covers the technical requirements of design, materials, manufacture, performance requirements, testing at the Vendor’s works, delivery to site and site tests and commissioning of metal oxide, gapless type surge arresters for alternating current systems. The specific requirements are covered in the technical data sheet. The Contractor shall demonstrate coordination between arrester protective characteristics and equipment lightning impulse withstand levels in accordance with IEC 60071-1/-2 and IEC 60099-4.

12.14.2 General Requirements

General

All the necessary flanges, bolts, nuts, clamps etc. required for assembly of complete arrester with accessories and mounting on support structure, shall be included in Bidder’s scope of supply.

All metal parts shall be of non-rusting and non-corrosive metal. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities, all similar parts, and particularly removable ones shall be interchangeable.

All the units of Arresters of same rating shall be interchangeable without adversely affecting the performance.

12.14.3 Marking

All arresters shall be supplied with a name plate which indicates the data specified in IEC 60099-4 engraved or embossed characters on the rubber polymer.

12.14.4 Grading

Grading resistors and/or grading capacitors and grading rings shall be provided for uniform voltage distribution between the units making up the arrester, as dictated by the voltage class of the arrester.

12.14.5 Drawings

Drawings incorporating the following particulars shall be submitted with the Bid:

Complete assembly drawing showing plan and elevation views of arrester incorporating mounting dimensions, overall dimensions, weight, electrical clearances for installation, details of terminal studs etc.;

The detailed dimensional drawing of the housing;

Ratings and description of special features, if any;

Power frequency voltage vs. time characteristic of the arrester.

12.14.6 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in Section 1.4.8 and 12.2. In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The equipment supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

12.14.7 Design Overview

The surge arrester shall be designed, constructed, and tested to IEC 60099-4 and the requirements of this specification. It shall be suitable for overvoltage protection of distribution and transmission networks.

The arresters shall be the metal oxide gap-less type and shall be connected between phase and earth. The arresters shall be suitable for outdoor installation. The arresters’ characteristics shall be proposed by the Contractor and shall comply with the results of the Contractor’s transient over voltage analysis to be reviewed and approved by the Engineer.

The arrestors must be effectively earthed so that the earth fault factor will be less than 1.5 at any location. The maximum separation between the transformer/reactor and the surge arrestors is 24m.

12.14.8 Technical Requirements

Table 12-12: Surge arrester specifications

330 kV Surge Arresters

Description	Required	Unit
Description	Outdoor	
Type of arresters	Gapless ZnO	
Type test	Authority, year, Doc.no	
Standards	IEC60099	
Creepage distance	13316	mm
Highest volage for equipment	362	kV
Rated voltage U_r	264	kV
Maximum continuos operating voltage U_c	≤ 210	kV
Nominal discharge current	20	kA peak
Line discharge class	4	
Maximal residual voltage 8/20 μ s (10kA)	≤ 660	kV peak
Maximum steep current impulse residual voltage 1/20 μ s (10kA)	≤ 535	kV
Impulse withstand current (peak value) (8/20 μ s)	20	kA
Long-wave surge current (2000 μ s)	To be stated by Bidder	A
Leakage current	To be stated by Bidder	mA
Insulation material	Polymeric rubber	
Surge counters per phase	Yes	

66 kV Surge Arresters

Description	Required	Unit

Description	Hollow core	
Type of arresters	Gapless ZnO	
Type test	Authority, year, Doc.no	
Standards	IEC60099	
Rated voltage U_r	60	kV
Rated short-circuit current	65	kA
Nominal discharge current	10	kA peak
Line discharge class	3	
Maximal residual voltage 8/20 μ s (10kA)	201	kV peak
Cont. operation voltage	44	kV
Energy absorption capability	8	kJ/kV
Impulse withstand current (peak value) (4/10 μ s)	100	kA
long duration current impulse	1100	A
Leakage current	To be stated by Bidder	mA
Insulation material	Silicon rubber	
Surge counters per phase	Yes	

12.14.9 Constructional Features

Surge arresters shall be of the hermetically sealed type and of self-supporting construction. They shall be provided with pressure relief devices and shall be capable of withstanding the internal pressures developed during various discharges or should safely vent the internal pressures associated with arrester failure without violent shattering. They shall have the ability to self-extinguish any fire caused by the arc.

The surge arrestors must be designed to protect electrical apparatus from high transient voltage surges with the following features: -

Ability for repeated operation to limit high transient voltage surges;

Ability to limit the duration and amplitude of follow up current;

Ability to withstand normal over-voltages on healthy phases which could approach line to line nominal voltages.

Internal components shall be dry at the time of assembly and arresters shall be permanently sealed. If elastomer gaskets or seals are used, precautions shall be taken to ensure adequate

compression and that such gaskets or seals do not deteriorate in service as a result of exposure to the environment or electrical stresses.

All ferrous, non-current carrying components exposed to the atmosphere shall be hot-dip Galvanized in accordance with ISO 1461.

If dissimilar metals are used for the arrester terminals and conductor clamping arrangements, proof shall be provided of the galvanic compatibility of these materials.

The arrester, when energized at rated operating voltage, shall not exhibit any visible corona, when viewed in complete darkness.

12.14.10 Arrester Housing

The housing of the arresters shall be polymeric rubber. Arresters with porcelain housing are not acceptable. The specific creepage of the arrester housing shall be rated at minimum of 53.7 mm/kV (phase-to-ground). The arrester housing profile characteristics shall comply with the guidelines of annex D of IEC 60815. The housing of the surge arrester shall be made of high quality silicone rubber of the following minimum properties:

Hydrophobic.

Insensitivity to ultra-violet radiation.

Excellent tracking resistance.

Excellent mechanical impact, abrasion and shear resistance and

Excellent long-term stability and resistance to ageing under climatic and electrical stresses.

Arresters offered shall have, incorporated in the design, an isolating device to isolate the earth lead in the event of arrester operation. The device shall operate only when the valve material of the arrester becomes damaged and the arrangements made to ensure such a condition shall be shown in the tender.

12.14.11 Mounting

The arresters in the switchyard shall be mounted on steel support structures and shall be fitted with a pressure relief device for high voltages (66 kV to 330kV).

All fittings, surge counters, baseplates, support structures and any other equipment as required will be supplied as part of this contract. The Contractor shall design the foundations and foundation bolt arrangement and issue to the Engineer for approval.

12.14.12 Discharge Counter

A self-contained discharge counter suitably enclosed for outdoor use and requiring no auxiliary or battery supply shall be provided for each single pole unit when specified in the Technical data sheets. The discharge units shall have the following characteristics:

The earth conductor from the arrester to the counter, as well as the terminal of the counter, shall be sufficiently insulated or protected by a screen against accidental touching;

The discharge counter shall be visible through an inspection window. The counter terminals shall be so located that incoming and outgoing connections are easily made with minimum possible bends. Suitably sized bypass shunts of copper to facilitate bypassing the discharge counter shall be furnished. The terminal connectors shall permit the connection of these shunts;

The discharge counter shall register operation whenever lightning or any other type of surge strikes the Surge Arrester and shall have six digits;

The discharge counter shall be of latest version. Descriptive literature along with drawings and salient features of the equipment offered shall be furnished with the bid;

The grounding terminals shall be suitable for accommodating grounding connection to earth mat.

12.14.13 Protection Characteristics

The protection level of the arrester shall be determined as the highest of the following values:

Residual voltage at nominal discharge current and 8/20 μ s, or

Standard lightning impulse voltage.

The protection level shall have a margin of safety of at least 40% compared to the BIL of the equipment to be protected.

12.14.14 Performance and Testing**12.14.15 General**

Surge arresters offered or supplied to this Specification shall be capable of complying with the tests detailed in BS 60099-4:2000 and IEC 99-4:1991-11 including wet tests and any additional tests specified herein or included in other acceptable specifications with which the equipment is claimed to comply. Tests shall include requirements set out below.

12.14.16 Operating Duty Tests

Arresters are required to withstand the effect of multiple lightning strokes which may consist of fifteen impulses over a period of one second. Comparatively high short circuit currents may occur at some points on the system and arresters are required to limit the follow-through power frequency current to values which will not damage the arrester. The residual voltage should not be so high that upon discharging the rated current, does not provide an adequate margin for the protection of substation equipment. Preference will be given to diverter designs which have been tested to prove their sustainability for these conditions. Details of the tests shall be provided in the tender.

12.14.17 Radio Influence Voltages

Radio influence tests shall be carried out to American N.E.M.A. standard; test details shall be supplied in the tender and the radio influence value in microvolt quoted,

Note: reseal voltages shall be recorded.

12.14.18 Routine tests

The following routine tests that shall be conducted:

Measure reference voltage (Uref).

Residual voltage test.

Internal partial discharge test.

Certified copies of type test reports shall be submitted during the PD process and shall include calibrated oscillograms demonstrating that each type of arrester offered complied with the minimum specified requirements. Fully completed test-certificates, in duplicate showing compliance with the routine dry power frequency test and the standard lightning voltage impulse test and the standard lightning-voltage impulse acceptance test, shall be submitted by the Seller immediately after testing.

12.14.19 Type Tests**12.14.20 The Contractor shall furnish type test certificates during the PD process for surge arrestors of identical design. Site Acceptance Test**

The site acceptance tests shall include, but not be limited to, the following

- Physical inspection
- Insulation resistance test
- DC withstand voltage at 1mA leakage current

- Leakage current at 0.75 of DC withstand voltage

12.14.21 Factory Acceptance Test (FAT)

The factory acceptance tests shall include, but not be limited to, the following

- Physical inspection
- Resistive leakage current of voltage U_c
- Total leakage current of voltage U_c
- AC reference voltage at 1mA
- Partial discharge test
- Insulation resistance test

12.15 Technical Specification for Junction Boxes, Terminal Boxes and Marshalling Kiosks

12.15.1 Introduction

This specification covers the technical requirements of junction boxes, terminal boxes and marshalling kiosks complete with all accessories for an efficient and trouble-free operations.

12.15.2 General Requirements

12.15.3 Labelling of Boxes

Engraved labels shall be provided on the outside and inside of each junction box, terminal box or marshalling kiosk to describe the function of the box and the functions of the various items of equipment within, all to the approval of the Project Manager.

Outdoor box labels are to be manufactured in a non-corrosive metal, these shall be secured with stainless steel or brass machine screws and nuts, the use of double sided tape or adhesives will not be permitted.

Indoor box labels can be manufactured in a three-layer plastic material suitable for machine engraving, these shall be secured with stainless steel or brass machine screws and nuts, the use of double sided tape or adhesives will not be permitted.

12.15.4 Drawings

Copies of the following drawings and documents shall be submitted for approval, before taking up manufacture.

General arrangement drawing of yard junction and marshalling boxes showing:

Overall dimensions

Sectional view

Bill of materials

Single line diagram and wiring diagram with terminal block details

12.15.5 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected, and tested in accordance with latest revisions of relevant IEC Standards such as IEC 60529 (IP rating), IEC 62208 (enclosures), IEC 60947-7-1 (terminals), IEC 60664-1 (insulation), IEC 60364/60439 (wiring), IEC 60068-2 (environmental tests), IEC 62262 (impact), IEC 61084 (cable management), and IEC 61000-6-2/4 (EMC), with material certifications and test reports provided.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Project Manager. The equipment supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

12.15.6 Design Overview

Cubicles, cabinets, and similar enclosed compartments containing electrical equipment shall be adequately ventilated to restrict condensation. All major or important compartments containing electrical equipment shall be provided with internal lighting facilities controlled by a door switch and a single phase 16 A square pin (British Standard) socket .

All cabinets shall be vermin proof with screened openings. Outdoor cabinets shall be watertight and dustproof and provided with hygostat-controlled heaters to inhibit collection of moisture. The heater must be arranged not to overheat any cables or equipment. Openings for drainage of condensed water shall be provided at the lowest point in the cabinets. Cable entrances shall be fitted with metallic cable gland.

12.15.7 Technical Requirements

12.15.8 Yard Marshalling Kiosks

Marshalling kiosks shall be manufactured from 3CR12 or a similar stainless steel and equipped with approved terminal blocks. Terminal blocks using screws acting directly on the wire (conductor) as well as spring type terminal blocks are acceptable.

All terminals, socket outlets and other parts of the cubicles shall be easily accessible without dismantling other parts when the access door is open.

Refer to the Technical Specification for Auxiliary Power and Control Cable for the requirements of the terminals.

12.15.9 Wiring

Refer to the Technical Specification for Auxiliary Power and Control Cable for the requirements of the wiring within kiosks and boxes.

12.15.10 Cable Entries

All cables shall be terminated / glanded at the base of the boxes and kiosks.

Gland plates for supporting cable glands shall be at least 450 mm above finished ground level. All gland plates shall be hard earthed to the kiosk or box via a separate conductor of adequate size; the reliance on gland plate fixing bolts will not be permitted.

For outdoor applications the back, sides and front of the box or kiosks shall project at least 50 mm below the gland plate to prevent moisture draining on to the plate and cable glands.

The gland plates must be pre-drilled to allow for the installation of the cables.

12.16 Technical Specifications for Substation Auxiliary Power Supply**12.16.1 General**

The power for the substation's auxiliary service shall be supplied from the tertiary windings of the main Power Transformers via 11kV cables and switchgear, two 500kVA, 11/0,4kV Station Transformers down to a Main 400V switchgear.

The 110V DC system is divided into two physically and electrically separated systems (SUB 1, SUB 2) with each battery charger supplied from different feeders in Main 400V switchgear.

The Telecommunication system (SDH-node, MUX etc.) shall have its own stand-alone 48V power supply system including battery bank, charger etc.

The UPS system shall utilize the 110V DC battery system with a Bypass feeder from the Main 400V switchgear.

In general, 110V DC shall be used for CB/DS/ES motor drive units, Control, Protection, Alarm circuits, etc.

220V AC UPS shall be used for Operating Workstations (OWS), computers and other equipment crucial for the substation's operation, not able to supply with 110V DC.

Indoor and Control Building Emergency lights shall be supplied by either 220V AC UPS or 110 VDC.

12.16.2 Standards

Table 12-13: Substation auxiliaries Standards

IEC 60071-2	Insulation coordination
IEC 60529	Degrees of protection provided by enclosures
IEC 61243-5	Voltage detecting systems
IEC 61869-2	Current transformers
IEC 61869-3	Voltage transformers
IEC 62271-1	High-voltage switchgear and control gear - Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC 62271-102	High-voltage switchgear and control gear - Part 102: Alternating current disconnectors and earthing switches
IEC 62271-103	High-voltage switchgear and control gear - Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-200	AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV

12.16.3 11kV Indoor Air Insulated Switchgear

12.16.4 Introduction

This section covers the technical requirements of design, materials, performance requirements, manufacture, testing at the Manufacturer’s factory and supply to the site and commissioning of auxiliary 11kV switchgear with all accessories for efficient and trouble-free operations.

12.16.5 General Requirements

The Air Insulated Switchgear (AIS) shall be metal-clad of vermin-proof tropical design, and suitable for erection close to or at walls. The design shall be of standardized type, earlier implemented in tropical countries. The switchgear shall be designed and manufactured in accordance with the latest applicable standards of IEC.

Insulation shall protect all live parts from soiling, humidity, foreign bodies, etc. as well as against access to hazardous part. It will additionally have the mechanical and thermal properties which are deemed to be suitable for the project .

The metal-clad panels shall have separate vacuum type circuit breaker and air-insulated busbar compartments. Thus, the possibility of transmitting of arc and failure from one compartment to another will be eliminated.

Each panel shall be a self-contained unit whose bus bars shall be connected to the bus bars of the adjacent panels.

LV section will be located in the front upper part of each panel, consisting of one part for the accommodation of operational/driving mechanisms and one part for the accommodation of the protective and monitoring devices.

A cable connection compartment will be located in the lower part of each panel; access to cables must be provided after removing the lid of the respective section from the front/back side of the panel.

Current transformers will be placed in the CB panels and the disconnecting panels. Unipolar isolated voltage measuring transformers will be located either in a part of cable connection section or over the buses, depending on the application.

Design of the switchgear must allow for the removal of individual breaker bays, or parts thereof, without disturbing the remaining bays.

All operating elements and indicators of the switchgear must be located on, or be visible from, the front side of the equipment.

All necessary fixing and earthing material and works are included in the scope of supply and services.

Each cubicle shall be of the totally enclosed metal-clad type and shall have the following minimum separation of compartments:

- Busbar compartment, air insulated,
- Switchgear / cable compartment, air insulated,
- Low voltage compartment with space for relay protection, air insulated.

The metal enclosures for each module shall resist any occurrence of abnormal pressure increase or shock waves generated by internal electrical arc faults. Pressure relief arrangements shall be made if deemed necessary.

The cubicles shall be painted in a colour approved by the Employer.

The switchboard (Group of cubicles) shall be of a standard modular design. Similar modules shall easily be interchangeable.

All internal wiring in the switchboard such as for CT, VT, control and indication shall be connected to terminals in the low-voltage cabinet for connections to the control and protection, and to the SCADA if the function or signal is not available by other means such as serial bus.

The arrangement in the cable compartment shall allow for connection of three-phase cables as well as single-phase cables respectively several single-phase cables per phase. The Contractor need to make sure that the necessary type, size and number of MV power cables can be connected as required for connection of the related feeder or equipment.

Enclosure

The switchgear and busbar shall all be contained in a stainless steel enclosure.

Each panel will be shielded by metal and will be arc-proof. The panel units will be mechanically assembled to each other by means of screws.

The finish of interior surfaces of the metal-clad enclosures shall facilitate cleaning and inspection. Any paints or other coatings that may be used shall be such that they will not deteriorate when exposed to vapors, arc products, etc. that may be present in the enclosures.

Each compartment must have, as a minimum, IP56 as degree of protection.

On the front side of each panel, appropriate engraved plates shall denote its name and function. The panels will be able to be installed on foundation frame or on raised false floor.

A grounding bus rated to carry the rated fault current shall be provided along with the full length of each unit. All units shall be provided with external studs for earthing connections.

12.16.6 Busbar

The busbar system(s) shall consist of copper bars fixed inside the bus compartment by means of insulators. The dimensioning and fixation of the busbars shall be designed to resist the electro-magnetic dynamic stresses caused by the prospective short circuit conditions without any mechanical damage, and to ensure that maximum permissible temperature be not reached under normal and short-circuit conditions.

Provisions shall be made as necessary for thermal expansion of the busbars to prevent either undesirable or destructive mechanical stresses in the bus supports and the connections, when ambient temperature is exceeded. Expansion joints shall be foreseen where necessary.

Both halves of the busbar shall be fitted with earth switches and VT's.

12.16.7 Circuit Breaker

All circuit breakers shall be of vacuum type three-pole and be equipped with motor spring operated mechanism for 110V DC.

The motor spring-operated devices shall have a direct-on-line starter. It shall be possible to set the operative spring manually with a hand-crank.

The circuit breakers shall have shunt coils for closing and tripping. The tripping coils shall be duplicated.

The operating devices shall be equipped with a selector switch for local and remote control.

The coil and relays in the closing circuits shall have a correct function between 85 and 110 % of the rated voltage. For tripping circuits, the limits are 70 and 110 %.

Motors shall be designed in accordance with valid IEC publication and work correctly between 85 and 110 % of rated voltage. The motors shall be effectively protected.

Motors shall be protected against switching over voltages caused by the operating mechanism auxiliaries. The voltage amplitude must not exceed 50 % of the r.m.s. value of the insulation level.

The operating mechanism shall be provided with an anti-pumping device.

The motor circuits shall be controlled 2-pole from the motor-protection and end-position contacts. An auxiliary relay for alarm shall be connected to the motor-voltage and have a closed contact for no voltage, tripped motor-protection and unloaded spring.

Manual tripping (mechanical) shall be possible even in the absence of supply voltage for emergency, unless the breaker is locked out.

One set of auxiliary contacts necessary for control purposes shall mechanically be linked to the circuit breaker. All contacts shall be wired and connected to terminals in the cubicle.

A switch shall be provided for the operating voltage for each circuit breaker. The switch shall in open position prevent all electrical operations of circuit breakers. The switch shall have at least 10 contacts and be labelled OPERATION.

The mechanism shall be provided with an operation counter for at least 9999 CO-cycles. The mechanism shall be able to respond up to 10,000 operations, under nominal conditions, without any maintenance.

12.16.8 Three-position Switch

A manually operated off-load three-position disconnecter placed on the main busbar side shall be fitted in each feeder. The disconnecter allows the circuit-breaker to be separated from the main busbars. The disconnecter has three defined positions:

- ON: circuit-breaker connected to the busbars system
- OFF: circuit-breaker isolated from the busbar and from earth
- Earth: circuit-breaker connected to earth

The disconnecter shall be fitted with mechanical position indicators and dedicated auxiliary switches, to provide an immediate visual indication of which of the three positions the equipment is in.

12.16.9 Current transformers

Current transformers shall be of thyroidal core of dry design.

Earthing of secondary windings shall be done through a disconnectable terminal inside the low-voltage cabinet. Unused cores shall be wired to terminals and short-circuited in the low-voltage cabinet. A legible circuit-diagram plate showing the transformer connection and terminal markings shall be permanently fixed inside the low-voltage cabinet. The separate main data for the different cores shall be shown on the plate.

All current transformers shall be provided with a test wire for primary injection test. Test wire shall be wired and connected to terminals in the low-voltage cabinet.

12.16.10 Voltage transformers

Voltage transformers shall be of the inductive type. They may be located in the in the cable compartment. The voltage transformer shall have two secondary windings, one intended for metering and voltage indication, and other one intended for earth-fault relay protection. Earthing of secondary windings shall be arranged via disconnectable terminal inside the low-voltage compartment.

A legible circuit-diagram plate showing the transformer connection and terminal markings shall be permanently fixed inside the low-voltage cabinet. The separate main data for the different cores shall be shown on the plate.

Each secondary winding shall be protected with individual MCBs with auxiliary contact for remote indication and signalling. To prevent maloperation of relay protection, interlock system etc. a supervision device for the MCB's or fuses shall be provided.

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s, and all instruments, operating elements and indicators of the switchgear, DC trip circuit test facilities, push buttons and lamps shall be mounted on the front of this compartment.

All necessary auxiliary contacts shall be provided to enable remote control, remote alarm, and indication of the position/state of any circuit breaker and disconnectors/earthing switch.

Completely separated and isolated circuits shall be used for switchgear control, tripping, alarms, and auxiliary devices.

These circuits shall have separate control power buses and feeders, suitably protected, for each power bus section with outgoing feeders, and for each pair of incoming power feeders and the associated bus tie breaker in secondary selective systems.

Each control circuit shall be protected by a two-pole miniature circuit breaker with auxiliary N/C contact. The auxiliary contacts of all MCBs of the same circuit type, e.g. breaker motor control, alarm, space heater, trip, etc. shall be wired in series to suitable group alarm terminals.

Where terminals are not marked permanently and conspicuously, each end of each control wire shall be permanently marked with plastic ferrules (closed ring type) and terminated with crimp-type pin or plug terminators.

All control wiring shall be properly marked and installed such that the likelihood of damage during normal operation, maintenance and fault conditions is minimized. Terminal strips for different voltage levels must be physically separated from each other and suitably identified. Terminals carrying dangerous voltages must be marked with a particular color and carry suitable warning labels.

Further terminals shall be provided for the current transformers, which shall permit instruments to be connected without interrupting the secondary CT circuits.

Voltages for control, trip and alarm shall be monitored by built-in normally energized auxiliary relays, separate for each bus or feeder section. These relays shall be time delayed on drop-off and their contacts shall be wired to group alarm terminals

Remotely controlled breakers shall have key-operated selector switches installed in their low voltage compartment with the following functions. The key shall be removable in a "remote" position only.

The switch shall have these positions/functions:

- LOCAL: The breaker can only be operated locally by its push-buttons or mechanically.
- OFF: The breaker cannot be operated electrically.
- REMOTE: The breaker can only be operated from the remote control room location.

Space heaters shall be installed in each low voltage cabinet to prevent condensation. Each heater element shall have an integral thermostat for control. Each switchgear section shall

have a common space heater feeder, fed from a separate power source, and protected by a two-pole MCB with auxiliary N/C contact wired to a group alarm terminal.

12.16.11 Auxiliary Transformer 11/0,4kV

12.16.12 General Design Requirements

The design parameters for the required equipment are listed in Technical Schedules.

The local auxiliary transformer shall be of the mineral oil immersed core type suitable for outdoor use with ONAN cooling.

The design shall be of sealed type with a welded cover design employing a tank flange not less than 50 mm in width and a cover-plate 12 mm smaller all round to provide the required welding lip.

Any holes or plugs used to facilitate vacuum/pressure testing, leak testing or oil filling of the transformers shall finally be sealed by welding.

The expansion space above the oil level shall not be less than 25 per cent of the volume of the oil at 20°C and shall be nitrogen filled. The transformers shall be sealed at atmospheric pressure and an oil level gauge shall be provided.

The transformer shall be designed to deliver full rated power continuously on any tapping within the specified tapping range under the following conditions:

With the voltage of the untapped winding at normal, without the need to down rate the transformer at the extreme tap positions and without exceeding IEC temperature limits.

With voltage applied up to 10% in excess of the rated tapping voltages and with injurious overheating.

The transformer shall be connected in accordance with IEC 60076 series , BS EN 60076-1 or equivalent: three phase transformer to Vector Group reference Dyn11.

Low Voltage side neutral shall be brought out of the tank to a readily accessible terminal and shall not be earthed inside the tank.

The transformer shall have a Low Low Impedance, a maximum of 5% with no plus-tolerance.

12.16.13 Windings

All windings and termination shall be fully insulated and the high-voltage winding shall be designed for impulse voltage tests.

Designs shall be such that electrical stresses are as uniform as possible throughout the windings under impulse conditions.

Windings shall be vacuum impregnated and insulating materials shall not be liable to soften, shrink, become brittle, carbonise, deteriorate, or collapse in any way during service.

Tappings shall be provided in the HV windings, preferably in the centre of the windings, to permit variation of the number of HV turns without significant variation in the kVA rating. The variations shall be affected by means of a manually operated tapping switch to be provided in accordance with section Off-Load Tap Changer below.

12.16.14 Cores

The general construction of the cores, framework and the clamping arrangements shall be robust and such that they will be capable of withstanding completely any stresses with may occur due to handling, transport or service. All cores and yokes shall be terminated and clamped by means of a suitable framework. Suitable means shall be provided for lifting the cores from the tanks.

Each part of the core shall be electrically earthed to the reactor tank. The internal earth connection shall be of the detachable link type and shall be located in an accessible position.

It shall not be possible for the core to move relative to the tank during handling or transport.

12.16.15 Off Load Tap Changer

A fully insulated No-Load, externally manually operated ganged Tap Changer (NLTC) shall be supplied, capable of withstanding the specified impulse voltage when connected to be transformer windings.

Clearly visible tap position indication shall be provided. The tap changer shall be operated by means of an external handle which can be locked in each operating position.

The tap changer shall be mechanically robust and provided with a device between the handle and the switch to permit operation without strain in the event of imperfect alignment between switch and handle; the tap changer operating shaft shall be fully insulated as between tank and switch and shall be provided with a suitable oil and vacuum tight gland where it passes through the tank.

High grade insulating materials shall be used in the construction of tapping switches which shall be designed with special attention to the elimination of points where tracking is likely to occur.

The use of wood shall be avoided wherever possible, and all the supports and terminal boards shall be completely unaffected by hot oil and non-moisture absorbent.

The tap changer shall be mounted on supports made of suitable high strength insulating material and shall be provided with self-aligning spring-loaded wiping contacts capable of maintaining good electrical contact without the need for periodic maintenance.

All clearances between tapping switch contacts and leads shall be indicated on drawings submitted at the time of bidding and such clearances shall be sufficient to prevent tracing or flashovers in the event of carbon or sludge deposits forming on leakage paths.

HV tapping required: Minus 7.5% : Minus 5% : Minus 2.5% : 0% : Plus 2.5% : Plus 5% : Plus 7.5%.

12.16.16 Bushings

All line terminals and neutral connections shall be brought out to porcelain outdoor type terminal bushings.

Arcing horns shall be fitted on the bushings at the transformer's high-voltage side.

12.16.17 Tank and Conservator

12.16.17.1 General

All external surfaces and parts made of steel are to be thoroughly shot blasted and cleaned, after which two coats of zinc chromate priming paint, one intermediate coat and one coat of finishing paint are to be applied. The colour shall be approved by the Employer.

All internal surfaces or tanks and conservators shall be shot blasted and cleaned, and a coat of protecting compound, unaffected by hot oil, shall be applied.

Transformers on which the paints are found to flake off or deteriorate within the guaranteed period shall be suitably cleaned and repainted by the supplier without any cost for the Employer.

Drain valves may be either screwed or flanged whilst conservator isolating valves shall be flanged. Drain valves shall be complete with captive plugs which shall be either of non-ferrous metal or galvanised.

12.16.17.2 Tank

Each transformer shall be housed in a tank of welded steel plate construction suitably stiffened where necessary but with a flat base.

The tank shall be provided with lifting lugs suitable for lifting the transformers bodily by means of a hoist or crane when it is completely assembled and ready for service.

The tank shall be provided with four fixing lugs on the base drilled with 15 mm holes for bolting to a platform. The fixing holes shall project beyond the ends of the tank and be placed to provide the most practical stable arrangement.

12.16.17.3 Conservator

If a conservator is required by design, it shall be of dimensions such that oil expansion may occur over the working range temperature from no load with the transformer cold at minus 1°C ambient air temperature to full load at plus 45°C ambient air temperature while the sump pipe remains covered, and the oil level is visible or indicated.

Drain plugs shall preferably incorporate approved sampling facilities and shall be mounted at the lowest part of the conservator tank and so designed that the sampling device can be readily cleared in the event of its being blocked by an accumulation of sludge etc., without the necessity of having to dismantle the device completely.

Oil level gauges on conservator tanks shall be of the refracting plate glass or other approved type, marked with the level at 20°C at no-load and capable of indicating the level of oil over the specified working range.

Dehydrating breathers shall be of the Silica Gel type which give indication of moisture absorption by change in colour of the charge.

An inspection window shall be provided and mounted in a position convenient for inspection.

The breather is to incorporate an oil seal to prevent contact with the external air when breathing is not taking place. The breather to be fitted on the LV end of the transformers.

12.16.18 Accessories and Fittings

Rating and diagram plates shall be of engraved stainless steel, brass or other approved non-corroding material.

Where a thermometer pocket is provided, it shall be of a thin-walled metal mounted in the tank cover. The pocket shall project 25 mm outside of the tank and shall be threaded along the whole projecting portion. A screwed cap shall be provided to cover the pocket when not in use.

12.16.19 Insulating Oil

The oil shall be of the inhibited mineral type and comply with IEC 60296 standard.

Oil shall preferably be supplied in bulk, dried, and cleaned on site. If oil is provided in drums, these shall have a volume of approximately 200 l and be full.

12.16.20 Tests

Type Test certificates shall be submitted to the Employer for review and acceptance. This shall include, but not limited to, a Temperature Rise Test and an Impulse Voltage Withstand test including Chopped Waves.

If these two tests are not included in the Type Test, they shall be carried out as additional tests e.g. during the Routine Test.

Routine Test certificates/protocols shall be submitted, immediately after completion of tests in the factory, for each and every transformer.

12.16.21 Packing and Transport

Transformers shall be transported to destination with their tanks full of oil up to the service level.

Bushings and any accessories or fittings likely to be damaged shall be protected adequately against damage in transit.

12.16.22 Bid Drawings

The following drawings shall be supplied with any Bid unless identical drawings have been previously supplied, in which case a statement in the Bid of the applicable drawing subjects, numbers and revisions will suffice together with details of the references under which previous supply was made:

General arrangement drawings of each rating of transformers offered showing:

Minimum clearance (phase to phase and earth to earth) on HV and LV bushings including clearance HV to LV.

Positions and identification in a separate legend of all fittings with type numbers.

Size and position of all fixing holes.

Total weights with and without oil and core lifting height and weight.

Detail dimensioned drawings of tapping switch illustrating type of material, clearances, between tapping points and to earth and method of operation.

Detailed dimensioned drawing of bushings, silica gel or plain oil seal type breather and conservator.

Where sealed transformers are offered, a cross-arrangement drawing shall be submitted with the Bid showing details of the tank construction and internal tank finish and the dept of the expansion space above the oil.

12.16.23 Emergency Diesel Generator

The Diesel Generator system shall be of a permanent installation on a ground platform with a shelter.

The generator shall be able to supply the prioritized loads up to a minimum of 15 hours continuously at 75% of rated power.

Stand-by generators shall be supplied and installed as specified in Scope-of-Work and Specifications. The set shall be developed for industrial applications with soundproofing housing.

The generator shall be erected on and fixed to a concrete pad and connected to the main AC distribution board by an underground cable. Additionally, a control cable shall be erected between the same points.

The generator shall start automatically on mains failure and cool down and stop with a delay when mains return.

Execution class in accordance with ISO 8528/5 (2005) taking into account the behaviour of the generator set in a permanent mode of operation with different load levels, as well as in a temporary mode of operation due to shocks in the load.

12.16.23.1 Bedplate and fuel tank

The engine-alternator shall be fixed to the bedplate by means of anti-vibration shock mounts that absorb vibrations. It shall be made of a phosphate, passivated steel profile treated with polyester dust paint that guarantees a resistance of not less than 500 hours in saline fog chamber in accordance with standard ASM B-117-09.

The fuel tank shall be fixed to the bedplate, allowing disassembling for maintenance or replacement. It shall be fitted with a drainage plug, wide cleaning cover and filler connection with lockable screw-on lid. The tank shall include level sensor, with low fuel alarm signal contact, and indication of fuel level at the electrical panel.

12.16.23.2 Soundproofed canopy

The generator set shall be soundproofed by means of galvanized, phosphate steel, passivated and finish using polyester dust paint that guarantees a resistance of at least 720 hours in a saline mist chamber in accordance with standard ASM B—117—09.

The canopy shall have IP56 protection, centre hoisting eyebolt and impact locks with key and door retainer. It shall be lined inside with a noise—absorbing material made of mineral wool with a 50mm thick Waterproof (MO) protector veil with a density of at least 50 kg/m³.

12.16.23.3 Engine

The engine shall be of reputable brand with availability of spare parts and service in all parts of Zambia. It shall be a 4 stroke diesel engine with direct injection and electronic engine regulation.

12.16.23.3.1 Cooling

Cooling of the sleeves shall be by water/glycol mixture in a closed circuit with radiator and expansion tank and pump driven by the engine. A cooling purge system towards the outside of the bedplate shall be included.

12.16.23.3.2 Lubrication

A gear pump lubrication system driven by the engine with lubricant filtering system shall be included, with an outward purge circuit with manual purge pump.

12.16.23.3.3 Air intake

The air intake for combustion shall be fitted with an air filter and filter change indicator.

Air intake cooling after a turbo shall be by means of an air/air exchanger.

12.16.23.3.3.1 Exhaust system

The system shall consist of interior and exterior aluminised steel exhaust pipes and silencer with a water drainage system.

12.16.23.3.3.2 Start

Start system shall use an electrical motor, battery, battery disconnecter and battery charge alternator driven by the engine.

Sealed lead acid battery with Spiralcell recombining technology, maintenance free shall be used.

12.16.23.3.3.3 Fuel system

The fuel system shall have a decanter filter capturing particles larger than 30 microns.

12.16.23.3.3.4 Alternator

Alternator with 4-poles, lifetime lasting greased bearings, H class insulation, without brushes, 2/3 coil and AVR (Automatic Voltage Regulator). Protection of all the windings by means of 2-part high quality polyester resin impregnation. The stator windings with a double impregnation. Final finish with a coat of EG43 varnish. Excitation system with MAUX auxiliary winding with overload capacity 3 times the nominal current for 20 s. Joining of engine and alternator through flexible disc coupling.

12.16.23.3.3.5 Standards

Refer to section 12.2.

12.16.23.3.3.6 Electric Panel

An electrical panel integrated in the generator set with digital control plate, quick switching of the grounding system (Tl', TN or IT) and emergency shutdown pushbutton.

Shall include an all-pole circuit breaker, manually actuated, with thermal—magnetic protection against overloads and short circuits, rated 630A.

A battery charge maintainer designed to be permanently connected to the battery and maintain it charged to its maximum capacity shall be included in the electric panel assembly. It shall have no moving parts. The charger shall switch to floating mode when the charge is complete.

12.16.23.3.4 Control Panel

The control panel shall include grid monitor that starts-up the generator set when it detects a failure in the electrical power supply from the grid and sends a signal to the switching panel to switch from the grid position to the group position. Once the power supply has been re-established, it sends an order to the switching panel to transfer the generator set power to the grid and shuts down the generator set once it has cooled down. It also starts-up the generator set using an external signal.

The control panel shall check a large number of parameters of the generator set which allows it to display information, statuses and alarms. It will shut down the generator set: Due to high coolant fluid temperature, low oil pressure, low coolant fluid level, etc.

It shall include an LCD screen with lighting, navigation menu buttons, independent operational mode buttons, and alarms and status indicating LEDs.

Communications shall be possible via USB, RS232, RS485, as Well as DSEnet® for system upgrade. Possibility of Ethernet connection shall be available, and MODBUS protocol available

for client software. It shall be completely configurable using a PC in Windows environment and free Scada type software in real time.

It shall include reading and displaying of parameters with RMS values, real time clock, events history log up to at least 250 events and programming of alarms, events, start-ups and shutdowns.

Operating modes: START-UP, SHUTDOWN, AUTO, MANUAL AND TEST.

As a minimum the following parameters shall be available:

12.16.23.3.4.1 Generator

- Generator voltage (L—N)
- Generator voltage (L—L)
- Generator frequency
- Generator current
- kW, kVA
- kWh, kVAh
- Power factor

12.16.23.3.4.2 Grid

- Grid voltage (L—N)
- Grid voltage (L—L)
- Grid frequency

12.16.23.3.4.3 Engine

- Turn speed
- Cooling fluid temperature
- Oil pressure
- Hour meter
- Battery voltage
- No. of start—ups
- Fuel level

12.16.23.3.4.4 Protections and alarms

- Start—up fault (generator set shutdown)
- High coolant temperature (alarm and generator set shutdown)
- Low oil pressure (alarm and generator set shutdown)
- Low fuel level (alarm)
- Low cooling fluid level (generator set shutdown)
- Overload (alarm and generator set shutdown)
- Battery voltage high (alarm)

- Battery voltage low (alarm)
- Battery charge alternator failure (alarm)
- Generator low frequency (alarm and shutdown)
- Generator high frequency (alarm and shutdown)
- Generator low voltage (alarm and shutdown)
- Generator high voltage (alarm and shutdown)
- External emergency shutdown (shutdown)
- Engine overspeed (shutdown)
- Maintenance interval (alarm)

12.16.23.3.5 Automatic Transfer Switch

The connection to the main LVAC board shall be through an Automatic Transfer Switch (ATS). It may consist of a motorised switch, or MCCB's, with integrated interlocking.

The switch shall allow for padlocking in all positions and have a Manual / Automatic mode selector and emergency manual control.

It shall have position indicator with visualised cut-off.

12.16.24 AC Supply 380/415V

12.16.24.1 General

The AC low voltage main distribution system shall have a voltage rating of 380/415 volts, $\pm 10\%$, 50Hz. The system shall be 3 phase, 4 wire with the transformer neutral grounded (TN-C).

The Main 400V switchgear shall be divided in two busbars connected with a bus coupler. The two incoming feeders shall be connected to one busbar each.

An Emergency Diesel Generator shall be supplied and connected to the busbar for prioritized loads, meaning the generator shall not be dimensioned to supply the total load of the switchgear.

Each one of the 11/0,4kV Local Transformers shall be rated to supply the entire switchgear load according to data in Technical Schedules.

In normal operation both local transformers shall be energized and only one of the incoming feeders circuit breakers closed. If power fails, an automatic switch-over shall be made to the other incoming feeder. If both feeders power fails, the bus-coupler shall open and Diesel generator shall start to supply the prioritized busbar.

The Contractor shall dimension the system with due consideration to the present and future load and cables shall be dimensioned for a maximum voltage drop of 5 % during full load. The

Contractor shall also select components assuring selectivity through the plant and document this selectivity through a selectivity plan.

12.16.24.2 Switchgear and Distributions Boards

12.16.24.2.1.1 General Design

The Main 400V AC switchgear and the larger ones of the sub distributions shall be of the floor mounted prefabricated metal enclosed type, with separate compartments for each feeder, etc. Small sub distributions may be of the wall mounted steel sheet or cast metal type.

The switchgear, boards and panels shall be self ventilated. No forced ventilation system is allowed.

Permissible temperature rise shall not be exceeded even when the free space available for future feeders is mounted with feeder equipment and loaded with rated current.

The covers (outside covers and doors, including hinges and locks) shall safely withstand the overpressure caused by short circuit currents and shall protect personnel against injury.

The design shall allow for easy access to the equipment, cable terminals, etc. during erection, maintenance, disassembly and extensions.

In addition to the required number of outgoing circuits, one more of each rating employed (but not less than five all together) shall be fully equipped ready for connection of future circuits.

Furthermore, each board and panel shall have at least 20% free space available for future extensions.

The Main 400V switchgear shall be designed so that additional panels can be added in the future (i.e. possibilities for extending the busbars).

Operating handles, operating switches and push buttons, signalling lamps, position indicators, instruments, etc., shall be placed on the fronts. Relays which are not incorporated on the circuit breakers shall be placed in separated compartments, metal shielded from the current carrying parts.

The busbars shall be of copper and shall have three phases and a PEN (PE+Neutral) bar (TN-C, 4-wire system).

12.16.24.2.1.2 Circuit Breakers

In general, Circuit Breakers (Molded Case Circuit Breakers, MCCB’s allowed) shall be used for all feeders and distribution circuits.

Miniature Circuit Breakers, MCB's, may be used on small circuits.

Fuses may be used in exceptional cases such as on very light loaded circuits, or in combination with small contactors and where the use of fuses is justified for the purpose of selectivity.

In the design of the distribution systems and in the selection of circuit breakers, MCB's, fuses and protection relays, due attention shall be paid to the selectivity of breaker tripping at overloads and at short circuits.

Full selectivity shall be achieved, only the feeder or circuit which has an overload or short circuit shall trip.

Undelayed MCB's shall be used only as the last breaker of a circuit. Selectivity between MCB's and fuses shall be proved, with ample margin.

The circuit breakers shall be manually operated except for the breakers in the Main 400V switchgear feeders from the Local auxiliary Transformer, Diesel Generator and Bus-coupler, which shall be electrically operated.

All circuit breakers and MCB's shall have three phase overload and short circuit protection to be provided as a part of the breaker assembly or provided separately as for the transformer circuit breaker (in this case separate current transformers shall be included).

The ratings of the overload and the short circuit protections shall be selected according to the current rating of the cable or circuit to be protected, and in accordance with the requirements of the selectivity as stated above.

The ratings of the overload and the short circuit protections shall cover the whole of range operations up to the maximum rating of the apparatus. The rating of settings on the overloads and circuit breakers shall not limit the operations of the equipment being protected.

Operating coils of circuit breakers, which are not continuously rated shall be suitably and economically protected from unexpected prolonged energization.

12.16.24.2.1.3 Current Transformers

Current Transformers shall have synthetic resin insulation or equivalent dry insulation.

The cores for measuring purposes of current transformers shall have Accuracy Class 1 and Instrument Security Factor less than or equal to 5.

The cores for protection shall have Accuracy Class 5P and accuracy limit factor greater than or equal to 20.

Power frequency test voltages, 1 minute:

- Primary: 3 kV
- Secondary: 2 kV

12.16.24.2.1.4 Instruments and Relays

Panel mounted instruments shall be of 96 x 96 mm square pattern with (at least) 90° pointer deflection.

Instruments shall be of the three-element type, for unbalanced three phase load and loaded neutral conductor.

The relays shall preferably be of the programmable numerical type.

The instruments and relays shall, as far as applicable, be of the same make and type as those of the other parts of the plant.

12.16.25 DC Supply

12.16.25.1 General

110V DC shall in general be used for the Control and Protection systems and for DC motors (CB, DS, ES), unless otherwise stated in this document for specific equipment, and when 110 V DC is already in use in existing substations covered within Scope of Supply.

48V DC has in general been foreseen as supply voltage for the Communication systems.

The design of the LV DC systems shall provide for:

- High operational security and reliability,
- Minimal maintenance,
- Simple operation and fault diagnosis,
- Alarm monitoring facilities.

The Contractor shall calculate and determine the battery capacities, the power ratings of chargers, the number of sub distribution boards, the number and size of circuits, etc., to suit the requirements of the equipment to be installed, but also considering future extensions.

Distribution

Each DC Main Distribution Board shall be provided with a voltage monitoring device with alarm contacts and signal lamps, one lamp for each type of fault. The device shall monitor maximum and minimum voltages as well as ground faults on both poles.

- DC busbars and internal conductors to circuit breakers, fuses, MCBs etc. shall be insulated.
- All circuit breakers and switches shall be manually operated.
- All circuit breakers, switches and MCBs shall be 2-pole, with thermal overload and magnetic short circuit protection in both poles.
- All circuit breakers, MCBs, switches, contactors, fuses, etc., shall be of a type specifically designated for DC use, and the dynamic current and the making and breaking capacities shall be ample for the short circuit power of the batteries.
- Due attention shall be paid to the selectivity of breaker tripping.
- All circuit breakers, miniature circuit breakers, switches and contactors shall have an alarm/indication contact.
- On circuits protected by fuses an undervoltage relay with alarm contact shall be provided.

12.16.25.2 110V DC system

The 110V DC shall comprise of two independent systems: SUB 1 and SUB 2.

Each system shall have its own battery, rectifier, distribution system and monitoring. The two systems shall be physically and electrically separated:

- Separate battery rooms
- Physically separated Rectifiers and Distribution boards. These can be in the same room, but the cabinets shall be installed in different rows or as far away from each other as possible.
- Physically separation of SUB 1 and SUB 2 cables (by e.g. routed on separate cable trays etc.)

The Rectifier and Main Distribution Board shall be located as close as possible to each battery room, but they are not allowed to be installed *in* the battery room.

The Main Distribution board in SUB 1 shall be able to cross-feed with the Main Distribution board in SUB 2, requiring one system to carry all loads while the other system is out of service or when boost charging one battery.

The battery systems shall be dimensioned for 12 hours of operation of normal loads such as control, protection, communication and inverters without charging.

The rectifiers shall be designed to recharge the batteries, up to 90% of rated C10-capacity within 12 hours after a six-hour discharge, while supplying the connected loads at the same time.

The voltage at individual components when the system is at no load must not exceed the nominal voltage (110V) by more than 10% and must not fall below the nominal voltage by more than 15% when the system is at full load. Therefore, shall all connected loads, e.g. tripping coils, be operable from 80 % up to 110 % of the nominal voltage (i.e. from 88 V to 121 V).

12.16.25.2.1 Battery

The batteries shall be of maintenance-free type VRLA Gel with a cell life expectancy of at least ten (10) years.

The capacities of the batteries shall be selected to permit a 12 hour service without AC power with DC loads as specified below. At the end of this period the voltage of the DC networks (measured on the busbars of the main distributions) shall be at least 90% of the rated voltage with the batteries being loaded as specified.

The battery must be dimensioned for secure and selective operation of the short circuit protection devices (fuses and MCBs).

The battery shall be erected on non-corrosive stands and be totally insulated from frames and earthed equipment. The battery must be erected in such way that maintenance and service easily can be carried out. Acid resistant vessels under the battery shall be included.

The floor in the battery room shall be provided with an acid-resistant gully connected to a sewage pipe. The floor shall have adequate sloping towards the gully. Further shall each battery room be equipped with a sink and emergency eye shower.

12.16.25.2.2 Rectifier (battery charger)

The rectifiers shall be of solid-state (thyristor or transistor) constant voltage charge type and have automatic current limitation.

The rating of each battery charger shall be sufficient to carry the specified maximum load of Contractors installed equipment plus 20% spare capacity whilst maintaining the batteries in a fully charged condition.

The batteries shall normally be kept charged by the battery charger system operating in float charge mode.

When the batteries are connected to the charger(s), the psophometric noise level at the power supply output under any operational condition and for loads between 0% and 100% of rated output power shall not exceed the equivalent of 2 mV at a frequency of 800 Hz after weighting as defined in ITU-T Recommendation O.41/P.53.

Ripple voltage on the charger outputs with the battery disconnected shall not exceed 0.1% of the working voltage.

The rectifiers shall be equipped with volt- and ampere-meters (accuracy class 0.2), indication lamps and Test outlets for 4 mm banana-plugs.

A mimic diagram shall be provided on the front panel of the battery charger cabinet(s) that clearly displays the main circuit components, their interconnections, and the various switching devices.

The local control panel shall also be mounted on the front panel of the battery charger cabinet(s) to show the mode of operation and the status of the key parameters.

The battery charger system shall be self-monitoring and generate alarms when faults are detected. Alarm conditions shall be displayed on a local control panel and connected via voltage free contacts to the local RTU to enable them to be annunciated to the operator.

As a minimum, the following information shall be displayed:

Measurements:

- Voltmeter displaying the supply output voltage
- Ammeters displaying the output current for each charger and the battery charge/discharge current.

Status Indications:

- Charger on/off
- Charger mode (float, boost, and equalizing),
- Current limiting in operation

Alarm Signals:

- AC supply failure,
- Charger faulty (each charger),
- Battery voltage high

- Battery voltage low
- Battery earth fault
- Battery fuse blown
- Output DC MCB trip (common for all MCBs)

If the DC-supervision is mounted in the rectifier, it shall be connected at the external side of the rectifier fuse to prevent mal-operation if the fuse will trip.

12.16.25.2.3 Battery Conductors and Fuses

Conductors from the batteries to the fuse boxes shall be mounted short circuit and earth fault proof. That is, the conductors shall be single pole insulated and in addition placed on insulators, separate for each pole. All conductors shall be placed at minimum 5 cm distance from each other, even at crossings.

The conductors shall lead through insulating pipes in the wall of the battery room to closed fuse boxes made of insulating material on the wall outside the battery room. For the 110 V DC system there shall be one box per pole. The wall holes shall be tightened against gas.

Conductor insulation, insulators and pipes shall be resistant to sulphuric acid.

12.16.25.3 48V DC system

.

For 48V DC power supply to Telecommunication Equipment, see 12.20.11

12.16.25.4 UPS 220V

An Online Uninterruptible Power Supply (UPS) system shall be supplied for power supply to essential systems that are not powered by the 110VDC systems, such as:

- PC Computers,
- Monitors,
- Printers,
- Indoor Emergency Lights

The UPS system shall be for continuous operation and shall include a Static by-pass switch to switch to the Main AC-supply in case of a failure in the UPS. In addition, a Manual

operated by-pass switch shall be included (located in the panel next to the inverter) for complete bypass of the inverter.

The UPS unit shall have self-diagnostics with alarm for internal faults and abnormal operations, communicated to the SCADA system.

12.16.25.5 Spare Parts

In addition to requested spare parts in this document and in the Price Schedules, Bidders are requested to state their recommendations at the time of bidding for extra spares bearing in mind that the auxiliary supply system is critical to the main operations and shall be in continuous uninterrupted operation for 25 years.

Spares shall be delivered with the associated equipment and, in order that spares may be placed on order at short notice, full details including Catalogue and/or spare part numbers of all spares should be supplied with Bid.

12.17 Technical Specifications for LV Housing Complex Distribution

A pole mounted transformer shall be erected at the existing 33 kV OHL passing the 330kV Stepdown Nakonde Substation plot at the east side, for distribution to new houses to be built under this contract. From the transformer a 3-phase LV OHL shall be built passing the new houses. Each of the six houses shall be connected to the line by 1-phase service connections. The LV OHL shall consist of Aerial Bundled Conductor (ABC) erected on wooden poles.

12.17.1 Distribution Transformers

12.17.1.1 Design

The transformer shall be designed for outdoor operation and continuous service. 250 kVA transformers and smaller should be suitable for pole mounting. Refer to drawing T1 - 33kV Pole Mounted Transformer.

Type

The transformer shall be of three-phase, oil-immersed, natural air cooled (ONAN) type. All distribution transformers shall be of sealed type with bolted lid.

12.17.1.2 Electrical Data

Short-circuit Currents

The transformer shall withstand the thermal and mechanical effects of any short-circuit that can appear at the terminal of any winding according to General Requirements.

Rated Voltage

The rated voltages shall be:

33 000 $\pm$ 2 x 2.5%/400 V

Vector Group

The vector group of the three-phase transformers should be Dyn11.

12.17.1.3 Losses

The losses should be stated and guaranteed in the Bid. These guarantees should be assumed as maximum values and shall not be exceeded.

12.17.1.4 Marking

Each transformer should be provided with a rating plate including the information stated in the IEC standards included in section 12.2.

12.17.1.5 Bushings

Bushings should withstand the same current as the windings and for the same period of time. Current carrying outer parts should be made of copper or copper alloy. It should be possible to change the bushings without dismantling the transformer cover. Each bushing should be marked with manufacturer and type. The marking should be visible after assembly of the fittings.

The outer creepage distance for the bushing should as per technical schedules.

The insulation levels of the bushings should be at least equal to those specified for the windings. The neutral connection should have a permanent, special marking, different from the phase connections.

12.17.1.6 Off-Load Tap Changer

The high voltage windings should be provided with an off-load tap changer. The off-load tap changer should have an external mechanism for manual operation. The operating mechanism should have an effective locking device for locking of the tap changer in any desired position.

12.17.1.7 Corrosion Protection

Transformers suitable for pole mounting should be hot-dip galvanised. Galvanising should consist of a continuous coating of zinc to a minimum weight of 600 g/m². The zinc coating should meet the requirements according to ASTM, A123, A143, A239 and A385. Other type of corrosion protection that can be shown to give a similar protection as hot-dip galvanising

may be accepted after special agreement. The inner surfaces of the tank, oil conservator and radiators should be coated by an oil resistant paint. Separate radiators and smaller parts such as brackets, etc. should be hot-dip galvanised. Fasteners mounted on hot-dip galvanised or ready painted part should be galvanised or made of stainless steel ISO class F1 or A2.

12.17.1.8 Tank with Accessories

Tank

The tank should be designed for natural cooling (ONAN) with a corrugated tank. The transformer should be equipped with lifting lugs for lifting the complete transformer with oil and mounted bushings. Lifting lugs should also be available for lifting the core and coils out of the tank.

Transformer shall have a flat tank bottom. Two earthing terminals for connection of earth wires of at least 120 mm² cross-sectional area should be provided, one placed on the cover close to the neutral terminal and one placed at the bottom of the tank.

Oil Conservator, Valves

All transformers shall be of sealed type and should be designed for the expansion of the oil due to changes in the temperature. A filling stub with an inner diameter of at least 25 mm should be placed at the top of the cover or oil conservator. Transformers should have an oil drain valve placed at the bottom of the tank.

Monitoring Devices

Sealed transformers should be equipped with a pressure relief protection.

Oil

The transformer should be filled with oil before delivery. The oil should contain at least 0.3 per cent by weight oxidation inhibitor of type diterbutyl paracresol (DBPC) according to IEC 60296

The oil must not contain PCB. If oil samples taken from the transformer on delivery contain 2 ppm or more of PCB, the Employer has the right to refuse the delivery of the transformer.

12.17.1.9 Testing

All transformers should be routine tested according to IEC 60076.

The Employer’s representative will have the right to be present during the acceptance testing. One set of the routine test records for each individual transformer should be handed over to

the Employer/Engineer. At the first delivery of a new type of transformer type test records shall be submitted. Type test records older than eight (08) years will not be accepted.

12.17.2 LV Fuses

The LV fuses shall be as indicated in drawing T1 - 33kV Pole Mounted Transformer part number 6.

12.17.3 Marking of Equipment

All main parts of the plant shall be equipped with designation labels, such as substation number and circuit number.

Sizes shall be chosen with regard to label location.

Warning labels shall be mounted on all dangerous parts of the installation. Labelling, as is deemed necessary to prevent dangers arising from palpation of equipment.

Warning labels shall have red lightnings at both ends.

Designation system for text on designation labels will be provided by the Employer.

Text on warning labels shall be approved by the Engineer.

Labels shall be fixed by stainless steel screws or rivets.

12.17.4 0.4kV OH – Lines

12.17.4.1 Poles

The requirements in ZESCO CO.14900.TCSP.00053 “12 m Eucalyptus Pole” shall be fulfilled.

The following publication shall be applicable:

ISO 15206:2010 Timber poles – Basic requirements and test methods

Fibre stress requirement minimum 55 MPa.

12.17.4.2 LV ABC

Design and Dimensions

The cable should be of supporting-core system with three phase four conductors of hard-drawn compacted stranded aluminium conductors insulated by carbon loaded XLPE laid up-around an aluminium-alloy supporting core insulated by XLPE.

Table 20 LV Conductors

Number of phase conductors	Phase conductor Cross-sectional area	Supporting core cross-sectional area	Current rating	Short-circuit rating	Maximum Design Load
n	mm ²	mm ²	A	kA	kN
4	120	70	283	11	8

12.18 Technical Specification for Auxiliary Power- and Control Cables

12.18.1 Introduction

This specification covers the technical requirements of design, materials, performance requirements, manufacture, testing at the Manufacturer’s factory and supply to the site and commissioning of auxiliary power and control cables with all accessories for efficient and trouble-free operations.

12.18.2 General Requirements

12.18.3 Cable Schedules

The Contractor shall provide the Engineer with a preliminary cable bill of quantities per station including the following breakdown (for reference purposes):

Scheme identification and cable block diagram;

Cable data sheets;

Cable schedule;

Control room length;

Racking and trench length;

Buried length;

Vertical length;

Total length of cable and

Drawings showing cable racks, fixing features, etc.

A summary table shall be provided by the Contractor indicating the type of cable to be used and the total length in meters.

All dimensioning calculations shall be submitted to the Engineer for approval.

12.18.4 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with standards listed in Standards and Codes.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The Auxiliary & Power Cables supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

12.18.5 Design Overview

The overall conductor shall be sized in accordance with relevant IEC Standards as listed below to suit the required continuous current carrying capacity of the cable circuit, allowing for the method of installation and climatic conditions specified.

- IEC 60502-2: Power cables (1kV–30kV, XLPE/PVC).
- IEC 60227 (PVC) / 60245 (Rubber): LV control cables (300/500V).
- BS 5308 (UK): Instrumentation/control cables.
- BS 6724 (UK): LSZH armored cables.
- IEC 60332-1/2/3: Flame retardancy (single/bundled cables).
- IEC 60754-1/2: Halogen gas emission (LSZH compliance).
- EN 50200 / BS 7846: Fire survival (90/120-minute circuit integrity)
- IEC 61156-6: Screened multicore cables (industrial Ethernet).
- IEEE 422/525: Shielding/installation in power plants/trays.
- IEC 60840/60502: UV/ozone resistance (outdoor use).
- ISO 6722: Automotive thin-wall auxiliary cables.
- IEC 60228: Conductor flexibility classes

The dimensions of the insulation, armour and outer sheath materials shall be governed by the values given in relevant IEC standards.

Under no circumstances will joints be permitted in any auxiliary or control cable.

All cabling from the equipment operating mechanism and associated auxiliary contacts shall be in the scope of supply of the Contractor and shall be carried out using 600/1000 V grade, minimum 2.5 mm² stranded copper conductor, armoured, multicore cables or single core cables laid in heavy gauge galvanised steel conduits, unless otherwise specified.

All cabling from CTs and VTs to the relay shall be in the scope of supply of the Contractor and shall be carried out using 600/1000 V grade, minimum 4 mm² stranded copper conductor, armoured, multicore cables or single core cables laid in heavy gauge galvanised steel conduits, unless otherwise specified. The selection of conductor sizes for current transformer circuits shall be supported by calculations.

12.18.6 Technical Requirements

12.18.7 Cables and Wires

The cables to be used shall be of multi-core 600/1000 V grade, be fire retardant, zero halogen and low combustible type with copper conductors and copper screen. The cables shall have oil and moisture-proof insulation and, where the temperature exceeds that of ambient air, thermal characteristic insulation at least equal to class A of IEC 60085.

The cables shall withstand all electrical, thermal and mechanical stresses under the stated service conditions, and at a voltage of 10 % above the rated value.

Special mechanical protection of the cables shall be provided where required. All underground cables shall be provided with a barrier sheath surrounding each core. The cables shall be in compliance with IEC 60502 Clause 5.4 and ISO 22190:2020 standards for resistant to termites and rodents. Steel wire armouring or equivalent mechanical protection shall be provided.

Cables shall be protected against direct sunshine.

All cables shall be terminated/glanded at the base of the boxes and kiosks.

Wherever the risk of inductively transferred disturbances during abnormal (short circuit, earth fault) conditions as well as during normal conditions exists, the cables shall be screened. The screen of telecommunication and control cables shall be earthed at one end only for connections within the powerhouse.

D.C. cables between charger and battery and between battery and distribution panel shall be single core type without metallic shield or armour and shall be made as short as possible up to first fuse place outside the battery room.

The neutral conductor shall be of the same cross-section as the phase- conductors.

The following conductor sizes are allowed to be used: 1.5, 2.5, 4, 6, 10, 16, 25, 50, 70, 120, 185 and 240 mm².

The surface of the sheath shall be marked as follows in English:

Name of manufacturer;

Year of manufacture;

Cross-section area of phase-conductors and number of cores.

Each Protection and Control cable shall have at least 10% s or minimum two (2) cores spare capacity to cater for future requirements or modifications. If two or more cables (for the same type of circuit and same voltage level) are routed between the same object in both ends, the spare capacity can be calculated based on the total amount of cores.

12.18.8 Cable Terminations

The minimum requirements for cable terminations are that after installation, they shall withstand the environmental and climatic conditions as well as the cable itself and thereby cause no risk for reduction of the expected lifetime of the system. They shall also fulfil the same electrical standards for insulation and current rating.

12.18.9 Secondary System Wiring into Panels and Kiosk

For wiring within boards, the "bunch" pattern shall be adopted. For a small number of connections, wiring may be grouped using flexible plastic bands or equivalent. For a large number of connections, a system using support strips or U-shaped trenchess (with covers) shall be used. The latter principal arrangement shall apply for cable distribution racks.

The screens or screened pairs of multicore cables shall be earthed at one end only. The position of the earthing connections shall be shown clearly on the diagram. Multi-stranded conductor ends shall be fitted with a suitable crimped thimble (bootlace ferrule type). The thimble shall be of correct type and length according to the core size. Each wire shall be separately terminated with crimped terminations unless otherwise approved.

The terminating of multi core power or control cables shall be carried out with suitably sized captive cone cable glands, the size of glands shall be determined by the gland manufacturer. Each gland termination indoors or outdoors shall be fitted with a neoprene shroud.

All wiring shall terminate at terminal blocks. The latter shall be of the moulded type and provided with barriers to separate power from control cables. All terminals shall be fitted with visible isolation bridges. It shall be possible to replace a single terminal block without dismantling a whole row. Where appropriate, terminal blocks shall be equipped with facilities for testing, such as short-circuiting, separating, plugging in, etc. Terminal blocks shall be located at least 300 mm from the bottom of the panel and shall be easily accessible. They shall be clearly marked, the designations being those entered in the respective wiring diagrams.

Terminal blocks for different voltages shall not be mixed between one another. The blocks shall be grouped for each voltage, and they shall be clearly marked for easy identification of the system voltage.

All internal secondary wiring connecting into terminal blocks for external connections shall be numbered at both ends with an approved type of identification marking device, these shall be permanently marked with black letters embossed on a yellow background or otherwise to approval of the Engineer. Interlocking type ferrules shall be used and shall match the size of conductor wire onto which they will be fitted.

Ferrule arrangements shall read from left to right on terminal rails and from the crimped lug to the insulation for relay and equipment terminations. The cable marking shall be fireproof.

Terminal blocks using screws acting directly on the wire (conductor) as well as spring type terminal blocks are not acceptable. To avoid squeezing of the wire the screw pressure shall be applied by a pressure plate having smooth edges.

Only one conductor shall be connected to each side of a terminal block and the branch-offs shall be made by interconnecting the necessary number of neighbouring blocks by means of copper strips, unless otherwise approved by the Employer.

All wiring shall be terminated in the terminal blocks with an approved crimping lugs or compression type connectors as approved by the Engineer.

All crimping lugs shall be suitable for the type of terminal equipment on to which it is to be terminated.

All crimps shall be made with the tool recommended by the manufacture of the lug and to the Engineer's approval.

All crimps shall bear a unique identification mark embossed by the tool.

The stripping tool shall be of the type which allows the length of the strip to be pre-set, and to the Engineer’s approval. Any “nicked” or damaged wiring will be rejected and removed from the work place.

Error! Reference source not found. below is a summary of the wire numbers to be used in the protection schemes where applicable and is based on a B.S. standard for protection / electrical installations.

Table 12-14: Protection Scheme Wire Numbering

Description	Numbering
Main 1 Protection Circuits	K101 & K102
Main 2 Protection Circuits / Backup Circuits	K301 & K302
Close Circuits	K501 & K502
Spring Rewind Circuits for Breakers and Disconnectors	M101 & M102
Main 1 DC Supply	J1 & J2
Main 2 and Backup DC Supply	J3 & J4
Spring Rewind Incoming Supply	H1 & H2
Bus Zone Trip Circuits and Breaker Fail Inputs to Bus Zone	K1, K2 or K101, K102 etc.
AC Supply on Earth Leakage Circuits	H11 & H71
Alarm Circuits and Inputs to Recorders	L101
Sub-Alarm Circuits for Supervisory etc.	LL101
Supervisory Control	W1, W2 and W3
Analogue Signals to Meters and Remote Indication	W101
Main 1 Protection CT Inputs	A11, A31, A51, & A71
Main 2 Protection CT Inputs	A111, A131, A151 & A171
Backup Protection or Recorder CT Inputs	C11, C31, C51 & C71
Main Measurements or Metering CT Inputs	D11, D31, D51 & D71
Check Metering CT Inputs	D111, D131, D151 & D171
Main Bus Zone CT Inputs	B11, B31, B51 & B71
Check Bus Zone Inputs	B111, B131, B151, B171
VT Inputs	E11, E31, E51 & E71

The table below indicates the colour coding to be adhered to for all wiring.

Table 12-15: Colour coding for wires

Circuit	Colour	Wire type
CT circuits	Phase coloured (R Y B Black)	Multi-stranded; Minimum 4.0 mm ²
VT circuits	Phase coloured (R Y B Black)	Multi-stranded; Minimum 4.0 mm ²
DC circuits	Grey	Multi-stranded; Minimum 2.5 mm ²
Alarm circuits	Grey	Multi-stranded; Minimum 1.5 mm ²
AC Circuits	Phase coloured	Multi-stranded; Minimum 2.5 mm ²

12.18.10 Cable Laying

Auxiliary and Control cables shall be laid in precast concrete cable trenches with Sub 1 and Sub 2 separated. Power cables shall be erected on own cable racks. The design of the cable trenches will be subject to the approval of the Engineer.

12.18.11 Cable Racks

All cable rack designs must be approved by the Engineer. Cable racks, accessories and suspension fittings shall be hot dip galvanised or be made of aluminium.

The cable racks shall be designed to allow the laying of the cable from the side(s) without pulling through. All racks and fixing devices shall be hot dip galvanised.

Accessories shall be designed so pulling of cables can be done without damage. Diversion plates shall be used at junctions.

The distance between a horizontal rack and the wall shall exceed 50 mm to allow cables to be pulled down between the rack and the wall. Sharp edges, tips of screw etc., shall be removed from the rack before cable pulling.

The cable racks shall be connected to the station earth wire system every 25 m if no earth wire is laid along the rack.

A copper earthing wire of minimum 50 mm² cross section shall be tied underneath to the rack and at every second step.

Furthermore, high voltage and control cables shall be laid on separate cable racks, and with a distance of at least 300 mm between respective type with Sub 1 and Sub 2 separated.

Cables on horizontal cable racks shall be tied to the rack at every third step and on vertical racks at every step.

12.18.12 Tests

Cables shall be subjected to routine and acceptance tests in accordance with standards specified. Test methods shall conform to relevant international standards. The Contractor shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National Standards.

Type and Routine test certificates for all types of cables shall be submitted to the Engineer.

12.19 Technical Specification for SAS, Protection, Metering and Monitoring

This specification addresses the detailed design, supply, installation, testing and commissioning of protection and control for Kasama 330kV substation extension and greenfield New Nakonde 330kV Stepdown substation.

12.19.1 General

The SAS and Protection equipment provided shall be suitable to protect the electrical system in the event of the occurrence of faults such as phase faults, earth faults, busbar faults, feeder faults, breaker failure, etc.

The Contractor shall ensure that the equipment offered is suitable for the application and that the equipment characteristics satisfy the tripping time and load current requirements.

Should equipment with different characteristics or operating principles to those specified be offered, the Tenderer shall state the reason for offering such equipment as well as the advantages of the said scheme over the one specified.

The utilisation of equipment in terms of functionality and information resolution shall be optimised while minimising the duplication of functions and hard-wiring by making use of data processing and communication facilities inherent to modern Intelligent Electronic Devices (IED). All IEDs, meters and disturbance recorders shall be time-synchronized by GPS or PTP/IEEE-1588, and that event, fault and metering records must be securely archived and made accessible to both utilities for settlement, compliance and dispute resolution.

The contractor shall provide a station-wide, redundant time synchronization system (dual GNSS clocks with PTP/IEEE 1588 and IRIG-B outputs) to align all protection, fault recorders, and settlement metering timestamps which is also critical for event analysis.

The equipment offered shall be of the latest proven numerical technology with the following general requirements;

Shall be standard “off the shelf” equipment having a proven track record in terms of in-service utilization in Utilities world-wide for similar voltage levels as per the scope of this works,

Protection Relays shall have a proven track record in terms of in-service utilization in world-wide transmission networks applications for at least 5 years,

Shall be designed to function as intended for at least 15 years without major maintenance (e.g. card replacement),

Spare parts shall be available for at least 10 years after the end of sales. Shall be IEC 61850 compatible,

The cumulative years of service is based exclusively on the in-service period of identical hardware and software versions offered (i.e. same relay family and/or type).

With the tender submission, the tenderer is to submit a set of drawings that show the high level protection scheme, protection panel/s layout, BCU / SAS panel layout (as applicable) and a drawing that depicts the communication topology architecture of the proposed offer. The drawings are to depict actual quantities of all major components offered.

12.19.2 Design Overview

The design shall be in the form of functional design specifications, detailed design specifications including panel schematic diagrams, interlocking schemes, interfacing diagrams, cable block diagrams, detailed cable termination schedules, protection and control IED/s relay logic diagrams and Input / Output Schedules.

Prior to procuring the Control and Protection (C&P) equipment, the Contractor shall prepare and submit a Functional Design Specification (FDS) to the Employer for review and approval. This document as a minimum shall indicate the following;

Proposed Panel General Arrangement (Door Layouts indicating the placement of the new C&P equipment to be housed in the panel);

For existing substations to be extended/refurbished:

Interfacing / Protection and Control Philosophy Drawings which shall indicate the interfacing between the SAS equipment supplied under the Scope of this project and all other equipment which shall include but not be limited to the Primary Plant (Circuit Breakers, Reactors, Disconnectors etc.), the DC distribution scheme, other bays for inter-bay interfaces, busbar protection scheme, station wide control and interlocking schemes, inter-tripping schemes, the SAS and any other equipment as per the applicability of the existing plant and design requirements;

Proposed Interlocking Schemes for inter-bay interlocking, busbar interlocking, equipment interlocking (Circuit Breakers, Disconnectors etc.). This may be presented in the form of interlocking matrices, descriptions and drawings;

Proposed Input / Output schedules for IED's and all other devices utilizing IO. The IO schedules must clearly indicate the proposed IO assignments as well as the spare IO.

Hardware and/or software ordering codes;

Concerns and/or deviations from the Scope of Work.

The procurement of the C&P equipment and detailed design shall proceed following the approval of the FDS by the Engineer. The FDS is followed by the Detailed Design Specification (DDS) which shall be prepared by the Contractor and submitted to the Employer for approval.

The DDS shall comprise the detailed schematics, scheme and interface drawings and detailed construction drawings. The approval of the DDS permits the Contractor to proceed with the construction works, i.e. the building and wiring of panels and other construction works required for the Protection, Control, Metering and Telecommunication systems.

The Contractor shall supply, install and commission the C&P equipment as indicated in the Scope of Supply. In the instances where the integration of the newly supplied C&P and SAS equipment with existing SAS scheme/s requires modifications to existing equipment and/or schemes and unless explicitly excluded from the Contractors Scope shall include the design, implementation of the modifications and testing and commissioning of these existing interfaces, modifications and equipment.

Where applicable, should the Contractor modify any existing scheme/s, the Contractors Scope shall include the supply of new drawings with the effected changes in replacement of the existing drawings.

All testing and commissioning during the FAT (Factory Acceptance Testing) and SAT (Site Acceptance Testing) shall be carried out utilizing a signed set of the latest revision of schematics.

Unless otherwise specified, Main 1, Main 2 and Backup protection functions shall be provided by separate protection devices. Various protection functions may be integrated in the same protection device. The Breaker Failure Protection (/breaker fail protection initiation) must be integrated within the Main and Backup protection devices.

Redundancy shall be built into the tripping circuits by means of the following features:

Separate main and back-up DC supplies from segregated DC supplies. Isolation of one must not affect the other;

Dual Main / Main and back up protection working in different modes and powered off different instrument transformers and power supplies;

Trip circuit supervision with circuit breaker in opened or closed state on both tripping circuits.

Cross tripping from relays to both tripping circuits.

Kasama 330kV substation

The equipment required for this project shall be selected, designed and configured to be fully integrated with the existing protection and control IEDs already in service in the Kasama 330kV substation. The Contractor is responsible for the supply, installation, configuration, testing and commissioning the new equipment as well as the expansion of the existing systems.

The Contractor shall be responsible for the detailed design of the protection, control and telecommunication schemes as detailed in the Scope of Supply, including integration thereof with the existing Substation Control Scheme, which shall include but not be limited to;

Integration with the Busbar Protection Scheme

Integration with the Buscoupler Protection Scheme

Integration with the WAMPACS Scheme

Integration with the substation automation system/s as applicable;

Integration with existing hardwired control and interlocking scheme/s as applicable;

Integration with existing busbar and bay Interlocking Scheme/s as applicable

Integration with existing control scheme/s;

Integration with DC Distribution Scheme.

12.19.3 Standards

The equipment covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected and tested in accordance with the standards listed in Section 1 and 12

The applied standards shall be the latest edition at the time of Contract signing.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed and resolved to the approval of the Employer. The protection and control equipment supplied under this project shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

For design and type testing of the protection and control equipment, the following standards shall be applicable:

General

Table 12-16: General standards for SAS, Protection, WAMPACS and Metering

IEC 60255:	Electrical relays
IEC 60038:	IEC Standard voltages
IEC 60068:	Environmental testing
IEC 60664:	Insulation coordination for equipment within low-voltage systems

CE-marking

EN 50081-2 Emissivity

(Industry) EN 50082-2 Immunity (Industry)

Table 12-17: Detailed Standards for SAS, Protection, WAMPACS and Metering

IEC 60255-6:	Measuring relays and protection equipment
IEC 60255-7:	Test and measurement procedures for electromechanical all-or-nothing relays
IEC 60068-2-3:	Test Ca: Damp heat steady state
IEC 60068-2-30:	Test Db and guidance; Damp heat, cyclic
IEC 60255-5:	Insulation tests for electrical relays
IEC 60255-22:	Electrical disturbance tests for measuring relays and protection equipment
IEC 60255-22-1:	1MHz burst disturbance test
IEC 60255-22-2:	Electrostatic discharge test
IEC 60255-22-3:	Radiated electromagnetic field disturbance test
IEC 60255-22-4:	Fast transient disturbance test
IEC 60255-11:	Interruptions to and alternating components (ripple) in D.C auxiliary energizing quantity to measuring relays
IEC 60255-6:	Measuring relays and protection equipment

IEC 60255-21:	Vibration, shock, bump and seismic tests on measuring relays and protection equipment
IEC 60255-21-1:	Vibration tests(sinusoidal)
IEC 60255-21-2:	Shock and bump tests
IEC 60255-21-3:	Seismic tests
IEC 60255-0-20:	Contact performance of electrical relays
IEC 60870-3class2:	Digital I/O, analogue I/O dielectric tests
IEC 60801-5/class3:	Digital I/O surge withstand test
IEC 60870-3/class 2:	Radio interference test
IEC 60801-4/4:	Transient fast burst test
IEC 60801-2/4:	Static discharge
IEC 60801-3/3:	Electromagnetic fields
IEC 61850	Communication and networks in substations

Table 12-18: Type test standards

Type Test Name	Type Test Standard	Conditions
Insulation Resistance	IEC 60255-5	100 MΩ at 500 Vdc (CM & DM)
Dielectric Withstand	IEC60255- 5 IEEE C37.90	50 Hz, 1mn, 2kV (CM), 1kV (DM) 50 Hz, 1mn, 1kV (CM) G 1.4 & 1.5 500V CM G 6 :1,5 kV CM
High Voltage Impulse Test	IEC 60255-5	5kV (CM),3kV (DM), 2kV (CM) Groups 1 to 6 :5 kV CM & 3 kV DM(1) Not on 1.4 & 1.5 : 5 kV CM & 3 kV DM(1)
Free Fall Test	IEC 60068-2-31	Test Ec : 2 falls from 5cm Test Ed : 2 falls from 0,5m
Free Fall Packaging Test	IEC 60068-2-32	2 falls of 5 cm (Computer not powered)

		25 falls of 50 cm (1) (2) (Packaging computer)
Vibration Response – Powered On	IEC 60255-21-1	Class 2 : 1g from 2 to 150Hz Class 2: Acceleration : 1g from 10 (1) to 150Hz
Vibration Response – Not Powered On	IEC 60255-21-1	Class 2 : 2g from 2 to 500Hz Class 2: Acceleration : 2g from 10 (1) to 500Hz
Vibration Endurance – Not Powered On	IEC 80068-2-6	Class 2 : 1g from 10 to 150Hz Class 2 : Acceleration : 1g from 10 (1) to 500Hz
Shocks – Not Powered On	IEC 60255-21-2	Class 1 : 15g, 11 ms
Shocks – Powered On	IEC 60255-21-2	Class 2 : 10g, 11 ms
Bump Test – Not Powered On	IEC 60255-21-2	Class 1 : 10g, 16ms, 2000/axis
Seismic Test – Powered On	IEC 60255-21-3	Class 1 :
On		Axis H : 3,5mm – 2g Axis V : 3,5mm – 1g Class 2 : Acceleration : 2g Displacement : 7,5mm selon axe H Acceleration : 1g Displacement : 3,5mm selon axe V
Damp Heat Test - Operating	IEC 60068-2-3	Test Ca : +40°C / 10 days / 93% RH

Cold Test - Operating	IEC 60068-2-1	Test Ab : -10°C / 96h Test Ab : - 25°C / 96 H
Cold Test - Storage	IEC60068-2-1	Test Ad : -40°C / 96h Powered On at -25°C (for information) Powered On at -40°C (for information)
Dry Heat Test - Operating	IEC 60068-2-2	Test Bd: 55°C / 96h 70°C / 2h 70°C / 24 H
Dry Heat Test - Storage	IEC 60068-2-1	Test Bd : +70°C / 96h Powered On at +70°C
Enclosure Protection	IEC 60529	Front : IP=56 Rear : IP=30
Inrush current (start-up)		$T < 1,5 \text{ ms} / I < 20 \text{ A}$ $T < 150 \text{ ms} / I < 10 \text{ A}$ $T > 500 \text{ ms} / I < 1,2 I_n$
Supply variation	IEC 60255-6	$V_n \pm 20\%$ $V_n + 30\%$ & $V_n - 25\%$ for information
Overvoltage (peak withstand)	IEC 60255-6	1,32 V_n max 2 V_n during 10 ms (for information)
Supply interruption	IEC 60255-11	From 2,5 ms to 1 s at 0,8 V_n 50 ms at V_n , no malfunction (for information)
40 s interruption	IEC 60255-11	

Ripple (frequency fluctuations)	IEC 60255-11	12% Vn at f=100Hz or 120Hz 12% Vn at f=200Hz for information
Supply variations	IEC 60255-6	Vn $\pm$ 20%
AC Voltage dips & short interruptions	EN 61000-4-11	2ms to 20ms & 50ms to 1s 50 ms at Vn, no malfunction (for information)
Frequency fluctuations	IEC 60255-6	50 Hz : from 47 to 54 Hz 60 Hz : from 57 to 63 Hz
Voltage withstand		2 Vn during 10 ms (for information)
High Frequency Disturbance	IEC 60255-22-1 IEC 61000-4-12 IEEE C37.90.1	Class 3 : 2.5kV (CM) / 1kV (DM) Class 2 : 1kV (CM)
Electrostatic discharge	IEC 60255-22-2 IEC 61000-4-2	Class 4 : 8kV contact / 15 kV air
Radiated Immunity	IEC 60255-22-3 IEC 61000-4-3 IEEE C37.90.2	Class 3 : 10 V/m – 80 to 1000 MHz & spot tests 35 V/m – 25 to 1000 MHz
Fast Transient Burst	IEC 60255-22-4 IEC 61000-4-4 IEEE C37.90.1	Class 4 : 4kV – 2.5kHz (CM & DM) Class 3 2 kV - 2,5 kHz MC Class 3 : 2kV – 5kHz (CM)

Surge immunity	IEC 61000-4-5	Class 4 : 4kV (CM) – 2kV (DM) Class 3 : 2kV (CM) on shield Class 4 : 4kV (CM) for information Class 3 : 1 kV MC
High frequency conducted immunity	IEC 61000-4-6	Class 3 : 10 V, 0.15 – 80 MHz
Harmonics Immunity	IEC 61000-4-7	5% & 10% de H2 à H17
Power Frequency Magnetic Field Immunity	IEC 61000-4-8	Class 4 : 50 Hz – 30 A/m permanent – 300 A/m short time Class 5 : 100A/m for 1mn 1000A/m for 3s
Power Frequency	IEC 61000-4-16	CM 500 V / DM 250 V via 0.1 µF
Conducted emission	EN 55022	Gr. I, class A and B : from 0.15 to 30 MHz
Radiated emission	EN 55022	Gr. I, class A and B : from 30 to 1000 MHz, 10m

12.19.4 Technical Data Sheets

The Contractor must clearly indicate his compliance to the Particular Requirements by accurately completing the Guaranteed Particulars Section of the Technical data sheets to the level of detail as specified in the subsequent paragraphs of this Section.

All deviations or exclusions from the Scope or Particular Requirements must be clearly indicated in a Deviations and Exclusions schedule which must be submitted as part of the Tender submission together with the Technical Data sheets. Any items required for a functional P&C solution that are not explicitly excluded from the Contractors exclusion list are deemed to be included in the Contractors Scope of works.

The manufacturer's name, type and designation number and ordering code of each type of relay or any other Intelligent Electronic Device (IED) offered, together with the corresponding pamphlet, brochure or buyers guide reference shall be entered by the Tenderer in the Technical data sheets. Documentation for each IED, including the functions and the number of instances thereof and a breakdown of the make-up of the order code must be provided.

12.19.5 Relay Protection

12.19.5.1 General

Each 330kV and (132)66kV bay’s Control and Protection system shall be divided into two (2) sub-systems, SUB 1 and SUB 2. These two systems shall be electrically and physically separated, all from separate 110V DC batteries/supplies, cables, CT/VT core connections/circuits, tripping circuits and tripping coils.

The 330kV and (132)66kV switchgear bays shall be protected by two Main protection systems (Main “1” and Main “2”). In addition a separate back-up overcurrent protection relay shall be provided, located in SUB 2.

In general, each bay shall have two cabinets;

SUB 1 cabinet including BCU and Main 1 protection IED (e.g. Differential Protection relay).

SUB 2 cabinet including Main 2 protection IED (e.g. Distance Protection relay) and Backup Feeder Protection relay.

SUB 1/SUB 2 protection system shall be capable of operating in stand-alone mode or in parallel with the other protection system in a “one out of two” tripping scheme.

Main 1/Main 2 protection shall be based on a unit protection principle e.g. current differential protection and aided distance protection scheme.

At Kasama 330kV substation the new protection panels (which shall be housed in the relay rooms in the main substation buildings) shall have the following minimum attributes:

Standard stand alone panel (the Contractor must ensure that the panel design and dimensions match the existing in the substations) equipped with the protection and control IEDs, miniature circuit breakers, fuses, fuse holders, terminals, wiring, test blocks, blanking plates, 230VAC plug socket, anti-condensation heater, door switch, light fitting and any other equipment not explicitly mentioned but required for the proper functioning of the scheme. The protection IED’s shall also have an adequate number of input and output channels.

For Kasama 330kV substation, the new bay’s protection IED’s should be matched to the existing suppliers and models installed if possible.

The contractor shall submit a protection coordination report compliant with IEC 60255 and ZESCO Protection Philosophy including SPAR and WAMPACS to be reviewed and approved prior to detailed design.

12.19.5.2 Line Relay Protection System

Main “1” Line Differential Protection system (SUB 1)

Shall consist of a numerical segregated longitudinal current differential protection over a multiplexed communication link to cover the complete length of the protected line.

The line shunt reactor shall be excluded from the transmission line differential protection zone.

To cover the possible failures in the communication link, the line current differential protection shall incorporate an integral 4-zone quadrilateral or mho phase and 4-zone quadrilateral ground distance protection function. A teleprotection scheme is not required for this integral distance protection.

The required communication link shall be a multimode fiber connection and communication converter conforming to G703-E1/T1 or IEEE C37.94 for fiber connection to the multiplexer of the PTN/OTN communication equipment.

The following functions shall as a minimum be included in the SUB 1 Main 1 protection IED:

Function	ANSI No.
Line Current Differential Protection with line charge compensation and protection channel interface for multiplexed link to the remote station	87L
Distance Protection 5-zone phase and 5-zone ground with quadrilateral characteristics, and mutual coupling compensation functionality	21/21G
Power Swing Trip and Blocking	
Load Encroachment blocking zone	
Directional Earth Fault Elements with permissive trip functionality for POTT and PUTT application	67N(F) & 67N(R)
Definite-time Overcurrent & Earth Fault Protection	50/50N
Inverse-time Overcurrent & Earth Fault Protection	51/51N
Directional time Overcurrent & Earth Fault Protection	67/67N
Overvoltage Protection	59

Function	ANSI No.
Undervoltage Protection	27
Circuit Breaker Failure Protection	50BF
Broken conductor detection	
CT Supervision	
VT Supervision	
VT Fuse Fail Supervision/Block	60
Trip for single-pole circuit breakers Circuit Supervision	74 TC
Synchro Check	25
Auto-Reclose Single-pole and three-pole sequenced and coordinated automatic reclosing functionality	79
Disturbance and Event Recording	
Fault Locator	
Self-monitoring	

Table 12-19: Main 1 Line protection IED functions

Main “2” Distance Protection system (SUB 2)

Shall consist of a numerical distance protection with permissive over-reach transfer-tripping unit protection. This distance protection scheme shall incorporate an integral directional earth fault element directional comparison teleprotection scheme for the detection of high resistance faults.

The line shunt reactor shall be excluded from the distance protection zone.

Distance protection shall be provided with an integral, two-way, high-speed, high-security inter-tripping facility. A set of inter-tripping signals which are to be transferred over the multiplexed communications system are required for the distance protection and for the directional comparison protection scheme.

The following functions shall as a minimum be included in the SUB 2 Main 2 protection IED:

Function	ANSI No.
Distance Protection 5-zone phase and 5-zone ground distance protection with quadrilateral characteristics and mutual coupling compensation functionality	21/21G
Power Swing Trip and Blocking	

Function	ANSI No.
Load Encroachment blocking zone	
Directional Earth Fault Elements with permissive trip functionality for POTT and PUTT application	67N(F) & 67N(R)
Definite-time Overcurrent & Earth Fault Protection	50/50N
Inverse-time Overcurrent & Earth Fault Protection	51/51N
Directional time Overcurrent & Earth Fault Protection	67/67N
Overvoltage Protection	59
Undervoltage Protection	27
Circuit Breaker Failure Protection	50BF
VT Fuse Fail Supervision/Block	60
Trip for single-pole circuit breakers Circuit Supervision	74 TC
Synchro Check	25
Auto-Reclose Single-pole and three-pole sequenced and coordinated automatic reclosing functionality	79
Disturbance and Event Recording	
Fault Locator	
Self-monitoring	

Table 12-20: Main 2 Line protection IED functions

Back-up Protection system (SUB 2)

Shall consist of numerical directional phase overcurrent and directional earth fault protection independent of the main relay protections. The earth fault overcurrent shall issue a transfer trip for failure of Main protection “1” and or loss of voltage measurement.

The following functions shall as a minimum be included in the SUB 2 Backup protection IED:

Function	ANSI No.
Definite-time Overcurrent & Earth Fault Protection	50/50N
Inverse-time Overcurrent & Earth Fault Protection	51/51N
Directional time Overcurrent & Earth Fault Protection	67/67N
Overvoltage Protection	59

Function	ANSI No.
Under/Over Frequency Protection	81
Circuit Breaker Failure Protection	50BF
Direct Transfer Trip	
CT Supervision	
VT Supervision	
Trip Circuit Supervision for single-pole circuit breakers	74TC
Disturbance and Event Recording	
Self-monitoring	

Table 12-21: Back-up Line protection IED functions

12.19.5.3 Transformer & Reactor Relay Protection System

Transformers and reactors shall be dimensioned for through-fault currents and inrush conditions resulting from the maximum short-circuit levels and protection settings, in line with IEC 60076-5. The relay settings and stabilizing resistors for differential and REF protection shall be justified by calculations and sensitivity checks for all operating states.

Main “1” Transformer and Reactor Differential Protection system (SUB 1)

The following functions shall as a minimum be included in the SUB 1 Main 1 protection IED:

Function	ANSI No.
Biased Current Differential Protection	87R/87T
Low Impedance Restricted Earth Fault Protection	64
Definite - timed overcurrent protection	50/50N
Inverse – time overcurrent protection	51/51N
Reactor over-excitation protection	24R
Reactor Buchholz protection	63
Reactor Pressure relief	
Reactor Oil Temperature	26
Reactor Winding Temperature	49
Circuit Breaker Failure Protection	50BF
Trip Circuit Supervision	74TC

Function	ANSI No.
Disturbance and Event Recording	
Self-monitoring	

Table 12-22: Main 1 Transformer & Reactor protection IED functions

Main "2" Transformer and Reactor Differential Protection system (SUB 2)

The SUB 2 Main 2 reactor protection relay shall be a duplication of the Main 1 protection IED, however the two IEDs shall be from different (approved by the Employer). The Reactor Mechanical protections shall only belong to SUB 1.

Neutral Reactor Protection system (SUB 2)

The following functions shall as a minimum be included in the SUB 2 Neutral Reactor protection IED:

Function	ANSI No.
Definite - timed overcurrent protection	50/50N
Inverse – time overcurrent protection	51/51N
Disturbance and Event Recording	
Self-monitoring	

Table 12-23: Neutral Reactor protection IED functions

Back-up Protection system (SUB 2)

The following functions shall as a minimum be included in the SUB 2 Backup IED:

Function	ANSI No.
Definite-time Overcurrent & Earth Fault Protection	50/50N
Inverse-time Overcurrent & Earth Fault Protection	51/51N
Directional time Overcurrent & Earth Fault Protection	67/67N
Circuit Breaker Failure Protection	50BF
Direct Transfer Trip	
CT Supervision	
Trip Circuit Supervision for single-pole circuit breakers	74TC
Disturbance and Event Recording	
Self-monitoring	

Table 12-24: Back-up Reactor protection IED functions

12.19.5.4 Bus-coupler Protection System**Main “1” Bus-coupler Protection system (SUB 1)**

The following functions shall as a minimum be included in the SUB 1 Main 1 protection IED:

Function	ANSI No.
Definite-time Overcurrent	50
Inverse-time Overcurrent	51
Directional time Overcurrent & Earth Fault Protection	67/67N
Undervoltage Protection	27
Circuit Breaker Failure Protection	50BF
Trip for single-pole circuit breakers	74TC
Disturbance and Event Recording	
Self-monitoring	

Table 12-25: Main 1 Bus-coupler protection IED functions

Main “2” Bus-coupler Protection system (SUB 2)

The following functions shall as a minimum be included in the SUB 2 Main 2 protection IED:

Function	ANSI No.
Distance 5-zone phase and 5-zone ground distance protection with quadrilateral characteristics and mutual coupling compensation functionality	21/21G
Overvoltage Protection	59
Under/Over Frequency Protection	81
Circuit Breaker Failure Protection	50BF
VT Supervision	
Trip for single-pole circuit breakers	74 TC
Disturbance and Event Recording	
Self-monitoring	

Table 12-26: Main 2 Bus-coupler protection IED functions

12.19.5.5 Busbar Differential Protection System

The new 330kV and 132 kV busbar systems shall be protected by a low impedance, phase-segregated, numerical busbar protection (BBP) with integral check zone and at least 2 unique protection zones (each switchgear is a double busbar design) and overall check zone.

The protection shall have the following properties:

- It shall be a phase segregated protection scheme without summation CTs
- It shall be sensitive to both short-circuits and earth faults within the bus system.
- The operation time including tripping relays shall be ≤ 30 ms.
- The protection shall withstand short-circuit currents thermally and dynamically for 1 sec.
- The protection shall be stabilised for through faults. It shall not give spurious function caused by CT over excitation during external fault, it must on the other hand function for internal faults even during over excitation of incoming feeder CT.
- The function of the protection shall supervise all CT secondary loops and shall be blocked if a measuring circuit is faulty.

The scheme shall be capable to protect a double busbar system. The BBP shall be able to operate on current transformers having a wide range of different ratios. The transformation to the proper ratio shall be determined by the input parameter at the bay level.

It shall be possible to feed the BBP system from two independent DC sources to enhance reliability, one SUB 1 feeder and one SUB 2 feeder.in parallel via DC/DC converter.The BBP scheme shall use at least two independent criteria for detection of an in-zone fault and shall initiate a trip signal only if both criteria are securely satisfied for a certain time. None of these criteria shall be voltage dependent.

At least one of these criteria shall compare the Fourier Transform of the absolute value of the vector addition of all currents with the addition of all absolute values of each individual current in each bay unit.

Combination of NO and NC auxiliary contacts on each disconnecter or breaker shall be provided for opening and closing the busbar replica of the protection in such a sequence that the auxiliary contractors operate before reaching the pre-arcing distance on closing the disconnecter, and after the pre-arcing distance has been exceeded on opening the disconnecter.

Full selectivity shall be achieved for every busbar zone. The replica of each feeder disconnecter, bus disconnecter, coupling CB and/or breaker sectionalizer shall be incorporated in the logic.

The protection trip command for each feeder shall be given directly to one of the circuit breaker’s tripping coil circuits as well as to the trip relay related to each feeder using mechanically latching master trip relays with minimum 4 N/O and 4 N/C contacts each.

The tripping command shall block the close-circuit of all circuits breakers concerned.

The sensitivity of the scheme shall be selectable to values higher than 120% of full load current or lower than the minimum system fault current, whichever is the smaller one.

The MMI shall consist of LEDs, a multi-functional display (IED integrated or stand-alone) and function keys on the front of each unit. LEDs shall inform at least about status and positions of HV-equipment, alarms, faults, initiation and tripping signals and condition of the BBP.

In case of a fault, faulty BB zone and phase and the fault current shall be indicated.

The display shall be able to show a painted mimic with the busbar and all its bays, breaker/disconnector status indications, as well as the zone number/naming;

The following functions shall as a minimum be included in the SUB 1 protection IED:

Function	ANSI No.
Biased Current Differential Protection	87B
Definite - timed overcurrent protection	50
Inverse – time overcurrent protection	51
Circuit Breaker Failure Protection	50BF
CT Supervision	
Disturbance and Event Recording	
Self-monitoring	

Table 12-27: Busbar protection IED functions

12.19.5.6 Protection Settings

A complete protection settings study must be carried out, with all settings supported by documented calculations. The protection settings shall be applied in a suitable simulation software package and the settings proposed must be modelled and demonstrated to be suitable for the system. This

Settings are to be applied and tested by the Contractor, including:

Protection scheme relaying devices;

The Contractor shall fully review the settings for the existing protection equipment, as there will be a significant change to fault levels and the direction of power flow and will make the necessary changes;

This shall be done in close liaison with the Employer. The Employer shall provide all the required network parameters to the Contractor. The Contractor shall submit a list of the parameters required one month prior to the information being needed;

The Employer shall approve all protection settings and philosophies to be applied;

Comprehensive protection setting calculations as well as the underlying network studies shall be submitted to the Employer for final approval, at least three months in advance of commissioning any new part of the substation;

The Bidder is required to determine the required CT ratios and R_s , V_{kp} and I_m values of the CTs where applicable that will suit the requirements of the protection relays being offered, and to specify the CTs accordingly. Calculations should accompany the CT design document to clarify the CTs proposed for approval;

The setting documentation shall be fully detailed and all calculations shall be shown. An electronic copy of the setting calculations shall be provided in excel that preferably mimics that of the relay software setting fields;

All relay configuration files (final), as well as all software applications necessary for changing the relay configuration, shall be supplied to the Employer on a USB together with the maintenance manuals.

12.19.6 Protection Functions

12.19.6.1 Overcurrent & Earth Fault (50/50N & 51/51N)

The Overcurrent and earth-fault protection shall operate the main and backup trip coils of the breakers.

The O/C and E/F protection function shall consist of a current measuring element per phase and a measuring element for residual/neutral current.

All protection functions, i.e. overcurrent (O/C) and earth fault (E/F) shall have elements with characteristics that comply with IEC 60255 and ANSI/IEEE C37.112-1996. It shall be possible to select between DTL, IDMT, VI, EI.

Resetting of a picked-up IDMT or DTL protection function shall be according to IEC 60255-4 Class A, Class B, Class C, Long-time inverse and Short-time inverse reset curves. Alternatively, a user defined DTL reset time (settable between 1 s and 20 s) may be provided.

12.19.6.2 Breaker Failure Protection (50BF)

BFP shall be provided for each individual CB. It shall be initiated by tripping commands initiated by each protection scheme associated to a feeder.

The trip scheme shall be in the position to extend single phase tripping to three phase tripping.

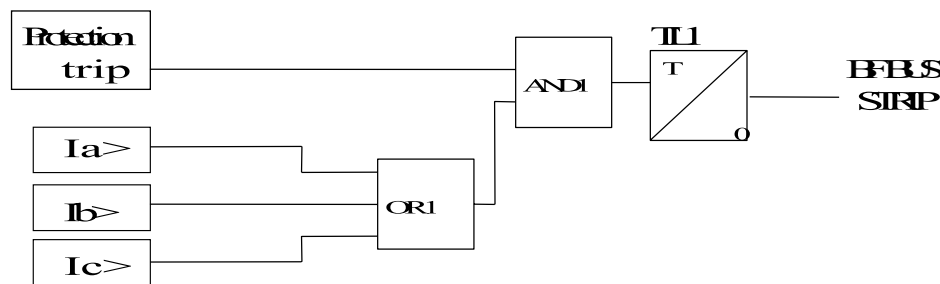
The three-pole scheme Breaker Failure Protection function (BFP) shall in principle be provided in accordance with the figure below.

The BFP timer shall start when there is a protection initiation and an overcurrent condition.

Any trip to the breaker shall be considered as a protection initiation.

The timer shall reset instantaneously if one of the input quantities reset.

A BFP bus trip output shall be produced once the set time has expired. This output shall initiate a bus trip in the affected bus zone and shall send an inter-trip signal to the remote end (where applicable). Supervisory indication of the bus trip output shall be provided.



The overall reset function of the BFP system shall not be slower than 15 ms. It shall be sensitive to detect from 0.2 to 2.0 times the rated feeder current, adjustable in steps of less or equal to 0.2 times of this current and being able to be operated continuously at 1.2 times the rated current.

The currents of the feeders shall be monitored for each phase separately.

The BFP shall react in different stages on not executed tripping commands. After recognising an unsuccessful tripping command, the trip command shall be sent to both trip coils of the stuck breaker. Only in the following the BFR shall trip all CBs adjacent to the not reacting one.

Tripping of adjacent CBs shall also include CBs on the remote end of an OHL or CBs on the secondary or tertiary side of a power transformer. In such cases, even the CB on the remote end of a line or on the secondary side of a transformer shall be locked-out.

During performance of a trip sequence, feeder currents shall be continuously monitored and already initiated trip signals shall be interrupted, if tripping of the stuck CB could be recognised.

All lock-out functions provided by the CBs e.g. SF6 under-pressure monitoring shall be incorporated to the BFP tripping logic. In case one of these lock-out functions is activated the trip signal to the remote CB shall be sent or performed without delay.

External signal inputs provided for non-current sensing elements e.g. Buchholz performed via binary inputs shall be incorporated in a tripping logic via auxiliary contacts.

The current detection shall have a very fast reset time to achieve an overall reset function of the BFP system in less than 15 ms. The BFP function shall be sensitive to detect from 0.2 to 2.0 times the rated feeder current, adjustable in steps of less than or equal to 0.2 times this current and be capable of being operated continuously at 1.2 times the rated current.

The tripping of BFR shall be of the non-self-reset type until a reset initiation is activated locally or remotely. The tripping shall be three-phase and definite, i.e. blocking of the auto-reclosing shall be provided.

12.19.6.3 Differential Protection (87)

The differential protection shall operate the main and backup circuit breaker trip coils as well as the master trip relay.

The differential relay shall provide adjustable second harmonic restraint for reactor inrush current condition, as well as adjustable fifth harmonic restraint during periods of over-excitation.

The differential relay shall include through fault restraint.

12.19.6.4 Restricted Earth Fault Protection (64)

The restricted earth fault protection shall operate the main and backup circuit breaker trip, as well as the master trip relay. The master trip relay shall operate the main and backup trip coils of the HV and LV breakers.

The restricted earth fault shall provide a low impedance differential protection and shall provide stabilisation against transformer/reactor inrush currents.

12.19.6.5 Synchro Check (25)

The **synchronism check** relay shall base its decision to close on a combination of the following:

The relative and absolute magnitudes of the incoming and running voltages;

The relative slip between these two voltages;

The relative angle between these two voltages;

A time delay for which all these conditions shall be met.

A snubber circuit shall protect the close output contact. The close pulse duration shall be settable.

12.19.6.6 Auto Reclose (79)

Main 1 and Main 2 Line relay protection systems shall be provided with Single-pole high speed Auto-Reclosing (SPAR) as well as with 3-pole delayed Auto-Reclosing functionality.

The option of choosing between single-pole or 3-pole auto-reclose shall be provided by means of Function Keys on the protection relay (when the bay is in Local Operating Mode) as well as selection in the substation control room’s HMI. In the same way it shall be possible to enable/disable the Auto-Reclose function.

The Auto-Reclose scheme shall be one shot only and shall go to lockout mode if a second fault occurs within the reclaim time.

The Auto-Reclose function shall be an integrated function in the Main 1 and Main 2 protection relays and independently initiated.

12.19.6.7 Switch Onto Fault (SOTF)

The Main 2 Line Distance Protection Relay shall be provided with a switch into-fault protection function, which shall cause instantaneous tripping for both close-in and far end faults when a faulted line is energized.

The logic shall use the voltage from CVTs connected on the line side. Also, any closing command for the CB can be used to initiate this function.

12.19.6.8 Trip Circuit Supervision (TCS)

The trip circuit supervision shall detect any discontinuity in the entire trip circuit when the circuit-breaker is in both the closed and the open positions. A faulty trip circuit shall be indicated clearly on the front of the panel or protection device. It is important that the TCS is wired such that all trip related circuitry is sitting in series with the Trip Coil being the last

component in the series circuit. Any disruption at any point in the series trip circuit will operate the TCS. The TCS must be a failsafe application.

12.19.6.9 Pole Discrepancy (52PD)

Three pole discrepancy protection shall be initiated by a set of circuit breaker auxiliary contacts at any time when the status of the three-poles of the circuit breaker is different. A pole disagreement trip shall be initiated after a set time delay.

12.19.7 Protection Devices

12.19.7.1 General Requirements

Each IED shall be provided with a sufficient number of correctly rated, electrically separate normally open contacts to cater for tripping of the two trip coils in each circuit breaker directly, making use of two separate isolated DC supplies. Relay elements shall also be fitted with sufficient, suitable contacts for interconnecting to the bay processor and for blocking functions where necessary.

All tripping contacts should be rated to the correct level for direct operation.

Operating of a relay element shall be clearly and positively indicated on the relay by an indicating light or alpha-numeric display. The indication shall always positively identify the type of fault and where applicable the affected phase, busbar or bus-zone.

At no time shall the relay protection functions be compromised by the downloading of new settings to the relay. Protection settings shall be completely alterable from the relay front panel and via the Substation - Local Area Network (S-LAN).

Each protection relay and function shall have at least two complete setting groups which may be selected from the relay front panel and a laptop computer. The alternative setting group shall be selected by either energising an opto-isolated input assigned to this function, or by a suitable command via the communication port of the relay. These inputs shall be energised from an internally generated DC source and must not be affected by induced power frequency AC signals in the wiring.

Relays, auxiliary coils and indication lamps specified for operation from a nominal 110 V DC substation battery supply, shall operate reliably and satisfactorily at any voltage between minimum limits 80 % to 120 % of nominal DC voltage, and shall be capable of withstanding the voltage level associated with boost charging of the station battery. Where relays require auxiliary power at a voltage other than the nominal DC voltage, provision shall be made for

the necessary DC to DC converter equipment. Preference shall, however, be given to equipment operating directly from the specified nominal DC voltage.

The relays shall all be of robust construction and shall have a positive action without chatter.

All relays shall be flush mounted.

12.19.7.2 Protection Devices & Functions

All protection devices shall operate in accordance with IEC standards, including performance characteristics, reliability, and dependability.

All numerical IEDs are to conform to IEC61850-6, 7-1, 7-2, 7-4 and 8-1.

All relays shall be suitably marked with the following information:

Functions of relay (e.g. OC, EF, differential etc.);

Indication of function of each flag in multipurpose relays;

Rated current and/or voltage of the relay coils;

Rated making/breaking capacity of tripping contacts.

12.19.7.3 Engineering Interface

All numeric protective devices shall be equipped with at least one RS-232/Ethernet/USB port to facilitate local and remote communication. The interface cables and software for local communications with the device must be provided.

12.19.7.4 Time Synchronisation

The main protection device(s) shall have a real time clock for time stamping of events and fault records. The real time clock shall not drift by more than 60 s in one month.

A facility to synchronize the clock of the main protective device using an external source shall be provided by SNTP or IRIG-B (Pulse width modulated IRIG B002). If IRIG B is not available, a pulsed type format: (1pps, 1ppm etc.) may be provided.

SNTP;

IRIG-B interface (Pulse width modulated IRIG B002);

1PP11MIN (Pulse per 11 minutes);

1PPM (Pulse per 1 minute).

12.19.7.5 Fault Recorder & Statistical Metering

The IEDs in each protection scheme shall provide a fault recording and statistical metering functionality. The device shall be configured to record the following minimum signals during a fault:

Analogue wave recording of current and voltage measurements;

Protection starter(s) operation;

Protection element(s) operation;

Breaker trip command;

Breaker status.

Fault recording and statistical metering (which shall be indicated on the relay mimic) will utilise the protection class CT cores and VTs where applicable.

The Engineer shall be able to view a graphical display of the recorded wave and digital state changes by downloading the data to an Engineering terminal.

All necessary software and data connection cables required to download and to analyse the data graphically shall be provided.

The above mentioned statistical metering shall be for indication and information purposes and is not intended to be utilised for billing purposes due to the accuracy classes of the CTs.

12.19.7.6 Capacitive Discharge

All input contacts used on protective relays activated by primary field devices exterior to the substations and / or via lengthy auxiliary cables, shall adhere to the capacitive discharge test specified below. This can be done by either fulfilling the requirement within the Protection relay itself or by using suitable Fast acting Inter-trip Relays or applying a delay in operation of the binary, all of which should not exceed a total time delay of more than 8msec.

No change of state or any operation shall occur for these circuits when a capacitor of capacitance shown below, charged to 1,5 Vn volts, is connected between any combination of terminals and any combination of terminals and ground.

Table 12-28: Relay Capacitors

Circuit type	Capacitor
Trip circuits	- 10 μ F
Other protection & control circuits	- 2 μ F
Carrier/channel interface	- 0,2 μ F

12.19.8 Protection Schemes

12.19.8.1 General

In order to minimise the effects of electrolysis, CB auxiliary switches and relay contacts shall be connected to the positive pole of the battery. All DC operating coils, flag coils and auxiliary relays shall be connected to the negative pole of the battery

12.19.8.2 Protection Functionality

The scheme design shall provide the minimum requirements defined in the attached Protection Function Block Diagrams. In addition, the following protection functions shall be provided:

DC Fail: The DC fail relays are to monitor the status of each DC supply where a protection relay device failure / watchdog contact is not present. The DC monitoring DC fail relays are to be applied in a failsafe application where upon application of the DC supply the normally closed contacts of the protection relay or the DC fail relays are to be maintained in an open state. Should the DC fail, the protection relay or DC fail relay shall be de-energised resulting in the closing of the applicable alarm contact. The DC monitoring device, be it the IED or a specific DC Fail relay should sit at the end of the circuit it is monitoring;

All MCBs in the protection / control schemes are to have auxiliary contacts that monitor the status of the MCB; these auxiliary contacts on the MCBs are to be wired into the Bay Control / Protection IED for alarm purposes;

The statuses of the busbar isolators shall be hardwired to the Bay Control IED for display purposes as well as for consideration in the new bays interlocking scheme;

Protection Not Healthy indications: Local and remote indication of any condition implying that the protection system is not capable of performing its intended function;

Electrostatic Discharge: The scheme shall be fitted with an electrostatic discharge point consisting of a 4 mm binding post / banana socket connected to earth through a 1 M Ω resistor;

Snubbers / Anti-pump Timers: Where required, the “Close” circuit of each scheme shall be fitted with an anti-pump timer and a snubber circuit. The main and back-up “Trip” circuits of each scheme shall also be fitted with a snubber circuit if required. The onus is on the supplier to verify the requirement of snubber circuits based on the contact ratings of their Protection / Bay controllers;

Fault Counter: Each scheme shall be fitted with a fault counter, which may be integrated in the protection relay;

Cross Tripping: All main protection functions shall cross-trip to the back-up trip coil and all back-up functions shall cross-trip to the main trip coil.

12.19.8.3 Interlocking

Philosophy

All disconnecting and earthing devices within the substation shall be interlocked in a manner that ensures that they always operate safely. The system employed shall satisfy two distinct categories:

Operational interlocking.

Interlocking associated with normal system operation and switching and intended to ensure that unsafe switching actions are prevented. Such interlocking shall be achieved by electrical means in a manner that permits the equipment to perform any safe operation. Contacts used for interlocking shall be directly driven auxiliary contacts of the main device.

Maintenance interlocking.

Interlocking associated with a series of switching operations whose purpose is to render the equipment or sections of the substation safe for access and maintenance by personnel. Such interlocking shall be achieved by mechanical interference type interlocks.

The applicable recommended interlocking facilities of IEC 62271-201 shall be provided, together with any additional interlocking as specified by the Engineer. Padlocking to the requirements of this specification shall be provided for operational and maintenance security.

Hardwired interlocking shall be provided between the earth switches and disconnectors for each bay:

The line disconnector shall be inhibited from closing if the line earth switch is earthed;

The bypass disconnector shall be inhibited from closing if the earth switch is earthed;

The line disconnector shall be inhibited from opening if the breaker is closed;

The busbar disconnector shall be inhibited from opening if the breaker is closed;

The line earth switch shall be inhibited from closing if the line disconnector or bypass disconnector is closed;

The bus coupler breaker shall be inhibited from closing if isolators within the bus coupler bay are open;

The bypass disconnectors shall be inhibited from closing if the bus coupler breaker is not closed.

Principles

Disconnectors shall be capable of switching the capacitive currents of associated connections.

Disconnectors shall not be used for load making or breaking.

Disconnectors shall not be used for making or breaking reactor magnetizing current.

Disconnectors shall not be used for parallel switching conditions unless specifically rated for such duty in accordance with IEC 62271-102.

It shall not be possible to operate any earth switch unless the point of application is disconnected from all possible sources of supply, and the operating devices of the disconnectors providing the points of isolation are locked in the open position. Where one of the points of isolation is remote, the isolation of that remote supply shall be confirmed by other means, e.g. by monitoring the VT secondary output voltage and a suitably inscribed warning label shall be fitted to the earth switch operating device.

It shall not be possible to operate any disconnectors if an associated earth switch is already closed except where special maintenance provisions have been made.

Where the load-breaking device is situated remote from a disconnector and cannot be fully interlocked the disconnector operating mechanism shall carry a suitably inscribed warning notice.

12.19.8.4 Local Indications

Local control of the bay shall be provided via a mimic control panel on the protection scheme. The mimic control panel shall be provided by an LCD mimic control panel integrated on the protection relays (IEDs), indicating the plant layout, plant status indication, and analogue values. All IEDs shall indicate trips and alarms utilising configurable LEDs on the IED. In addition to the LEDs for alarms, the relay HMI may be utilised.

The following minimum indications shall be provided on each panel/bay (where applicable):

Status indications

Circuit breaker status;

Disconnecter status indication;

Earth switch status indication;

CB healthy indication;

Supervisory ON.

The same type of indicators shall be used on all panels for a specific function.

Alarm indications:

Protection healthy indication;

Overcurrent Trip: IDMT and Hi-set;

Earth-fault Trip: IDMT and Hi-set;

Reactor Differential protection Trip;

Reactor Restricted Earth-fault Trip;

Reactor protection trip (Buchholz, Pressure, Temperature);

Line Differential protection trip;

Line Distance protection trip, including zone of operation, distance to fault, phase of operation, line check trip, pole disagreement trip, VT fuse fail, communication fail;

Intertrip send / received;

Protection relay faulty;

Trip circuit faulty;

Breaker Fail trip;

Bus bar/Breaker fail protection trip;

Breaker not healthy;

SF6 gas alarm;

Earth applied;

Under / over voltage;

Reactor alarms.

Analogue indications:

	OHLs	Bus-section / buszone
MW	X	
MVAR	X	
Current – A ²	X	X
Voltage – kV	X	
Busbar Voltage – kV		X
Busbar Frequency – Hz		X

All analogue display meters shall be transducer driven; alternatively these values can be displayed on the LCD mimic and be shown as a larger scale on the LCD as a separate page.

12.19.8.5 Reset Pushbutton

A reset pushbutton shall be provided for resetting all protection trip indications.

12.19.8.6 Remote Indications & Controls

Provision shall be made for the remote indications and controls to be available on the SAS HMI and through the Gateway to NCC.

12.19.8.7 DC Supply Arrangement

The nominal DC voltages for substations are 110 VDC and 48 VDC.

The DC supplies shall be provided from the 110 VDC battery/charger units for Switchgear / Protection, and control equipment. The tripping supply circuits shall be used only for the tripping of the respective circuit breakers and associated relay auxiliary supplies. Indications, closing and monitoring functions may not be derived from the tripping supplies. The main and backup protection supplies are to be fused separately from the DC source.

12.19.9 Stand-alone 330kV and 132kV Disturbance Fault Recorders

12.19.9.1 General

The disturbance records files shall be stored according to the latest standard of IEEE C37.111 COMTRADE and shall be able to transfer both automatically and manually to ZESCO

2 The current for all three phases shall be shown on the IED.

Disturbance Analysis function. Transmission shall be via FTP, SFTP or SCP for encrypted and secure handling of usernames and passwords.

12.19.9.2 Settings

It shall be possible to set and, if necessary, change the following:

- The name of the device and the individual object assignment of the channels,
- the number of active recording channels, analog and binary,
- Possibility to disable the display of analog and binary spare channels during registration,
- Recording times,
- Type of time synchronization and adjustment for time offset

12.19.9.3 DFR Start

The start of the DFR shall be triggered from each IED containing relay protection functions and its most sensitive protection stage, received remote trip (from connecting substations) and transformer Buchholz trip.

It shall be possible to start the DFR in the following ways:

- Manual start with associated software of the equipment via connected Engineering service computer and via remote connection over WAN from Disturbance Analysis
- Manual start locally via pushbutton on or in the disturbance recorder
- External start via binary input or via GOOSE telegram according to IEC 61850-8-1 via station bus
- Start on position change on selectable binary channels
- Start when set level or derivative is exceeded on analogue channels

12.19.9.4 Static Memory

When DFR's memory becomes full, the oldest record is deleted to make room for the next one.

In case of loss of auxiliary power supply to the DFR, settings or recordings shall not be affected.

The memory of the DFR shall be large enough to at a minimum store 50 disturbances with 10 seconds of recording at the maximum sampling rate per object.

12.19.9.5 Registration Time

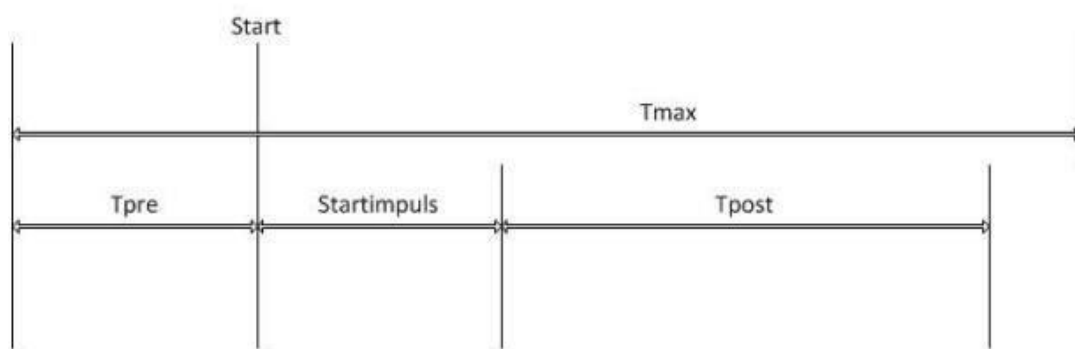
The disturbance recorder shall be able to record all channels for a settable time before the time of trigger, which is referred to as T_{pre} in Picture below.

This means that all channels to be recorded must be continuously monitored.

The recording shall then continue for a settable time, referred to as T_{post} in Picture below.

The total duration of the recording shall be $T_{pre} + \text{start pulse duration} + T_{post}$, but limited to the adjustable time T_{max} , as shown in the Picture below.

When the disturbance recorder receives the trigger impulse, the start time shall be time stamped with both date and time.



12.19.9.6 Recording Channels

The Disturbance Recorders shall be enabled and configured with analog and binary channels. Where it is possible to name the analog and binary channels, it shall be done with the object designations and with the measurement transformer used.

For the two 330/132kV disturbance recorders, the following shall be recorded:

- 3-phase currents for all 330/132kV objects
- Earth Fault current (summarized $3I_0$ or measured I_0)
- Voltages
- Trip-signals from all individual protection trip circuits
- Circuit Breaker Closing-maneuver signals
- Received/Sent Acceleration signal from connecting substations
- Received/Sent Trip signal from connecting substation

12.19.10 Transformer Automatic Voltage Regulator (AVR)

An Automatic Voltage Regulator/Tapchanger Control Unit shall be installed for each of the new transformers. AVR control panels shall include, but not limited to, the following features and functions:

- Transformer tap positions, Current, voltage and power measurements.
- Alarm annunciator for all transformer and tap changer, voltage control and protection related indications and alarms.
- Circulating current/Out of step control for each transformer
- Local/remote control in tap changer control mechanism box
- Remote/supervisory control selection in control room.
- IEC 61850 Communication to Substation Automation System
- Remote operation in control room.
- Supervisory tapping and operation mode selection from NCC
- Master/Follower selection for each Transformer
- Independent/parallel selection for each transformer
- Auto/Manual selection for each transformer
- Compensation possibility for Z and R-X compensation
- Blocking for over-current and low voltage.

12.19.10.1 General functional Requirements

The Automatic Voltage Regulator unit (AVR) shall measure the main voltage at the relevant regulation point.

The setting range for the voltage setpoint shall be within 90-110% of the rated voltage. Resolution and dead-band shall be adapted to the tap changer.

It shall be possible to adjust the setpoint value from Remote Station HMI/SCADA and locally on the AVR unit. The setpoint shall be displayed at all manoeuvring locations.

Time delay between steps shall be adjustable between at least 10 and 120 seconds.

To ensure the AVR does not operate continuously, there must be an insensitivity range (dead-band) which is adjustable.

12.19.10.2 Requirements for Blocking AVR functions

The AVR shall be blocked in case of overcurrent and abnormal voltage (over- and undervoltage).

Over- and undervoltage blocking and overcurrent blocking shall be possible to test via test switches.

Overcurrent shall block both the manual and automatic operation of the tap changer by interrupting the auxiliary supply voltage for manoeuvre.

The overvoltage and undervoltage blocking shall be realised by an external function (e.g. measurement value monitoring in the transformer relay protection).

Overvoltage and undervoltage blocking shall only block the automatic voltage control. Manual operation shall not be blocked by over- or undervoltage blocking.

The AVR shall be blocked (both step up and step down manoeuvre) by an internal function at ‘zero voltage’, normally approx. 30-50% of nominal voltage (due to e.g. switched off transformer or voltage collapse). It shall also be blocked if the voltage measurement is lost (due to e.g. tripped MCB).

12.19.10.3 Parallel Mode functional requirements

With parallel feeding transformers, co-regulation shall be used to distribute the load evenly and minimise the circulating current between the transformers.

The AVR system shall be able to be operated/indicated in Single/Parallel operation and Master/Slave operation locally and remotely (HMI/SCADA).

If the tap changers have a deviating position (time delayed) when operating together in parallel mode, the automatic regulation shall be blocked, and an alarm shall be given. When switching to ‘manual’ and disconnecting the controlling transformer, parallel mode shall be automatically disabled/blocked.

The choice between Master/Slave shall be arbitrary between the transformers.

It shall be ensured that only one AVR unit can be Master.

When a regulation order is issued, the Master's tap changer must wait for the Slave's tap changer before a new regulation order may be issued.

If the tap changers in question are in different positions when activating parallel mode, the Slave must be adjusted via impulses to the same tap position as the Master. The Master shall meanwhile be blocked.

12.19.10.4 Technical Requirements

Setting range	90–110 % of U_n , resolution ≤ 1 % of U_n
Allowed deviation (dead-band)	± 0.5 % to ± 3 % of U_n , resolution ≤ 1 % of U_n
Time characteristic	definite time (optional inverse time)
Time delay between stepping	10–120 s (definite time)

Regulating pulse	One pulse after each delay period or continuous in case of persistent deviation. The pulse duration shall be adjustable between 1 and 10 s
Undervoltage block	70–90 % of U_n stepless
Overvoltage block	110–130 % of U_n stepless
“Zero Voltage” block	30–50 % of U_n stepless

12.19.11 Substation Automation & Remote Supervision

12.19.11.1 Architecture

The existing substations local area network (SLAN) is a dual fibre optic ring-based communication network on which all the IEDs are connected and communicate via IEC 61850, to exchange data such as primary device status, analogue values and statuses derived by each IED, enabling inter-bay signalling for substation wide interlocking.

Kasama substation is equipped with Schneider PACiS Substation Control Systems (SASs) which are installed within the 330kV control buildings.

All the existing protection, control relays are housed in stand-alone panels installed in integrated protection and control panels. Detailed drawings shall be provided as required;

The substation networks are dual fibre optic ring based on IEC 61850. Remote information is sent to the BCC and NCC via a network based on IEC 60870-5-104;

Bay Control for the existing equipment is carried out from an existing operator work station (OWS) in the control rooms or supervisory from the NCC.

12.19.11.2 Security

To minimise the requirement for system redundancy, each IED of the system shall be continually self-supervised. For the purposes of alarming and indications, the IED self-supervision shall make provision for reporting to the SAS. The system shall provide user-friendly diagnostic tools, with clear alarms indicating malfunctions of the system.

The IED equipment offered shall be proven to be specifically developed for and used in power transmission applications and meet the impulse and electromagnetic withstand requirements for these applications as specified in IEC 60255.

The protection relays shall operate independently of the communication network.

Interlocking shall inhibit the operation of any primary plant device with a failure of any other device that ensures the safe operation of the primary plant device and thus of plant and personnel.

The IEDs shall be based on distributed, intelligent multi-processor technology and fibre optic communications. Event data is required to be stored in the IEDs and the Substation Automation System.

12.19.11.3 Technology

The equipment offered shall be of the latest proven numerical technology and IEC 61850 compliant. The IEDs shall have forward compatibility with future devices for a period of 10 years. All devices shall have communication facilities to enable them to be connected and communicate with the SAS (as per the application).

Suppliers shall offer reliability statistics for supplied IEDs, Ethernet switches and gateways as applicable to the Scope of supply for this contract. These statistics shall include at least MTBF (Mean Time Between Failures).

Should the supplier not be able to fulfil the protection functionality for a specific scheme with their protection relays, they should find another supplier whose Protection relays do and be able to integrate it into the total substations communication architecture and be able to fulfil peer to peer communication for the current application in consideration of the existing architecture and integration requirements in so far as IEC61850 is concerned.

12.19.12 Substation Local Area Network (SLAN)

12.19.12.1 General

All SCADA communication shall be based on TCP/IP communication principles.

The LAN protocol shall be of the latest standard and technological trend, IEC 61850, including GOOSE protocol when applicable.

The Contractor shall present a structured IP Plan for the substation which shall be approved by the Employer.

In substations with an existing LAN and where additional equipment are to be added, the Employer will provide the existing IP Plan or IP-addresses to use.

All connection between switches shall be done with Optical Fibre.

Connections between equipment and switches shall as far as possible be made with Optical Fibre if the units are in different cabinets.

Where a certain equipment cannot connect with Optical Fibre, Media Converter or Shielded Data Cable (type Cat5 or better) shall be used.

Equipment in the same cabinet as the switch can be connected with Shielded Data Cable (type Cat5 or better) or with Optical Fibre.

12.19.12.2 Communication Bus Performance

Interconnection between Substation Level and Bay Level shall be accomplished through a 10/100 Mbps industry standard LAN. In the "worst case traffic scenario", the load shall not exceed 80% of the network capacity anywhere in the network.

This requirement applies for network system/equipment delivered and installed by the Contractor within the Scope of Supply.

Performance on existing substation LANs shall not be the Contractors responsibility. However, if performance for some part of the LAN affects the Scope of Supply to the extent that the requirements cannot be met, the Contractor shall be given option to e.g. replace a LAN-switch or upgrade a communication path to fulfil the requirements.

12.19.12.3 Requirements for Updating Functions via Station Bus

The following performance requirements apply for updating:

Table 12-29: Updating functions via station bus

Function	Time requirement
Analog measured values	Integrating dead band, $\leq 0.3\%$
Indications from time marking in IED to database in RTU / Gateway	$\leq 0,5$ seconds
Control from output signal in RTU / Gateway to activated control output in control terminal	$\leq 0,5$ seconds
Indications and measured values in Local HMI	$\leq 0,5$ seconds
Operation from activation in HMI to activated output in control terminal	$\leq 0,5$ seconds

12.19.12.4 Switches

Provided LAN-switches shall be of Rugged construction for industrial environments.

LAN-switches in the system shall be monitored with a common alarm to HMI/SCADA.

All switches shall fulfil:

- Collision-free network traffic.
- Be able to handle Layer 3 traffic.
- Be able to supervise and manage via remote access.

SNMP version 3 or newer shall be supported.

- Bandwidth of minimum 2 Mbit
- Built-in self-monitoring.
- Fast recovery in case of error (20-100 ms depending on application).

The time for network reconfiguration shall not be so long that it affects the function of connected IEDs or gives unjustified alarms.

- Fan cooling or other moving parts are not allowed.
- 110 VDC Dual power supply
- Minimum 8 ports for LAN connections which shall be flexible, either in combinations of both RJ45 and Optical Fibre or via exchangeable modules (SFP).
- Where applicable minimum 2 ports for WAN connections, possible to connect via exchangeable modules (SFP) the following interfaces:

1. Optical Fibre.

2. RJ45

3. SDH E1 interface.

The switches shall support division of traffic in VLAN with prioritization in general as follows:

- VLAN 1: Switch management.
- VLAN 10: Station’s LAN IEC 61850-8-1
- VLAN 20: (ELAN) Configuration, upload and download via Service Computer, Metering Computer etc. shall if possible be separated in an individual VLAN in each switch.

The final number of VLAN and prioritization setup will be confirmed by the Employer for each substation.

The switches shall support “VLAN Priority tagging” according to IEEE 802.1Q and must be able to be configured so they do not delete or change 802.1Q information from incoming messages.

12.19.13 Engineering Local Area Network (ELAN)

As per the applicability of the existing architecture, the Engineering Local Area Network (ELAN) must form an integral part of the SLAN. The IEDs offered must make provision for the future ELAN to be on a separate IEC 61850 communication network. This network will be used for access to the IEDs for interrogation, re-configuration and re-setting purposes.

12.19.14 Integrated Disturbance Recording

A disturbance recorder shall be integrated into each of the IEDs supplied. The recorder shall have a recording resolution of at least 1 kHz. The disturbance recorder shall be able to record a minimum of 12 digital inputs and 12 analogue inputs.

Time, amplitude, and angle measurement shall be able to be done by the supplied analysis software. Zooming of time windows as well as amplitude shall also be possible.

The analysis software shall provide the functionality to download the disturbance recordings from the IEDs on a separate PC via the ELAN or directly to a PC or Laptop by via connection directly to the front port of the IED.

The recording downloading functionality shall be integrated into the analysis software and not be done by separate software.

12.19.15 Bay Control Unit (BCU)

Bay Controller IED – The BCU shall be as per specification and capable of integration with the SAS and shall be equipped with the following functions as a minimum:

- Synchro-Check
- Bay Control and Interlocking for the Bay Primary Equipment;
- Acquisition of measured and counted values;
- Execution and monitoring of alarms including alarm annunciations;
- Data communication to the SAS via IEC 61850;
- Condition monitoring of primary plant devices;
- Programmable Lockout and Lockout Reset functionality;
- Local/Remote Selection;
- Self-monitoring;
- The Bay Controller will perform all bay related functions such as local control (from the Bay IED HMI), event, disturbance and alarm handling and storage, command sequences, bay and station wide interlocking and output of commands;

- The Bay Controller shall have an Integrated Graphic Interface of an adequate size and resolution for the display of the entire line and reactor bay Single Line Diagram (SLD) including bay primary device statuses, measurements and alarms;
- The Integrated Graphic Interface must permit for the execution of control commands to the controllable primary devices;
- As far as practicable the Bay Controller through the above reporting and message functionality must facilitate easy fault finding and addressing of interlocks, lockouts and any other conditions inhibiting the desired operations.

In addition to the above, the following are also applicable:

- The interlocking functionality configured in the Bay Controller shall ensure safe and reliable operation of the primary plant devices. Discrepancies such as intermediate switchgear positions, switchgear faults, faulty data transfer, shall prevent non-permissible switching operations. Reasons in the form of screen messages on the graphic displays of the HMI/mimic and text messages or clearly labelled LEDs on the Bay Controller shall provide clear and exact reasons for the inhibiting of the requested switching operation;
- The scheme is to be equipped with a Master Hand Resettable Lockout Relay with a Flag indication;
- The permissible levels of controls shall be as follows:
 - **Operation from the primary equipment itself**, i.e. operation from the breaker, isolator or earth switch mechanism box in the field when the device is selected to Local. The Local selection at the operating mechanism box of any primary device will inhibit any Remote control and shall permit only Local operation in the field;
 - **Operation from the Bay Controller HMI**. This level of control shall be permitted when the primary device in the field is selected to Remote and the Bay Controller is selected to Local. All other levels of control shall be inhibited;
 - **Operation from the SAS**. This level of control shall be permitted when the primary device in the field is selected to Remote and the Bay Controller is selected to Remote and the SAS is selected to Local;
 - **Operation from the National Control Centre**. This level of control shall be permitted when the primary device in the field is selected to Remote, the Bay Controller is selected to Remote and the SAS is selected to Remote.

The factory acceptance tests for SAS shall include, but not be limited to, the following:

- Physical inspections and wiring checks
- Secondary injection test

12.19.16 Substation HMI system**12.19.16.1 General**

The HMI images shall be structured in an ergonomically correct way, which i.e. means that object status changes may not take place with only colour changes.

Images shall only contain the information necessary for the function of the selected image.

All images shall display the station name, date and time as well as an alarm line with the latest unacknowledged alarms.

Switching between images should be possible with buttons on the screen or with function keys on the keyboard.

At least one User login shall be implemented: one English Operator login where all text shall be in English language.

12.19.16.2 Performance

Image switching from keystroke to updated image (150 dynamic points) shall take place in <2 seconds.

Updating of indications and measured values shall take place in <2 seconds.

Events and alarms shall be presented in respective list in <5 s (after possible time delay has expired).

Manoeuvres must be executed <0.5 s (from keystrokes executed until the order leaves the computer system, even if the output is in another computer).

All lists in the system must be saved and stored for at least the last 6 months of events.

12.19.16.3 Symbols

Symbols for devices shall be designed so that you can clearly determine what type of device it is and in what position the device is.

12.19.16.4 Operation

Command sequences shall be (selectable) carried out by single-step or two-step procedure with check-back.

Two-step procedure means selection and check-back followed by an order (On/Off, Open/Close Increase/Decrease etc.).

12.19.16.5 Analog Real Time Values

Measured values shall be displayed next to the object.

Non-updated or incorrect measured value must be "marked as old".

12.19.16.6 Setpoints

These shall be displayed next to the object to which they belong and are changed via a separate dialog. If there is a limit for the setpoint, possible values to write shall be written in the dialog box.

A new value shall be activated with an Execution button.

12.19.16.7 Alarm List

The list shall be sorted so that the last error signal is at the top of the list.

All active and all inactive unacknowledged alarms shall be presented.

One should be able to distinguish if it is a:

- Active acknowledged alarm signal
- Active unacknowledged alarm signal
- Inactive unacknowledged alarm signal

Signals shall be able to be acknowledged individually or per page.

If the time stamp is uncertain, e.g. due to time synchronization error in an IED, it should be indicated in the Alarm List.

The Alarm List shall be possible to be sent to a printer on request. It shall be possible to do this for an individual page and for a filtered list. It shall be possible to filter with date and time and/or individual object.

12.19.16.8 Event List

The list shall be sorted so that the most recent event is at the top of the list. In the Event List, all events in the station must be printed with a time stamp.

These are events of the type:

- Relay protection and automation indications
- Switchgear indications
- Fault/alarm signals
- Operator notifications.

If the time stamp is uncertain, e.g. due to time synchronization error in an IED, it should be indicated in the Event List.

The Event List shall be possible to be sent to a printer on request. It shall be possible to do this for an individual page and for a filtered list. It shall be possible to filter with date and time and/or individual object.

12.19.16.9 Operating Workstation (OWS)

The Operating Console shall either be Directly connected to the RTU (viewscreen, keyboard, pointing device and printer) or a KVM Computer (with viewscreen, keyboard, pointing device and printer) connected over LAN.

The Operating Console can be offered by the Bidder as a Desktop version and/or as a cabinet built-in version, whatever is most suitable for respective substation.

For cabinet built-in version, the viewscreen shall always be visible with closed door/frame.

The Viewscreen shall be minimum 24 inches for desktop version and minimum 17 inches for 19” rack mount version.

Keyboard, pointing device, printer and applicable cables shall be supplied and installed by the Contractor.

Wireless communicating devices are not allowed.

Power supply shall be battery-backed with capacity to supply the Operating Console for 12 hours on battery only. Power supply to the is not required to be battery-backed.

12.19.17 Time Synchronisation

The Contractor shall supply a complete setup including all accessories like antenna, cables etc. to determine Coordinated Universal Time (UTC).

The GPS time server system shall as minimum include an NTP Time Server, IRIG-B and be able to synchronize the SDH network. This means the time server shall have two possible sources for synchronized time: the local antenna and from SCADA via communication protocols.

The satellite receiver shall include compensation for propagation delay to ensure an overall accuracy of ± 1.5 ms. The receiver shall also allow the local time offset to be entered. The internal computer clocks shall be set according to the GPS time.

If the GPS signal is lost and sync from SDH network is not available, the time shall continue based on the computer internal clock. The time shall return to within ± 1.5 ms of UTC within five minutes of reacquisition of signal.

Health of the time server and lost GPS signal shall be monitored with time delayed alarm locally and to SCADA.

The GPS time server shall have a digital display that shows local time in 24-hour HH:MM:SS format.

Power supply shall be battery-backed 110V DC.

12.19.18 Remote Terminal Unit (RTU)

12.19.18.1 General

The RTU's design shall be based on standardised hardware and software.

It shall be provided with an extensive self-test and monitoring system. All essential functions shall be monitored, e.g., prospective cooling system (fans), program executions, memories, analogue input channels etc.

In case of a detected fault a local alarm shall be generated via a potential free contact and transmitted to the Control Centre.

In case of disturbances in the power supply the terminal shall shut down. When the voltage recovers the terminal shall automatically restart.

12.19.18.2 Data Transmission

Data transmission between RTU and central SCADA/DMS equipment shall use standard transmission channels.

Transmission speed shall be selectable between 9600 kbit/s to 2 Mbit/s for IP connections (IEC-104).

Short transmission interrupts of up to 3 sec. shall not cause permanent effects or alarm to the operator.

All transmitted data shall be protected against errors with schemes corresponding to at least Hamming distance = 4 for indications and command orders and at least Hamming distance = 2 for analogue values. A bit error rate of 1×10^{-5} shall not reduce the transmission capacity more than 5 %.

12.19.18.3 Time Synchronisation

The RTU shall support time synchronization with NTP/SNTP, with the ability to configure two different time servers.

In the absence of time synchronization, the time deviation of the internal clock shall be less than 2 min / year.

All reporting to superior SCADA system shall have UTC.

12.19.18.4 Auxiliary Power Supply

The RTU shall have two redundant power supplies.

The power supply modules shall be able to handle voltage 110 VDC and to be easily replaced during repair or to adapt the equipment to a different voltage level.

12.19.19 Energy Metering

Independent Tariff Meter (Landis + Gyr (E880) or CEWE Prometer 540 or equivalent) and Power Quality Meter as Unipower 2210 or equivalent (on the OH Line bays only) shall be provided by the Contractor as specified in Scope of Supply.

A metering management system/HMI shall be included, with all necessary software and hardware, station computer and connectivity to manage the metering.

The metering management system shall be suitable for use with all meters subscribing to the IEC 62056 standard. Preference shall be given to a system which also allows integration with meters using proprietary protocols for global meter suppliers to allow integration of existing meters.

12.19.19.1 Standards

Meters shall conform to the following standards:

- IEC 62052-11 – Electricity metering equipment (AC) – General requirements, tests and test conditions - Part 11: Metering equipment;
- IEC 62053-21 - Electricity metering equipment (AC) - Particular requirements - Part 21: Static meters for active energy (classes 1 and 2);
- IEC 62053-23 - Electricity metering equipment (AC) - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3);
- IEC 62052-31 - Electricity metering equipment (AC) - General requirements, tests and test conditions - Part 31: Product safety requirements and tests.
- IEC 62053-61 - Electricity metering equipment. Power consumption and voltage requirements.

12.19.19.2 General Specifications

The metering system shall provide the following functionality:

- All metering shall be duplicated as main and check units for each line;
- Metering Class 0.2S
- 13-way metering test blocks shall be included for each meter.
- Panel mounted
- 2 Ethernet communication ports
- Opto head (IEC1107)
- Equipped with inputs to receive external pulses from other meters to record energy
- More than 1 year logging memory
- Instantaneous values with high accuracy
- Power Quality measurement
- Energy Metering – Active, Reactive and Apparent
- Easy to Configure using software available in English
- Open protocol
- Load Profile Recording
- Phase failure and voltage loss recording
- All readings to be Primary Values
- CT/VT error compensation
- Sealing tab screws
- Front panel buttons to navigate useful information
- Software security to allow calibration (highest) and read only (lowest)
- The tariff meters supplied shall carry out four quadrant revenue-class energy and demand metering with 5-period time of use functionality;
- The tariff meters shall be able to calculate not less than 5 different maximum demands in different MD registers
- Active energy (Wh)
Energy measurement for import and export
- Reactive energy (VArh)
Energy measurement for import and export
Reactive energy for all quadrants QI-QIV
Indication of either capacitive or inductive
- Apparent energy (VAh)
Energy measurement for import and export
Calculated independently for each phase, total calculated as a square root of watts and vars

The metering panels shall include test blocks, terminal blocks and wiring which is typically required for commercial security. The panels shall include all hardware necessary for

settlement metering, including CT/VT terminations, test links, communication interfaces and security features, and that they are costed separately from protection/SAS panels.

12.19.19.3 Load Profile

The Energy Meters Shall have large capacity for data-logging purposes for various demand periods such as 1, 5, 15, 30 and 60 minutes.

Table 12-30: Mandatory Logged Quantities (Per phase/total/min & max values)

Logged Value	By Phase	Total	Min/Max
Active energy import/export	X	X	
Reactive energy import/export		X	
Reactive energy inductive/capacitive		X	
Reactive energy QI-QIV		X	
Apparent energy import/export	X	X	X
Phase voltage	X		X
Phase to phase voltage	X		X
Current	X	X	X
Active power	X	X	X
Reactive power	X	X	X
Apparent power	X	X	X
Frequency		X	X
Phase angle	X		X
Power factor (pf)	X	X	X
THD voltage	X	X	X
THD current	X	X	X

12.19.19.4 Local Display

The Energy Meter shall have a display that can show the following instantaneous values with high accuracy:

- Current in each phase
- Phase to phase voltage
- Phase to neutral voltages
- Power factor per phase and total
- Phase angle
- Frequency
- Active power per phase and total
- Reactive power per phase and total
- Apparent power per phase and total
- THD for voltage and current
- Vector diagram

12.19.19.5 Communication Interface

The energy meters shall have the following communication interfaces:

- Two (2) Fast Ethernet 10/100 electrical port (RJ-45)
One port shall support IEC 61850 for surveillance and send alarms (Reporting to SAS)
.
- One (1) Serial Communication port RS422/RS485
Hardware RS232 serial port
Port type 5-pole connector (phoenix)
Supported Protocol: IEC 62056-21/IEC1107 Mode C programming mode or DLMS/COSEM/MODBUS, IEC 61850 and 4G communication module
- Optical Communication Hardware IEC 62056-21/IEC1107 optical port
- GPRS(3G/4G)

The meter shall be provided with a slot for insertion of a SIM card for GPRS communication on the 3G/4G Global System for Mobile communication (GSM).

12.19.19.6 Third-party communication

Meters shall be capable of interfacing with third party AMR systems. To achieve the following:

- Meters shall use a protocol that allows it to be automatically detected when connected to a communications bus using e.g. the DLMS/COSEM protocol to IEC 62056 Parts 1 to 9, Euridis bus to IEC 62056-3-1, or similar proprietary protocol;

- All protocols employed shall use an open system architecture based on publicly available international standards, and be freely available to any third party for integrating into an AMR/AMI central collection system;
- The protocol employed shall demonstrate compliance and/or certification to IEC 62056 or other relevant standards;
- Meters shall be capable of being multi-dropped onto the same communication bus for remote interrogation and programming purposes;

12.19.20 Metering Management System – AMI/Remote reading

The Energy Metering System shall allow and manage remote reading from a remote server..

12.19.20.1 Remote Meter Reading

The system shall have the following remote meter reading functions and capabilities:

- The Metering system shall initiate the meter reading and collection of ends of month cumulative active, apparent, reactive energy and average maximum demand reading at the beginning of each month.

The readings shall be for both import and export power flows.

This feature shall be scheduled by the user.

- Time Of Use (TOU) shall be fully configurable both on the meters and the AMI system and TOU registers shall be readable on the AMI system.
- Remote reading of values such as load profiles, instrumentation measurements profiles, live line measurements, meter configurations and historical meter data shall be available at the request of the user/operator.
- Remote configuration of the AMI meters

12.19.20.2 Meter Management

The Metering system shall be capable of:

- Automatic recognition of connected meters
- Remote meter diagnostics
- Remote meter configurations and upgrade
- Flagging potential meter or communications link failures
- Identifying instances of meter tamper or interference
- Indication of offline meters

12.19.20.3 Time Synchronisation

The Metering system shall be synchronized to a GPS-disciplined time source with accuracy compatible with settlement and event analysis (e.g. sub-millisecond where required) using PTP/IRIG-B or equivalent. The time synchronization architecture shall be common with SAS, SCADA, and WAMPACS, and that loss of sync is alarmed and treated as a reportable condition.

All revenue and check meters at Kasama and Nakonde shall be synchronized to the same time source as the National Control Centre to support settlement reconciliation and disturbance analysis.

12.19.20.4 Communication

The Metering system shall be open and function with any meters with the international communication standard from suppliers’ other than the supplier of the system

International standard communication protocol compability: IEC 62056.

The Metering system at the substation shall be connected to the ZESCO optic fiber network using the standard Fast Ethernet interfaces.

All Energy Meters at the substation shall be accessible through the LAN network.

The Metering System LAN in the control room shall be linked to the SDH equipment, located in the communication room, using UTP cable.

The UTP cables shall be the standard CAT-6 and shall use the TIA/EIA-568-B wiring and color-coding standard.

At Kasama substation the cables shall be laid through a flexible rodent resistant PVC pipe using existing cable trenches.

At New Nakonde Substation, the cables shall be laid according to requirements for cable installations in this document.

Each UTP cable on the LAN shall not exceed 100 meters in length.

The physical (hardware) interface on the ZESCO SDH terminals for the Fast Ethernet connection shall be the standard RJ-45 electrical port.

12.19.20.5 Metrology and Quality of Supply

- Voltage monitoring
- Meter status monitoring
- Under voltage/overvoltage threshold setting and alarms.

- Measurement values shall be configurable to Mega or kilo (MW/kW, MWh/kWh, MVA/kVA, MVAh/kVAh, MVAR/kVAR, MVARh/ kVARh etc) depending on measurement magnitude and to two decimal places for the higher scale (Mega) and shall be primary values.

12.19.20.6 System Expandability

The system shall be expandable and upgradable to accommodate future additional circuits and meters.

12.19.20.7 Metering System Features

The Metering system shall read the historical billing data stored in the meters and logged load profiles data in the meters as well as live (instantaneous) accumulative and instrumentation measurements. The following are the features of the metering system:

- Scheduled meter readings
- Real time meter readings
- Automatic retry for reading failure
- Alarming of reading failure
- Provision for manual entry of meter reading in case of failure of automated reading for any reason
- Monthly and daily analysis reports for low voltages, high voltages, line and sub-network loss analysis. These reports should be user customizable and configurable.
- Remote metering
- Line voltage loss detection
- Remote management and upgrades
- Archive management
- Event management
- Time synchronization
- Bi-directional meter supporting
- Back up management
- Statistics and reports. The readings and reports should be exportable to other computer programs such as excel
- Data inquiry
- Interfaces supporting
- Network structure, scheme or topology indicating location of installed meters

12.19.21 Technical Specification for a Power Quality Recorder**12.19.21.1 Design and Performance Requirements for Power Quality Recorders**

The specification outlines the essential design, manufacturing, and operational standards for power quality recorders intended for permanent installation. These devices must meet high-quality standards and be capable of continuous operation under specified environmental conditions.

Must conform to IEC 61000-4-30 and IEC 62586 standards and statutory provisions.

Designed for robust performance in continuous service conditions.

Expected to have a long service life despite potential anomalies in specifications.

12.19.21.2 Environmental Operating Conditions

- Operates at altitudes up to 2,000m above sea level.
- Maximum ambient temperature of +45°C and minimum of -1°C, with a daily average of 35°C.
- Relative humidity tolerance of 85%.
- Designed to withstand frequent lightning storms, with an Isokeraunic level of 86 days/year.

12.19.21.3 Required Markings on Power Quality Recorders

- Must include manufacturer's name, model, and serial number.
- Current and voltage input specifications must be clearly marked.
- Communication port labels (e.g., RS-232, Ethernet, USB) are required.
- Input channels for current (I1, I2, I3, I4) and voltage (U1, U2, U3, U4) must be labeled.

12.19.21.4 Accessories Included with Power Quality Recorder

- Includes surge arresters for protection against voltage spikes.
- Connectors are provided for secure and reliable connections.

12.19.21.5 Licensing Requirements for Data Management

Power quality recorders must come with necessary licenses for effective data analysis and integration with existing systems. These licenses enable various functionalities for data management.

- Licenses should allow automatic data retrieval based on user-defined schedules.
- Must support database management, reporting, and data analysis functions.
- Capable of analyzing voltage dips and harmonics direction.
- Licenses should facilitate firmware upgrades and configuration of the power quality recorder.

12.19.21.6 Reporting and Analysis Capabilities of Power Quality Recorders

- Summarized management and energy reports for all recorders are required.
- Steady state trend reports with statistical analysis and user-defined parameters must be included.
- Individual event reports and compliance reports for voltage sags, swells, and interruptions are necessary.
- User-configurable report templates and periodic automated reports (daily, weekly, quarterly, annual) should be available.
- System error reports and analysis of faulty recordings are essential for troubleshooting.

12.19.21.7 Minimum Requirements for Power Quality Recorder

- Type: Three-phase power quality recorder for permanent installation.
- Class: Class A PQ recorder as per IEC 61000 – 4 – 30.
- Maximum Weight: 2.5 kg.
- Casing: Metal casing required.
- Voltage Inputs: 4 isolated voltage inputs with a measurement range of 0 – 1000 Vrms.
- Current Inputs: 4 differential isolated inputs with a burden of no more than 0.1 VA.
- Sampling Rate: Minimum of 256 samples per cycle.
- Accuracy: 0.1% according to IEC standards.
- Storage Capacity: Minimum of 100 days of data storage.
- Communication: USB, RS-232, RS-485, Ethernet, and Access Point availability.

12.19.21.8 Measurement Parameters for Power Quality

- Voltage: RMS values recorded every $\frac{1}{2}$ cycle.
- Current: RMS values recorded every $\frac{1}{2}$ cycle.
- Frequency: Range of 45 – 55 Hz.
- Harmonics: Voltage and current harmonics up to the 50th, including inter-harmonics.
- Flicker: Compliance with Flicker accuracy Class F1.
- Sags & Swells: Must record sag management data and event depth.

- Power Measurements: Active, reactive, and apparent power calculations.
- Energy: Measurement of active energy (kWh), reactive energy (kVARh), and apparent energy (kVAh).

12.19.21.9 Software and System Requirements

- System Reliability: Critical communication programs must run as Microsoft Service programs.
- Security: Login must be secured by Windows Authentication and support SQL Server login.
- Software Characteristics: Integrated MS SQL database, trending with over 5 years of historical data.
- Import/Export Capability: Support for manual and automatic functions to various formats including Excel and Word.
- Real-Time Capabilities: Must provide real-time data display and analysis without gaps in measurement.

12.19.21.10 Environmental and Other Requirements

- Operating Conditions: Must function at an altitude of 2000 m, with a maximum relative humidity of 85% and an operating temperature range of -1 to 40°C.
- Certification: Must provide quality assurance certificates and routine test results.
- Training: Product training for four engineers, including travel and accommodation costs.
- Warranty: Minimum warranty period of 1 year.
- Applicable Standards: Compliance with IEC 61010 and IEC 61000 standards is required.

12.19.22 Factory Acceptance Test (FAT)

FAT is mandatory for all metering equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on metering system equipment.

The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers and Consultant personnel (one). Prior to travelling, no later than one (1) month, the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer. Site Acceptance Test (SAT)

Site Acceptance Tests (SAT) shall be performed on site upon installation of the whole system. This shall be done to ensure the system performs according to specification and integrates well with other components.

12.19.23 Temperature Monitoring

Temperature monitoring devices shall be installed on all Power Transformers and Reactors within the Scope of Supply.

The device shall monitor both Winding temperature and Oil temperature.

The temperature devices shall be equipped with temperature transducers for the purpose of remote monitoring and readings signals shall be transmitted by 4-20mA signal.

The indications on these gauges shall be read on the temperature devices on the local SAS HMI as well as at NCC.

12.19.24 Test Blocks

Test blocks for each protection circuit and associated instrument transformers shall be provided. The test blocks shall have adequate terminals/sockets to allow for the isolation of all trip related circuits, i.e. aided trip send/receive to allow for the testing of the individual functions, and the instrument transformer circuits. The test plugs will also allow for the external injection of voltage and current for the testing of the specific relay.

The insertion of the test plug into the sockets of the test blocks shall isolate all trip-related circuits, disable breaker fail and allow for the external monitoring of these circuits.

The test plugs shall not isolate the DC auxiliary supply to each of the relays.

For energy / statistical metering applications 13-way test blocks are acceptable but it would be preferred if the Protection & Metering test-blocks could be the same type.

With the Test-blocks supplied on the contract, the supplier is to supply the applicable test handles and links for bridging or shorting circuits on the test handles. There should be no less than 5 Test Handles with accessories supplied per substation.

12.19.25 Protection of CT circuits

Removal of the test plugs shall short the CT circuits.

12.19.26 Protection of VT circuits

Removal of the test plugs shall isolate the VT circuits. All VT circuits shall be protected by MCBs.

12.19.27 Panel Wiring

- Multi-stranded flexible copper conductor 600/1000V grade solid dielectric insulated single core wiring shall be used for all wiring.

- All wiring shall be number ferruled at both ends of each conductor. The numbering method employed shall conform to the system
- All wiring will be numbered using slip-on type wire numbers that will not detach from the wire unless the pre-insulated lug is removed from the wire end first. Push-on type numbers are not acceptable.
- All CT and VT circuit wiring shall have a minimum cross-sectional area of 4 mm², with red, yellow, blue according to the relevant phases and black for the neutral.
- Ground wiring shall be green/yellow coloured insulation copper wire.
- All internal signal wiring and control wiring shall have a minimum cross-sectional area of 1.5 mm² with grey wire for DC wiring and black wire for AC wiring. All wiring for trip signals shall carry an additional ferrule marked 'TRIP.'
- All wires shall be provided with pre-insulated lugs, which shall be of the hooked flat blade (spade) type for terminal connections and ring ferrules for CT connections. For relay terminal connections ring type or hooked flat blade types shall be used, alternatively where space limitations are experienced, boot lace ferrules could be considered if approved in writing by the Owner. Push-on lugs and bare copper terminations shall not be considered.
- All wiring shall be placed in adequately supported trunking or looms with 20% spare capacity per wireway. Consideration shall be given during the design stage to temperature rise within trunkings or looms. The designer shall ensure that excessive temperature build-up does not occur within trunking or looms during normal operation of the system.
- DC supply wiring shall be a minimum cross-sectional area of 2.5 mm² with red coloured insulation for positive and black for negative.
- AC auxiliary supply wiring shall be a minimum cross-sectional area of 2.5 mm² with brown coloured insulation for phase and blue for neutral.

All panel wiring shall be as detailed in the Technical Specification for Auxiliary and Power Cables

12.19.28 Labelling

All protection relays, test blocks, switches, relays and terminal strips shall be clearly labelled. Labelling on the outside of the panel shall consist of engraved trafolite labels; labelling inside the panel shall be printed with a suitable thermal label.

The terminal strips on the back-plate of the scheme shall be legibly numbered, for example X1, X2, etc.

All alarms and trips associated with the described protection schemes shall be individually and clearly displayed and labelled on the front of the associated panel.

12.19.29 Terminals

Terminals used in protection function circuits shall be of type “B” screw clamp insertion (Klippon RSF1 or Entrelec M10/10 & M6/8 equivalent). This excludes fuse terminals and terminals used in the alarm and meter pulse circuitry. All terminal blocks shall be equipped with facilities for testing, such as short-circuiting, separating, plugging in, isolatable etc.

Refer to the *Technical Specification for Auxiliary Power and Supply Cables* for the other detailed requirements relevant to Terminals.

All wiring to the terminal strips shall be such that the signal flow through the terminals will be from the top to the bottom for horizontally mounted terminal strips and from the left to right for vertically mounted terminal strips. The following standard terminal strip numbers shall be allocated inside switchboards;

- XDC: Incoming DC supply;
- XAC: Incoming AC supply;
- X1: AC Heater Supply;
- X2: Buswiring;
- X3: CT wiring;
- X4: VT wiring;
- X5: Trip wiring*;
- X6: General wiring;
- X7: Switching device auxiliary signals;
- X8: Field wiring;
- X9: SCADA wiring.

* Terminal block for Trip wiring X5 should be red in colour.

A maximum of 2 wires per terminal connection point shall be allowed.

12.19.30 Drawings

The Designs shall be produced on a per bay basis, and shall be fully integrated and totally stand-alone, including all detailed design information pertaining to the primary, secondary and ancillary equipment comprising the integrated scheme.

The designs shall include the following main sections:

Cubicle layouts;

Scheme Logic diagrams (to be approved before detailed design stage);

Bay single line diagram;

AC key diagrams;

Main 1 / Main Protection, DC key diagrams;

Main 2 / Backup Protection, DC key diagrams;

Primary equipment Control, DC diagrams;

Primary equipment Indication, DC diagrams;

Secure DC, key diagrams;

SCADA, Measurements and Statistical Metering key diagrams;

Main 1 / Main Protection Panel cabling schedules;

Main 2/Backup Protection Panel cabling schedules;

Disconnecter and Earth switch DC key diagrams;

Yard junction box cabling schedules;

Bay cable block diagram 1;

Relay logic diagrams.

12.19.31 Operation and Maintenance

The control and protection equipment shall be designed for minimum maintenance and attention. All IEDs offered shall be capable of monitoring their own health and must provide an alarm in the case of an internal relay failure (IRF) or critical error.

The IEDs and the design shall make provision for these failure alarm/s to be transmitted to the Control Room by means of the communications channels and a potential free contact.

The extent of maintenance requirements for each major device offered by the Tenderers shall be stated.

A Service Laptop PC with all necessary softwares installed, configuration files, commissioning test files, and As- Built soft copy drawings (incl. O&M manuals) shall be handed over to the Employer at project handover.

12.19.32 Factory Acceptance Test (FAT)

FAT is mandatory for all Substation Automation Systems equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on SAS & SCADA system equipment.

The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers. Prior to travelling, no later than one (1) month, the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer.

FAT is mandatory for all **protection** equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on protection system equipment.

The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers and Consultant personnel (one). Prior to travelling, no later than one (1) month, the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer.

The factory acceptance tests for protection shall include, but not be limited to, the following:

- Physical inspections and wiring checks
- Function tests
- Secondary injection test

FAT is mandatory for all **metering** equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on metering system equipment.

The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers Consultant personnel (one). Prior to travelling, no later than one (1) month, the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer.

The factory acceptance tests for metering shall include, but not be limited to, the following:

- Physical inspections and wiring checks
- Secondary injection test
- Accuracy test

12.19.33 Site Acceptance Test (SAT)

SAT for protection, metering and SAS shall include integrated testing of protection schemes (including tele-protection and SPAR), revenue metering chains (CT/VT to meter to gateway, including time sync), and SCADA/telecom interfaces, with acceptance criteria referenced to the applicable IEC and IEEE standards.

12.20 Technical Specification for Telecommunication

This chapter describes the existing transmission system telecommunication equipment and describes and specifies all new telecommunication equipment to be supplied by the prospective contractor. The contractor shall supply, install, test, commission and integrate Optical Transport Network (OTN), Packet Transport Network (PTN), Synchronous Digital Hierarchy (SDH), Private Automatic Branch Exchange (PABX), Pulse Code Modulation (PCM) and 48VDC charger equipment at existing and new substations accordingly.

Under the Optical Fiber Projects of 2006, 2011 and completed in 2013 in phases one, two and three respectively and the North Western Grid Extension Project, a high capacity optical network was implemented on the 330, 132, 88 and 66 kV power networks covering all the ten provinces of Zambia.

ZESCO operates a vast private telecommunications network. Additionally, ZESCO has a commercial license to lease excess capacity on the network. ZESCO’s existing telecommunication systems consists of an optical fiber network, microwave radio network, VHF mobile and fixed radio systems equipment. In addition, ZESCO leases some dedicated lines from ZAMTEL where the ZESCO network is not available.

The optical fibers cables used are mainly based on Optical Pilot Ground Wire (OPGW) but All Dielectric Self Supporting (ADSS) fibers are also used on 11 and 33 kV distribution lines.

The telecommunications infrastructure has been an integral part of ZESCO systems since the company was established. The purpose of having a telecommunication infrastructure in a power company is to ensure that the provision of electricity from the point of generation to the point of supply to the customers is done efficiently, reliably and safely. This is done by offering telecommunications services and network facilities for voice, control, protection and various information systems as follows:

- Operations and Business voice communication
- Supervisory Control and Data Acquisition (SCADA)
- Tele-protection (High Voltage Line differential, permissive and direct protection)
- Tele-metering (measurands)
- Access Control and remote surveillance of key installations (CCTV).
- Video conferencing system (VCS) for remote interactive meetings.
- Vehicle tracking system (VTS).
- Enhanced corporate connectivity for information systems like Business Information Systems (BIS), email, internet etc.

Tasked with the responsibility of offering the services listed above, ZESCO has implemented the following telecommunication networks:

- Telephone network
- High voltage Power Line carrier network
- Mobile Radio Network
- Fixed Radio Network
- Video Conferencing Network.
- Access Control and CCTV Network
- Optical Fiber Network.

Due to the extensive telecommunications network with excess capacity especially on the optical fiber network, ZESCO management made a corporate decision to diversify into the provisioning of commercial telecommunication services to the ICT industry. The commercial activities started on a small scale on the microwave radio network in 2003. When the optical fiber network was implemented in 2007, full scale telecommunications business operations commenced with the acquisition of a telecommunications license from the communications authority (ZICTA) in the wholesale category of Carrier of Carriers.

12.20.1 Existing telecommunication equipment

The optical transmission equipment is based on SDH and DWDM/OTN technologies and was supplied by ZTE Corporation of China. The equipment type is called ZXMP S385 and ZXONE9700/ZXMP M920 for SDH and DWDM/OTN respectively. The network has multiservice transport capabilities. The installed backbone OTN transmission capacity is 4000 Gbps with 40 channel DWDM optical multiplexers.

12.20.2 330 kV Nakonde Stepdown substation

12.20.3 Optical Fibre Link

Supply of optical fiber approach cables (ADSS) from the gantries on the Nakonde-Kasama bay, Nakonde-Tunduma bay, Nakonde -Isoka 66kV bay and New Nakonde- Nakonde Town 66kV bay at Nakonde Stepdown substation to the telecom’s equipment room

12.20.4 Optical Transport Network (OTN)

Optical Transport Network (OTN) equipment with the following characteristics/requirements.

- Not less than 4000G of transmission capacity in all (Kasama, Tunduma, Isoka, Nakonde town) four (4) directions respectively
- The proposed telecoms terminal equipment shall be able to reliably transfer telecommunication signalling through a distance of 226km without a repeater station. The equipment must have cross connection capabilities
- Must be open for integration and monitoring on the already operational ZTE Network Management System (NMS)

- The equipment must be linked to the already operational ZXONE9700E equipment at Nakonde Town and Isoka substations
- Service interface modules:
 - 2 x 155M – 2.5G Modules/Cards with SFP’s
 - 2 x 10G Modules/Cards with SFP’s (with 1310 nm and 1550 nm).
 - 2 x Service cards with LAN capabilities.
 - 4 x 100G Modules/Card with SFP’s by four ports.
 - 6 x 4 port L4K Card or higher version
 - 8 x E2K x 10 ports board
 - 8 x E2K x 20 ports board

The Optical Transport Network (OTN) to be installed should have extra subracks to face in the direction of Kasama, Tunduma, Nakonde Town and Isoka.

The contractor shall also install, commission and integrate the subracks at 330kV Kasama Substation.

12.20.5 Synchronius Digital Hierarchy (SDH)

One (01) Synchronous Digital Hierarchy (SDH) multiplexer with STM-64 optical transmission capacity each and the following interfaces:

- Optical Transmission Modules:
 - x 2 ports STM-64
 - 4 x 4 ports STM-16
- Service Interfaces
 - 63 x E1 ports
 - 1 x 8 ports STM-1
 - 8 x 100 Base TX ports (Fast Ethernet - Electrical)
 - 8 x 100 Base FX ports (Fast Ethernet – Optical)
 - x Gigabit Ethernet ports x 4 control modules
- Engineer’s Order Wire

One (1) FOX615 SDH MUX for communication with same equipment in TANESCO’s station Tunduma and NCC.

- Two (02) Power Supply cards
- Two (02) CESM1 cards
- Two (02) SAMO2
- LEDS1
- TEPI1
- OPIC1
- LESU1

- LEXI1
- LEDE1
- ETOP1(With Single Mode SFP's)
- ELET1

12.20.6 Packet Transport Network (PTN)

One Packet Transport Network (PTN) equipment with the following characteristics/requirements:

- Transmission rate
 - 10G
 - 100G
- Double supply voltage of -48VDC
- Supported interfaces/rates
 - 2Mbps
 - 100Mbps
 - 155Mbps
 - GE
 - 10G
 - 100G
- Line/Service Interface modules
 - 3 x 100G
 - 2 x 12 ports 10G module
 - 4 x 16 ports GE module
 - 1 x 4 port STM-1
 - 1 x 63 TDM E1 processing module

12.20.7 PCM230 access MUX

One (1) PCM P230 access multiplexers for telephony and Ethernet services. Each unit shall have the following interfaces:

- 4 ports for distance protection channels, IEC 60834 - 1
- 4 ports for 64 kbps G.703 co-directional channels.
- 4 ports for 2 Mbps G.703 (E1) channels.
- 8 port FXO
- 4 Port FXS.

12.20.8 PDH/SDH MUX

The PDH/SDH PCM multiplexers shall be supplied with patch codes, power cables, and accessories for the complete installation and interfacing to the existing ZXMP S385 SDH multiplexer.

12.20.9 PCM Access MUX

One (1) PCM Access Multi plexer with the following interfaces:

- 8 ports for 2 wire subscriber lines
- 4 ports for RS-232 (or V24/ V28) data channels
- 4 ports for 64 kbps G.703 co-directional channels.
- 4 ports for 2 Mbps G.703 (E1) channels.
- 2 Ethernet ports
- 8 Ports FXO
- 4 Ports FXS

12.20.10 PABX modern exchange

The contractor shall supply test, install, commission and integrate one (1) ALCATEL PABX modern exchange which will be used for internal calls and for external calls to the public switched telephone network.

- Twenty (20) analogue telephone handsets
- Twenty (20) digital telephone handsets
- Twenty (20) VoIP telephone handsets (Alcatel compatible)
- One (1) Optical Distribution Frame (ODF) with optical connectors (FC) and pigtails for complete multiplexer unit installation
- One (1) Digital Distribution Frame (DDF) with electrical connectors and patch cables for complete installation.
- One (1) Main Distribution Frame (MDF) with Krone type terminal blocks for terminating telephone.
- One (1) lot Wiring for power cables and distribution blocks, data circuits, telephones, etc
- One (1) lot Mechanical accessories, cabling, splice boxes and any other electrical, mechanical or optical parts required for a complete Optic Fibre Equipment installation
- Installation of items above to the existing telecommunication system and the National Control Centre
- Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc)

- Laptops with Maintenance software for the OTN, PTN, SDH/PDH Multiplexers and PABX. The laptop processor shall have Intel core i9 or better CPU, 1TB HDD, 16GB RAM.
- At the National Control Centre (NCC) in Lusaka the bidder shall include in the scope of works the following equipment:

12.20.11 48V DC power supply (charger and batteries)

DC Power System (Charger and Batteries) with the following characteristics/requirements:

- Three phase AC input
- Switched Modular charger type
- Single phase AC input voltage range between 140V – 280V
- Input Current range between 6A – 600A
- Output DC voltage range between 42V – 58V
- Output high-off voltage range between 58V – 62V
- Able to handle 16 x 48VDC, 100Ahr Lithium batteries
- Must be open for integration and monitoring on the already operational ZTE Power Management System (PMS)
- Supply of 48V lithium batteries, 12 batteries with a total of 1200Ah

12.20.12 Kasama 330 kV substation

12.20.13 Optical Fibre Link

Supply and installation of optical fiber approach cable (ADSS) from the gantries on the Nakonde bay at Kasama substation to the telecom’s equipment room.

12.20.14 Optical Transport Network (OTN)

Optical Transport Network (OTN) equipment with the following characteristics/requirements. Not less than 4000G of transmission capacity in one (1) direction, Nakonde Stepdown.

- The proposed telecoms terminal equipment shall be able to reliably transfer telecommunication signalling through a distance of 226km without a repeater station. The equipment must have cross connection capabilities
- Must be open for integration and monitoring on the already operational ZTE Network Management System (NMS)
- The equipment must be linked to the already operational ZXONE9700E equipment at Kasama
- Service interface modules:
 - x 155M – 2.5G Modules/Cards with SFP’s
 - 2 x 10G Modules/Cards with SFP’s (with 1310 nm and 1550 nm)
 - 2 x Service cards with LAN capabilities
 - 4 x 100G Modules/Card with SFP’s by four ports
 - 4 x 4 port L4K Card or higher version

- 8 x E2K x 10 ports board
- 8 x E2K x 20 ports board

The Optical Transport Network (OTN) to be installed should have extra subracks to face in the direction of Nakonde Stepdown.

12.20.15 Synchronius Digital Hierarchy (SDH)

One (01) Synchronous Digital Hierarchy (SDH) multiplexer with STM-64 optical transmission capacity each and the following interfaces:

- Optical Transmission Modules:
 - 3 x 2 ports STM-64
 - 4 x 4 ports STM-16
- Service Interfaces:
 - 63 x E1 ports
 - 1 x 8 ports STM-1
 - 8 x 100 Base TX ports (Fast Ethernet - Electrical)
 - 8 x 100 Base FX ports (Fast Ethernet – Optical)
 - 2 x Gigabit Ethernet ports x 4 control modules
 - Engineer’s Order Wire

12.20.16 Packet Transport Network (PTN)

One Packet Transport Network (PTN) equipment with the following characteristics/requirements:

- Transmission rate
 - 10G
 - 100G
- Double supply voltage of -48VDC
- Supported interfaces/rates
 - 2Mbps
 - 100Mbps
 - 155Mbps
 - GE
 - 10G
 - 100G
- Line/Service Interface modules
 - x 100G
 - 2 x 12 ports 10G module
 - 4 x 16 ports GE module
 - 1 x 4 port STM-1
 - 1 x 63 TDM E1 processing module

12.20.17 PCM A230 MUX

One (1) PCM Access Multiplexer each with interfaces for SCADA, Speech and Data as follows:

- 8 ports for 2 wire subscriber lines
- 4 ports for RS-232 (or V24/ V28) data channels
- 4 ports for 64 kbps G.703 co-directional channels.
- 4 ports for 2 Mbps G.703 (E1) channels.
- 2 Ethernet ports
- Ports FXO
- 4 Ports FXS

12.20.18 PDH/SDH MUX

The PDH/SDH PCM multiplexers shall be supplied with patch codes, power cables, and accessories for the complete installation and interfacing to the existing ZXMP S385 SDH multiplexer.

12.20.19 PCM Access MUX

One (1) PCM Access Multiplexer each with interfaces for SCADA, Speech and Data as follows:

- 8 ports for 2 wire subscriber lines
- 4 ports for RS-232 (or V24/ V28) data channels
- 4 ports for 64 kbps G.703 co-directional channels.
- 4 ports for 2 Mbps G.703 (E1) channels.
- 2 Ethernet ports
- 8 Ports FXO
- 4 Ports FXS

12.20.20 PABX modern exchange

The contractor shall supply, test, install, commission and integrate one (1) ALCATEL PABX modern exchange which will be used for internal calls and also for external calls to the public switched telephone network.

- Twenty (20) analogue telephone handsets
- Twenty (20) digital telephone handsets
- Twenty (20) VoIP telephone handsets (Alcatel compatible)
- One (1) Optical Distribution Frame (ODF) with optical connectors (FC) and pigtails for complete multiplexer unit installation
- One (1) Digital Distribution Frame (DDF) with electrical connectors and patch cables for complete installation.
- One (1) Main Distribution Frame (MDF) with Krone type terminal blocks for terminating telephone.
- One (1) lot Wiring for power cables and distribution blocks, data circuits, telephones, etc

- One (1) lot Mechanical accessories, cabling, splice boxes and any other electrical, mechanical or optical parts required for a complete Optic Fiber Equipment installation
- Installation of items above to the existing telecommunication system and the National Control Centre
- Pre-Commissioning Tests and Checks (full documentation of test results, function checks, as-built drawings (layout, plans, single line, key, wiring etc)

12.20.21 DC power charger and batteries

DC Power System (Charger and Batteries) with the following characteristics/requirements:

- Three phase AC input
- Switched Modular charger type
- Three phase AC input voltage range between 242V – 485V
- Input Current range between 6A – 600A
- Output DC voltage range between 42V – 58V
- Output high-off voltage range between 58V – 62V
- Able to handle 16 x 48VDC, 100Ahr Lithium batteries
- Must be open for integration and monitoring on the already operational ZTE Power Management System (PMS)
- Supply of 48V lithium batteries, 12 batteries with a total of 1200Ah

12.20.22 Site Acceptance Tests (SAT)

The site acceptance tests shall include, but not be limited to, the following

- Physical inspection and wiring
- BER (Bit error rate) test
- Ethernet Link Test
- SDH System Protection Test
- PCM function test
- Network management system functional test

12.20.23 Factory Acceptance Test (FAT)

FAT is mandatory for all telecommunication equipment prior to shipment. No shipment release authorization shall be granted in the absence of FATs on telecommunication system equipment.

The arrangements for FATs shall include local transportation and associated costs for a duration to be proposed by the Contractor and approved by the Employer for Three (3) ZESCO engineers and Consultant personnel (one). Prior to travelling, no later than one (1) month,

the Contractor shall avail the FAT Program and Schedule indicating the duration of FAT to the Employer. The following equipment shall be subjected to FAT:

- OTN
- PTN
- SDH and PCM
- PABX
- FOX
- ADSS

The factory acceptance tests shall include, but not be limited to, the following

- Physical inspection and wiring
- BER (Bit error rate) test
- Ethernet Link Test
- System Protection Test
- Function test
- Network management system functional test

12.21 Technical Specification for EMS

ZESCOs SCADA system ABB Network manager with state estimator has a grid model which will be fed with static and realtime data. Static data to be delivered by contractor described below.

12.21.1 Transmission Line

- Positive Sequence Impedance [Ohm]
- Total parallel p.u. resistance [Ohm]"
- Total parallel p.u. reactance [Ohm]
- Total parallel conductance [μ S]
- Total parallel susceptance [μ S]
- Total zero sequence resistance [Ohm]
- Total zero sequence reactance [Ohm]
- Total Zero sequence shunt conductance [μ S]
- Total zero sequence shunt susceptance [μ S]
- LENGTH [212km]
- LINE TYPE

12.21.2 Line Types

- Line Type Name
- Series Resistance [ohm/km]
- Series Reactance [ohm/km]

- Shunt Susceptance [$\mu\text{S}/\text{km}$]

12.21.3 Two Winding Transformer Type

- Data engineering Unit
 - Short circuit Current [kA]
 - No load loss [kW]
 - IMP.VOLTS %
 - Short circuit loss [kW]
 - Short circuit impedance [% of rated impedance]
- Zero sequence data Engineering Unit
 - No load current [% of rated current]
 - No load loss [kW]
 - Short circuit impedance [% of rated impedance]
 - Short circuit loss [kW]
- Grounding Impedance Engineering Unit
 - High side ground resistance [Ohm]
 - High side ground reactance [Ohm]
 - Low side ground resistance [Ohm]
 - Low side ground reactance [Ohm]
- Winding config.
 - High side [Y solid grounded/Delta]
 - Low side [Y solid grounded/Delta]

12.21.4 Three Winding Transformer Type

- Rated voltage [kV]
 - Primary side
 - Secondary side
 - Tertiary side
- Rated power [MVA]
 - Primary side
 - Secondary side
 - Tertiary side
- Short circuit current [kV]
 - Primary side
 - Secondary side

- Data engineering unit
 - No load current [% of nominal current]
 - No load loss [kW]
 - Short circuit impedance [% of rated impedance]
 - Short circuit loss [kW]

- Zero sequence data Engineering Unit
 - No load current [% of rated current]
 - No load loss [kW]
 - Short circuit impedance [% of rated impedance]
 - Short circuit loss [kW]

- Grounding Impedance Engineering Unit
 - Primary side ground resistance [Ohm]
 - Primary side ground reactance [Ohm]
 - Secondary side ground resistance [Ohm]
 - Secondary ground reactance [Ohm]
 - Tertiary side ground resistance [Ohm]
 - Tertiary ground reactance [Ohm]

12.21.5 Tap Changer

- Tap Control
- Nominal position
- Neutral value
- Controlled Equipment
 - Type
 - Equipment Identity
- Tap position
 - Max
 - Min
 - Neutral

12.21.6 Shunt Compensator data

- Nominal power
 - Active Power[MW]
 - Rated Power [MVAW]
 - Reactive Power[MVAR]

- SVC Susceptance (SVC only)
 - min[MW]
 - max[MW]
 - min[MVAr]
 - max[MVAr]
- SVC (only)
 - Slope[%]
 - RefVoltage[kV]
 - Voltage high limit[kV]
 - Voltage low limit[kV]
- Grounding Impedance
 - "Neutral resistance [Ohm]
 - Neutral reactance [Ohm]"

12.21.7 Switch

- Short Circuit Calculation (SCA)
 - Breaker rating in RMS [kA]
 - Breaker rating peak in [kA]

12.21.8 Automatic Load

- Contingency Analysis (SA)
 - Target Load
 - Distribution factor

12.21.9 Series Compensator

- Base data Engineering unit
 - Series resistance [Ohm]
 - Series reactance [Ohm]
 - Shunt conductance [μ S]
 - Shunt susceptance [μ S]
- Zero sequence data Engineering unit
 - Series resistance [Ohm]
 - Series reactance [Ohm]
 - Shunt conductance [μ S]
 - Shunt susceptance [μ S]

12.22 Technical Specification for Surveillance and Access Control Systems**12.22.1 CCTV****12.22.2 General**

The video surveillance system shall be based on a robust and efficient Distributed Network Architecture and shall serve two purposes, namely, Substation Operations and Security Operations. Therefore, two surveillance monitoring stations shall be installed - one in the Substation Control Room and the other in the Security Control Room.

The CCTV surveillance system coverage shall include but not limited to the following areas:

- Security accesses into the site compound
- Perimeter Fence Lines adjacent to land access
- Accesses into all buildings including Control Building
- Battery Room
- Workshop
- Telecommunication Room
- Transformer area
- Main Gate
- Switchgear Room

12.22.3 Standards

IEC 50132 Alarm systems - CCTV Surveillance Systems for use in security applications, at security grade 3 level.

12.22.4 Surveillance Cameras

The selection of surveillance cameras at entrances and accesses shall be sufficient to provide facial identification during day light and night-time hours. Image sizes shall be set to a 1.6m high target filling a minimum of 50% of picture height.

Perimeter fence detection shall be required to identify the attempted access of persons, the surveillance cameras shall have pan, tilt and zoom functionality to allow the onsite staff to interrogate a particular region of the perimeter. The field of view should be set to a 1.6 m high target filling a minimum of 10% of picture height.

The perimeter fence surveillance cameras must return to default positions after one minute of inactivity has elapsed in regard to the pan, tilt and zoom functions.

Surveillance cameras should be selected that can cover the detection range required for the purpose of the CCTV surveillance system.

Surveillance cameras should be adjustable in both the vertical and horizontal axis and should be mounted at a height relative to their range.

Illumination shall be provided to ensure the capture of images in accordance with these requirements.

12.22.5 Camera Location and Housing

Cameras should be positioned in such a way that when looking horizontally across an area they are not adversely affected by the rising or setting of the sun.

Where a camera faces a boundary, it should be positioned so that movement outside the secure area is not detected.

The detectors shall not be installed directly on the perimeter fence, or in immediate proximity where they can be vandalised from outside the perimeter fence.

Detectors shall be installed within a Perspex housing to reduce the likelihood of failure during a physical attack.

Table 12-31: Kasama 330kV Substation indicative required number/type of CCTV cameras:

No.	Location/ Installation site	Type	Qty
1	Transformers	Thermal	2
2	Reactors	Fixed camera	4
3	Workshop	Fixed camera	4
4	Workshop Building	PTZ Camera	2
5	Main Gate	Fixed Camera	3
6	Main Building	Fixed Camera	5
7	Main Building	PTZ Camera	1
8	Generator Room	Fixed camera	1
9	Transformers	Thermal	2
10	Battery Room	Fixed Camera	1
11	Control Room	Fixed Camera	2
12	Relay Room	Fixed Camera	2

13	Comms/Telecoms	Fixed Camera	2
14	Passage	Fixed Camera	3
15	11kv Switch Room	Fixed Camera	1
16	Substation Perimeter	Fixed Camera	22
Total			57

Table 12-32: Nakonde Stepdown Substation indicative required number/type of CCTV cameras:

No.	Location/ Installation site	Type	Qty
1	Relay Room	Fixed Camera	2
2	Hallway	Fixed Camera	2
3	Hallway Main Entrance	Fixed Camera	1
4	AC/DC Room	Fixed Camera	1
5	Comms Room	Fixed Camera	2
6	Storeroom	Fixed Camera	1
7	Switchgear Room	Fixed camera	2
8	Generator Room	Fixed camera	1
9	Main Entrance	Fixed camera	2
10	Main building	Fixed camera	4
11	Main Building PTZ	PTZ Camera	1
12	Battery Room	Fixed Camera	2
13	Transformers	Thermal Camera	2
14	Reactors	Fixed Camera	2
15	Workshop	Fixed Camera	5
16	Workshop	PTZ Camera	3
17	Main Gate	Fixed Camera	2

18	Guard House	Fixed Camera	3
19	Control Room	Fixed Camera	1
20	Substation Perimeter	Fixed Camera	24
Total			63

12.22.6 Equipment and Data Storage

If wireless systems are to be used, then annunciation of failures shall be provided, this is to include, but not be limited to the following:

- Low Battery
- Loss of wireless signal
- Indication of the failed unit

Camera signal shall be monitored for signal loss, if this is not restored after 5 seconds then this shall be alarmed.

Two transmission paths shall be provided, in the event of the failure of the main transmission media, then the second shall continue to send images to the receiving controller.

The images from the cameras, covering 24-hour periods, shall be stored on a digital medium. It shall be possible to retrieve recorded information and review all data stored.

Monitoring shall be done from the storage and control equipment and shall be mounted within the 19” rack cabinet in the Control Room, and monitoring screens shall be provided within the Control Rooms.

12.22.7 Network Video Recorder (NVR)

The NVR shall record Alarms as well as video and audio from selected Transmitters/ Receivers.

The NVR shall act as central storage for Alarms so that when one Control Centre Station acknowledges an alarm, all the other Stations will see that it has been acknowledged

It shall be possible to record the same IP Camera or Transmitter on multiple NVRs.

It shall also be possible to specify that an NVR records from any valid transmitter video stream. This makes it possible to have one NVR recording a high bit rate video stream on the same LAN as the Transmitter whilst simultaneously another NVR can be recording a lower bit rate video stream over a slow WAN connection.

NVRs shall be able to communicate through a stateful firewall or a Network Address Translation (NAT) router. This allows several instances of Control Centre to be running behind a single NAT router sharing the same Internet address to access a remote NVR.

NVRs shall automatically manage free disk space by deleting recordings older than the specified number of days or when a minimum disk space threshold is met.

NVRs shall allow a video thinning threshold to be set whereby after a specified time, recorded video is thinned down to just the I-frames.

It shall be possible to start recordings based on the following conditions:

- Start on receipt of Alarm from a Transmitter for a set duration of time.
- Set to run continuously 24 x 7 x 365.
- Time scheduled using start and stop time at the same time on selected days of the week.
- Time scheduled by starting at a specific time on a specific day and recording 24 hours every day until a specific stop time on a specific day. E.g. Start Monday 09:00 and stop Friday 18:00.
- Start based on a manual operator requesting a recording

To comply with data protection requirements NVRs shall be able to store recorded video on hard disk for a specified number of days and then delete recordings older than the specified time limit

NVRs shall have a mode of operation whereby they record until full and then stop recording to preserve the recorded footage.

Administrators shall be able to protect individual recordings from deletion for use as evidence.

Failover and Redundancy

The Administrator must be able to configure redundant failover NVRs for each Primary NVR. Two modes shall be available:

- Continuous Mode: The Failover NVR synchronizes its job schedule with the Primary NVR and continuously records cameras at the same time as the Primary NVR.
- Failover Only Mode: The Failover NVR synchronizes its job schedule with the Primary NVR but only starts recording when it detects that the Primary NVR is no longer available on the network. The administrator must be able to manually failover from a Primary to a Failover NVR. The administrator must be able to manually re-synchronize the recording schedule back from a Failover to a Primary NVR.

The administrator must be able to manually failback from a Failover NVR to a Primary NVR, thereby reinstating the system to its original configuration.

Various redundancy strategies shall be supported such as:

- One Primary NVR monitored by multiple Failover NVRs
- Multiple Primary NVRs monitored by one Failover NVR
- Chains or Webs of redundancy cover amongst multiple NVRs

12.22.8 Management Software

The management software shall be able to control cameras and modify parameters of remote cameras. The following functions shall be supported:

- **PTZ Control:** turn remote pan/tilt up, down, left or right, adjust lens aperture and focal length (only if camera has PTZ function)
- **Multiple PTZ control modes:** use mouse or PC keyboard to make PTZ control; users can choose according their preferences.
- **PTZ contention:** the system allocates contention privileges to users at the same level to ensure one camera is under the control of one user at one time.
- **3D positioning:** users can drag the mouse on the surveillance image to control the camera surveillance direction and view angle, zoom in/out or focus on an object.
- **Camera parameter configuration:** configure parameters of remote cameras such as video parameters (resolution, code stream, frame rate) and alarm parameters (motion detection, privacy mask).
- **One-screen surveillance:** multiple remote sites or multiple areas of one site are under real-time surveillance on one screen; 1/4/9 picture and full screen browsing are available.
- **Panorama video browsing:** click primary equipment or a component on the plane figure to open the real-time videos of its interlinked cameras.
- **Dual-service view:** both surveillance view (primary equipment view) and maintenance view (site view) are available for direct operations.
- **Patrol:** all accessed cameras shall support video patrol function with configurable parameters.
- **Preset and home preset:** each surveillance spot (if only the camera supports preset function) can invoke presets during linkage, patrol and video browsing; home preset function is available, that means the pan/tilt returns to its home preset position after a preset timespan
- **Device tree:** the device tree function helps in directly locating the surveillance spots and shows device status such as offline, alarm, etc.
- **Video recovery:** after checking other functions and users shift back to the real-time surveillance interface, the system shall recover the real-time videos.
- **Manual video storage:** users can store real-time videos while browsing, if necessary, to save important clues and evidences.
- **All-day storage:** Important scenarios shall need 24/7 surveillance footages for future investigation and review.

- **Timing storage:** users can store videos within some specific timespan to save storage space.
- **Alarm-storage linkage:** external alarms or internal alarms like motion detection alarm will trigger the video recording to keep evidences; It shall be possible to pre-record 5~180s prior to the alarm to keep the whole activity before and after for analysis; pre-record time shall be configurable.
- **Footage query:** It shall be possible to query footages by surveillance spot, surveillance location, motion/activity, footage storage path, date/time, alarm or combined conditions and to play the wanted footage when it is fetched.
- **Video playback:** It shall be possible to play video online or after downloading them to the local system according to alarm index, normal play, fast play, slow play, frame play, drag, pause, snapshot or multi-shot the footages.

The video surveillance system shall support intelligent video analysis functions (motion detection, privacy mask etc). The system and product should comply with the ONVIF.

The system shall support Preset & Home function, so the system turns the camera to preset position at arranged time

The surveillance client shall support patrol; patrol interval is configurable; multi-queue patrol in different windows

The system shall provide function as the entire screen switching, so the system can make every set period of time to update a few cameras in the patrol. You can preset several different inspection plans and switching sequence.

Cameras should be linked with other subsystems such as access control subsystem, perimeter and other alarms.

12.22.9 Commissioning

Commissioning tests and focusing of all CCTV cameras shall be done using SecuriTEST IP CCTV Tester. Tests on the CCTV Surveillance System and associated equipment shall include but not limited to the following:

- Confirmation of recording and reviewing functions
- Confirmation of smart/ intelligent analytics features
- Confirmation of pan, tilt and zoom functions, plus return to default surveillance positions
- Generation of test and configuration reports of each individual camera
- All Cat 6 LAN cables shall undergo an onsite Level IV cable analysis using Fluke DTX-1800 Cable Analyzer. The test results shall form part of the commissioning.

12.22.10 Spare Parts

Recommended spare parts for the CCTV Surveillance System and associated equipment, to be agreed, shall be provided for an agreed period of operation and maintenance.

12.22.11 Documentation

The Contractor shall submit the following documentation:

- Network configuration documents describing the network hardware included, VLANs configured, Trunk ports etc.
- System drawings including logical network and device layout, physical device layout, etc.
- Project implementation specification
- Project schedule definition
- Standard system documentation (e.g. Operator’s guide)
- Maintenance documentation
- Training documentation
- Test procedure documentation
- Network configuration documentation including device name, user ID, user password and IP address lists.
- Project management and status reports as agreed with the Employer.
- Three (3) copies of hard copy as-built system documents shall be submitted up on project completion and handover. A soft copy shall be emailed to the Employer.

12.22.12 Access Control System**12.22.13 General**

The Access Control System (ACS) shall be an integrated solution that consists of hardware and software designed to control entry into selected areas and manage the movement of people/assets within. The system must be designed to increase security by defining access permissions based on area and time for each user and maintaining an audit log of all events.

The access control system shall be designed, manufactured and originate from reputable manufacturers. The access control system delivered shall comply with the Factories Act Chapter 441 (Part VI) of the laws of Zambia.

Table 12-33: Kasama 330kV Substation indicative required number and type of equipment:

No.	Site/ Location	Description					Door Returner	Turnstile
		System Controller	Tag Reader	Door Controller	Gate Motor	Magnet Lock		
1	Main Site	1						

No.	Site/ Location	Description					Door Returner	Turnstile
		System Controller	Tag Reader	Door Controller	Gate Motor	Magnet Lock		
1.2	Workshop		2	1		1	1	
1.3	Battery Room		2	1		1	1	
1.4	Relay Room		2	1		1	1	
1.5	Stores Room		2	1		2	1	
1.6	Comms Room		2	1		1	1	
1.7	AC/DC Room		2	1		1	1	
1.8	Control Room		2	1		1	1	
	Security Office		2	1		1	1	
1.11	Generator Room		2	1		1	1	
1.12	Superintendent Office		2	1		1	1	
1.13	Turnstile		2	1		1		
1.14	Passage		2	1		1	1	
1.15	Main Gate		4	2	1			1
1.16	Switch Gear Room		2	1		1	1	
Total		1	30	15	1	14	13	

Table 12-34: 330kV Nakonde Stepdown Substation indicative required number/type of equipment:

No.	Site/ Location	Description					Door Returner	Turnstile
		System Controller	Tag Reader	Door Controller	Gate Motor	Magnet Lock		
1	Main Site	1						

1.2	Workshop		4	2		1	1	
1.3	Battery Room		2	1		1	1	
1.4	Relay Room		2	1		1	1	
1.5	Stores Room		4	2		2	1	
1.6	Comms Room		2	1		1	1	
1.7	AC/DC Room		2	1		1	1	
1.8	Control Room		4	2		2	2	
1.9	Security Office		2	1		1	1	
1.10	Generator Room		2	1		1	1	
1.11	Superintendent Office		2	1		1	1	
1.12	Passage		2	1		1	1	
1.13	Main Gate		4	2	1			1
1.14	Switch Gear Room		2	1		1	1	
Total		1	34	17	1	14	13	1

12.22.14 System Controller

The System Controller shall be an intelligent hardware device with a full on-board database of tags and access data. The System Controllers shall operate in a truly standalone mode when there is no network connection available to the Access Control System (ACS) database engine module.

Each system controller/cluster controller shall be capable of storing up to 10 000 tags and shall be capable of buffering up to 100 thousand transactions should the connection to the ACS polling module be lost.

The System Controllers shall allow for the easy expansion of door controllers without the need to physically wire power and communications between these devices.

The ACS Server shall provide an auto detect function that shall poll the RS485 bus, or the LAN/WAN for any ACS controllers. The ACS controllers shall respond back with their respective factory assigned addresses, which shall be automatically inserted into the ACS database.

The ACS system controllers’ logical addresses shall automatically be assigned to the devices without any user intervention.

The ACS System Controller shall support up to 64 physical devices connected via RS485 terminal communications bus, TCP/IP or proprietary solutions.

12.22.15 Door Controller

The ACS door controllers shall include the following types:

- Proprietary door controllers for connection of proprietary ACS readers.
- 3rd Party door controllers for connection of 3rd Party door readers such as biometric devices

Door Controllers shall have the following, or a combination of the following, components built in to facilitate the opening of doors and the monitoring of doors:

- Dry contact relays
- Digital inputs
- Ports for connection to ACS readers
- Communications port for 3rd Party readers
- RS485 and SBUS connectivity.

The Door Controllers shall allow for easy expansion without the need to physically wire power and communications between these devices.

Each Door Controller shall support up to two (2) readers.

12.22.16 Electromagnetic Lock

Outdoor electromagnetic locks shall be designed to resist the ingress of water with fully sealed electronics encased by stainless steel with a 300 kg holding force suitable for access controlled medium duty outdoor applications.

12.22.17 Proximity Card Reader

See Technical Schedules.

12.22.18 Card Enroller

See Technical Schedules.

12.22.19 Card Drop Box Unit

See Technical Schedules.

12.22.20 Proximity Card

See Technical Schedules.

12.22.21 Manual Override Key Switch

See Technical Schedules.

12.22.22 Request to Enter/Exit Button

See Technical Schedules.

12.22.23 Emergency Door Release

See Technical Schedules.

12.22.24 Turnstile

The outer structure shall be made of appropriate durable and robust material.

It shall be made with appropriate locking devices to prevent it from being removed without appropriate tools. It shall also be designed to integrate with access control units.

The turnstile should be equipped with an automatic release function for use during power outages.

12.22.25 Automatic Sliding Gate Motor

See Technical Schedules.

12.22.26 Commissioning

Commissioning tests shall include but not limited to:

- Normal access using an access card
- Remote door access
- Key override function
- Emergency exit function
- Live transaction viewer
- Report generation etc.

12.22.27 Documentation

The Contractor shall submit the following documentation:

- Manufacturer's instructions and manuals for installation, maintenance, and operation of the system
- Overall system operation and maintenance instructions—including preventive maintenance and troubleshooting instructions
- Test certificates and internal test reports for the Access Control System

12.23 Technical Specification for Earthing and Lightning Protection

12.23.1 Scope

This specification covers the technical requirements of the design, supply at site and installation of an earthing and lightning protection system complete with all accessories for an efficient and trouble-free operation. The contractor shall submit design calculations based on site-specific soil resistivity measurements (per IEEE Std 80), design fault current, and fault duration to ensure step & touch potentials are within safe limits.

12.23.2 General Requirements

The earth grid design must use the maximum earth fault currents and fault clearing times derived from the final protection study performed by the contractor, including future network reinforcements. The coordination of substation earthing with telecom and control system earthing shall be compliant with IEEE Std 80 and IEC 61936-1.

12.23.3 Drawings and Information

The Contractor shall provide as a minimum the following drawings or calculations:

Drawings showing the earthing electrode system in the outdoor switchyard and Service Building;

Drawings showing all risers from the earth electrodes with necessary free ends;

Instructions for laying and connection of the earth electrodes with material specifications and quantities;

Earthing resistance and voltage rise calculations;

Instructions for measuring the earthing resistance;

Drawings showing the location of all main earthing bars as well as interconnections between the earth electrodes;

Drawings showing the connections from the earthing bars to all equipment and apparatus;

Short circuit and conductor temperature rise calculations.

12.23.4 Standards

The Earthing System covered by this specification shall, unless otherwise stated, be designed, manufactured, inspected, and tested in accordance with standards listed in Standards and Codes.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The earthing and lightning protection supplied shall satisfy all applicable statutes, regulations, and safety codes of Local Statutory authorities.

The responsibility for the overall earthing and lightning protection systems, for the whole Substation plants, lies with the Contractor. This specification shall also apply to temporary site installations.

The latest versions of the following standards shall be considered for the design, calculation and installation of the earthing and lightning protection systems:

IEC 60364

Low-voltage electrical installations (all relevant parts)

IEC 60479

Effects of current on human beings and livestock (all parts)

IEC 61936-1

Power installations exceeding 1 kV a.c. - Part 1: Common rules IEC 62305

Protection against lightning (all parts)

EN 50522

Earthing of power installations exceeding 1 kV a.c.

IEEE Standard 80

Guide for safety in a.c. Substation grounding

The earthing system calculations shall be based upon actual soil conditions at site and the calculated short-time currents. The switchgear rating should not be used for this calculation.

12.23.5 Design Overview

The station earthing system shall be designed principally according to IEEE 80 "Guide to safety in substation grounding".

The Contractor shall prepare and submit a comprehensive Grounding System Design Report including earth mat apparatus earthing and lightning protection for the Engineer's review and approval. No procurement of grounding materials or commencement of site works for the grounding system shall occur prior to receiving this approval. The system design shall be based on the maximum earth fault current that is expected to occur during the design life of the station including transmission system contributions.

The earthing system shall provide for:

Adequate protection for personnel and equipment against dangerous voltages, currents and lightning surges;

Safe step and touch voltages for the entire plant, whereby for outer fences special care shall be taken to avoid danger for personnel standing outside and inside these fences;

A low earthing impedance for the surge arresters;

A low earthing impedance for the transformer neutrals, and a sufficiently low neutral conductor impedance;

Limitation of the induced, or capacitively transformed, voltages on low-voltage, low-current and electronic cables, circuits, panels and other equipment;

Flow of short-circuit, earth-fault and double earth-fault currents through the earthing systems, and not through other conducting parts or building elements, to a degree not hazardous to people or equipment.

The earthing system shall have the following main technical characteristics:

All connections between equipment and the earthing network shall be exposed (not embedded) and easily accessible for checking of the transition points. Bare conductors, as part of the open earthing system, embedded directly in the concrete will not be accepted. Similarly, bolted connections of metallic constructions do not form an acceptable earthing connection;

For all areas, the earthing system shall extend to all metal parts, even if these do not constitute a conducting part of an electric system of the works, such as machinery, operating panels, cat-walks, piping, sewers, rails, metal tanks, lighting fixtures, cable racks, etc.;

All earth conductors shall be of copper;

The earthing resistance shall be $\leq 0.5 \Omega$, i.e. cannot exceed 0.5Ω ;

The earth conductors shall be designed for carrying the earth-fault currents of the various parts of the plant for at least 3 seconds without exceeding a surface temperature of 250°C ;

Risers or earth conductors are not allowed to touch cables;

Main earth connections shall be made by approved cad welding process;

Connections from the main earth mat to the steel structures (riser connections) shall be made by compressed lugs with provision for two holes in the contact pad;

All connection points shall be protected against all types of corrosion including bi-metallic;

All main earth mat connections will be done using exothermic welding and tested for continuity to avoid high resistance connections;

Buried connections shall be welded, connections above earth shall as a main rule be clamped and shall be easily accessible for inspection;

All designs and calculations must be submitted to the Engineer for approval;

Facility for temporary earthing points must be provided.

12.23.6 Technical Details

12.23.7 Earth Mat

The earth mat and associated conductors must be installed at an optimal depth and spacing to achieve the safe step and touch values as set-out in the relevant international standards. This must however be approved by the Engineer.

The particulars for which the earth mat is to be designed is as follows:

Phase-ground fault level of 10kA no split factor allowance, the contractor shall verify that phase-to-ground fault levels for the project sites are below 10kA;

Fault Duration for touch potential: 0.50s;

Fault duration for conductor final temperature: 3.0s;

System X/R Ratio: 10;

Delayed Auto-reclosing at 10.0-15.0s and high speed auto reclosing at 0.7s;

Maximum temperature of exposed earth conductor: 250°C ;

Maximum temperature of buried earth conductor: 400°C ;

Minimum separate earth bonds to a structure: two.

Body Weight for Safety Calculations: A bodyweight of 70 kg shall be used for all step and touch potential safety calculations.

Surface Layer Material: A minimum of 150 mm layer of crushed rock with a wet resistivity of 3000 Ω -m shall be assumed for all outdoor areas

Isokeraunic values in the project area

Soil resistivity values in the project area

The soil resistivity measurements provided with the bid shall be used as a basis for bidding purposes. The contractor shall be expected to carry out detailed soil resistivity measurements on the proposed substation site for substation earthing design.

Main earth mat conductors shall be designed for the maximum fault current that might be achieved. In addition, the combined resistance of earth mat in the substation shall not exceed 0.5 Ω (maximum) to the general body of earth, with the provision that under the worst-case substation fault condition, the GPR does not exceed 5 kV. To reach the desired earth resistance, additional grounding rods shall be installed as necessary. The rods shall be connected to the earth mat.

All the equipment, structures and towers shall be earthed by running main and duplicate earthing conductors from the equipment base along the structure to the main earth mat. The earth mat shall be formed by compressed joints or approved welding of the copper earthing conductors at all crossing points.

Once all joints below ground level are completed, the Contractor will observe a "Hold Point" and no further related work will be permitted until the relevant joints have been inspected by the Engineer and approved accordingly. Ducts resistance across all connection points will be measured by the Contractor. A revised earthing layout drawing together with a spreadsheet specifying test points of the newly installed system will be presented to the Engineer for inspection and approval prior to energisation of the system. Once approval is given to proceed, the relevant joints/connections shall be treated with bitumen paint, allowed to dry before backfilling the excavation.

Whenever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, railway tracks, etc., the earth conductor shall be laid at a minimum depth of 500 mm below existing services and shall be re-routed in the event that the earth conductor is in conflict with any foundation.

Earthing conductors running along cableways inside cable trenches, columns, beams, walls, etc. shall be supported and secured by suitable cleats or brackets at intervals of 800mm. Wherever the earth conductor passes through a wall, floor, etc., a suitably sized PVC pipe shall be provided for the passage of the conductor. After installation of the conductor, both ends of the piping shall be sealed with an approved hydrophobic material to prevent water ingress.

Where the earth conductor is to be buried in concrete, a layer of at least 100 mm of concrete shall be cast over the earth conductor.

Electrical measurements of the subsoil at various depths shall be made at the site in order to determine the layered effects of the ground from which the effective ground resistivity and hence the expected resistance of the proposed earth grid system may be predicted.

The earthing grid shall be effectively protected against corrosion. Cathodic protection, if considered, may adversely affect other equipment and shall be subject to approval by the Employer/Engineer.

In actual design, the earthing system shall take the form of a combination of grids of buried conductors and earth rods driven vertically into the ground. Within the grid, conductors shall be laid in parallel lines at reasonably uniform spacing. They shall be located along rows of structures or equipment to facilitate the making of earth connections, where practical.

12.23.8 Equipment and Structure Earthing

The following equipment shall be connected directly to the earth electrodes or the risers:

All power transformer neutrals and transformer tanks. Main transformer tanks shall be earthed in two points diagonally from each other, by different risers.

All steel structures in the outdoor switchyard.

All surge arresters. The earth conductor from the arrester to the counter, as well as the inter-terminal of the counter, shall be suitably insulated or screen-protected against accidental touching and shall be of minimum $2 \times 95 \text{ mm}^2$.

Each item shall be directly connected to an earthing conductor and not with a series connection through other metallic parts.

For the current and voltage transformers, an earth connection to the housing shall be provided. Earthing of the cores and neutrals shall be done on the transformers and not on the terminal boxes.

The fence of the switchyard and other fences for transformer cells, etc. shall be earthed to the earthing system at intervals of not more than 20 m and to the earthing electrode system at all corners and gates. Gates shall be connected to earthed gate posts by a flexible copper braid or equivalent. Flexible copper braids of minimum 35 mm² shall also be used for connecting all sections of pipes, metal trays, conduits, rails, cable racks, etc., unless these are welded together, or each section is separately earthed.

Earthing conductors for telecommunication equipment and electronic systems shall be insulated and shall be run separately from the systems, panels, etc., directly to a main earthing bus close to a connection to the earthing electrode system. These earthing conductors shall be of minimum 50 mm² and shall not be branch-off from the earthing of the high-power systems.

The below concrete template shall be manufactured from a suitable steel capable of maintaining the required bolt formation and bending stresses imposed by the concrete casting and the heat absorption when the two copper earth straps are welded to the template.

The foundation bolts are to be fixed to the template by means of a hot dipped galvanised steel washer and nut either side of the template and torqued to the required value which shall be dependent on the bolt size. Special care must be given to achieving and maintaining a good contact surface between the washers and template thus avoiding a high resistive contact joint.

The Employer or his representative is to be notified by the Contractor at least 72 hours prior to the casting of the concrete foundation to enable an inspection to take place on each holding down bolt earthing arrangement. In the event that the Employer or his representative reject the earthing arrangement as constructed the Contractor shall re-work the template and earth connection to the satisfaction of the Engineer.

The earth connections between earthing points on the equipment and the main earthing grid shall be made by short and direct earth conductor leads free of kinks, sharp bends and splices. In the case where earth pads have not been provided on the equipment to be earthed, earth connection points shall be added in consultation with the Engineer.

Whether specifically shown on the detailed drawings or not, steel reinforced concrete columns, metallic stairs etc. shall be connected to the nearest earth point by two earth leads. Earth continuity shall be ensured by bonding the different sections of hand-rails and metallic stairs.

Metallic pipes, conduits, and cable tray sections for cable installation shall be bonded to the main earth every 5 metres or at intervals as agreed to by the Engineer to ensure electrical continuity.

Metallic conduits and water pipes shall not be used as earth continuity conductors under any circumstances.

A separate copper earth conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits, switch boxes, sockets etc.

Wherever an earthing conductor crosses or runs along a metallic structure or pipes of gas, water, steam or conduit or steel reinforcement in concrete, it shall be bonded to the same.

The substation earth mat shall be buried at a minimum depth of 600 mm below finished ground level. At crossings with Services 500mm clearance below pipes/cables shall be obtained. Should previously unknown rock outcrops or similar obstacles be encountered whilst excavating earth mat conductor trenches, the Engineer may authorise the Contractor to reduce the burial depth. All buried joints shall be inspected pre-backfill by the Engineer.

Lighting poles, junction boxes on the poles, cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along the supply cable, which in turn, shall be connected to the earthing grid conductor at a minimum of two points.

Flexible earthing conductors shall be used wherever earthing of moving parts (handles) are to be connected to the earthmat.

For transformer neutral earthing, 2 sections of minimum **of 70mm²** copper conductor **each**. The connection from the HV and MV neutral shall be directly connected to the substation earth mat by the shortest route possible via a CT. These must be separate connections.

All equipment support structures shall be connected to the main substation earth grid with a minimum of **Dual 70mm²** copper conductor; these shall be connected at opposite diagonal corners.

Auxiliary earthmat shall be provided for each disconnector operating box location, where a person would normally stand to operate the disconnector. Design must be confirmed with the Engineer.

12.23.9 Cable Earthing

Metallic sheaths and armour of all multi core auxiliary and signal cables shall be earthed at both equipment and cubicle ends for outdoor cables and cables running from outdoor into the building. Metallic sheaths and armour of all multi core auxiliary and signal cables shall be earthed at supply end only.

Sheath and armour of multi core power cables shall be earthed at both ends. Sheath and armour of single core power cables shall be earthed at the switchgear end only.

12.23.10 Jointing

Above ground earth connections to equipment earth points shall be bolted. The surface of the contact area shall be free from scale, paint, enamel, grease, rust or dirt. A minimum of two bolts shall be used for making each connection.

All equipment bolted connections, after being checked and tested shall be painted with anti-corrosive paint/compound.

Connections between the equipment earth lead and the main earth conductors shall be by a welding process which is subject to approval by the Engineer.

All main earth mat connections will be done using exothermic welding and tested for continuity to avoid high resistance connections.

Buried connections shall be welded, connections above earth shall as a main rule be provided with compression lugs with two holes and bolted by two bolts and shall be easily accessible for inspection.

The ohm resistance of a unit length of conductor with a joint shall not be greater than the resistance of an equivalent unit length of conductor without a joint.

12.23.11 Earthing Inside Switch Room and Control Room

An earthing conductor of sufficient area shall be provided extending the whole lengths of the switchboards and control cabinets.

All panels inside the control/relay room shall be earthed by connecting two copper earth leads of suitable size from the main earth point within each panel, to the main earthing bar of suitable size running horizontally the length of the control/relay room cable trench wall. This earth conductor shall in turn be connected to a main earth distribution bar fixed at the wall in the relay room which in turn is connected to the switchyard earthmat by duplicate connections.

All loose cable gland plates shall be separately hard earthed to the main earth connection within the cubicle, kiosk, etc.; reliance on the cable gland plate fixing bolts will not be accepted.

Building Structural Earthing to the substation earth grid conductors

Main earth bar in the substation building shall be connected to two different sections of the earth mat. Further, all metal structures in the building including re-enforcement steel shall be connected to the main earth bar.

Fence Earthing

All metallic fence-lines shall be connected to the buried earth grid. The points of bonding to the earth grid shall not exceed 10 m. A detailed calculation is necessary to ensure touch voltages are safe unless it is possible to install a grading electrode or a perimeter electrode typically 1m away and buried 1m deep.

Gate openings in fence lines shall be bonded across between posts with a minimum conductor of 70 mm² to prevent differences in potential. Gate hinges shall be bonded with 35 mm² flexible braid conductor.

12.23.12 Earthing of Other Types of Equipment

Earth terminals of low-voltage equipment shall be earthed by wires designed for the actual earth fault current.

Connection and marshalling cubicles etc. for low-voltage or control equipment shall be connected to the earthing system irrespective of whether they are mounted on otherwise grounded structures or not.

Cubicle doors, where electrical apparatus or instruments are installed, shall be earthed by a flexible earthing cord.

Earthing through bolted connections at supports etc. is not allowed.

12.23.13 Temporary Earthing Devices

Busbars and outgoing feeders shall normally be equipped with fixed earthing switches. Where temporary earthing devices are required for certain maintenance or repair work on the switchgear, such devices shall be included in the supply and the proposed design shall be documented in the Tender. Connection points shall be

As no IEC Standard exists for temporary devices, the design and test methods are subject to approval of the Engineer.

When temporary earthing devices are used, both the phase conductor and the steel structure shall have designated fixed contact points.

One (1) set of three-phase temporary earthing devices shall be delivered for each switchboard for use when temporary earthing is required.

Three (3) sets of three-phase temporary earthing devices, one for each winding, shall be delivered for the transformers for use when temporary earthing is required.

Earthing devices shall be designed for 1 s duration of maximum fault current. Earthing switches in connection with disconnectors shall be designed for the same fault current as the disconnectors.

12.23.14 Corrosion Risks

The Contractor shall be observant of the risks for corrosion of buried or embedded galvanized steel structures if connected to copper.

12.23.15 Lightning Protection System

The lightning protection system shall be carried out with earth wire secured with suitable clamps on gantry tower peaks in the switchyard.

Conductors included in the lightning protection arrangement shall not be connected directly to the conductors of the safe earth system installed above ground level.

Any applicable vertical "down" conductors shall be clamped at 750mm intervals to the gantry tower steelwork with clamps purposely manufactured for the securing of conductor.

All equipment support structures and vertical gantry columns are to be fitted with earth ball studs, suitable for securing portable working earths.

Lightning masts or gantry mounted spikes shall be positioned and installed in the switchyard to provide total and complete earth screen coverage for all primary electrical equipment within the substation area.

The Contractor shall undertake a risk assessment according to IEC 62305 and shall base the design of the lightning protection system on the results obtained.

In addition,

Earthing and Lightning Protection Materials

Whenever dissimilar materials are to be joined, transition plates are to be inserted as required to ensure that electrolytic action is avoided. Connections between sacrificial dissimilar metals should be avoided wherever possible.

Buried earthing conductors

High conductivity hard-drawn bare copper stranded conductor or tape shall be used for buried earth conductors. All conductors passing from an external location to an internal location shall be PVC insulated copper stranded conductors.

Exposed earth conductors

All exposed earthing conductors shall be PVC insulated stranded copper conductors.

Lightning protection conductors

Lightning protection down conductors shall be high conductivity bare copper tape.

Building lightning protection air termination conductors shall be either high conductivity bare copper tape or solid conductor.

Overhead conductor for the switchyard lightning protection shall be hot dip galvanized steel.

Conductor fittings

All conductor fittings shall be manufactured from high strength copper alloys with phosphor bronze nuts, bolts, washers and screws. Binary brass copper alloys will not be acceptable.

Bi-metallic connectors shall be used between conductors or connections of dissimilar materials. Insulating material shall be interposed between metallic fittings and structures of dissimilar metals to prevent corrosion.

Earth rods

Earth rods shall be hard-drawn high conductivity copper with a diameter of 19 mm and shall be provided with hardened steel driving caps and tips. Couplings may be used to obtain the overall rod depth required by the design.

If difficult driving conditions arising from hard or rocky ground are encountered then high tensile steel rods shall be used. High tensile steel rods shall have a molecularly bonded high conductivity copper coating with a minimum radial thickness of not less than 0.25 mm.

High conductivity copper for earth rods shall have a minimum copper content of 99.9% including silver.

The steel for copper-clad rods shall be low carbon steel with a tensile strength of not less than 570 N/mm².

12.23.16 Testing and Commissioning

After the on-site construction, the resistance to earth of each earthing electrode system shall be measured. The earth system in the control building and the outdoor switchyard shall be disconnected into separate systems when measuring. The Contractor shall suggest the measurement set-up for approval by the Engineer.

The earthing electrode systems shall be checked for resistance and reliable connections. These tests shall be carried out according to IEEE 81, and will include, inter alia:

Resistance of existing earth grid;

Soil resistivity and

Resistance of final earthmat.

If there are no available drawings of the existing earthmat affected by this project. It will be the responsibility of the Contractor to determine the locations and resistance of the existing earthmat and produce approved as-built drawings of the final earthmat.

Test Requirements

The following test requirements are stipulated with regard to the earthing system:

- measurement of earthing resistance after installation
- measurement of earthing resistance before commissioning.

The following test requirements are stipulated with regard to the lighting protection system:

- visual inspection after installation
- continuity tests after installation.

12.24 Technical Specification for Structural Steelwork

12.24.1 Introduction

This specification covers:

The supply, fabrication, testing, galvanising and storing at site of structural steelwork including supply of all consumables and rivets, bolts, nuts, washers, and other required items for fabrication and field connections of all structural steelwork covered under the scope of the Contract.

The erection and the installation of the fabricated steel structures in position. The aligning and grouting of the bases all complete as per the approved drawings, these specifications, and any other provision of the Contract.

The supply, fabrication, and erection of miscellaneous metal items of light nature in gates, grills, staircase handrails, partitions, structural mullions and transom's, ladders, hangers,

masonry anchors, shelf angles, chequered plates anchor bolts, fasteners, etc. shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast mild steel, aluminium, brass, cast iron, galvanised mild steel sheets, aluminium sheets, expanded metal, stainless steel, wire mesh etc. as per design.

Structural steel shall conform to the latest editions of Eurocode 3, ISO 10721, ISO 1461 or other equivalent standard.

All specified steel structures, except where otherwise required, shall be hot-dip galvanized. The minimum weight of galvanizing coat shall be:

- 900 g/m² on steel sections 5 mm thick and over
- 600 g/m² on steel sections 2 - 5 mm thick.

(Galvanizing coat is provided as sample. ZESCO should provide weight of galvanizing coat)

Bolts and nuts shall conform to approved standards.

All welding joints shall conform to approved standards

All structural steel works shall be protected from damage during handling, transporting, unloading and storage. The Contractor shall be responsible for the correct positioning and correct levels of structures in relation to the relevant drawing.

Design Characteristics

If not otherwise approved, site joints for the structure shall be bolted and not welded. The construction methods shall be such as to permit easy erection and shall conform to the stipulation given in other parts of these specifications.

Maximum dimensions and weight of the structure elements will be limited by the local transport conditions which should be investigated and verified by Contractor.

Materials

Structural steel primer paints shall be those of a recognized manufacturer experienced in coatings. The type of paint shall be submitted to the Employer for approval prior to use.

All other materials not specifically described but required for a complete and proper installation of structural steel, shall be new, free from rust and subject to approval by the Employer/Engineer.

Surface Conditions

Prior to installation of the work of this subsection, installed work of all other subsections must be carefully inspected and it must be verified that all such work is complete up to the point where this installation may properly be initiated.

It shall be verified that structural steel may be fabricated and erected in agreement with the original design, the approved drawings and related standards.

Non-Structural Steelwork

This portion of the scope includes all labour, materials, equipment and services required to complete all steel work shown on drawings and as specified herein, including, but not being limited to, the following items:

- anchor bolts, levelling plates and slim packs with complete instructions and templates to facilitate installation
- base plates, columns, beams, girders, bracing, hangers, and related connections (bolted and welded)
- floor plating
- supports for equipment or elements from other supplies
- corrosion, protection
- temporary erection bracings and supports
- miscellaneous steel structures (like ladders, rails, etc.)
- Unless specifically excluded, furnishing and installing of all structural steel work indicated on the drawings, specified or obviously needed to make the work of substation complete.

- All ferrous materials, their dimensions, forms, weights, tolerances chemical and mechanical properties, shall comply with the relevant standards or approved equivalents.
- All work shall be carried out in accordance with the requirements of the drawings and the specification. All parts in the assembly shall fit accurately together and corresponding parts should preferably be interchangeable. Forced correction to fit the member together will not be allowed.
- The Contractor shall submit to the Employer/Engineer for approval the country of origin and manufacturer of the steel he proposes to supply.
- All steel shall be carefully stored and handled so that pieces are not subjected to excessive stress or damage. Steelwork shall be stored on site such that it will be free from earth and dirt and will be properly drained.
- The Contractor shall be responsible for the correctness of his shop details and site connections.
- All steelwork shall be smooth, un-deformed, straight and free from cracks, twists and burrs.
- In the event of damage, immediately all repairs and replacement necessary shall be undertaken by the Contractor, subject to the approval by the Employer/Engineer and at no additional cost to the Employer.

12.24.2 General Requirements

12.24.3 Information to be submitted by the Contractor

12.24.3.1 Test Reports

Manufacturer's mill test reports in respect of steel materials, rivets, bolts, nuts and electrodes as may be applicable.

12.24.4 Quality Assurance

The Contractor shall submit a write up on the method he proposes to adopt to assure the accuracy of erection. This shall include information about the instruments such as theodolites, which the Contractor will use to centre, align and connect members.

12.24.5 Conformity with Designs

Except where the standard connection details are furnished the Contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer.

The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the Contract and/or as approved by the Engineer. Provision of all relevant International specifications and codes of practice shall be followed unless otherwise specified in the Contract.

The Contractor will erect the entire fabricated steel structure, align, tie all members, complete all field connections, and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Employer. All work shall conform to the provisions of the relevant International standard specifications and/or the instructions of the Engineer.

12.24.6 Tendered rate

Even though it may not be specifically mentioned in the schedule of items, the tendered rate shall include all work to be provided by the Contractor in accordance with this Contract and cost of all materials and labour required to complete the work or incidentals, hire charges of construction plant, equipment and erection tools, insurance, all necessary transport, taxes and royalties, making necessary arrangements for approaches, yard, security, safety and other facilities, power, fuel, lubricant, services, supervisions, over-heads, profits etc. complete in all respects.

It shall also include cost of all other work and supplies not specifically mentioned, here, implied as being necessary to complete the works in all respects in accordance with the Contract.

12.24.7 Standards

The equipment/material covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with ISO 10721 and ISO 17607-1:2023.

In case of any conflict between the standards and this specification, this specification shall govern. Any discrepancy between the various specifications/standards shall be discussed with the Engineer. The equipment supplied shall satisfy all the requirements of Local Statutory authorities.

12.24.8 Overview and Contractor Requirements**12.24.9 General**

The use of pre-engineered structures from reputed manufacturers is a requirement and shall be subject to approval in writing by the Engineer. However, if the required items are not readily available, the Contractor may fabricate the same, in accordance with the specifications below.

Where pre-engineered structures are being used, the manufacturer’s instructions / procedures for erection of structural steel work shall be followed, with the approval of the Engineer and under the expert supervision of the manufacturer.

12.24.10 Work to be provided by the Contractor

The work to be provided by the Contractor unless otherwise specified elsewhere in the Contract, shall include, but not be limited to the following:

SANS 1200 H-1990 Section 5.1 refers regarding drawings and shop details;

Furnish all materials, labour, tools and plant, power, all consumables such as oxygen, acetylene, electrodes etc. required for fabrication and supply, all necessary bolts, nuts, washers and tie rods for field connections;

Suitably mark, bundle and pack for transport of all fabricated materials;

Prepare and furnish detailed bill of materials, drawing office despatch lists, bolt lists and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork;

Refer to SANS 1200 H-1990 for handling and erection of structural steelwork.

Receiving, unloading, checking and moving to storage yard at site for all structures fabricated outside of and arriving at site;

Transportation of all fabricated structural steel materials from site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures;

Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks;

Aligning, checking the plumb, levelling, bolting and securely fixing the fabricated steel structures in accordance with the drawing or as directed by the Engineer.

All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

Removal of bends, kinks, twists, etc. for parts damaged during transport and handling;

Cutting, chipping, filing, grinding etc. if required for preparation and finishing of site connections;

Reaming of holes for use of higher size bolt if required and as per Engineer's specifications;

Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of riveting or bolting will be permitted only at the discretion of the Engineer;

Drilling of holes, which are either not drilled at all or drilled in incorrect location during fabrication as per Engineer's specifications;

Carry out tests in accordance with these specifications if directed.

12.24.11 Work by Others

No work under this specification will be provided by any agency other than the Contractor, unless specifically mentioned otherwise elsewhere in the Contract.

12.24.12 Technical Requirements

12.24.12.1 General

Steelwork for the substation shall include busbar and equipment supports, earthwire peaks, lighting masts, and all other steelwork required for the construction of the substation.

12.24.12.2 Busbar and equipment supports

Equipment and busbar supports shall be lattice or tubular galvanised steel structures. The tensions of busbars and stringers, weight of the equipment, wind load, and the dynamic loads under fault conditions and operation of circuit breakers, and any applicable seismic withstand requirements must be considered in the design of the structures.

Pre-engineered steel structures from reputed manufacturers are required. The steel members shall be stamp embossed indicating structure codes or an equivalent method of identification. All structural steel members shall be hot-dip galvanised as per the relevant international

standards and specifications below. All assembly bolts shall be not less than 16 mm diameter and minimum grade 8.8.

12.24.12.3 Earthwire peak or Lightning Masts

Overhead shield-wires, vertical down conductors, and/or lightning masts are used for lightning protection. The associated support structures and foundations must be designed to the same standards and codes of practice as equipment supports and support foundations.

12.24.12.4 Outdoor Lighting

All luminaires for external lighting shall be suitable for outdoor duty and shall be adequately earthed and all earth terminations and fittings, fixing brackets and supports shall be included.

Orientation lighting

The substation shall be equipped with an outdoor orientation lighting system. The standard lighting equipment shall be designed for the 400/230 V AC system. Lighting fittings shall be installed mainly along substation roads, transformer and parking areas and substation building access doors.

The outdoor lighting system shall be switched from the control room by a main switch in the low voltage distribution board. The orientation lighting shall be operated with means of photocell and relay and via a changeover switch with three positions, On - Photocell Relay - Off.

The outdoor lighting installation shall conform to protection class IP56.

Pole top mounted respectively building wall, fixed lighting fittings shall be of LED-type.

The required outdoor (around transformers) illumination level (E): 20 lx

The required outdoor (switchyard) illumination level (E): 10 lx

To cope with contamination and deterioration of lighting fittings an enhanced initial planning factor of 1.43 shall be used for determination of the initial illumination level.

The fittings are to be connected by cables via cable-end boxes fitted inside the poles. Each pole must be connected to the earthing grid of the substation.

The poles shall be hot dip galvanised with installed cable end boxes and fuses including cables connected to the light house fittings.

Flood lighting

The substation shall be equipped with an outdoor flood lighting system. The standard lighting equipment shall be designed for the 400/230 V AC system. The flood lights shall be installed mainly on separate towers/poles (not gantries) for illumination of the switchyard and transformer areas in case of necessary works or in case of emergency. Flood lights shall be provided at the gate and guard houses switchable separately from the switchyard flood light.

The total flood lighting system shall be switched from the control room by a main switch in the low voltage distribution board.

The outdoor lighting installation shall confirm to protection class IP56.

Pole top mounted or respectively building wall fixed lighting fittings shall be of LED-type.

The illumination level (E) shall be approximately 100 lx

To cope with contamination and deterioration of lighting fillings an enhanced initial planning factor of 1.43 shall be used for determination of the initial illumination level.

The fittings are to be connected by cables via cable-end boxes fitted inside the poles. Each pole has to be connected to the earthing grid of the substation.

The poles shall be hot dip galvanised with installed cable end boxes and MCB including cables connected to the light house fittings.

12.24.13 Materials

12.24.13.1 General

The Contractor shall supply all materials that are required for the work. Such materials shall be free from all imperfections, mill scales, slag intrusions, lamination, pitting, rust etc. that may impair their strength, durability and appearance.

All materials shall be of tested quality only, unless otherwise permitted by the Engineer. If desired by the Engineer, test certificates in respect of each consignment shall be submitted. Wherever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory for each lot of 50 metric tonnes or less of any particular section.

12.24.13.2 Material/Component Supplier Approval

No material or component shall be obtained by a Contractor or his subContractors from any source, which has not been previously audited by a responsible party and designated as an approved supplier. The Engineer may, at his discretion, require evidence that such audits have

been satisfactorily made and/or evidence of the competence of the designated supplier to meet the necessary quality requirements.

12.24.13.3 Material Condition

No material may be used in a metallurgical or physical condition significantly different from that assumed for design purposes. This requirement refers to all physical and mechanical properties of the material, including deterioration of surface condition, up to the time of commissioning, by corrosion.

12.24.13.4 Material Substitution

Substitution of a specified material will only be accepted if the proposed material is satisfactorily demonstrated to the Engineer to be equal in all respects or superior to the original on which the design was based.

Recycling and/or reconstitution of solders brazing metals, white and bearing metals, tin, zinc, cadmium and similar materials is not permitted without the specific approval of the Engineer. In each case it is expected that virgin metals or their exact equivalent will be used.

12.24.13.5 Material Specification

Proprietary materials not covered by appropriate specifications will only be considered on submission of the necessary technical details, to permit a full and complete appraisal of their suitability for the proposed use.

Paints to be used for shop coat of fabricated steel under the purview of this Contract shall conform to the relevant SANS specification. Ready mixed paint, air-drying, red oxide zinc chrome priming and acid resistant primer may be used. SANS 1200 HC Corrosion Protection of Structural Steelwork refers. All paint finishes and coats as per drawing or Engineers specification.

Structural Steel

SANS 1200 H-1990 Section 3.1 to 3.4 refers.

Welding Consumables

SANS 1200 H-1990 Section 3.5 refers.

Bolts, Nuts and Washers

All nuts, bolts, etc. shall be manufactured to an approved standard. Bolts or studs, which are subject to high temperature and pressure, shall be manufactured to an approved material

specification, with nuts of similar material. All fasteners shall be suitably protected from corrosion at all stages.

Bolts and studs for electrical connections shall preferably be of brass M6 size alternatively size M5 may be used, but these must be manufactured of stainless steel, phosphor bronze or high tensile brass.

The use of electro-galvanised or cadmium plated bolts and nuts will not be accepted for use outdoors.

Nuts and pins shall be locked in position with lock nuts or lock washers, or other approved devices acceptable to the Engineer, Lock washers shall not be used above M24 size except when a spring type is specially approved.

No bolt or stud shall project through its nut by more than approximately 10 mm or four threads whichever is the less, except for terminals and relay stems.

Bolts, nuts, and washers on outdoor equipment shall be manufactured of non- corroding material, where they are in contact with non-ferrous parts in conductor clamps and fittings and elsewhere if specially required.

Special spanners shall be provided for bolts and nuts, which are not easily accessible by means of an ordinary spanner.

12.24.13.6 Special Material Requirements

Aluminium and Aluminium Alloys

Aluminium, where its use is approved by the Engineer, shall be of high commercial quality. The composition, including the percentages and nature of impurities, shall be stated in the schedules.

All aluminium alloys shall be of approved composition as stated in the schedules.

Aluminium and alloy castings shall be sound and free from porosity.

Stainless Steels

Stainless steels may be of ferritic, martensitic, or austenitic types depending on their application. Each material selected for a specific use shall be to the approval of the Engineer.

12.24.13.7 Storage of Materials

General

All material shall be stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has deteriorated or damaged and has become unfit for use, as determined by the Engineer, shall be removed immediately from the site, failing which, the Employer shall be at liberty to get the materials removed by other agency and the cost incurred thereof shall be realised from the Contractor's dues.

Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials. The yard shall have proper facilities like, drainage and lighting, suitable access for large cranes, trailers and other heavy equipment's. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Contractor should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor for the yard, at his own cost as directed by the Engineer.

Cover Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

12.24.13.8 Assembly

SANS 1200 H-1990 Section 5.3 refers.

12.24.13.9 Setting-out

SANS 1200 H-1990 Section 5.4 refers.

12.24.13.10 Erection

SANS 1200 H-1990 Section 5.5 refers.

12.24.14 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer.

The quality control operations shall include but not be limited to the following items of work:

Erection	Lines, levels, grades, and plumbs, joint characteristics including tightness of bolts.
Grouting	Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.
Painting	Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.
Electrodes	Manufacturer's certificate, thickness and quality of flux coating.
Welders	Qualifying tests
Welding sets	Performance tests
Welds	Inspection, x ray, and ultrasonic tests.
Paints	Manufacturer's certificate, physical inspection reports.

Table 12-35: Quality control for steelwork

12.24.14.1 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable and in good working condition and shall have the approval of the Engineer.

12.24.14.2 Method and Sequence of Erection

The method and sequence of erection shall have the prior approval of the Engineer. The erector shall arrange for the most appropriate and economical method and sequence available to him consistent with the drawings and specifications and such information as may be furnished to him prior to the execution of the Contract.

12.24.14.3 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any bylaws of State, Municipal or other local authorities.

12.24.14.4 Grouting

SANS 1200 H-1990 Section 5.6 refers.

All structure bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and require the Engineer's approval before proceeding with the grouting.

Grouting shall be carried out with non-shrink grout from an approved supplier.

The position to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid airlocks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm downgraded stone chips may be added to the above noted grout, if required by the Engineer or shown in the drawing;

If required by the Engineer, certain admixtures like aluminium powder, 'Ironite' or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout. The Contractor shall make necessary arrangements to provide such items. The cost of these shall be added to the cost of structural steel work;

Grouting shall be carried out, strictly according to the manufacturer's specifications.

12.24.14.5 Painting after Erection

No painting of structural steelwork will be conducted without the strict approval of the Engineer.

12.24.14.6 Final Cleaning up

Upon completion of erection and before final acceptance of the work by the Employer, the Contractor shall remove free of cost all false work, rubbish and all temporary works in connection with the performance of his work.

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

12.24.15 Sundry Items

Refer to SANS 1200 H-1990 Section 5.7 and SANS 1200 HA-1990 regarding handrails, ladders, open grid floors and floor plate floors.

12.24.15.1 Anchor Bolting

The Contractor shall submit the manufacturer's specification showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

12.24.15.2 Pipe Joints

Mild steel pipes shall be joined by threaded sockets or by welding, cast iron pipes shall be spigot and socket as well as joined and caulked with hemp and molten lead.

12.24.16 Tolerance

SANS 1200 H-1990 Section 6 refers.

12.24.17 Testing

SANS 1200 H-1990 and HC-1988 Sections 7 refers.

12.24.18 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection.

Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor.

In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Contractor to the satisfaction of the Employer with all cost for the Contractor.

The Contractor shall bear the cost of all tests. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained. However, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as directed by the Engineer. The method of testing and application of loading shall be as approved by the Engineer.

12.24.19 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit.

If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during the 24 hours under load, the test shall be repeated.

The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

12.24.20 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole.

Complete tests under both conditions may be necessary to verify the strength of the structure.

The structure shall be deemed to have adequate strength if, during the test, no part fails and upon removal of the test load, the structure shows a recovery of at least 80 per cent of the maximum deflection or strain recorded during the 24 hours under load.

12.24.21 Structures of Same Design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous sub clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load of 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 times the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

12.24.22 Repair for Subsequent Tests and use after Strength Tests

An actual structure which has passed the "Strength test" as specified herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been

strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness test' as specified herein before.

12.25 Technical Specification for Substation Civil Works

The specification covers the design, preparation of general arrangement, construction drawings, supply of all labour as well as materials and construction of all civil and structural works on a turnkey Design, Supply, and Installation basis for the works required at the Kasama and Nakonde Stepdown Substations.

The civil designs for Kasama and Nakonde Stepdown (platform levels, drainage, oil containment, foundations, roads and buildings) demonstrate adequate space and load capacity for all specified primary plant (transformers, reactors, spare bays and STATCOM).

The civil works are predominantly driven by the requirements of the electromechanical equipment to be provided under this Project and the conditions or specifications stipulated hereafter.

This document represents the basic specification information for calculating the lump sum price of the works concerned but should not be considered to be a complete description in every respect. Drawings which can be found in Section 7 "*Employer's Requirements*" of the Tender Documents indicate the intended layout of the works but are not intended to be conceived as final.

The price offered shall be understood as the total sum for the complete civil services and installations and finishing works to suit the requirements and the functions of the works concerned.

Design and choice of construction materials shall consider and ensure the reduction of future maintenance works, and therefore, all civil elements shall be designed to minimize maintenance and to result in a durable construction with a minimum design life of 50 years.

The Contractor shall prepare all necessary basic and detailed design calculations and drawings in accordance with the Project requirements.

The design of all structures under this Contract shall be such that differential and total settlements or other movements shall not exceed acceptable limits and full provision shall be made for all expansions and other joints. Structural members subjected to flexure shall be designed to have adequate stiffness to limit deflections or any deformations that affect strength or serviceability of a structure adversely. The maximum allowable deflections of

structural members shall be in accordance with the relevant design standards and/or the limits prescribed by the machinery manufacturers.

The dimensions of the buildings and containers shall be such as to provide adequate space for the safe installation and proper operation, maintenance and repair of all equipment to be accommodated in them.

In order to save energy for air conditioning, adequate thermal insulation of buildings shall be provided. The general transmission coefficient, including walls, roof, windows and doors shall be $K \leq 0.7$.

Suitable access to the roofs of the buildings shall be provided for maintenance and repair of any installation.

All rooms with fire hazard shall be provided with suitable emergency exits.

Proper access roads shall be provided to bring in all the equipment and to take it out in case of maintenance. These access roads shall be suitable for the vehicles which will be used (cars, forklifts, trucks/trailers, etc.) to reach up to the point of unloading/loading of the equipment.

Safe, convenient and straight forward accesses and means shall be provided so as to enable taking equipment in and out of all rooms, at all levels, using suitable stairwells, ramps and suitable mechanical hoists. The dimensions of rooms, stairwells, doors etc. shall be designed to suit the aforementioned transport concept.

All civil designs, calculations and drawings shall be subject to approval by the Employer/Engineer before start of manufacturing and construction.

Particular Architectural RequirementsResponsibilities of the Contractor

The Contractor shall be solely responsible in all respects for the suitability and stability of the buildings, structures and foundations.

The Contractor shall also be solely responsible for verifying the suitability of his designed foundations for the effective ground conditions.

If the soil has been excavated according to the approved design and the type of ground requires modifications in the design, these modifications shall be carried out by the Contractor without extra charge and shall be approved by the Employer/Engineer.

The work to be completed under this specification consists of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion of civil and structural works and proper functioning of the plant, all in strict accordance with the specification, including revision and amendments thereto as may be required during the execution of the work.

The Contractor shall comply with the ZESCO specifications for Civil Works attached as appendix S5 to this specification. Should there be a discrepancy between this specification and the ZESCO Civil Works specification, the Contractor shall notify the Engineer. The Engineer shall recommend the specification to follow in that case.

Contractor shall obtain approval of all drawings from the Engineer before taking up construction works.

12.25.1 Submissions

The following information shall be submitted by the Contractor for review and approval by the Engineer.

Design criteria for structural steel and reinforced concrete. The criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors and maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information;

Structural design calculations and drawings (including construction /fabrication) for all reinforced concrete, structural steel and timber structures. Prior to submission, all civil engineering documentation (i.e. structural design calculations, civil/structural drawings, geotechnical investigation reports, etc) must be endorsed by a Civil Engineering firm registered with both the Engineering Institution of Zambia (EIZ) and the Association of Consulting Engineers of Zambia (ACEZ), and in possession of a valid practicing license, issued

by the Engineering Registration Board (EngRB). The firm’s seal must be present on all design and drawing submissions.

A fully detailed construction programme displaying the critical paths, the delivery times of materials and other relevant information.

12.25.2 Earthworks

12.25.3 Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

Items	Description
Lines, Levels	Regular confirmation of levels and setting out lines.
Back-filling	Periodic confirmation of quality and moisture content of fill material. Regular confirmation of compaction levels.

Table 12-36: Quality control for earthworks

12.25.4 Information Regarding Site Condition

The Contractor must satisfy himself regarding the character and volume of all work under this item including any expected surface, sub surface and/or sub soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain expected construction methods likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

12.25.5 Setting out of Works and Clearing the site

The Contractor will prepare and submit to the Engineer, detailed drawings of the proposed necessary excavation work for approval. The submitted drawings will show all dimensions, specifications, proposed slopes, shoring, approaches, de-watering sumps, berms, etc.

On receiving the approval from the Engineer, with modifications and corrections if necessary, the Contractor will set out the work from the control points as indicated on the drawings by the Contractor and approved by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after whom the Contractor will proceed with the work. It should be noted that this checking by the Engineer, prior to start of the work, will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawings. Subsequent corrections will be free of cost to the Employer in case any errors are noticed in the Contractor's work at any stage.

The materials obtained will be the property of the Employer and the materials pronounced useful by the Engineer shall be conveyed and properly stacked as directed by the Engineer.

The dumping site for all site waste shall be approved by the Engineer to ensure it is not dumped in a restricted area.

12.25.6 Excavation

12.25.7 General

All excavation shall be done to the minimum dimensions as required for safety and to facilitate work. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method proposed for excavations, including dimension, side slopes, shoring, de-watering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

The area to be excavated shall be cleared of fences, trees, plants, logs, stumps, roots, bush, vegetation, rubbish, slush, etc. and other objectionable matter. Disposal of this material must be approved by the Engineer.

Excavation shall include careful removal of all materials of whatever nature and whether dry or wet, necessary for the construction of work, exactly in accordance with lines, levels, grades and curves shown on the plan or as directed by the Engineer. It shall be taken to exact widths and levels of the lowest step of foundation / footing and the sides shall be left to plumb, nature of the soil permitting.

All shoring, strutting, timbering or cutting of extra trench widths required for providing extra working space shall be done by the Contractor, the same shall be deemed to have been included in the tender rates.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. Soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the additional costs associated with the work will be deemed included in the rates supplied by the Contractor. The final excavation if so instructed by the Engineer, should be carried out just prior to laying the blinding concrete.

A degree of accuracy for excavations for structural foundations must be agreed with the Engineer prior to the works.

In the event that the excavation is carried out to depth greater than that shown on the drawing, the excess depth shall be filled up to the required level at the Contractor's cost with

selected material as approved by the Engineer and compacted to 95% of modified AASHTO density or with mass concrete of grade 15 MPa or higher as approved by the Engineer in each individual case.

The corners of the excavated pits shall be made true and square and all loose soil/debris shall be removed to the satisfaction of the Engineer.

Just before placing the foundation concrete, all trench bottoms shall be lightly watered and thoroughly rammed (compacted).

The Contractor shall provide suitable drainage arrangements to prevent surface water from any source entering the foundation pits, any costs incurred are for the Contractor.

Any obstacle encountered during excavation shall be reported immediately to the Engineer and shall be dealt with by the Contractor as instructed by the Engineer.

Removal of buried piping or cables shall not be carried out without prior permission of the Engineer and the Contractor shall take all measures to protect such lines, cost of such protective measures are deemed to be included in the rates for various items of excavations.

No blasting shall be permitted for excavation of foundation even in rocky formation without the permission of the Engineer.

The Contractor shall not undertake any casting of concrete for the foundations until the excavations, rebar, shutter work and setting out have been inspected and approved by the Engineer.

12.25.8 Lateral Support in Surface Excavations

Any lateral support, strutting and timbering required for protecting the side of excavation and for ensuring the safety of workmen and equipment, shall be deemed included in the rates.

The Contractor shall be responsible for the design of the lateral supports. These shall be strong enough to resist side thrust and prevent slips, blow and damage to adjacent works and property.

Lateral support shall include all labour, materials etc, keeping the same in position as required and dismantling and removing the same after the work has been completed.

Excavation shall not be carried out below the foundation level of nearby structures until the required precautions have been taken.

Adequate fencing is to be supplied and erected enclosing excavations during construction activities.

The withdrawal of the shoring shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

12.25.9 De-watering

All excavations shall be kept free from water:

During inspection and measurements;

When the placing of concrete or masonry is in progress and reach natural ground level and above;

Until the Engineer is satisfied that the concrete or mortar have set and hardened sufficiently;

During backfilling and compaction.

The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rainwater and subsoil water accumulated in any foundation enclosure, basements or trenches, in such a manner as to preclude the possibility of any damage to the foundation, trenches, concrete or masonry or any adjacent structure.

Pumping arrangements shall be adequate to ensure no delays in construction.

12.25.10 Back Filling and Compaction

Backfilling and Compaction shall be done according to AASHTO. The specific compaction strength shall be set by the Engineer at 93% or 95%.

12.25.11 Protection and Safety

Adequate protective measures shall be taken to ensure that the foundation excavation does not affect or damage adjoining structures.

All required measures shall be taken by the Contractor at his own cost to ensure safety of the excavation, the people working in or near the excavation and people and property in the vicinity. He shall be entirely responsible for any injury to life and damage to property caused by his negligence or accidents due to construction operations.

12.25.12 Concrete Foundations

12.25.13 General

The foundation is the transition between the superstructure and the in situ soil/rock and it has to be designed for a variety of loadings on the basis of site-specific characteristics. These site-specific characteristics often are difficult to define.

A geotechnical survey determines the extent of variation in soil types according to predefined soil categories. They may also be conducted to ascertain soil strength at a particular location.

12.25.14 Foundation Design Criteria

Many factors have to be considered when designing a foundation that will perform satisfactorily. These factors include the following:

Geotechnical characteristics;

Loadings and safety factors;

Foundation types;

Foundation response to load;

Soil or rock response to loads;

Construction procedure.

Foundations shall be designed to support the ultimate loads and according to the soil/rock parameters.

The structural design of foundations shall be done in accordance with relevant standard such as Eurocode 2, BS 8110 and Zesco’s specifications of SP-CSS-001 – Civil Works. All foundation designs shall be signed off by a registered professional Engineer.

12.25.15 Geotechnical Investigation and Soil Classification

It is considered optimal to predefine a limited number of different soil/rock strength classes, for which standard foundations are designed. The number of categories of soil strength chosen represents a trade-off between cost and practicality.

The soil/rock condition and strength characteristics must be investigated and reported by a registered geotechnical professional before any foundation construction starts or to provide soil strength parameters for the evaluation of the existing foundations.

12.25.16 Information to be submitted by the Contractor

12.25.16.1 Design Mix

Specifications giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per National Standards is to be submitted to the Engineer for his approval before it can be used on the works.

12.25.16.2 Inspection Reports

The Engineer in accordance with this specification may desire inspection reports in respect of formwork and reinforcement and any other item of work.

12.25.16.3 Test Reports

All materials such as cement, aggregates, reinforcement and concrete, etc used for the works shall be tested as per relevant standards before use.

12.25.16.4 Certificates of Tests for Reinforcement

For each consignment of reinforcement used in the works, the Contractor, shall, if required by the Engineer supply a certificate from the manufacturer and / or tests performed by a recognised testing laboratory and give the ultimate strength, yield stress, elongation, the results of cold bent test and mill test reports. All the tests shall be conducted in accordance with the applicable and relevant National Standard specifications. If so required by the Engineer, the Contractor shall arrange to get the chemical composition of the bars tested and obtain a certificate of test results. All the cost of sampling and testing shall be borne by the Contractor.

12.25.17 Materials

12.25.18 General

All materials used in the work shall be new and of quality and standard as specified. Materials delivered for the work shall be of the same quality as that of the approved samples.

Delivery of materials shall be made sufficiently in advance of construction requirements to enable further samples to be selected and tested, if so desired by the Engineer.

No material shall be used in the works until approved. Approved materials should be stored in such a manner that there will be by no means any loss of quality.

Materials failing to comply with these specifications shall be immediately removed from the site by the Contractor.

The Contractor shall be deemed to have included in his costs all the sourcing and transportation to site of all materials required for successful project execution. Where there is need to establish quarries for aggregates or borrow pits for backfill material, all permits shall be obtained by the Contractor or his agents and the quarries/borrow pits shall meet the project ESMP and local requirements.

12.25.19 Steel Reinforcement

All main reinforcing steel shall conform to SANS 920 Type C, Class 2, Grade II hot rolled deformed bars with a minimum yield stress of 450MPa. The minimum bar size utilised shall be 10 mm.

All secondary reinforcing for stirrups, hoops and spirals, shall as a minimum conform to SANS 920 Type "A" hot rolled bars of plain cross-section of mild steel with a minimum yield stress of 250MPa.

Reinforcing steel of different grades and sizes shall be stored separately and in a manner, which will permit easy identification and prevent mixing up of different sizes and grades. All bars shall be properly tagged for easy identification.

Reinforcement bars shall be stored at site in such a manner as to prevent corrosion and contamination of the surface by deleterious materials like dirt, oil, grease, paint etc. When placed in the work, all reinforcement shall be free of loose mill scale, rust and any deleterious matter.

Bars displaying excessive rusting will be rejected and removed from the site.

Steel reinforcement shall always be protected from damage due to impact and rough handling.

The bars shall be accurately fixed and securely wired in the configuration and position shown on the drawing.

12.25.19.1 Bending

All bending to be compliant with SANS 282. No reinforcement shall be bent or straightened, once it has been placed and positioned without the written approval of the Engineer, whether or not it is partially embedded in concrete.

Reinforcing steel shall not be straightened in a manner that will damage the material causing fracture. The re-bending of steel can only be carried out with the written approval of the Engineer.

Reinforcing bars shall be bent by machine or another approved method that produces a gradual and even bending motion.

Bars having fracture cracks or split/ends shall be rejected and removed from site.

12.25.19.2 Bending Schedules

Bending schedules shall be submitted for approval prior to the steel being transported to site, the schedules shall indicate steel size, bending radii and fixing. Each reinforcement drawings must include a bending schedule.

12.25.19.3 Welding and Coupling

Field welding of reinforcing bars will not be permitted under any circumstance without the written consent of the Engineer. Such approval will require identification of the type of steel used.

Procedure for welding mild steel reinforcing bars shall generally follow the requirements of the National Standards, code of practice for welding of mild steel bars used for reinforced concrete constructions. Welders employed for this work shall have passed the relevant qualification tests for welders.

Whenever plans call for the use of couplers to join bars, such couplers shall have sufficient cross section to transmit the full strength of the bars. The screw thread shall be metric coarse pitch conforming to the national standards and relevant to the diameter of bar to be coupled.

No concrete shall be placed until the Engineer has inspected the reinforcement placement and approved the same. Concrete placed in violation of this provision will be rejected and removed at the Contractors costs.

12.25.19.4 Control

The installation of reinforcement steel shall be completed well in advance of concrete pouring and examined by the Engineer. Immediately prior to the pouring of the concrete, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with BS 8110 unless otherwise specified.

12.25.19.5 Cover

Unless indicated otherwise on the drawings, clear concrete cover for reinforcement shall be a minimum of 50 mm in foundations.

12.25.19.6 Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. Local warming may be permitted if steel is kept below 100°C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by the Engineer.

Re-bending or straightening incorrectly bent bars shall not be done without approval of the Engineer.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Engineer prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be of suitable material. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

12.25.20 Cement

Unless otherwise stated in the specifications and drawings or approved by the Engineer, the cement to be used in the concrete works shall be standard Portland cement. Only one type of cement shall be used in any one mix. Any cement that is to be used at the site shall be tested before use if so directed; if on testing the cement does not comply in full with the specifications, the total consignment from which the sample has been drawn shall be rejected and removed from the site.

12.25.21 Fine Aggregates

Fine aggregates shall consist of natural sand or manufactured sand or any approved combination thereof. Aggregate smaller than 4.75 mm and within the grading limits and other requirements is termed as fine aggregate.

In the event of the fine aggregate being contaminated by dirt or other deleterious materials, the Engineer may call for the aggregate to be washed, in this event only clean fresh water shall be used for this purpose.

12.25.22 Coarse Aggregate

Coarse aggregate shall generally conform to the requirements of BS EN 12620 and shall consist of hard, strong, durable particles of crushed stones and shall be free from elongated soft pieces, vegetable matter and other deleterious matter. It shall have no adherent coating. Flaky and elongated particles shall be avoided. Aggregates of sizes ranging between 4.75 mm and 150 mm will be termed as coarse aggregate.

Maximum size of coarse aggregate for use in reinforced concrete work shall be limited generally to 30 mm.

Aggregates such as slag, crushed over burnt concrete blocks, bloated clay ash, sintered fly ash and tiles shall not be used.

In the event of the coarse aggregate being contaminated, the Engineer may call for the aggregate to be washed, in this event only clean fresh water shall be used for this purpose. Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by an approved method if instructed by the Engineer.

12.25.23 Water

Potable water is considered satisfactory for this purpose. The Engineer may require the Contractor to get the water tested from an approved laboratory at the Contractor's expense.

The pH value of the water shall generally lie between 6 and 8. Where water contains excess of acid, alkali, sugar or salt, the Engineer may refuse to permit its use.

The Contractor has to make his own arrangements for getting water of sufficient volume required for the construction at his own cost.

12.25.24 Storage of Material at Site

12.25.25 General

All materials shall be stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and correctness for the work. The Contractor shall make his own arrangements for the storage of adequate quantity of materials.

Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the total cost incurred thereof shall be realised from the Contractor's dues.

12.25.26 Cement

Cement shall be stored off the ground on suitable dry wooden pallets away from the outer walls, not exceeding 10 bags in height in a dry leak-proof, well ventilated container or shed to prevent deterioration due to moisture or intrusion of foreign matter.

Different consignments of cement shall be stacked separately and identified separately so that they can be used in the order in which they are received.

No cement which has become damaged / deteriorated shall be used in the work.

Bulk cement shall be stored in airtight containers with the date of arrival, consignment number marked on the container. The Contractor shall make suitable safe arrangements to transfer cement from the bulk containers to the cement bin at the batching plant. Consignments shall be used in the order of their receipts at site. Any substandard or partly

set cement shall not be used and shall be removed from the site as soon as it is detected. The Contractor shall notify the Engineer of such event.

Cement held in storage for a period of ninety days (90) or longer shall be tested. If at any time the Engineer has reason to consider that any cement is defective, then irrespective of its origin, date of manufacture and manufacturer's test certificates, such cement shall be tested immediately at the Contractor's cost at an approved laboratory preferred by the Engineer and until the test results of such tests are found satisfactory, the cement shall not be used on any work. The Contractor is not entitled to any claim of any nature on this account.

12.25.27 Aggregate

Stockpiles shall be built in successive horizontal layers of not more than 1m thickness, with each layer being completed before the next is started.

It is recommended that Aggregate shall be stored on planking or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from being intermixed.

If the stockpile is stored on the ground, then the last 300 mm layer from the stockpile of aggregate shall not be used. The aggregate piles shall be allowed to drain until it has reached uniform moisture content.

Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

12.25.28 Strength of Concrete

Unless otherwise specified on drawings, the minimum required strength for mass concrete shall be 28 MPa at 28 days.

12.25.29 Quality Control

The Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer, this is to assure full compliance with contract requirements and maintain and submit to the Engineer records of the same. All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Engineer. Materials rejected by the Engineer shall be removed from site and shall be replaced by the Contractor immediately. The quality control operation shall include but not be limited to the following items of work, where applicable:

Table 12-37: Quality control for concrete

Items	Description
Admixture	Type and quantity used in concrete.
Aggregate	Physical, chemical, and mineralogical qualities, grading, moisture content, and impurities.
Water	Impurities test and chemical analysis.
Cement	Tests to satisfy relevant National Standard specifications.
Formwork	Material, shapes, dimensions, lines, and elevations, surface finish, adequacy of form ties, bracing, shoring and coating.
Reinforcement	Quantity of steel, shapes, dimensions, length of splices, clearances, ties and supports. Material test or certificate of compliance relevant to National Standards specifications.
Grades of concrete	Test and mix design
Batching and mixing	Types and capacity of plant, concrete mixers and transportation equipment.
Joints	Location of joints, water-stops and filler materials, and dimension of joints, quality and shape of joint material
Embedment	Material, shape, location, setting and anchorage items.
Placing	Preparation, rate of pouring, weather and height considerations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
Compaction	Number of vibrators, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand spading, and tamping.
Setting out of base	Lines, elevations and bedding mortar.
Concrete finishes	Uniform texture; free from holes, pins and formwork.
Tolerances	Degree of Accuracy II to SANS 1200 G-1982 Section 6 for relevant items.
Curing	Methods and length of time.

Copies of records and tests for the items noted above, as well as records of corrective action taken shall be submitted to the Engineer for approval as may be required.

12.25.30 Types of Concrete

The concrete type shall be either mass concrete or reinforced concrete. Unless otherwise specified in the schedule of items, all structural concrete shall be reinforced concrete.

12.25.30.1 Mass Concrete

The minimum required strength for mass concrete shall be 28 MPa after 28 days.

The cement content of the mix specified in SANS 10100 for any mass concrete shall be proportionately increased if the quantity of water in a mix has to be increased to overcome

the difficulties of placement and compaction, so that the cement/water ratio as specified is not exceeded.

In the case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation.

All the relevant requirements for this concrete as given in SANS 10100 shall apply.

12.25.30.2 Reinforced Concrete

The mix shall be designed to produce the grade of concrete (not less than the grade used for mass concrete) having the required workability and characteristic strength not less than appropriate values given in SANS 10100.

Mix proportions used for a particular designation of concrete shall be based on the results of tests carried out on samples as per various preliminary mix designs. Only the materials proposed for use in the works shall be used for the samples.

Any of the recognised methods of mix design may be used in the design of trial mixes. Trial mixes shall take into consideration the workability required at site for placing the concrete in the structure.

Preliminary mix design will have to be redone if the source of the materials changes or any change in mix proportions is to be made in the course of construction.

12.25.31 Mix Design Criteria

Concrete trial mixes will be designed by an approved materials laboratory to achieve the strength, durability and workability necessary for the work. In general, the design will keep in view the following considerations:

Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level by defining minimum cement/water ratio;

The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified;

The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the densest and most workable mix. This is to be determined by laboratory tests, field trials and suitable changes in aggregate grading;

The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies, which it is expected to be subjected to in actual service.

12.25.32 Batching

SANS 1200 G-1982 Section 5.5.2 refers.

To change from weight batching to volume batching the written permission of the Engineer must be obtained.

12.25.33 Concrete mixing

SANS 1200 G-1982 Section 5.5.3 refers.

The mixing of concrete shall be strictly carried out in an approved mechanical concrete mixer.

The mixing equipment shall be capable of combining the aggregates, cement and water within the specified time into a thoroughly mixed and uniform mass, and discharging the mixture without segregation. The entire batch shall be discharged from the drum before recharging. No batch shall be mixed on the remains of a previous batch of concrete.

Mixer blades shall be replaced when worn down more than ten percent (10%) of their depth.

Should any mixer at any time produce unsatisfactory results it shall be removed from site and replaced at the expense of the Contractor.

Mixing time shall be as indicated below. Excessive mixing requiring additions of water will not be permitted. Timing shall start when all solid materials are in the mixer drum, if all of the mixing water shall be introduced before one fourth of the mixing time has elapsed. Each batch shall be mixed thoroughly until the mix achieves uniform colour and consistency.

Capacity of Mixer	Min. mixing time
1m ³ or less	1 1/2 minutes
2 and 3 m ³	2 1/2 minutes
4 m ³	3 minutes

Adequate mixing capacity shall be provided at the site to deliver a continuously quantity of concrete for a pour. The quantity of material mixed per batch shall not exceed manufacturer's rated capacity.

Normally, hand mixing of concrete shall not be permitted. However, the Engineer may allow this in specific cases.

Ten percent (10%) extra cement shall have to be added to the normal mixes when mixed by hand. It shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency.

No additional payment shall be made to the Contractor for mixing by hand or for using extra cement due to hand mixing are allowed.

Records and charts for batching and mixing operations shall be prepared and kept as specified herein and promptly handed over to the Engineer on a daily basis.

12.25.34 Formwork

12.25.35 Installation of Formwork

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer the drawings and calculations for the design of the formwork shall be submitted to the Engineer for approval.

Materials used for the formwork shall be capable of withstanding the working load and remain undistorted throughout the curing period that it's left in service.

Formwork shall be of wood, metal or other suitable material. The formwork shall be mortar-tight and shall be designed, constructed, braced and maintained such that the finished concrete will be true to the line and elevation, and will conform to the required dimensions and contours. It shall be designed to withstand the pressure of concrete, the effect of vibration as the concrete is being placed and all loads incidental to the construction operations without distortion or displacement.

Where the bottom of the formwork is inaccessible, provision shall be made for cleaning out extraneous material immediately before placing the concrete.

All exposed corners of the concrete shall be chamfered approximately 20 mm. All formwork dimensions shall be checked, and if necessary, corrected before any concrete is placed.

All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer. Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

If Engineer rejects any improper formwork after inspection, at any stage of construction, it is responsibility of the Contractor to get corrected before concreting at no extra cost to the Employer.

12.25.36 Removal of Forms

Before stripping and removing any formwork, the Contractor must notify the Engineer in writing 24 hours in advance to enable him to be present and inspect the newly exposed concrete.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected in its entirety and reconstructed by him without any additional cost to the Project.

The Engineer may at his discretion, decide to postpone the removal of formwork if he considers it necessary to extend the curing process.

Forms for various types of structural components shall not be removed before the minimum periods specified as per SANS 1200 G-1982 Section 5.2.5, Table 2. The removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

Stacking of formwork material or any other material will not be permitted on any newly constructed floor without the permission of the Engineer.

12.25.37 Transportation, Placing and Compaction of Concrete

12.25.38 Transportation

SANS 1200 G-1982 Section 5.5.4 refers.

Concrete shall be transported from the mixing plant to the site casting within the initial setting time from the time water is added to the cement by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

When conveyors are used to get the concrete mix at the required delivery place it shall be of a size and design to ensure optimum flow. The conveyors shall be of non absorbent materials and shall be maintained in a clean condition. Use of long troughs, chutes, etc, shall be permitted only with the written approval of the Engineer. In the case that such conveyors lead to inferior quality concrete, the Engineer may decide to discontinue their use.

Concrete that has stiffened so that it cannot be satisfactorily placed shall not be used and shall be discarded.

12.25.39 Placing

SANS 1200 G-1982 Section 5.5.5 refers.

Formwork, reinforcement, preparation of surface, embedment, joint seal’s etc., shall be inspected and approved in writing by the Engineer before concrete is placed.

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joints must be roughened by wire brushing, chipping, sand blasting or any other approved means for a proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air jetting or water at high pressure.

As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner, which may cause segregation. Any placing drop over 1500 mm shall be directed through chutes and these shall only be employed with the approval of the Engineer.

All sleeves, inserts, fixings, anchors and embedded items required for associated work or for its own support shall be placed prior to the concrete being placed and securely fixed.

All others work that is related to the concrete or must be supported by it, shall be given ample notice and the opportunity to introduce and/or furnish embedded items before the concrete is placed.

Voids and slots in sleeves, anchors and inserts shall be filled temporarily with readily removable material to prevent the ingress of concrete into the voids.

When placing concrete on a slope, pouring shall start at the lowest point and it shall be placed on the face of the previously placed concrete.

Special care shall be taken not to displace reinforcement and embedded parts during the placing and compaction of concrete.

Concrete shall be placed continuously until completion has been reached on that part of the work between construction joints or as directed by Engineer.

Record the time and location of placing structural concrete.

12.25.40 Compaction

SANS 1200 G-1982 Section 5.5.6 refers.

All concrete shall be thoroughly compacted during placement. The Engineer shall remain the final deciding authority on the type of vibrators to be used for any particular case.

Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork.

As far as possible, only internal vibration shall be used for compacting concrete, unless specified otherwise. Internal vibrators of a high frequency type conform to the requirements of the National Standard shall be preferred. Use of immersion vibrators for compacting concrete shall generally follow the recommendation of the National Standards.

Use of other types of concrete vibrators shall be permitted only if immersion vibrators are found impracticable because of its size or inadequate working clearance of the unit to operate correctly.

Adequate number of vibrating units shall be provided to compact the concrete at the rate of placing envisaged. In order to provide against breakdown of units, stand-by units driven by alternative power units shall be available at the work site.

Care shall be taken to prevent contact of vibrators against reinforcement steel and embedment. Vibrators shall not be allowed to come in contact with forms or finished surfaces. Vibrators shall not be used to push and transfer concrete into adjoining areas.

When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Placing of concrete between successive layers shall be done shortly after each other. The minimum time must be agreed with the Engineer.

All necessary equipment required for concrete works shall be maintained in clean and good working condition by the Contractor. In case the Engineer deems that the equipment is not maintained properly, it will be rejected and Contractor shall replace with new equipment at no extra cost to the Employer.

12.25.41 Curing and Protection

Curing of concrete shall be in accordance with SANS 1200 G-1982

Concrete shall be cured by keeping it moist for the period of time specified in clause 5.5.8 of the above standards to ensure that complete hydration and hardening take place.

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous, fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Engineer.

Curing of concrete shall start after 8 hours of placement and in hot weather within 4 hours of placement for exposed faces. In very hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C while placing.

The ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage and adequate steps shall be taken to prevent flotation and flooding.

The concrete shall be initially protected from damage on account of impact, undue pressure, excessive heat drying winds and rain, etc. by covering with wet sacking, hessian or similar absorbent material soon after the initial set for the period of complete hydration with a minimum of 3 days unless otherwise directed by the Engineer. After the final set, the concrete shall be cured as per SANS 1200 G-1982 Section 5.5.8 (e).

12.25.42 Repair and Replacement of Unsatisfactory Concrete

After inspection by the Engineer any unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by new sound concrete at the Contractor's cost.

The Engineer may, at his sole discretion, allow retaining concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Project. The Contractor will inspect all concrete work immediately after the forms are removed and he will promptly report the occurrence of any defects to the Engineer. All repair works will be carried out as per the instruction and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

Sack rubbing with mortar and stoning with carborundum stone;

Cutting away the defective concrete to the required depth and shape;

Cleaning of reinforcement and embedment;

Roughening by sand blasting or chipping;

Installing additional reinforcement/welded mesh fabric;

Dry packing with stiff mortar;

Plastering, guniting, shotcreting etc;

Placing and compacting concrete in the void left by cutting out defective concrete.

Voids that have been approved by the Engineer for filling shall be provided with anchors, keys or dovetail slots wherever necessary to attach the new material securely in place. Surface of prepared voids shall be wetted for 24 hours prior to the placement of the patching material.

Immediately after patching is completed, the patched areas shall be covered with approved non staining water saturated material, which shall be kept wet and protected against sun and wind for a period of 12 hrs. Thereafter the patched area shall be kept continuously wet by a fine spray or sprinkling for not less than 10 days.

All materials, procedures and operations used in the repair of concrete and also the finished work shall be subject to the approval of the Engineer. All filling shall be sound and free from shrinkage cracks.

12.25.43 Adverse Weather Conditions

SANS 1200 G-1982 Section 5.5.9 refers to cold, hot and prolonged rainfall conditions.

When pouring concrete during very hot weather conditions, the Contractor shall take all precautions to stagger the work toward the cooler parts of the day to ensure that the temperature of the concrete can be controlled by pre-cooling, post-cooling or any other method, if so required.

12.25.44 Extension of Existing Foundations

When extension of the existing foundations is required, the joint surfaces of the existing foundations must be roughened by chiselling and grooving and cleaned thoroughly by grit and high pressure water blasting or wire brushing. Reinforcing steels must be placed between the existing and new concrete. The numbers and sizes of steel reinforcement must be the same as or more than the steel reinforcement in the existing foundations. Holes should be drilled into the existing foundations to the length of 40d (d is the diameter of the reinforcement to be placed between the existing and new foundations) to be jointed to the existing reinforcing steels by means of a special coupling and be properly anchored by epoxy compounds.

Concrete grade to be used for the extension must be the same as or higher than the existing concrete grade in the existing foundations.

Any proposed extensions of existing foundations must be presented to the Engineer for his approval before taking up construction works.

12.25.45 Clean-Up

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

12.25.46 Sampling and Testing**12.25.47 Concrete**

The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer.

12.25.48 Aggregates

The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with SANS 1083. The acceptance criteria for the samples tested shall be in accordance with the requirements of the relevant SANS code.

12.25.49 Water

Sampling and Testing of water being used for concrete works as per relevant SANS code will be carried out by the Contractor at regular intervals and whenever directed by the Engineer.

12.25.50 Acceptance Criteria

Standard deviation based on test result and determination of standard deviation shall conform to relevant standards.

12.25.51 Fire wall (Spatial separation)

Transformer/Reactor passive fire protection requires that transformer/reactors are spatially separated, and that the oil from a reactor that ruptures is drained away quickly to prevent a large fire. The required spatial separation depends on the volume of oil in the transformer/reactor, and is given by the following table:

Table 12-38: Fire wall separation

Volume of oil (kl)	Separation (m)
> 60	23
30 – 60	15
10 – 30	10
2 – 10	7.5
< 2	1.5

Where adequate spatial separation cannot be obtained, fire barriers are installed between transformers/reactor. If fire barriers are required, they must have a 3 hour fire rating, and extend 0.3 m above the highest part of the transformer/reactor (generally the bushings or conservator), and be 0.6 m wider than the transformer/reactor (including the radiators). Fire

barriers of precast concrete, sheet steel, and face brick have been used successfully in projects. Wind loading and the impact on transformer cooling must be considered in the design of the fire barriers.

Direct flame impingement on heat radiation barriers should be prevented by allowing a minimum clearance of 1.5 m between the catchment walls and the barrier.

12.25.52 Oil Containment

12.25.53 General

This chapter discusses the specifications for a Secondary Containment System. This is a system capable of preventing the escape of Oil to Controlled Waters in the event of failure to any part of a specified Primary Containment System (i.e. the tank or enclosure used for the continuous, permanent containment of Oil for operating and storage purposes). Secondary Containment for large items of plant shall comprise, as a minimum, an Oil Retaining Area and, where required, an Underground Oil Containment Facility plus interconnecting drainage system. Where the Oil Retaining Area of Transformers and Reactors contains more than 50,000 litres of Oil it shall be designed and constructed to include an Underground Oil Containment Facility, connected through a Fire Trap. Those containing less than 50,000 litres of Oil may be exempt if permitted by the scheme specification.

Any design proposal different from what is described in this specification must be discussed with the Engineer for his approval. The Bidder must highlight this in his tender.

12.25.54 Constructional Requirements

12.25.54.1 Earthing

The installation of Oil containment infrastructure is likely to involve the inclusion of metallic items such as pipes and access steps at Oil Retaining Areas etc. In such cases, where there is a risk to individuals from transferred touch potentials on the infrastructure during system fault conditions or where the installation may be subject to induced voltages or circulating currents, then the Contractor shall ensure that all equipment and materials are installed in accordance with the earthing requirements of ZESCO.

12.25.54.2 Oil Retaining Area Design

The Oil Retaining Area shall consist of a base slab, formed around plant foundations as necessary, and single skin walls not less than 225mm thick forming a container impermeable to Oil and water and constructed to provide an effective life in excess of 40 years, with

appropriate maintenance. It shall be of reinforced concrete, designed and constructed in accordance with BS EN 1992-3 and the associated ZESCO Specifications.

All impermeable internal surfaces shall be designed to maintain their load bearing function and integrity in the event of a fire for a minimum of four hours in accordance with BS EN 1991-1-2, BS EN 1992-1-2.

Walls shall be designed to be monolithic with the base slab. In addition no contraction or expansion joints shall be incorporated in the design of walls and slabs, which should allow for full restraint of shrinkage and thermal expansion/contraction. All construction joints shall have continuous reinforcement.

Crack width and spacing shall be controlled by the reinforcement which shall be designed to achieve 'Tightness Class 1' as defined in BS EN 1992-3 Clause 7.

No external holes shall be allowed through any part of the Secondary Containment System. All services, pipes, cables etc. shall be carried over walls to maintain their integrity.

Oil Retaining Area walls may be detailed to facilitate the installation of HV plant by allowing sections to be cast after the main construction. Continuity of such sections should be achieved by conventional lapped reinforcement. However, where this is not practicable, continuity may be provided by the use of reinforcing bar couplers. Where couplers are to be used, allowance shall be made at the design stage to ensure the required cover is maintained to both the reinforcement and the couplers.

Slabs formed within Oil Retaining Areas between transformer/plant plinths shall be laid to a minimum slope of 1 in 80 to collecting sumps or channels (or Flame Traps where an Underground Oil Containment Facility is present).

All pedestrian access areas shall have an approved slip resistant surface and be capable of supporting a minimum imposed load of 5 kPa. The surfacing shall not comprise stone chippings, cobbles, pebbles or other loose media. Major Maintenance and General Maintenance requirements shall be identified and suitable additional provision (e.g. load from scaffold) accommodated in the design as necessary. Areas or surfaces not suitable for loads greater than pedestrian access shall be marked with suitable warning signage indicating their limitations (e.g. 'Pedestrian Access Loading Only').

12.25.54.3 Flame Traps

Flame Traps shall comprise of a pit/chamber of 300 mm depth filled with washed and uniformly sized stone of 38 mm diameter or greater. Other configurations shall not be used

unless proven by testing. Plan dimensions of Flame Traps shall be governed by the greater of the following requirements:

The Flame Trap(s) must facilitate a total flow rate of at least 7,000 litres/minute.

Where provision for planned access to the Underground Oil Containment Facility is required, the plan dimensions of individual traps shall be a minimum of 600 mm by 600 mm. Any site specific health and safety issues which necessitate a larger opening shall take precedence over this requirement.

The metal grating used to support the loose stone shall be designed such that it does not excessively deform or lose a significant proportion of its strength in the event of a fire. Openings in the grating should be sized appropriately so that they do not restrict the flow of Oil through the Flame Trap.

12.25.54.4 Underground Oil Containment Facilities

The underground Oil Containment Facilities shall take the form of a containment area integral with the plant foundation (underground moat).

Flame Traps, manholes, catchpits, pipes and channels forming the interconnecting drainage system between the Oil Retaining Area and Underground Oil Containment Facility shall be a closed free flowing gravity system capable of accommodating Oil and water at temperatures of 80°C at a rate of 7,000 litres per minute.

Where Active Automatic Fire Protection Systems are installed, its pipework shall be sized to discharge the calculated flow rate without accumulation of fluid in the Oil Retaining Area.

Manhole cover levels forming part of the system shall be equal to or above the maximum height of the related Oil Retaining Area walls or bolted down and sealed against egress of Oil/water with the relevant hydraulic head.

The 'underground moat' shall be formed around the HV plant foundations. Oil entering the Underground Oil Containment Facility from a transformer fault involving a large discharge of Oil shall pass through a Flame Trap(s). The accumulation of rain water shall be manually pumped out by means of a single draw off point. An automatic bund water control unit, including an oil separator, will thus not form part of the scope of works.

The Integral Underground Oil Containment Facilities shall be connected to a single draw off point to facilitate remote emptying (by pumping) of the below ground areas in the event of a catastrophic failure of the contained HV equipment.

All pipework and connections shall be suitable for Oil and water at 80°C.

The vertical pipework within the 'underground moat' compartment shall be fixed to the side walls as appropriate and terminated horizontally, 25 mm above the top of the base slab, via a 90° bend. The precise location shall be to suit site logistics and may be within the sump, allocated for a future installed Bulk Water Control Unit, noting that this location will generally be submerged in Oil and/or water and additional anti corrosion measures may be necessary.

Above ground, the system shall terminate in a vertical riser pipe with 180° bend and gate valve.

The outlet of the riser pipe shall be a nominal 100mm above the top of the Oil Retaining Area walls and shall have a threaded end, fitted with a blanking cap. The size of the cap must be approved by the site operator.

The riser pipe shall be clearly marked, declaring where the pipe terminates and what assets are hydraulically coupled together with associated asset Oil volumes. It shall be supported by a concrete post and protected from vehicular impact by appropriately spaced concrete bollards or lengths of a recognised safety barrier system. It shall be located close to the substation access road in a position that would permit vehicular access in the event of a fire in the associated transformer.

The cross site route of the pipework (i.e. between the external face of the Oil Retaining Area wall and the perimeter of the Fire Damage Zone) shall be a continuous, closed system as short as practicable and with minimal vertical and horizontal deviations.

Pipework within the Fire Damage Zone shall have a 4 hour fire resistance. This will generally be best achieved by direct burying wherever practicable.

12.25.55 Dimensional Requirements and Clearances

12.25.55.1 Oil Containment/Storage Requirements

The Net volume of the Secondary Containment system shall be 110% of the volume of Oil in all the items within the Oil Retaining Area. The 'Net' volume shall be taken as the total area enclosed by the external walls of the item under consideration minus the volume displaced by items of plant or other permanent features.

The capacity of the Secondary Containment System shall be taken as the capacity of the Oil Retaining Area or, where present, the capacity of the Underground Oil Containment Facility but not both together.

12.25.55.2 HV Plant Oil Retaining Area

The height of all Oil Retaining Area walls shall be a minimum of 400 mm above finished substation ground level or the support plinth(s) of the associated Oil containing equipment, whichever is the greater.

The minimum clear horizontal distance between the internal face of an Oil Retaining Area wall and any Oil containing plant within it shall be 2.0m for Transformers and Reactors and 1.0m for all other equipment unless it can be demonstrated that a lesser dimension is appropriate.

Bushings shall not project beyond the internal face of an Oil Retaining Area wall.

Where Oil Retaining Areas are connected to an Underground Oil Containment Facility, the system shall be capable of draining Oil at a rate of at least 7,000 litres per minute.

12.25.55.3 Control Panels

Control panels forming part of the Oil containment system shall be sited within the associated substation compound. They shall be mounted as close as practicable to the controlled equipment a minimum of 1.2 m above ground level and more than 2 m from the substation security fence.

12.25.56 Site Drainage System for Oil Containment

There shall be no free drainage outlet installed from the Secondary Containment System as part of the works. Rainwater shall be pumped out manually by means of the installed pipework, discharging to the Site Drainage system linked to an Oil Separator. The Contractor will be responsible for the installation of an Oil Separator or to make modifications to the existing site drainage.

12.25.57 Access

All parts of Underground Oil Containment Facilities shall be accessible for inspection purposes. The Contractor shall submit the proposed maintenance regime for agreement prior to construction work.

'Underground moat' type installations shall be configured to prevent routine personnel access to the below ground sections however the design shall make allowance for the possibility that planned access may be necessary to carry out repair work during the units' design life. Consequently, man access points having minimum dimensions of 600mm by 600mm shall be incorporated at the underside of the stone filled Flame Trap to ensure all underground compartments could be entered if required.

All pumps (if applicable) shall be fully accessible from ground level, either by recovery or siting. Where recovery is required a handling assessment shall be completed and/or suitable lifting arrangements provided. The assessment shall consider the loading imposed by

pipework and water retention. Pumps shall be clearly and uniquely labelled at the point of access.

12.25.58 Pedestrian Walkway Systems

In such circumstances where foot access for operation or maintenance activities is required, a walkway system shall be laid.. Slabs shall be laid with a minimum clearance to pipework/ducting of 25 mm.

Components of modular flooring systems shall be individually stable i.e. the system shall remain structurally sound if sections are removed.

A non-ferrous, non-conductive, and non-magnetic material, resistant to Oil & UV exposure shall be used. Recycled material shall be encouraged for environmental sustainability. Grating panels are to be designed for a minimum load of 5.0 kPa and be in accordance with the requirements of BS 4592. Where the system will be required to accommodate loading from temporary works such as access scaffolds, this shall be considered at the design stage and may require stronger panels to be used.

The upper face of the panels should be finished to provide an all weather nonslip surface.

Panels shall be removable as part of planned maintenance work only.

Panels shall be non combustible with a minimum fire resistance of Class 2 to BS 476-7.

12.25.59 Internal Substation Roads

The roads within the substation site shall consist of a minimum 100mm sub-base compacted to 95% MOD AASHTO. Followed by 200mm (minimum) thick reinforced concrete course, adequate weight/load resistance for the off-loading apron in front of the Statcom. The access road must be designed to carry a load of 8 tonnes per axle in accordance with Road Development Agency Guidelines. Horizontal alignment – minimum inner turning radius is to be 15 to 20m.. The substation internal road must comply with SANS 1200 M.

12.25.60 Fencing and Gates

The Contractor shall procure and install fence and a main gate, matching the fence and gate already installed on site.

The Contractor may re-use the existing fencing that forms part of the substation expansion if it is found to be in good condition.

12.25.61 Yardstone

The additional yardstone must match the existing yardstone on site.

13 RECOMMENDED SPARE PARTS AND MAINTENANCE EQUIPMENT

13.1 Spare Materials

The Contractor shall include under this project, spare parts and maintenance equipment. The calibration certificates of each maintenance equipment shall be supplied along with the equipment.

In addition, bidders are requested to state their recommendations at the time of bidding for extra spares bearing in mind that the equipment shall be in continuous uninterrupted operation for not less than 10 years. The Contractor shall ensure availability of spare parts for a period of 10 years.

Spares shall be delivered with the associated equipment and, in order that spares may be placed on order at short notice, full details including Catalogue and/or spare part numbers of all spares should be supplied with Bid.

Each spare part shall be labelled with the following:

- The number of the Contract Number on which the part was supplied.
- The Item No. on the Order, which specified the part.
- The serial number of the equipment for which the part may be used.
- The part number.

Spares shall be priced item wise.

The Schedule of Prices sets out quantities of Mandatory Spare materials which are required by the Employer, which will be paid for at the rates entered in the schedule, as incorporated into the Contract.

In the event that the Employer requires other items not listed in the scheduled spare items, these shall be supplied at the appropriate rates for supply and delivered to the Employer’s Stores at Local Transport and Delivery Rates to be agreed in consultation with the Employer at the appropriate time.

Any spare material shall be strictly inter-changeable with the parts for which it is intended and be packed, treated in a manner suitable for storage in the tropical climate which prevails in Zambia, the Site, and the project area as a whole.

The packaging and tropicalisation treatment shall be such as to provide safe storage for an indefinite period and each package or part is to be clearly marked, identifying contents by item and quantity, where applicable.

The additional quantities to be supplied shall be confirmed by the Employer before delivery.

Tenderers must state how long they anticipate that replacement spares will be available in stock.

14 TESTING AND INSPECTION

This section contains general requirements for inspections and tests of material, parts, equipment and workmanship of the plant during manufacture, assembling and erection and upon completion to demonstrate compliance with the Employers Requirements, codes and standards to ensure overall reliability of plant operation and performance. Tests shall include cybersecurity protocols for SCADA/EMS installation and/or extensions per WB electronic procurement security.

All materials used in the Contract works shall be made available for inspection and test by the Employer and the Employer’s Representative during manufacture and it is the Contractor's responsibility to advise ZESCO when equipment and materials are available for inspection. All tests, inspections and examinations, as well as the results and finding established thereby shall be recorded and duly signed by the parties involved. The Contractor shall prepare complete test reports on all tests carried out in the factory or by the subcontractors. The reports shall include all measured and calculated data presented in tables and graphs. The reports shall demonstrate compliance of the Works with the requirements of the Contract. Three (03) hard copies alongside a soft copy of all reports shall be furnished to the Employer.

The Employer / Employer's Representative shall, at all reasonable times, be allowed free and ready access to the Contractor's premises and those of his suppliers for the purpose of inspecting the specified equipment components, and obtaining information as to the progress of the work. Failure on the part of the Employer / Employer's Representative, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Employer / Employer's Representative will not prejudice the right of the Employer to reject the Plant if it does not give complete satisfaction in service.

The Contractor shall submit an Inspection & Test Plan (ITP) to the Employer for approval. The ITP shall cover all items of equipment to be provided under this project through the manufacturing and erection stages of the project, and shall indicate the salient points of manufacture and/or erection at which the Employer/Employer's representative is required to attend. Stages of manufacture or erection where attendance is required by the Employer/Employer's representative is required, shall be Witness/Hold points in the process. Adequate advance notice shall be provided to the Employer by the Contractor of any

forthcoming Witness/Hold points in the reports to be submitted by the Contractor as required. Formal written notification shall be given 28 days prior to any Witness/Hold point inspection to be performed.

Inspection and testing shall consist of:

- Inspection and tests on raw materials
- Factory tests and inspections:
 - Routine tests
 - Type and special tests
 - Factory acceptance tests
- Inspections and tests during construction
- Inspections at the end of construction works (final construction checks)
- Tests on completion
- Performance verifications.

TYPE TEST

All main components and equipment offered for and supplied under this Contract shall be type tested. Bidders shall enclose in his Bid Type Test Certificates separately for each such main component and equipment offered.

Such Type Test Certificates shall be issued by internationally recognized testing organizations for type tests carried out on components and equipment which are, in the opinion of the Employer / Employer's Representative, of identical type or identical in all essential respects to the equipment offered. If any of the Type Tests Certificates submitted is not applicable to the component or equipment offered, the Employer / Employer's Representative reserves the right to require re-testing or the inclusion of additional tests in the routine test program. The Bidder shall enclose in his Bid the reports for all type tests and additional type tests certificates as per technical specification along with equipment / material drawings separately for each such main component and equipment offered. The type tests conducted earlier should have been conducted in accredited laboratory based on ISO / IEC Guide 25 / 17025 and the test reports submitted shall be of the tests conducted within last 8 (eight) years prior to the date of bid opening (unless specially agreed with the purchaser). In case the test reports are of the test conducted earlier than 8 (eight) years prior to the date of bid opening, the Bidder shall repeat these test(s) at no extra cost to the Employer. In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement

stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

In case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

During manufacture, erection and after completion all materials, components and equipment supplied as well as works performed under this Contract may be subjected to inspection by the Employer / Employer's Representative, should they so require. The works may also be subjected to inspection and tests by any approved agencies of insurance or inspection companies, approved by the Employer / Employer's Representative, in accordance with the provisions of these technical requirements.

All materials used in the Contract Works shall be made available for inspection and test by the Employer during manufacture and it is the Contractor's responsibility to advise Employer when equipment and materials are available for inspection.

The Employer has the right to inspect materials and equipment, and witness factory tests of any plant and equipment included in this Contract.

Each consignment of material shall be inspected and tested in the presence of Employer or their representatives.

The Contractor shall give at least forty-five (45) days' notice of the date, time, and place of inspection to the Employer so that arrangements can be made to have the inspection witnessed or issue the Inspection Waiver Certificate.

Four (4) weeks prior to the tests, the Contractor shall submit an outline of the procedures and tests in its plans to demonstrate fulfilment of the requirements specified in the subsequent sections of the detailed technical specifications.

The Contractor shall carry out the tests stated in the Tests section of this Technical Specification in accordance with the conditions thereof and the latest applicable Standards or Recommendations and such additional tests as in the opinion of the Employer are necessary to determine that the Works comply with the conditions of this Specification either under test conditions (in the Manufacturer's Works, on the Site, or elsewhere), or in ordinary working.

Type tests necessary to prove compliance with the Specification and not specifically mentioned in the Schedules shall be undertaken at no extra cost to Employer. Type tests may be omitted at the discretion of the Employer if satisfactory evidence is given of such tests already made on identical equipment.

All materials used shall also be subjected to and shall withstand satisfactorily such routine tests as are customary in the manufacture of the types of plant or material included in the Works.

The original and copies of test records whether or not they have been witnessed by the Employer shall be supplied to the Employer.

Measuring apparatus shall be approved by the Employer and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

The Contractor shall be responsible for the proper testing of work completed or plant or materials supplied by a Sub-Contractor to the same extent as if the work, plant or materials were completed or supplied by the Contractor himself.

The cost of all routine or sample tests on materials and/or analyses shall be borne by the Contractor.

The cost of additional tests and/or analyses required by the Employer and effected elsewhere than at the works of the Contractor or a subContractor or on the Site will be borne by Employer should such tests prove satisfactory.

The Contractor will be called upon to pay all expenses incurred by the Employer in respect of any work or material found to be defective, of inferior quality, adulterated or otherwise unacceptable.

The Contractor shall supply suitable test pieces of all materials as required by the Employer. If required by the Employer test specimens shall be prepared for check testing and forwarded at the expense of the Contractor to an independent testing authority selected by the Employer.

No inspection or passing by the Employer of work, plant or materials whether carried out by the Contractor or sub-Contractor, shall relieve the Contractor from his liability to complete the Contract works in accordance with the Contract or exonerate him from any of his guarantees.

14.1 Compulsory Witnessed Tests

Factory/laboratory type or acceptance tests must be witnessed. Costs of these tests including the compulsory witnessing shall be included in the price unless such tests are named in the Price Schedules and, if satisfactory and approved, shall be paid for at the rates stated in the Price Schedules.

At least 45 days’ notice of the date, time and place of all tests shall be given to Employer so that arrangements can be made to have the test witnessed.

Prices for type/acceptance tests shall include manufacture, supply, erection and dismantling of all materials and provision of all test facilities.

The Contractor shall also include in the price for the attendance by three (3) Employers representatives and one (1) Engineers representative to witness the tests, which shall include where required:

- Local transportation and associated testing facilities/attendance cost.

Any costs incurred by the Employer in attending a repeat type test brought about as a result of a failure of the subject under test and postponement of the test programme shall be to the account of the Contractor.

The following shall have compulsory witnessed tests;

- Power Transformers
- Reactors
- Instrument Transformers
- HV Switchgears
- Substation Automation, Metering and Protection Systems
- Telecoms Systems
- WAMPACS System
- CCTV system
- IEC 61850 interoperability,
- GOOSE performance
- Time sync (PTP/NTP) verification
- Cyber hardening baseline
- End-to-end protection scheme proving (including channel redundancy)

15 SCHEDULE OF GUARANTEED TECHNICAL CHARACTERISTICS

15.1 Instructions To Bidders

The Technical Schedules are included in Excell format in the submission to the Bidder to facilitate the preparation of a tender as well as in pdf format in the document.

The Technical Schedules form an integral part of the Tender Specifications and shall be filled in as follows:

- The Bidder/Contractor will be bound to comply with the requirements stated in these Technical Data Schedules as well as those stated in the Technical Specifications;
- Only the “Tendered” column of the following pages must be filled in by the bidder completely. The schedules shall not be changed or modified in any way;
- Each item called for in Technical Data Schedules must be type-written. If a particular item is not applicable or not quoted, the letters NA (Not Applicable) or NQ (Not Quoted) shall be typed in the space provided. For any data missing from the Technical Data Schedules, the most unfavourable data proposed by any competitor will be assumed for evaluation purposes;
- Deviations to specifications shall be explained separately;
- References to manufacturers’ names, model numbers or existing ZESCO equipment are included only to define required functionality, compatibility, interoperability and performance, and shall be read as ‘or equivalent’, unless an exact match is expressly stated to be mandatory for interface reasons. Where an exact match is mandatory, the Employer shall state the interface reason expressly.;
- Catalogues and further descriptive information on all equipment quoted and the pertinent data shall be submitted sufficiently in such a way that the Project Manager shall have full and complete knowledge of the system and equipment offered. This information shall be summarized on suitably arranged sheets and attached to these Technical Schedules.
- Bidders are required to fill in and sign the attached Schedules of Guaranteed Technical Characteristics for each type of equipment and attach one copy of each with their bids. Information given on these schedules shall be binding. Quotations on items for which the subject schedule is not duly filled and submitted in attachment to the bid shall not be taken into account. Missing data or information may entitle the Employer to reject the bid.

15.2 Technical Schedules

See Chapter 16.

16 TECHNICAL SCHEDULES

Content List

General Requirements

Particular Requirements

17 DRAWINGS

Lit.	Drawing	Pages
A1	Kasama Substation Layout_ REV01_30062026	1
A2	PP-ZTIP003-ODSS-C001 - Kasama Substation as-built drawing for the control building_ REV00_30062026	1
B	KASAMA-SLD-REV01_30062026	1
	PP-ZTIP-P04-ODSS-C109_ Nakonde SS GA_ R00_30062025	1
D	330 kV Nakonde Stepdown Substation SLD_ REV03_30062026	1
E	330 kV Nakonde Stepdown Substation 11kV Aux SLD_ REV01_30062026	1
F	330 kV Nakonde Stepdown Substation Terracing_ REV01_30062026	1
G	PP-ZTIP-P04-ODSS-C101 – Nakonde Stepdown_ Control Building (Ground Floor Plan)_ REV00_30062026	1
H	330 kV Nakonde Stepdown Substation Guard House	1
I	330 kV Nakonde Stepdown Substation Generator House	1
J	330 kV Nakonde Stepdown Substation House 150 m ²	4
K	330 kV Nakonde Stepdown Substation House Type B	5
N_1	ZESCO Standard Guard House Building	1
N_2	ZESCO Standard Guard House _ Big Guard House Window Schedule_ 012020	1
O	Septic Tank and Soakaway	1
P	Water Tank Stand Detail 1 REV00 30062026	1
R1	Energy Meter Communication	1

R2	WAMPACS drawings applicable for new Nakonde Stepdown Substation_REVA_12112020	1
T1	33kV Pole Mounted Transformer	1
T2	Kasama Substation Lightning and Earth Network_Asbuilt_20102015	1
T3	Kasama Substation System Architecture_Asbuilt_20102015	1
T4	PP-ZTIP-P04-ODSS-C108_Nakonde Site Plan_Rev00_30062026	1
T5	Kasama SS Primary Equipment Section Drawing_Asbuilt_20102015	1
T6	Retaining wall cross section drawing_ REV00_30062026	1
T7	Oil Drum Shelter General Arrangement_ REV00_30062026	1
T8	PP-ZTIP-P04-ODSS-C107_Oil Holding Dam_GA_R00_30062026	1
T9	S3 & S4 Nakonde Substation Topo Map (ARC1950).dwg	1
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18 SUPPLEMENTARY INFORMATION

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S2	Hydrological Meteorological Report	17
S3	330 kV Nakonde Stepdown Substation Topographic Map 1	1
S4	330 kV Nakonde Stepdown Substation Topographic Map 2	1
S5	ZESCO Civil Works Specification SP-CSS-001	75
S6	Work Schedule	1
	S7 to S10 in separate document	
S7	ESIA Report	468
S8	ESIA Appendices	960
S9	ESMP Report	278
S10	ESMP Appendices	150
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S12	Environmental and Social Commitment Plan(ESCP)	11
S13	Stakeholder Engagement Plan(SEP)	29
S14	Grievance Redress Mechanism(GRM)	38
S15	Gender Action Plan(GAP)	22
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S17	Finishes Schedule	5
S18	Safety Rules and Procedures of ZESCO Limited	102
S19	Gravel Classification System	1

19 SCHEDULES OF GUARANTEED TECHNICAL CHARACTERISTICS



Schedule of Particular Standard Material Specifications Summary

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0.3.	Main Design Data 132(66) kV, 2000 m.a.s.l
0.4.	Main Design Data 11 kV, 2000 m.a.s.l
0.5.	Main Design Data 0.4 kV, 2000 m.a.s.l
0.6.	Material
	Transmission Substations
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1.2.	LGKK-600
1.3.	Bison
1.4.	ACS 7/4.11 Shield Wire
1.5.	Tension insulator set
1.6.	Suspension insulator set
1.7.	Post insulator
1.8.	Hardware and fitting for phase conductor
1.9.	Hardware and fitting for Earth-wire
1.10.	Earthing Conductor for Substation
2.	330 kV Equipment
2.1.	330 kV Circuit Breaker
2.2.	330 kV Disconnecter Line
2.3.	330 kV Disconnecter Transformer
2.4.	330 kV Earthing Switch at Disconnecter
2.5.	330 kV Current Transformer Line Feeder Bay
2.6.	330 kV Current Transformer - Transformer Bay
2.7.	330 kV Capacitive Voltage Transformers
2.8.	330 kV Surge Arresters
2.9.	#NV
3.	132 kV & 66kV Equipment
3.1.	132 kV Circuit Breaker
3.2.	132 kV Disconnecter
3.3.	132 kV Earthing Switch
3.4.	132 kV Current Transformers
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4.	Transformers
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5.	Reactor
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6.2.	11 kV Surge Arresters
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7.2.	11 kV Cable Terminations
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9.9.	All Bay Control Units
9.10.	Bay Control Unit OHL and Reactor
9.11.	Busbar protection 330 and 132 kV - Main I
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9.14.	Line Protection 330 and 132 kV - Back-up
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9.19.	Transformer Protection 11/0.4 kV
9.20.	Digital Meetering
9.21.	Meters, indicating Instrument
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9.23.	Optical Distribution Frame (ODF)
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9.26.	Packet Transport Network Equipment
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9.28.	FOX 615 Equipment STM-16
9.29.	PABX Equipment
9.30.	Laptop Computer

10.	Wide Area Monitoring Protection and Control
10.1.	WAMPACS
11.	Distribution
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11.2.	ABC 3x120+70
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11.4.	33/0.4 kV Housing Distribution Transformer
12.	Civil
12.1.	Gabions
13.	Tools
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13.2.	Circuit Breaker Analyser
13.3.	Omicron CT Analyser
13.4.	OTDR
13.5.	Earth Resistance Tester
13.6.	Micro-Ohmmeter
13.7.	Dielectric Oil Tester
13.8.	SF6 Gas Leak Detector
13.9.	SF6 Gas Filling kits
13.10.	Secondary Injection Test Set
13.11.	Tool Box
13.12.	Disturbance fault recorder
13.13.	Vacuum Pump for Transformer Drying
13.14.	Insulation Resistance Tester 15000V
13.15.	OMICRON CPC100
14.	Transformer and Reactor Mechanical Protection
14.1.	Sergi Fire Protection or Equivalent
14.2.	Kelman Online Dissolve Gas Analysis or Equivalent

0. General Requirements

0.1. Climatic Conditions

Item	Description	Required	Tendered	Unit
0.1.1	Maximum outdoor air temperature;	+45		°C
0.1.2	Minimum outdoor air temperature	-1		°C
0.1.3	Annual max. average air temperature	+35		°C
0.1.4	Maximum temperature of conductor	+75		°C
0.1.5	Maximum temperature of earth wire	+50		°C
0.1.6	Precipitation	850-1200		mm/year
0.1.7	Precipitation > 1 mm	81		days/year
0.1.8	Design wind (gust, 3 sec);	40		m/s
0.1.9	Design wind speed (sustained);	100		km/h
0.1.10	Average lightning	High, 10-15		flashes/km ²
0.1.11	Relative humidity (min/max)	39/85		%
0.1.12	Maximum soil temperature (at 1 m depth);	+30		°C
0.1.13	Maximum soil thermal resistivity	1.2		km/W
0.1.14	Maximum solar radiation on plan;	1035		W/m ²
0.1.15	Exposed bare metal temperature;	+75		°C
0.1.16	Altitude above sea level;	1600		masl
0.1.17	Design altitude substations	2000		
0.1.18	Altitude correction factor according to IEC60071-2 ≤200000 masl	1.13		-
0.1.19	Safety factor for outdoor insulation	1.05		-
0.1.20	Atmosphere pollutants	Medium/Dust		-
0.1.21	Seismic hazard (Mercalli scale);	VI to VII (strong-very strong)		-
0.1.22	Degree of protection, outdoor	IP56		-
0.1.23	Degree of protection, indoor	IP54		-

0.2. Main Design Data 330 kV, 2000 m.a.s.l

Item	Description	Required	Tendered	Unit
0.2.1	Nominal system voltage, Un;	330		kV r.m.s
0.2.2	Rated voltage, Ur;	362		kV r.m.s
0.2.3	Rated short time current (1 sec);	40		kA
0.2.4	Rated short-duration power frequency withstand voltage	580		kV r.m.s
0.2.5	Rated lightning impulse withstand voltage	1,245		kVp
0.2.6	Rated switching impulse withstand voltage phase to earth	1080		kVp
0.2.7	Rated switching impulse withstand voltage, phase to phase ratio to the phase to earth peak value	1.50		-
0.2.8	Rated frequency, f;	50 ±2.5%		Hz
0.2.9	Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)		mm/kV
0.2.10	Minimum clearance, phase to phase;	3842		mm
0.2.11	Minimum clearance, phase to earth;	3390		mm
0.2.12	Safe working clearance (to the nearest live conductor in air);	5933		mm
0.2.13	Minimum height of support structure	2825		mm
0.2.14	Bay width;	21000		mm
0.2.15	Voltage quality	±5		%
0.2.16	Frequency quality	±2.5		%
0.2.17	System earthing;	Effectively grounded		-

0.3. Main Design Data 132(66) kV, 2000 m.a.s.l

Item	Description	Required	Tendered	Unit
0.3.1	Nominal system voltage, Un;	66		kV r.m.s
0.3.2	Rated voltage, Ur;	145		kV r.m.s
0.3.3	Rated short time current (3 sec);	31.5		kA
0.3.4	Rated short-duration power frequency withstand voltage	311		kV r.m.s
0.3.5	Rated lightning impulse withstand voltage	735		kV r.m.s
0.3.6	Rated switching impulse withstand voltage	356		kVp
0.3.7	Rated frequency, f;	50 ±2.5%		Hz
0.3.8	Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)		mm/kV
0.3.9	Minimum clearance, phase to phase;	1774		mm
0.3.10	Minimum clearance, phase to earth;	1398		mm
0.3.11	Safe working clearance (to the nearest live conductor in air);	4945		mm
0.3.12	Bay width;	12200		mm
0.3.13	Voltage quality	±5		%
0.3.14	Frequency quality	±2.5		%
0.3.15	System earthing;	Effectively grounded		-

0.4. Main Design Data 11 kV, 2000 m.a.s.l

Item	Description	Required	Tendered	Unit
0.4.1	Nominal system voltage, Un;	11		kV r.m.s
0.4.2	Rated voltage, Ur;	12		kV r.m.s
0.4.3	Rated short time current (3 sec);	31.5		kA
0.4.4	Rated short-duration power frequency withstand voltage (phase to earth and between phases);	32		kV r.m.s
0.4.5	Rated short-duration power frequency withstand voltage (across open breaker gap and/or isolating distance);	32		kV r.m.s
0.4.6	Rated lightning impulse withstand voltage (phase to earth and between phases);	85		kVp
0.4.7	Rated lightning impulse withstand voltage (across open breaker gap and/or isolating distance);	85		kVp
0.4.8	Rated frequency, f;	50 ±2.5%		Hz
0.4.9	Minimum insulator creepage distance (USCD);	53.7 (class e , very heavy)		mm/kV
0.4.10	Minimum clearance, phase to phase;	305		mm
0.4.11	Minimum clearance, phase to earth;	226		mm
0.4.12	Safe working clearance (to the nearest live conductor in air);	2938		mm
0.4.13	Voltage quality	±10		%
0.4.14	Frequency quality	±2.5		%
0.4.15	System earthing;	Effectively grounded		-

0.5. Main Design Data 0.4 kV, 2000 m.a.s.l

Item	Description	Required	Tendered	Unit
0.5.1	Nominal system voltage, Un;	0.4		kV r.m.s
0.5.2	Rated voltage, Ur;	1		kV r.m.s
0.5.3	Rated short time current (3 sec);	7.5		kA
0.5.	Rated short-duration power frequency withstand voltage (phase to earth and between phases);	2.3		kV r.m.s
0.5.	Rated short-duration power frequency withstand voltage (across open breaker gap and/or isolating distance);	2.3		kV r.m.s
0.5.	Rated lightning impulse withstand voltage (phase to earth and between phases);	7.5		kVp
0.5.	Rated lightning impulse withstand voltage (across open breaker gap and/or isolating distance);	7.5		kVp
0.5.	Rated frequency, f;	50 ±2.5%		Hz
0.5.	Voltage quality	±1		%
0.5.1	Frequency quality	±2.3		%
0.5.1	System earthing;	Effectively grounded		-

0.6. Material

Item	Description	Required	Tendered	Unit
0.6.	Cast iron			
0.6.	Malleable iron type	Black hear		
0.6.	Malleable iron strength	>330		N/mm ²
0.6.	Minimum tensile strength:	140		N/mm ²
0.6.	Manufacturing from:	Best grey pig and scrap iron		
0.6.	Preparation:	Close grained, tough and uniform in character		

0.7. Galvanizing Minimum above ground

Item	Description	Required	Tendered	Unit
0.7.1	Steel > 6 mm local coating min	505; 70		g/m ² ; μm
0.7.2	Steel > 6 mm mean coating min	610; 85		g/m ² ; μm
0.7.3	Steel > 3 mm to u 6 mm local coating min	395; 55		g/m ² ; μm
0.7.4	Steel > 3 mm to u 6 mm mean coating min	505; 70		g/m ² ; μm
0.7.5	Steel W 1.5 mm to u 3 mm local coating min	325; 45		g/m ² ; μm
0.7.6	Steel W 1.5 mm to u 3 mm mean coating min	395; 55		g/m ² ; μm
0.7.7	Steel < 1.5 mm local coating min	250; 35		g/m ² ; μm
0.7.8	Steel < 1.5 mm mean coating min	325; 45		g/m ² ; μm
0.7.9	Castings W 6 mm local coating min	505; 70		g/m ² ; μm
0.7.10	Castings W 6 mm mean coating min	575; 80		g/m ² ; μm
0.7.11	Castings < 6 mm local coating min	430; 60		g/m ² ; μm
0.7.12	Castings < 6 mm mean coating min	505; 70		g/m ² ; μm

Transmission Substations**1. Conductor****1.1. Tarantula**

Item	Description	Required	Tendered	Unit
1.1.1	Manufacturer	Bidder to state		
1.1.2	Manufacturer's type and reference	Bidder to state		
1.1.3	Country of origin	Bidder to state		
1.1.4	Description	AAC		
1.1.5	Standard specification applied	IEC 61089, EN 50341-1, 50341-1, 50852, 50182, 60889, BS 215		
1.1.6	Aluminum strands	37		Nos.
1.1.7	Aluminum strands diameter	5.23		mm
1.1.8	Overall conductor diameter	36.6		mm
1.1.9	Total conductor cross section	794.6		mm ²
1.1.10	Ultimate breaking strength of stranded conductor	12600		daN
1.1.11	DC resistance of conductor at 20°C (Guarantee Value)	0.0363		ohms/km
1.1.12	Weight per km of conductor	2200		Kg
1.1.13	Initial modulus of elasticity	48250		N/mm ²
1.1.14	Final modulus of elasticity	58600		N/mm ²
1.1.15	Coefficient of linear expansion	23		Per 10 ⁻⁶ C°
1.1.16	Length of conductor per drum	Bidder to state		m
1.1.17	Gross weight per drum	<1300		kg
1.1.18	Material of drum	Wood/Steel		-
1.1.19	Diameter of drum core	Bidder to state		mm
1.1.20	Total diameter of drum	Bidder to state		mm
1.1.21	Total width of drum	Bidder to state		mm
1.1.22	Materials used for termite proofing of drums	IEC 60502 Clause 5.4 ISO 22190:2020		-
1.1.23	Whether all tests in relevant standard specification will be carried out?	Yes		-

1.2. LGKK-600

Item	Description	Required	Tendered	Unit
1.2.1	Manufacturer	Bidder to state		
1.2.2	Manufacturer's type and reference	Bidder to state		
1.2.3	Country of origin	Bidder to state		
1.2.4	Description	AAC		
1.2.5	Standard specification applied	IEC 61089, EN 50341-1, 50341-1, 50852, 50182, 60889, BS 215		
1.2.6	Aluminum strands	35		Nos.
1.2.7	Aluminum strands diameter	3		mm
1.2.8	Overall conductor diameter	51		mm
1.2.9	Aluminium conductor cross section	587		mm ²
1.2.10	Ultimate breaking strength of stranded conductor	149		kN
1.2.11	DC resistance of conductor at 20°C (Guarantee Value)	0.0397		ohms/km
1.2.12	Weight per km of conductor	2520		Kg
1.2.13	Initial modulus of elasticity	Bidder to state		N/mm ²
1.2.14	Final modulus of elasticity	Bidder to state		N/mm ²
1.2.15	Coefficient of linear expansion	19.91		Per 10 ⁻⁶ C°
1.2.16	Length of conductor per drum	Bidder to state		m
1.2.17	Gross weight per drum	<1300		kg
1.2.18	Material of drum	Wood/Steel		-
1.2.19	Diameter of drum core	Bidder to state		mm
1.2.20	Total diameter of drum	Bidder to state		mm
1.2.21	Total width of drum	Bidder to state		mm
1.2.22	Materials used for termite proofing of drums	IEC 60502 Clause 5.4 ISO 22190:2020		-
1.2.23	Whether all tests in relevant standard specification will be carried out?	Yes		-

1.3. Bison

Item	Description	Required	Tendered	Unit
1.3.1	Manufacturer	Bidder to state		
1.3.2	Manufacturer's type and reference	Bidder to state		
1.3.3	Country of origin	Bidder to state		
1.3.4	Description	ASCP		
1.3.5	Standard specification applied	IEC 61089, EN 50341-1, 50341-1, 50852, 50182, 60889, BS 215		
1.3.6	Aluminum strands	54		Nos.
1.3.7	Aluminum strands diameter	3		mm
1.3.8	Steel strands	7		Nos.
1.3.8	Steel strands diameter	3		mm
1.3.9	Overall conductor diameter	27		mm
1.3.10	Aluminium conductor cross section	381.7		mm ²
1.3.11	Steel conductor cross section	49.5		mm ²
1.3.12	Ultimate breaking strength of stranded conductor	120		kN
1.3.13	DC resistance of conductor at 20°C (Guarantee Value)	0.07573		ohms/km
1.3.14	Weight per km of conductor	1444		Kg
1.3.15	Initial modulus of elasticity	47600		N/mm ²
1.3.16	Final modulus of elasticity	73200		N/mm ²
1.3.17	Coefficient of linear expansion	19.91		Per 10 ⁻⁶ C°
1.3.18	Permanent elongation due to creep after 10 years	Bidder to state		m/m
1.3.19	Length of conductor per drum	Bidder to state		m
1.3.20	Gross weight per drum	Bidder to state		kg
1.3.21	Material of drum	Wood/Steel		-
1.3.22	Diameter of drum core	Bidder to state		mm
1.3.23	Total diameter of drum	Bidder to state		mm
1.3.24	Total width of drum	Bidder to state		mm
1.3.25	Materials used for termite proofing of drums	IEC 60502 Clause 5.4 ISO 22190:2020		-
1.3.26	Whether all tests in relevant standard specification will be carried out?	Yes		-

1.4. ACS 7/4.11 Shield Wire

Item	Description	Required	Offered	Unit
1.4.1	Description	ACS 7/4.11 AWG		
1.4.2	Standard	ASTM B415, ASTM B416		
1.4.3	Minimum UTS	101		kN
1.4.4	Total cross section	93.1		mm ²
1.4.5	Number of wires	7		nos
1.4.6	Wire diameter	4.11		mm
1.4.7	Overall diameter	12.3		mm
1.4.8	Ultimate tensile strength	101.14		kN
1.4.9	Modulus of elasticity	158620		N/mm ²
1.4.10	Coefficient of linear thermal expansion	13		10 ⁻⁶ /°C
1.4.11	DC resistance at 20°C	0.922		Ohms/km
1.4.12	Weight	619		kg/km

1.5. Tension insulator set

Item	Description	Required	Tendered	Unit
1.5.1	Manufacturer	Bidder to state		-
1.5.2	Manufacturer's type and reference	Bidder to state		-
1.5.	Country of origin	Bidder to state		-
1.5.	Description	Brown glazed porcelain		-
1.5.	Standard specification applied	IEC 60120, 60305, 60372, 60375, 60383		-
1.5.	Nominal voltage	330/132		kV
1.5.	Highest system voltage	362/145		kV
1.5.	Nominal disc diameter	280		mm
1.5.	Related electro-mechanical strength	160		kN
1.5.1	Sacrificial zinc sleeve on pin	Yes		-
1.5.1	Mechanical routine test load	80		kN
1.5.1	Lightning dry impulse withstand	75		kV
1.5.1	Short duration dry power frequency withstand voltage	110		kV
1.5.1	Overall creepage distance for a set at 330/132 kV	13,316 / 5,334		mm
1.5.1	Number of strings per phase	3		No.
1.5.1	Lightning impulse withstand voltage pos/neg 330/132kV	1245/735		kV
1.5.1	Switching impulse withstand voltage 330/132kV	1080/356		kV
1.5.1	Wet power frequency withstand Voltage 330/132kV	580/311		kV
1.5.1	Corona Inception Voltage	>230		kV
1.5.1	Radio Interference Voltage	220		kV
1.5.2	Radio Interference	45		dB/1µV
1.5.2	Electro-mechanical failing load	2*160		kN
1.5.2	Shielding Rings	Yes		-
1.5.2	Grading Rings	Yes		-
1.5.2	Length of complete set including fittings	Bidder to state		mm
1.5.25	Weight of complete set	Bidder to state		kg
1.5.26	Corona voltage	Bidder to state		

1.6. Suspension insulator set

Item	Description	Required	Tendered	Unit
1.6.1	Manufacturer	Bidder to state		-
1.6.2	Manufacturer's type and reference	Bidder to state		-
1.6.3	Country of origin	Bidder to state		-
1.6.4	Description	Brown glazed porcelain		-
1.6.5	Standard specification applied	IEC 60120, 60305, 60372, 60375, 60383		-
1.6.6	Nominal voltage	330/132		kV
1.6.7	Highest system voltage	362/145		kV
1.6.8	Nominal disc diameter	280		mm
1.6.9	Related electro-mechanical strength	160		kN
1.6.10	Sacrificial zinc sleeve on pin	Yes		-
1.6.11	Mechanical routine test load	80		kN
1.6.12	Lightning dry impulse withstand	75		kV
1.6.13	Short duration dry power frequency withstand voltage	110		kV
1.6.14	Overall creepage distance for a set at 330/132/66 kV	13,316 / 5,334		mm
1.6.15	Number of strings per phase	1		-
1.6.16	Lightning impulse withstand voltage pos/neg 330/132kV	1245/735		kV
1.6.17	Switching impulse withstand voltage 330/132kV	1080/356		kV
1.6.18	Wet power frequency withstand Voltage 330/132kV	580/311		kV
1.6.19	Corona Inception Voltage	>230		kV
1.6.20	Radio Interference Voltage	220		kV
1.6.21	Radio Interference	45		dB/1µV
1.6.22	Electro-mechanical failing load	2*160		kN
1.6.23	Shielding Rings	Yes		-
1.6.24	Grading Rings	Yes		-
1.6.25	Length of complete set including fittings	Bidder to state		mm
1.6.26	Weight of complete set	Bidder to state		kg
1.6.27	Corona voltage	Bidder to state		

1.7. Post insulator

Item	Description	Required	Tendered	Unit
1.7.1	Manufacturer	Bidder to state		-
1.7.2	Manufacturer's type and reference	Bidder to state		-
1.7.3	Country of origin	Bidder to state		-
1.7.4	Description	Brown porcelain		-
1.7.5	Standard specification applied	IEC60168, 60273		-
1.7.6	Lightning impulse withstand 330/132 kV	1245/735		kV
1.7.7	Short duration power frequency withstand voltage 330/132 kV	580/311		kV
1.7.8	Overall creepage distance for a set at 330/132 kV	13,316 / 5,334		mm
1.7.9	Specified Mechanical Failing Load	Bidder to state		kN
1.7.10	Height	Bidder to state		mm
1.7.11	Weight	Bidder to state		kg

1.8. Hardware and fitting for phase conductor

Item	Description	Required	Tendered	Unit
1.8.1	Manufacturer of tension clamps	To be stated by Bidder		-
1.8.2	Manufacturer's type and reference	To be stated by Bidder		-
1.8.3	Country of origin	To be stated by Bidder		-
1.8.4	Description	To be stated by Bidder		-
1.8.5	Standard specification applied	EN 50341		-
1.8.6	Type of suspension clamps	To be stated by Bidder		-
1.8.7	Breaking strength of suspension clamps	120		kN
1.8.8	Slipping of suspension clamps (>95% of conductor ultimate strength)	To be stated by Bidder		kN
1.8.9	Manufacturer of tension joints	To be stated by Bidder		-
1.8.10	Manufacturer's type and reference	To be stated by Bidder		-
1.8.11	Country of origin	To be stated by Bidder		-
1.8.12	Description	To be stated by Bidder		-
1.8.13	Standard specification applied	EN 61284, EN 61897		-
1.8.14	Single or two piece type of tension joint	To be stated by Bidder		-
1.8.15	Tensile strength of tension joint	To be stated by Bidder		kN
1.8.16	Slipping strength of tension joint	To be stated by Bidder		kN
1.8.17	Manufacturer of repair sleeves	To be stated by Bidder		-
1.8.18	Manufacturer's type and reference	To be stated by Bidder		-
1.8.19	Country of origin	To be stated by Bidder		-
1.8.20	Description	To be stated by Bidder		-
1.8.21	Standard specification applied	IEC, EN		-
1.8.22	Type of repair sleeve	To be stated by Bidder		-
1.8.23	Manufacturer of armour rods	To be stated by Bidder		-
1.8.24	Manufacturer's type and reference	To be stated by Bidder		-
1.8.25	Country of origin	To be stated by Bidder		-
1.8.26	Description	To be stated by Bidder		-
1.8.27	Standard specification applied	IEC, EN		-
1.8.28	Type of armour rods	To be stated by Bidder		-
1.8.29	Material of armour rods	To be stated by Bidder		-
1.8.30	Dimension of armour rods	To be stated by Bidder		-
1.8.31	Manufacturer of vibration dampers	To be stated by Bidder		-
1.8.32	Manufacturer's type and reference	To be stated by Bidder		-
1.8.33	Country of origin	To be stated by Bidder		-
1.8.34	Description	To be stated by Bidder		-
1.8.35	Standard specification applied	IEC, EN		-
1.8.36	Type of vibration damper	To be stated by Bidder		-
1.8.37	Weight of vibration damper	To be stated by Bidder		kg
1.8.38	Type of attachment of vibration damper	To be stated by Bidder		-
1.8.39	Whether all fitting supplied are hot dip galvanised	Yes		-

1.9. Hardware and fitting for Earth-wire

Item	Description	Required	Tendered	Unit
1.9.1	Manufacturer of tension clamps	To be stated by Bidder		-
1.9.2	Manufacturer's type and reference	To be stated by Bidder		-
1.9.3	Country of origin	To be stated by Bidder		-
1.9.4	Description	To be stated by Bidder		-
1.9.5	Standard specification applied	IEC, EN		-
1.9.6	Type of tension clamps	To be stated by Bidder		-
1.9.7	Breaking strength of tension clamps	To be stated by Bidder		kN
1.9.8	Slipping of tension clamps	To be stated by Bidder		kN
1.9.9	Manufacturer of repair sleeves	To be stated by Bidder		-
1.9.10	Manufacturer's type and reference	To be stated by Bidder		-
1.9.11	Country of origin	To be stated by Bidder		-
1.9.12	Description	To be stated by Bidder		-
1.9.13	Standard specification applied	IEC, EN		-
1.9.14	Type of repair sleeve	To be stated by Bidder		-
1.9.15	Manufacturer of armour rods	To be stated by Bidder		-
1.9.16	Manufacturer's type and reference	To be stated by Bidder		-
1.9.17	Country of origin	To be stated by Bidder		-
1.9.18	Description	To be stated by Bidder		-
1.9.19	Standard specification applied	IEC, EN		-
1.9.20	Type of armour rods	To be stated by Bidder		-
1.9.21	Material of armour rods	To be stated by Bidder		-
1.9.22	Dimension of armour rods	To be stated by Bidder		-
1.9.23	Manufacturer of vibration dampers	To be stated by Bidder		-
1.9.24	Manufacturer's type and reference	To be stated by Bidder		-
1.9.25	Country of origin	To be stated by Bidder		-
1.9.26	Description	To be stated by Bidder		-
1.9.27	Standard specification applied	IEC, EN		-
1.9.28	Type of vibration damper	To be stated by Bidder		-
1.9.29	Weight of vibration damper	To be stated by Bidder		kg
1.9.30	Type of attachment of vibration damper	To be stated by Bidder		-
1.9.31	Whether all fitting supplied are hot dip galvanised	Yes		-

1.10. Earthing Conductor for Substation

Item	Description	Required	Tendered	Unit
1.10.1	Material	Electrolytic copper (≥99.9%)		
1.10.2	Conductor Type	Bare copper earth wire		
1.10.3	Standard Compliance	IEC 62561-1, IEEE 80, BS 7430		
1.10.4	Minimum Cross-Section	Calculated per fault current (min. 120mm²)		mm²
1.10.5	Maximum Resistance (entire grid)	≤0.5		Ω
1.10.6	Fault Current Capacity	10kA for 3s (250°C surface)		kA/s
1.10.7	Buried Conductor Temp Limit	400°C (short-term)		°C
1.10.8	Conductor Spacing	Optimized for step/touch potential (per IEEE 80)		m
1.10.9	Connections	Exothermic welding (UG), compression lugs (AG)		
1.10.10	Welding Standard	ASTM B828 / IEC 62561-1		
1.10.11	Corrosion Protection	Bitumen coating (UG), anti-oxidant paste (AG)		
1.10.12	Riser Connections	Dual 70mm² min. per structure		
1.10.13	Ground Rods	Copper-bonded steel, Ø19mm x 3m		
1.10.14	Rod Spacing	min. 3		m
1.10.15	Grid Perimeter Conductors	70mm² stranded		
1.10.16	Concrete Embedment	100mm concrete cover		mm
1.10.17	Wall Penetrations	PVC sleeve + hydrophobic seal		
1.10.18	Step/Touch Potential	Complies with IEEE 80 (fault duration 0.5s)		V
1.10.19	GPR Limit	≤5kV under worst-case fault		kV
1.10.20	X/R Ratio	10 (system specific)		
1.10.21	Auto-Reclose Consideration	1s delay accounted in design		s
1.10.22	Soil Resistivity Testing	4-point Wenner method (IEC 60364-6)		Ω-m
1.10.23	Temporary Earth Points	M10 brass studs		
1.10.24	Warranty	20 years against corrosion		years

1.11. Lightning Protection

Item	Description	Required	Tendered	Unit
1.11.1	Type	Lightning Mast		
1.11.2	Material	Stainless steel / Galvanized steel		
1.11.3	Standard Compliance	IEC 62305/IEEE Std 998		
1.11.4	Mast Type	Tubular Steel / Lattice Steel / Composite		
1.11.5	Mast Height (m)	Required height based on rolling-sphere analysis		
1.11.6	Minimum Tip Diameter	Suitable for effective lightning interception		
1.11.7	Base Plate Dimensions	To be provided by bidder		
1.11.8	Wind Load Design	As per site conditions (provide calculations)		
1.11.9	Corrosion Protection	HDG (Hot-dip galvanized) / Painted / Other		
1.11.10	Mast Foundation Type	Pad & pedestal / Concrete block / Anchor bolts		
1.11.11	Mast Earthing	Directly bonded to earthing grid		
1.11.12	Minimum Cross-Section			mm ²
1.11.13	Type	Gantry Mounted Spike		
1.11.14	Spike Length (mm)	Typically 500–1500 mm		mm
1.11.15	Material	Stainless steel / Galvanized steel		
1.11.16	Mounting Arrangement	Mechanical & electrical bonding to gantry steel		
1.11.17	Positioning	Highest elevation of gantry structure		
1.11.18	Protection Zone	Must meet rolling-sphere and protective-angle criteria		
1.11.19	Gantry-mounted spikes integrated into shielding model	Yes		
1.11.20	Down-conductor Type	Galvanized steel / Copper / Structural steel path		
1.11.21	Cross-sectional Area	Adequate for lightning current		
1.11.22	Bonding to Mast / Spike	Low-impedance permanent bonding		
1.11.23	Bonding to Earth Grid	Stainless/Galvanized clamps; exothermic weld preferred		
1.11.24	Separation Distances	As per internal LPS requirements		
1.11.25	Termination	Direct integration into main earth grid		
1.11.26	Earth Resistance Target	<0.5		Ω

2. 330 kV Equipment

2.1. 330 kV Circuit Breaker

Item	Description	Required	Tendered	Unit
2.1.1	Maker's name	To be stated by Bidder		-
2.1.2	Maker's type and reference	To be stated by Bidder		-
2.1.3	Country of origin	To be stated by Bidder		-
2.1.4	Description	To be stated by Bidder		-
2.1.5	Type	SF6		-
2.1.6	Number of poles	3		Nos.
2.1.7	Single/three-phase operation	Single-phase		-
2.1.8	Type test	Authority, year, Doc.no		-
2.1.9	Standards	IEC 62271-100		-
2.1.10	Class	Outdoor		-
2.1.11	Classification	C2-M2		-
2.1.12	Insulation material	Brown glazed porcelain		-
2.1.13	Minimum Creepage distance	13316		mm
2.1.14	Rated normal current	4000		A
2.1.15	Rated peak withstand current	100		kA peak
2.1.16	Rated short-circuit breaking current (3s)	40		kA
2.1.17	Rated short-time withstand current	50		kA
2.1.18	First pole to clear factor	1.3		-
2.1.19	Capacitive voltage factor	1.2		-
2.1.20	Total break time	≤45		ms
2.1.21	Maximum closing time	≤80		ms
2.1.22	Operating mechanism	Spring		-
2.1.23	Circuit for point-on wave relay	Yes		-
2.1.24	Operating sequence	O-0.3sec-CO-3min-CO		-
2.1.25	Interruption chambers in series per phase	2		Nos.
2.1.26	Interrupting chamber values of distribution elements	To be stated by Bidder		pF/Ω
2.1.27	Motor rated voltage	110		V DC
2.1.28	Operating coils closing / opening	110		V DC
2.1.29	~~Deleted~~			-
2.1.30	Number of trip coils	2		Nos.
2.1.31	SF6 Block and alarm	Yes		-
2.1.32	Auxiliary contacts (8NO+8NC)	110/7.5		V DC/A
2.1.33	Heating elements with hygrostate/Light/Outlet	230		V AC

2.2. 330 kV Disconnecter Line

Item	Description	Required	Tendered	Unit
2.2.1	Maker's name	To be stated by Bidder		-
2.2.2	Maker's type and reference	To be stated by Bidder		-
2.2.3	Country of origin	To be stated by Bidder		-
2.2.4	Description	To be stated by Bidder		-
2.2.5	Type	Motor operated		-
2.2.6	Mode of opening/closing	Three-column, horizontal, center-rotating, double-break type		-
2.2.7	Execution of operation	Gang operated 3-phase		-
2.2.8	Rated normal current	3150		A
2.2.9	Rated short-time current (3s)	40		kA
2.2.10	Insulator	Brown glazed porcelain		-
2.2.11	Integrated Earthing Switch; Manually operated	On Line and Reactor disconnectors		-
2.2.12	Type test	Authority, year, Doc.no		-
2.2.13	Standards	IEC		-
2.2.14	Class	Outdoor		-
2.2.15	Minimum shear force	To be stated by Bidder		kN
2.2.16	Minimum torsional force of rotating insulators	To be stated by Bidder		kNm
2.2.17	Minimum creepage distance	13316		mm
2.2.18	Closing/ opening time	To be stated by Bidder		sec
2.2.19	Operation motor rated voltage	110		V DC
2.2.20	Auxiliary Contacts (8NO+8NC)	110/7.5		V DC/A
2.2.21	Heating elements with hygrostat	230		V AC

2.3. 330 kV Disconnecter Transformer

Item	Description	Required	Tendered	Unit
2.3.1	Maker's name	To be stated by Bidder		-
2.3.2	Maker's type and reference	To be stated by Bidder		-
2.3.3	Country of origin	To be stated by Bidder		-
2.3.4	Description	To be stated by Bidder		-
2.3.5	Type	Motor operated		-
2.3.6	Mode of opening/closing	Three-column, horizontal, center-rotating, double-break type		-
2.3.7	Execution of operation	Gang operated 3-phase		-
2.3.8	Rated normal current	3150		A
2.3.9	Rated short-time current (3s)	40		kA
2.3.10	Insulator	Brown glazed porcelain		-
2.3.11	Integrated Earthing Switch; Manually operated	Yes		-
2.3.12	Type test	Authority, year, Doc.no		-
2.3.13	Standards	IEC		-
2.3.14	Class	Outdoor		-
2.3.15	Minimum shear force	To be stated by Bidder		kN
2.3.16	Minimum torsional force of rotating insulators	To be stated by Bidder		kNm
2.3.17	Minimum creepage distance	13316		mm
2.3.18	Closing/ opening time	To be stated by Bidder		sec
2.3.19	Operation motor rated voltage	110		V DC
2.3.20	Auxiliary Contacts (8NO+8NC)	110/7.5		V DC/A
2.3.21	Heating elements with hygrostat	230		V AC

2.4. 330 kV Earthing Switch at Disconnecter

Item	Description	Required	Tendered	Unit
2.4.1	Maker's name	To be stated by Bidder		-
2.4.2	Maker's type and reference	To be stated by Bidder		-
2.4.3	Country of origin	To be stated by Bidder		-
2.4.4	Description	At disconnector		-
2.4.5	Type	Manual		-
2.4.6	Rated short time current (3s)	40		kA
2.4.7	Type test	Authority, year, Doc.no		-
2.4.8	Standards	IEC		-
2.4.9	Class	Outdoor		-
2.4.10	Auxiliary Contacts (8NO+8NC)	110/7.5		V DC/A
2.4.11	Heating element with hygrostat	230		V AC

2.5. 330 kV Current Transformer Line Feeder Bay

Item	Description	Required	Tendered	Unit
2.5.1	Maker's name	To be stated by Bidder		-
2.5.2	Maker's type and reference	To be stated by Bidder		-
2.5.3	Country of origin	To be stated by Bidder		-
2.5.4	Description	Transmission class		-
2.5.5	Type	Outdoor CT		-
2.5.6	Type test	Authority, year, Doc.no		-
2.5.7	Standards	IEC 61869, BS3938		-
2.5.8	Class	Outdoor		-
2.5.9	Creepage distance	13316		mm
2.5.10	Rated short time thermal current (3s)	40		kA _{RMS}
2.5.11	Number of secondary cores	7		Nos.
2.5.12	Nominal current	1200-2400		A
2.5.13	Secondary rated current PX	1		T
2.5.14	Secondary rated current 5P20	1		A
2.5.15	Rating factor	1.2		-
2.5.16	Rated burden protection core 5P20	10		VA
2.5.17	Rated burden measuring core	5		VA
2.5.18	Protective cores number and class	1x 5P20 3 x class PX 0.5V/turn		-
2.5.19	Measuring cores number and class	2 x 0.2s Fs<5		-
2.5.20	Spare core	1 x class PX 0.5V/turn		-

2.6. 330 kV Current Transformer - Transformer Bay

Item	Description	Required	Tendered	Unit
2.6.1	Maker's name	To be stated by Bidder		-
2.6.2	Maker's type and reference	To be stated by Bidder		-
2.6.3	Country of origin	To be stated by Bidder		-
2.6.4	Description	Transmission class		-
2.6.5	Type	Outdoor CT		-
2.6.6	Type test	Authority, year, Doc.no		-
2.6.7	Standards	IEC 61869, BS3938		-
2.6.8	Class	Outdoor		-
2.6.9	Creepage distance	13316		mm
2.6.10	Rated short time thermal current (3s)	40		kA _{RMS}
2.6.11	Number of secondary cores	7		Nos.
2.6.12	Nominal current	100-200/300-600		A
2.6.13	Secondary rated current PX	1		T
2.6.14	Secondary rated current 5P20	1		A
2.6.15	Rating factor	1.2		-
2.6.16	Rated burden protection core 5P20	10		VA
2.6.17	Rated burden measuring core	5		VA
2.6.18	Protective cores number and class	1x 5P20 3 x class PX 0.5V/turn		-
2.6.19	Measuring cores number and class	2 x 0.2s F<5		-
2.6.20	Spare core	1 x class PX 0.5V/turn		-

2.7. 330 kV Capacitive Voltage Transformers

Item	Description	Required	Tendered	Unit
2.7.1	Maker's name	To be stated by Bidder		-
2.7.2	Maker's type and reference	To be stated by Bidder		-
2.7.3	Country of origin	To be stated by Bidder		-
2.7.4	Description	Outdoor CVT		-
2.7.5	Type	Line bay		-
2.7.6	Type test	Authority, year, Doc.no		-
2.7.7	Standards	IEC		-
2.7.8	Class	T1		-
2.7.9	Creepage distance	13316		mm
2.7.10	Primary rated voltage	330/√3		kV
2.7.11	Secondary rated voltage	2x 110/√3		V
2.7.12	Secondary rated voltage Open Delta	110/√3		V
2.7.13	Rated short time thermal current (3s)	40		kA _{RMS}
2.7.14	Rated burden	30		VA
2.7.15	Voltage factor (continuous / 30sec);	1.2 / 1.5		-
2.7.16	Protection Class	0.5(3P)/3P		-
2.7.17	Measurement Class	0.2		-
2.7.18	Max. Force on Terminal	>1000		N
2.7.19	Gross Weight	To be stated by Bidder		kg
2.7.20	HV Terminal Type	To be stated by Bidder		-

2.8. 330 kV Surge Arresters

Item	Description	Required	Tendered	Unit
2.8.1	Maker's name	To be stated by Bidder		-
2.8.2	Maker's type and reference	To be stated by Bidder		-
2.8.3	Country of origin	To be stated by Bidder		-
2.8.4	Description	Outdoor		-
2.8.5	Type of arresters	Gapless ZnO		-
2.8.6	Type test	Authority, year, Doc.no		-
2.8.7	Standards	IEC60099		-
2.8.8	Creepage distance	13316		mm
2.8.9	Highest voltage for equipment	362		kV
2.8.10	Rated voltage Ur	264		kV
2.8.11	Maximum continuous operating voltage Uc	≤210		kV
2.8.12	Nominal discharge current	20		kA peak
2.8.13	Line discharge class	4		-
2.8.14	Maximal residual voltage 8/20μs (10kA)	≤660		kV peak
2.8.15	Maximum steep current impulse residual voltage 1/20μs (10kA)	≤700		kV
2.8.16	Impulse withstand current (peak value) (8/20 μs)	20		kA
2.8.17	Long-wave surge current (2000 μs)	To be stated by Bidder		A
2.8.18	Leakage current	To be stated by Bidder		mA
2.8.19	Insulation material	Polymeric rubber		-
2.8.20	Surge counters per phase	Yes		-

3. 132 kV & 66kV Equipment

3.1. 132 kV Circuit Breaker

Item	Description	Required	Tendered	Unit
3.1.1	Maker's name	To be stated by Bidder		-
3.1.2	Maker's type and reference	To be stated by Bidder		-
3.1.3	Country of origin	To be stated by Bidder		-
3.1.4	Description	To be stated by Bidder		-
3.1.5	Type	SF6		-
3.1.6	Number of poles	3		Nos.
3.1.7	3-ph. Single/three-phase operation	Three-phase		-
3.1.8	Type test	Authority, year, Doc.no		-
3.1.9	Standards	IEC 62271-100		-
3.1.10	Class	Outdoor		-
3.1.11	Classification	C2-M2		-
3.1.12	Insulation material	Brown glazed porcelain		-
3.1.13	Minimum Creepage distance	5334		mm
3.1.14	Rated normal current	2500		A
3.1.15	Rated peak withstand current	100		kA peak
3.1.16	Rated short-circuit breaking current (3s)	31.5		kA
3.1.17	[Deleted]			
3.1.18	First pole to clear factor	1.5		-
3.1.19	Capacitive voltage factor	1.2		-
3.1.20	Total break time	≤50		ms
3.1.21	Maximum closing time	≤70		ms
3.1.22	Operating mechanism	Spring		-
3.1.23	Operating sequence	O-0.3sec-CO-3min-CO		-
3.1.24	Interruption chambers in series per phase	To be stated by Bidder		Nos.
3.1.25	Interrupting chamber values of distribution elements	To be stated by Bidder		pF/Ω
3.1.26	Motor rated voltage	110		V DC
3.1.27	Operating coils closing / opening	110		V DC
3.1.28	[Deleted]			
3.1.29	Number of trip coils	2		Nos.
3.1.30	SF6 Block and alarm	Yes		-
3.1.31	Auxiliary contacts (8NO+8NC)	110/7.5		V DC/A
3.1.32	Heating elements with hygrostate/Light/Outlet	230		V AC

3.2. 132 kV Disconnecter

Item	Description	Required	Tendered	Unit
3.2.1	Maker's name	To be stated by Bidder		-
3.2.2	Maker's type and reference	To be stated by Bidder		-
3.2.3	Country of origin	To be stated by Bidder		-
3.2.4	Description	3-phase		-
3.2.5	Type	Motor operated		-
3.2.6	Mode of opening/closing	Horizontal centre break		-
3.2.7	Integrated Earthing Switch; Manually operated	on line disconnectors		-
3.2.8	Type test	Authority, year, Doc.no		-
3.2.9	Standards	IEC		-
3.2.10	Class	Outdoor		-
3.2.11	Creepage distance	5334		mm
3.2.12	Rated Voltage	132		kV
3.2.13	Maximum service voltage	145		kV
3.2.14	Number of poles	3		Nos.
3.2.15	Rated normal current	2000		A
3.2.16	Rated short time current for isolator and earth switch	315		kA
3.2.17	Rated peak withstand current for isolator and earth switch	100		kA _{peak}
3.2.18	One minute power frequency withstand voltage	275		kV
3.2.19	Lightning impulse withstand voltage, to earth & between poles	650		kV
3.2.20	Closing/ opening time	To be stated by Bidder		sec
3.2.21	Operation motor rated voltage	110		V DC
3.2.22	Auxiliary Contacts (8NO+8NC)	110/7.5		V DC/A
3.2.23	Heating elements with hygrostat	230		V AC

3.3. 132 kV Earthing Switch

Item	Description	Required	Tendered	Unit
3.3.1	Maker's name	To be stated by Bidder		-
3.3.2	Maker's type and reference	To be stated by Bidder		-
3.3.3	Country of origin	To be stated by Bidder		-
3.3.4	Description	At disconnector switch		-
3.3.5	Type	Manual		-
3.3.6	Type test	Authority, year, Doc.no		-
3.3.7	Standards	IEC		-
3.3.8	Class	Outdoor		-
3.3.9	Auxiliary Contacts (8NO+8NC)	110/7.5		V DC/A
3.3.10	Heating elements	230		V AC

3.4. 132 kV Current Transformers

Item	Description	Required	Tendered	Unit
3.4.1	Maker's name	To be stated by Bidder		-
3.4.2	Maker's type and reference	To be stated by Bidder		-
3.4.3	Country of origin	To be stated by Bidder		-
3.4.4	Description	Transmission class		-
3.4.5	Type	Outdoor CT		-
3.4.6	Type test	Authority, year, Doc.no		-
3.4.7	Standards	IEC60044, BS3938		-
3.4.8	Class	Outdoor		-
3.4.9	Creepage distance	5334		mm
3.4.10	Rated short time thermal current (3s)	315		kA
3.4.11	Number of secondary cores	7		Nos.
3.4.12	Nominal current	300-600/600-1200		A
3.4.13	Secondary rated current PX	1		A
3.4.14	Secondary rated current 5P20	1		A
3.4.15	Rating factor	1.2		-
3.4.16	Rated burden protection core 5P20	20		VA
3.4.17	Rated burden measuring core	15		VA
3.4.18	Protective cores number and class	1x 5P20 3 x class PX 0.5V/turn		-
3.4.19	Measuring cores number and class	2 x 0.2s F<5		-
3.4.20	Spare core	1 x class PX 0.5V/turn		-

3.5. 132(66) kV Capacitive Voltage Transformers

Item	Description	Required	Tendered	Unit
3.5.1	Maker's name	To be stated by Bidder		-
3.5.2	Maker's type and reference	To be stated by Bidder		-
3.5.3	Country of origin	To be stated by Bidder		-
3.5.4	Description	Transmission class		-
3.5.5	Type	Outdoor CVT		-
3.5.6	Type test	Authority, year, Doc.no		-
3.5.7	Standards	IEC60044-5, BS3938		-
3.5.8	Class	T1		-
3.5.9	Creepage distance	5334		mm
3.5.10	Primary rated voltage (interconnectable between two voltage levels)	Interconnectable between 132/V3 and 66/V3		kV
3.5.11	Capacitance	3500, +10%-5%		F
3.5.12	Number of secondary windings	3		Nos.
3.5.13	Secondary rated voltage	2x 110/V3		V
3.5.14	Damping circuit of reactor provided	Yes		-
3.5.15	Rated burden each winding	100		VA
3.5.16	Voltage factor (continuous / 30sec);	1.2 / 1.5		-
3.5.17	Protection Class	0.5(3P)/3P		-
3.5.18	Measurement Class	0.2		-
3.5.19	Max. Force on Terminal	>1000		N
3.5.20	Gross Weight	To be stated by Bidder		kg
3521	HV Terminal Type	To be stated by Bidder		-

3.6. 66 kV Capacitive Voltage Transformers

Item	Description	Required	Tendered	Unit
3.6.1	Maker's name	To be stated by Bidder		
3.6.2	Maker's type and reference	To be stated by Bidder		
3.6.3	Country of origin	To be stated by Bidder		
3.6.4	Description	CVT		
3.6.5	Type	Oil filled		
3.6.6	Type test	Authority, year, Doc.no		
3.6.7	Standards	IEC, class T1		
3.6.8	Class	Outdoor		
3.6.9	Insulation material	Brown glazed porcelain		
3.6.10	Creepage distance	2344		mm
3.6.11	Primary rated voltage	66		kV
3.6.12	Secondary rated voltage	3x 110/V3		V
3.6.13	Rated burden	20		VA
3.6.14	Voltage factor (continuous / 30sec);	1.2 / 1.5		
3.6.15	Protection Class	3P		
3.6.16	Measurement Class	0.2		
3.6.17	Max. Force on Terminal	>1000		N
3.6.18	Gross Weight	To be stated by Bidder		kg
3.6.19	HV Terminal Type	To be stated by Bidder		

37 66 kV Surge Arresters

Item	Description	Required	Tendered	Unit
3.7.1	Maker's name	To be stated by Bidder		
3.7.2	Maker's type and reference	To be stated by Bidder		
3.7.3	Country of origin	To be stated by Bidder		
3.7.4	Description	Hollow core		
3.7.5	Type of arresters	Gapless ZnO		
3.7.6	Type test	Authority, year, Doc.no		
3.7.7	Standards	IEC60099		
3.7.8	Rated voltage Ur	60		kV
3.7.9	Rated short-circuit current	65		kA
3.7.10	Nominal discharge current	10		kA peak
3.7.11	Line discharge class	3		
3.7.12	Maximal residual voltage 8/20µs (10kA)	201		kV peak
3.7.13	Cont. operation voltage	44		kV
3.7.14	Energy absorbtion capability	8		kJ/kV
3.7.15	Impulse withstand current (peak value) (4/10 µs)	100		kA
3.7.16	long duration current impulse	1000		A
3.7.17	Leakage current	To be stated by Bidder		mA
3.7.18	Insulation material	Silicon rubber		
3.7.19	Surge counters per phase	Yes		

4. Transformers

4.1. Power Transformer 330/132(66)/11 kV

Item	Description	Required	Tendered	Unit
4.1.1	Rated power	90/90/10		MVA
4.1.2	Nominal primary voltage	330		kV
4.1.3	Nominal secondary voltage	interconnectable between 132 and 66		kV
4.1.4	Nominal tertiary voltage	11		kV
4.1.5	Highest system voltage	352/145/12		kV
4.1.6	Vector group	YNyn0+d1		-
4.1.7	Cooling	ONAN/ONAF		-
4.1.8	Power at ONAN, minimum of rated power	75		%
4.1.9	Colour	RAL7032 (Grey)		-
4.1.10	Maker's name	To be stated by Bidder		-
4.1.11	Maker's type and reference	To be stated by Bidder		-
4.1.12	Country of origin	To be stated by Bidder		-
4.1.13	Description	oil filled		-
4.1.14	Type	Power transformer		-
4.1.15	Type test	Authority, year, Doc.no		-
4.1.16	Standards	IEC60076		-
4.1.17	Transformer Class	Outdoor		-
4.1.18	Single or three phase units	three phase		-
4.1.19	Type of core	grain oriented silicon steel		-
4.1.20	Type of tank	upper flange		-
4.1.21	Tank fully vacuum proof	Yes		-
4.1.22	Specification of oil (general)	IEC 60296, class I		-
4.1.23	Oil corrosive sulfur free	Yes		-
4.1.24	Oil PCB free (certification to be provided)	Yes		-
4.1.25	Supplier, type of oil	To be stated by Bidder		-
4.1.26	Tap changer	On-load		-
4.1.27	Tap changer make	MR Germany or comparable vacuum type		-
4.1.28	Tapping range	+10 / -15		%
4.1.29	Step range	1.25		%each
4.1.30	OLTC drive	Motor drive 3-ph 380-415 VAC		-
4.1.31	Operation contact life at rated through current	>300000		Nos.
4.1.32	Mechanical tap position indicator	Yes		-
4.1.33	Impedance voltage at rated power, primary/secondary	14		%
4.1.34	Impedance voltage at rated power, primary/tertiary	24		%
4.1.35	Impedance voltage at rated power, secondary/tertiary	8		%
4.1.36	Zero sequence impedance at principal tapping	166 (shorted secondary)		%
4.1.37	Temperature rise oil/top, maximum	60		K
4.1.38	Temperature rise winding, average, resistance method	65		K
4.1.39	Temperature rise winding, hot spot, resistance method	78		K
4.1.40	Bushing type	Porcelain		-
4.1.41	Continuous overload for bushings	20		%
4.1.42	Minimum creepage distance (USCD)	53.7		mm/kV
4.1.43	Neutral bushing fully insulated at nominal voltage	Yes		-
4.1.44	Neutral current transformer cores	1 x 5P20 1 x class X		-
4.1.45	Load losses (75°C), Guarantee	To be stated by Bidder		kW
4.1.46	No load losses (75°C), Guarantee	To be stated by Bidder		kW
4.1.47	Insulation levels (prim/sec/tert) (not corrected for altitude):			
4.1.48	- Power frequency withstand voltage (phase and neutral)	570/275/28		kV
4.1.48(a)	HV - neutral	85		kV
4.1.48(b)	MV - neutral	140		kV
4.1.49	- Lightning impulse level (phase and neutral)	1300/650/95		kV
4.1.49(a)	HV - neutral	185		kV
4.1.49(b)	MV - neutral	325		kV

4.1.50	Tests:			
4.1.51	Routine tests according to IEC 60076	on each unit		-
4.1.52	Type tests according to IEC 60076	on one unit		-
4.1.53	All special tests according to IEC 60076	on one unit		-
4.1.54	Dimensions total (length x width x height)	To be stated by Bidder		mm
4.1.55	Dimensions transport (length x width x height)	To be stated by Bidder		mm
4.1.56	Weight of oil	To be stated by Bidder		kg
4.1.57	Total weight of completely assembled transformer	To be stated by Bidder		kg
4.1.58	Auxiliary power, control	110		V DC
4.1.59	Auxiliary power, tap changer motor	3ph 400		V AC
4.1.60	Auxiliary power, heater	230		V AC
4.1.61	Noise level, Guarantee	<78		dB(A)

5. Reactor

5.1. Shunt Reactor 330 kV (10MVar)

Item	Description	Required	Tendered	Unit
5.1.1	Maker's name	To be stated by Bidder		-
5.1.2	Maker's type and reference	To be stated by Bidder		-
5.1.3	Country of origin	To be stated by Bidder		-
5.1.4	Description	Shunt reactor		-
5.1.5	Type	Single phase		-
5.1.6	Rated power	10		MVar
5.1.7	Nominal primary voltage (Un)	330		kV
5.1.8	Maximum continuous operating voltage (Um)	362		kV
5.1.9	Cooling	ONAN		-
5.1.10	Colour	RAL7032 (Grey)		-
5.1.11	Rated short-time current (3s)	40		kA
5.1.12	Type test	Authority, year, Doc.no		-
5.1.13	Standards	IEC		-
5.1.14	Class	Outdoor		-
5.1.15	Type of core	grain oriented silicon steel		-
5.1.16	Type of tank	upper bolted flange		-
5.1.17	Tank fully vacuum proof	Yes		-
5.1.18	Specification of oil (general)	IEC 60296, class I		-
5.1.19	Oil corrosive sulfur free	Yes		-
5.1.20	Oil PCB free (certification to be provided)	Yes		-
5.1.21	Supplier, type of oil	To be stated by Bidder		-
5.1.22	Insulation levels (prim/sec) (not corrected for altitude):			
5.1.23	- Power frequency withstand voltage (phase and neutral)	570/70		kV
5.1.24	- Lightning impulse level (phase and neutral)	1300/170		kV
5.1.25	Overvoltage withstand capacity continuously	1,1 x Un		-
5.1.26	Overvoltage withstand capacity for 1 minute	1,25 x Um		-
5.1.27	Overvoltage withstand capacity for 5 seconds	1,5 x Um		-
5.1.28	Overvoltage withstand capacity for 1 second	1,75 x Um		-
5.1.29	Positive internal pressure withstand capability	>70		kPa
5.1.30	Negative internal pressure withstand capability at empty tank	>50		mmHg
5.1.31	Temperature rise oil/top, maximum, at 1000masl	60		K
5.1.32	Temperature rise winding, average, resistance method, at 1000masl	65		K
5.1.33	Temperature rise winding, hot spot, resistance method, at 1000masl	78		K
5.1.34	Bushing type	Porcelain		-
5.1.35	Continuous overload for bushings	20		%
5.1.36	Minimum creepage distance primary side (USCD)	53.7		mm/kV
5.1.37	Minimum creepage distance neutral side (USCD)	53.7		mm/kV
5.1.38	Losses (75°C), Guarantee maximum at 35°C ambient temperature	To be stated by Bidder		kW
5.1.39	Bushing current transformer primary side:			
5.1.40	Number of cores	5		Nos.
5.1.41	Turn ratio	1/800		-
5.1.42	Secondary tapings turns ratios	1/100/200		-
5.1.43	Class	0.25/ 4 x PX		-

5.1.44	Rated burden protection core	10		VA
5.1.45	Rated burden measuring core	5		VA
5.1.46	Bushing current transformer neutral side:			
5.1.47	Number of cores	3		-
5.1.48	Turn ratio	1/800		-
5.1.49	Secondary tapings turns ratios	1/100/200		-
5.1.50	Class	0.2S/ 2 x PX		-
5.1.51	Rated burden protection core	10		VA
5.1.52	Rated burden measuring core	5		VA
5.1.53	Dimensions total (length x width x height)	To be stated by Bidder		mm
5.1.54	Dimensions transport (length x width x height)	To be stated by Bidder		mm
5.1.55	Weight of oil	To be stated by Bidder		kg
5.1.56	Total weight of completely assembled reactor	To be stated by Bidder		kg
5.1.57	Auxiliary power, control	110		V DC
5.1.58	Auxiliary power, heater in control box	230		V AC
5.1.59	Noise level	<75		dB(A)

5.2. Neutral Compensating Reactor 35 kV

Item	Description	Required	Tendered	Unit
5.2.1	Maker's name	To be stated by Bidder		-
5.2.2	Maker's type and reference	To be stated by Bidder		-
5.2.3	Country of origin	To be stated by Bidder		-
5.2.4	Description	Neutral reactor		-
5.2.5	Type	Single phase		-
5.2.6	Rated power	15		kVar
5.2.7	Nominal primary voltage	35		kV
5.2.8	Maximum continuous operating voltage	42		kV
5.2.9	Core type	Core		-
5.2.10	Cooling	ONAN		-
5.2.11	Colour	RAL7032 (Grey)		-
5.2.12	Rated short-time current (3s)	40		kA
5.2.13	Type test	Authority, year, Doc.no		-
5.2.14	Standards	IEC60076, 60137		-
5.2.15	Class	Outdoor		-
5.2.16	Type of core	grain oriented silicon steel		-
5.2.17	Type of tank	upper flange		-
5.2.18	Tank fully vacuum proof	Yes		-
5.2.19	Specification of oil (general)	IEC 60296, class I		-
5.2.20	Oil corrosive sulfur free	Yes		-
5.2.21	Oil PCB free (certification to be provided)	Yes		-
5.2.22	Supplier, type of oil	To be stated by Bidder		-
5.2.23	Magnetizing linearity	140		% Vn
5.2.24	Current density at maximum load and rated voltage and rated voltage tap	To be stated by Bidder		A/mm ²
5.2.25	Direct impedance at rated voltage N-X1, X2, X3	997/904/815		Ω
5.2.26	Zero-sequence impedance at rated voltage	To be stated by Bidder		Ω
5.2.27	Tolerance to be applied to the reactor impedance	5		%
5.2.28	RIV max. Voltage level (IEC 62271-1) at 0.5 MHZ and 230 kV test voltage (1.1 ur/√3) Maximum	2500		mV
5.2.29	HV bushing rated current	362		A
5.2.30	Neutral busching rated current	123		A
5.2.31	Lightning impulse level HV winding	200		kV
5.2.32	Lightning impulse level neutral	75		kV
5.2.33	Rated short-duration AC withstand voltage HV winding	95		kV
5.2.34	Rated short-duration AC withstand voltage neutral	28		kV
5.2.35	Temperature rise oil/top, maximum, Guarantee	60		°C(G)
5.2.36	Temperature rise winding, average, resistance method, Guarantee	65		°C(G)
5.2.37	Temperature rise winding, hot spot, resistance method, Guarantee	78		°C(G)
5.2.38	Bushing type	Porcelain		-
5.2.39	Continuous overload for bushings	20		%

5.2.40	Minimum creepage distance (USCD)	53.7		mm/kV
5.2.41	Total losses (75°C)	To be stated by Bidder		kW
5.2.42	Current transformers:			
5.2.43	<u>HV neutral</u>			
5.2.44	Number of cores	3		Nos.
5.2.45	Accuracy class	PX		-
5.2.46	Burden	30		VA
5.2.47	Rated current ratio	100/1		-
5.2.48	Dimensions total (length x width x height)	To be stated by Bidder		mm
5.2.49	Dimensions transport (length x width x height)	To be stated by Bidder		mm
5.2.50	Weight of oil	To be stated by Bidder		kg
5.2.51	Total weight of completely assembled transformer	To be stated by Bidder		kg
5.2.52	Auxiliary power, heater	230		V AC
5.2.53	Noise level, Guarantee	<78		dB(A)

5.3. 36kV Surge Arrester

Item	Description	Required	Tendered	Unit
5.3.1	Type			
5.3.2	Rated voltage	36		kV
5.3.3	Continuous-running voltage	22		kV
5.3.4	Nominal discharge current	10		kA
5.3.5	Creepage Distance	31		kV/mm
5.3.6	Applicable Standard	IEC 60099-5		
5.3.7	DC 1mA reference voltage (not less than)	51		kV
5.3.8	Leakage current under 0.75 times DC 1mA the reference voltage	≤50		mA
5.3.9	Rated frequency	50		Hz
5.3.10	Frequency Reference Voltage	≥36		kV
5.3.11	The maximum residual voltage under 500A operation impact power (peak, not more than)	90		kV
5.3.12	The maximum residual voltage under 10kA lightning shock electrical flow (peak, not more than)	108		kV
5.3.13	The maximum residual voltage under 10kA steep shock wave peak not more than)	115		kV
5.3.14	Large current shock resistance ability: 4/10ms2times	85		kA
5.3.15	Tolerance ability under long duration shock current: 2ms Square wave current impulse (peak)	150		A
5.3.16	Rated short circuit resistance current capability			
5.3.17	large current	16		kA
5.3.18	low current	800		A
5.3.19	Insulation and resistance strength of the shell			
5.3.20	Rated lightning impulse withstand voltage (peak)	185		kV
5.3.21	Rated short-time power frequency withstand voltage (effective value)	95/dry, 80/wet		
5.3.22	Durability against pollution			
5.3.23	Artificial contamination test with salt	0.06		mg/cm²
5.3.24	the equivalent creepage distance	31		mm/kV
5.3.25	The largest amount in partial discharge	10		pC

6. 11 kV Equipment

6.1. 11 kV Indoor Compact Metal Clad Air Insulated Switchgear

Item	Description	Required	Tendered	Unit
6.1.1	Type	Compact AIS		-
6.1.2	Manufacturer	Bidder to state		-
6.1.3	Country of origin	Bidder to state		-
6.1.4	Manufacturer's type designation	Bidder to state		-
6.1.5	Standard	IEC 62271-200		-
6.1.6	Type test report	Bidder to state		-
6.1.7	Rated voltage	12		kV
6.1.8	Maximum system voltage	12		kV
6.1.9	Lighting impulse withstand voltage	81		kV
6.1.10	Power frequency withstand voltage (1 min)	30		kV
6.1.11	Rated frequency	50		Hz
6.1.12	Rated short circuit breaking current (3 sec)	31.5		kA
6.1.13	Rated peak short circuit current	80		kA
6.1.14	LSC-category	LSC-2A		-
6.1.15	Internal arc classification	IAC AFLR		-
6.1.16	Insulation medium	Air		-
6.1.17	Degree of protection			-
6.1.18	- MV switchgear	IP41		-
6.1.19	- LV compartment	IP41		-
6.1.20	Feeder width	Bidder to state		mm
6.1.21	Busbar			-
6.1.22	Rated current at 20° C	2000		A
6.1.23	Conductor material	copper		-
6.1.24	Circuit Breaker			-
6.1.25	Type (Manufacturer's identification)	Bidder to state		-
6.1.26	Standard	IEC		-
6.1.27	Rated Current	2000		A
6.1.28	Rated short circuit breaking current	31.5		kA
6.1.29	Rated short circuit making current	Bidder to state		kA
6.1.30	Rated frequency	50		Hz
6.1.31	Rated operation sequence	O-0.3sec-CO-3min-CO		-
6.1.32	Closing time	<35		ms
6.1.33	Break time	Bidder to state		ms
6.1.34	Make time	Bidder to state		ms
6.1.35	Arcing time	Bidder to state		ms
6.1.36	Life span for contacts (number of operations)			-
6.1.37	- at rated current	Bidder to state		Nos
6.1.38	- at rated breaking current	Bidder to state		Nos
6.1.39	Arc quenching medium	vacuum		-
6.1.40	Auxiliary contacts			-
6.1.41	- number of NO	12		Nos
6.1.42	- number of NC	12		Nos
6.1.43	- Voltage / current	110/7.5		V/A DC
6.1.44	Operation mechanism for opening / closing	spring/spring		-
6.1.45	Spring charging motor	110		V DC
6.1.46	Number of tripping coils	1		-
6.1.47	Earthing switch/Disconnecter			-
6.1.48	Type (Manufacturer's identification)	Bidder to state		-
6.1.49	Standard	IEC		-
6.1.50	Rated current	2000		A
6.1.51	Rated short circuit withstand current (3 s)	31.5		kA
6.1.52	Rated peak short circuit current	80		kA
6.1.53	Current Transformer		-	-
6.1.54	Type (Manufacturer's identification)	Bidder to state		-
6.1.55	Manufacturer	Bidder to state		-

6.1.56	Country of origin	Bidder to state		-
6.1.57	Standard	IEC		-
6.1.58	Rated primary current cable feeder	50		A
6.1.59	Rated primary current transformer feeder	150		A
6.1.60	Rated secondary current	1		A
6.1.61	Rated burden	10		VA
6.1.62	Protective cores number and class	2 x 5P20 1 x class X		-
6.1.63	Measuring cores number and class	1 x 0.2s Fs<5		-
6.1.64	Rated short time withstand current	31.5		kA
6.1.65	Rated peak short circuit current	81		kA
6.1.66	Impulse withstand voltage (peak)	30		kA
6.1.67	Permanent overload factor	1.2		-
6.1.68	Insulation material	Bidder to state		-
6.1.69	Voltage Transformer			
6.1.70	Type (Manufacturer's identification)	Bidder to state		-
6.1.71	Manufacturer	Bidder to state		-
6.1.72	Country of origin	Bidder to state		-
6.1.73	Standard	IEC		-
6.1.74	Impulse withstand voltage (peak)	81		kV
6.1.75	Power frequency withstand voltage (1 min)	30		kV
6.1.76	Rated frequency	50		Hz
6.1.77	Rated primary voltage	11/V3		kV
6.1.78	Rated secondary voltage	2x110/V3		V
6.1.79	Accuracy class	0.5		Class
6.1.80	Output	10		VA
6.1.81	Permanent overload factor continuous	1.2		-
6.1.82	Insulation material	Bidder to state		-
6.1.83	Surge Arresters (if installed in AIS swgr)		-	
6.1.84	Maximum system voltage	12		kV
6.1.85	Nominal operating voltage	11		kV
6.1.86	Frequency	50		Hz
6.1.87	MO type	Bidder to state		-
6.1.88	Standards	IEC60099		-
6.1.89	Rated voltage Ur	10		kV
6.1.90	Nominal discharge current	10		kA peak
6.1.91	Line discharge class	class 1		-
6.1.92	Maximal residual voltage 8/20µs (10kA)	40		kV peak
6.1.93	Maximum cont. operation voltage	7.3		kV
6.1.94	Maximum steep current impulse residual voltage 1/20µs (10kA)	50		kV
6.1.95	Impulse withstand current (peak value) (4/10 µs)	100		kA
6.1.96	Long-wave surge current (2000 µs)	250		A

6.2. 11 kV Surge Arresters

Item	Description	Required	Tendered	Unit
6.2.1	Maker's name	Bidder to state		-
6.2.2	Maker's type and reference	Bidder to state		-
6.2.3	Country of origin	Bidder to state		-
6.2.4	Description	Outdoor		-
6.2.5	Type of arresters	Gapless ZnO		-
6.2.6	Type test	Authority, year, Doc.no		-
6.2.7	Standards	IEC60099		-
6.2.8	Rated voltage U_r (phase-earth / neutral-earth)	10		kV
6.2.9	Nominal discharge current	10		kA peak
6.2.10	Line discharge class	class 3		-
6.2.11	Maximal residual voltage 8/20 μ s (10kA)	40		kV peak
6.2.12	Maximum cont. operation voltage (phase-earth / neutral-earth)	7.3 / 5.4		kV
6.2.13	Maximum steep current impulse residual voltage 1/20 μ s (10kA)	50		kV
6.2.14	Impulse withstand current (peak value) (4/10 μ s)	100		kA
6.2.15	Long-wave surge current (2000 μ s)	250		A
6.2.16	Leakage current	Bidder to state		mA
6.2.17	Insulation material	Silicon rubber		-
6.2.18	Surge counters per phase	No		-

7. Power Cables

7.1. 11 kV Power Cable

Item	Description	Required	Tendered	Unit
7.1.1	Type	3-core+screen		-
7.1.2	Manufacturer	Bidder to state		-
7.1.3	Country of origin	Bidder to state		-
7.1.4	Manufacturer's type designation	Bidder to state		-
7.1.5	Type test	Authority, year, Doc.no		-
7.1.6	Standard	IEC 60502/SANS 1339		-
7.1.7	Cross section areas	70		mm ²
7.1.8	Conductor material	CU		-
7.1.9	Rated voltage U ₀ /U	11/6.35		kV
7.1.10	Highest system voltage U _m	12		kV
7.1.11	Impulse withstand voltage	95		kV
7.1.12	Conductor longitudinal water sealing system	Bidder to state		-
7.1.13	Conductor screen	Bidder to state		-
7.1.14	Conductor screen thickness	Bidder to state		mm
7.1.15	Insulation type	XLPE		-
7.1.16	Insulation thickness	Bidder to state		mm
7.1.17	Insulation screen type	Bidder to state		-
7.1.18	Insulation screen thickness	Bidder to state		mm
7.1.19	Screen longitudinal water sealing system	Bidder to state		-
7.1.20	Cu wire screen cross section area	Bidder to state		mm ²
7.1.21	Oversheath type	HDPE		-
7.1.22	Oversheath colour	Black		-
7.1.23	Oversheath thickness	Bidder to state		mm
7.1.24	Complete cable diameter	Bidder to state		mm
7.1.25	Complete cable weight	Bidder to state		kg/m
7.1.26	Maximum continuous conductor temperature at normal operation	Bidder to state		°C
7.1.27	DC resistance	Bidder to state		Ohm/km
7.1.28	Capacitance	Bidder to state		µF/km
7.1.29	Current carrying capacity in ground	Bidder to state		A
7.1.30	Current carrying capacity in air	Bidder to state		A
7.1.31	Short-circuit current capacity, start temperature 90 °C, end temperature 250 °C, 1 s	Bidder to state		kA
7.1.32	Manufacturer's specification	Bidder to state		-

7.2. 11 kV Cable Terminations

Item	Description	Required	Tendered	Unit
7.2.1	Type	Bidder to state		-
7.2.2	Manufacturer	Bidder to state		-
7.2.3	Country of origin	Bidder to state		-
7.2.4	Manufacturer's type designation	Bidder to state		-
7.2.5	Type test	Authority, year, Doc.no		-
7.2.6	Standard	IEC 60502/SANS 1339		-
7.2.7	Cross section	70		mm ²
7.2.8	Rated voltage U ₀ /U	11/6.35		kV
7.2.9	Highest system voltage U _m	12		kV
7.2.10	Impulse withstand voltage	95		kV
7.2.11	Current carrying capacity	see related cable		A
7.2.12	Manufacturer's specification	Bidder to provide		-

8. Auxiliary Systems

8.1. 11/0.4 kV Substation Auxiliary Transformer

Item	Description	Required	Tendered	Unit
8.1.1	Type	3-phase oil immersed		-
8.1.2	Manufacturer	Bidder to state		-
8.1.3	Country of origin	Bidder to state		-
8.1.4	Manufacturer's type designation	Bidder to state		-
8.1.5	Standard	IEC 60076, EN HD 428, EN 50216		-
8.1.6	Type test report	Authority, year, Doc.no		-
8.1.7	Installation	Outdoor		-
8.1.8	Rated power	500		kVA
8.1.9	Rated voltage	11/0.4		kV
8.1.10	Off-circuit tap changer	$\pm 2 \times 2,5\%$		-
8.1.11	Impedance	4		%
8.1.12	Connection	Dyn11		-
8.1.13	Short-circuit voltage	Bidder to state		%
8.1.14	Zero-sequence impedance	Bidder to state		ohm
8.1.15	No-load losses	Bidder to state		W
8.1.16	Load losses	Bidder to state		W
8.1.17	Temperature rise, oil	50		K
8.1.18	Temperature rise, winding	55		K
8.1.19	Type of cooling	ONAN		-
8.1.20	Sound level	Bidder to state		dB(A)
8.1.21	Type of tank	Sealed, bolted lid		-
8.1.22	Type of core	Core		-
8.1.23	Total weight	Bidder to state		kg
8.1.24	Dimensions (length x width x height)	Bidder to state		mm

8.2. Stand-by Diesel Generator

Item	Description	Required	Tendered	Unit
8.2.1	Type	Bidder to state		-
8.2.2	Manufacturer	Bidder to state		-
8.2.3	Country of origin	Bidder to state		-
8.2.4	Manufacturer's type designation	Bidder to state		-
8.2.5	Motor brand/designation	Bidder to state		-
8.2.6	Generator brand/designation	Bidder to state		-
8.2.7	Control panel brand/designation	Bidder to state		-
8.2.8	Standard	ISO8528		-
8.2.9	Type test report	Bidder to include		-
8.2.10	Installation	Outdoor		-
8.2.11	Design temperature	-10 to + 70		°C
8.2.12	Mechanical structure	Soundproofed		-
8.2.13	Rated voltage	400/230		V
8.2.14	Voltage stability	± 1		%
8.2.15	Standby power	250 / 200		kVA / kW
8.2.16	Prime power	227 / 182		kVA / kW
8.2.17	Zero-sequence impedance X ₀	Bidder to state		%
8.2.18	Battery	Bidder to state		V DC
8.2.19	Performance class	G3		-
8.2.20	EPA exhaust emission	EPA3 or similar		-
8.2.21	Acoustic pressure L _{pA}	<71		dB(A) a7
8.2.22	Acoustic power L _{wA}	<97		dB(A)
8.2.23	Fuel tank capacity	>400		litres
8.2.24	Empty weight	Bidder to state		kg
8.2.25	Dimensions (length x width x height)	Bidder to state		mm

8.3. Battery 110 V DC

Item	Description	Required	Tendered	Unit
8.3.1	Maker's type and reference	Bidder to state		-
8.3.2	Manufacturer	Bidder to state		-
8.3.3	Country of origin	Bidder to state		-
8.3.4	Description	Station control supply		-
8.3.5	Type test	Authority, year, Doc.no		-
8.3.6	Standards	IEC		-
8.3.7	Type	Maintenance-free VRLA GEL Long life		-
8.3.8	Nominal voltage	110		V DC
8.3.9	Service voltage	Bidder to state		V DC
8.3.10	Number of cells	Bidder to state		Nos
8.3.11	Capacity at 10 h discharge time	Bidder to state		Ah
8.3.12	Reference ambient temperature	Bidder to state		°C
8.3.13	Voltage per cell fully charged	Bidder to state		V DC
8.3.14	Voltage per cell fully discharged	Bidder to state		V DC
8.3.15	Quantity of electrolyte per cell	Bidder to state		cm ³
8.3.16	Dimensions of complete battery (height x width x depth)	Bidder to state		mm
8.3.17	Erected in cubicle	Yes/No		-
8.3.18	Mass of complete battery	Bidder to state		kg

8.4. Battery Chargers 110 V DC

Item	Description	Required	Tendered	Unit
8.4.1	Maker's type and reference	To be stated by Bidder		-
8.4.2	Manufacturer	To be stated by Bidder		-
8.4.3	Country of origin	To be stated by Bidder		-
8.4.4	Description	Station control supply		-
8.4.5	Type test	Authority, year, Doc.no		-
8.4.6	Standards	IEC		-
8.4.7	Nominal voltage	110		V DC
8.4.8	Service voltage	To be stated by Bidder		V DC
8.4.9	Rated voltage on float charge	To be stated by Bidder		V
8.4.10	Rated voltage on boost charge	To be stated by Bidder		V
8.4.11	Rated voltage absorption charge	To be stated by Bidder		V
8.4.12	Charging characteristic	To be stated by Bidder		-
8.4.13	Accuracy of output voltage	To be stated by Bidder		+/- %
8.4.14	Rated max. output boost charge	To be stated by Bidder		A
8.4.15	Rated input	To be stated by Bidder		kVA
8.4.16	Max. Ripple (without the battery connected in parallel)	To be stated by Bidder		V
8.4.17	Reference ambient temperature	To be stated by Bidder		V
8.4.18	Stability of the output voltage	To be stated by Bidder		%
8.4.19	Main and standby function	Yes		-
8.4.20	Dimensions (w x d x h)	To be stated by Bidder		mm
8.4.21	Total mass	To be stated by Bidder		kg

8.5. Battery 48 V DC

Item	Description	Required	Tendered	Unit
8.5.1	Maker's type and reference	To be stated by Bidder		-
8.5.2	Manufacturer	To be stated by Bidder		-
8.5.3	Country of origin	To be stated by Bidder		-
8.5.4	Description	Telecom system		-
8.5.5	Type test	Authority, year, Doc.no		-
8.5.6	Standards	IEC, ITU		-
8.5.7	Type	Lithium ion		-
8.5.8	Nominal voltage	48		V DC
8.5.9	Service voltage	To be stated by Bidder		V DC
8.5.10	Number of cells	To be stated by Bidder		Nos
8.5.11	Capacity at 10 h discharge time	To be stated by Bidder		Ah
8.5.12	Reference ambient temperature	To be stated by Bidder		°C
8.5.13	Voltage per cell fully charged	To be stated by Bidder		V DC
8.5.14	Voltage per cell fully discharged	To be stated by Bidder		V DC
8.5.15	Dimensions of complete battery (height x width x depth)	To be stated by Bidder		mm
8.5.16	Erected in cubicle	Yes/No		-
8.5.17	Mass of complete battery	To be stated by Bidder		kg

8.6. Battery Chargers 48 V DC

Item	Description	Required	Tendered	Unit
8.6.1	Maker's type and reference	To be stated by Bidder		-
8.6.2	Manufacturer	To be stated by Bidder		-
8.6.3	Country of origin	To be stated by Bidder		-
8.6.4	Description	Telecom system		-
8.6.5	Type test	Authority, year, Doc.no		-
8.6.6	Standards	IEC, ITU		-
8.6.7	Nominal voltage	48		V DC
8.6.8	Service voltage	To be stated by Bidder		V DC
8.6.9	Rated voltage on float charge	To be stated by Bidder		V
8.6.10	Rated voltage on boost charge	To be stated by Bidder		V
8.6.11	Rated voltage absorption charge	To be stated by Bidder		V
8.6.12	Charging characteristic	To be stated by Bidder		-
8.6.13	Accuracy of output voltage	To be stated by Bidder		+/- %
8.6.14	Rated max. output boost charge	To be stated by Bidder		A
8.6.15	Rated input	To be stated by Bidder		kVA
8.6.16	Max. Ripple	To be stated by Bidder		V
8.6.17	Reference ambient temperature	To be stated by Bidder		V
8.6.18	Stability of the output voltage	To be stated by Bidder		%
8.6.19	Main and standby function	No		-
8.6.20	Dimensions (w x d x h)	To be stated by Bidder		mm
8.6.21	Protection degree	54		IP
8.6.22	Total mass	To be stated by Bidder		kg

8.7. CCTV Surveillance System and Access Control

Item	Description	Required	Tendered	Unit
8.7.1	IP Bullet camera complete with accessories			
8.7.2	Maker's type and reference	To be stated by Bidder		-
8.7.3	Manufacturer	To be stated by Bidder		-
8.7.4	Country of origin	To be stated by Bidder		-
8.7.5	Video interface	ONVIF		-
8.7.6	Profile for broadcast and storage	H.2064 High profile		-
8.7.7	Resolution	Full HD with 1080p@30fps		-
8.7.8	Built-in IR	Effective distance ≥80		m
8.7.9	Image enhancement	Digital Wide Dynamic Range		-
8.7.10	Image quality	Tru day/night with mechanical IR cut filter		-
8.7.11	Resolution/Quality	4Megapixel (1920x1080)		-
8.7.12	Zoom/Focus	Remote		-
8.7.13	Lens type	Motorised vari-focal		-
8.7.14	Focal length	2.7-12		mm
8.7.15	Time	Embedded real-time clock, NTP Client		-
8.7.16	Ingress Protection & Vandal Resistance rating	IP67, IK10		-
8.7.17	<u>Support smart function</u>			
8.7.18	Intrusion detection	Yes		-
8.7.19	Line crossing detection	Yes		-
8.7.20	Motion detection human and vehicle targets classification)	Yes		-
8.7.21	Video tampering alarm	Yes		-
8.7.22	Exception alarm	Yes		-
8.7.23	Face detection	Yes		-
8.7.24	<u>Event Linkage:</u>			
8.7.25	Upload to FTP/memory card/NAS	Yes		-
8.7.26	Notify surveillance centre	Yes		-
8.7.27	Trigger recording	Yes		-
8.7.28	Trigger capture	Yes		-
8.7.29	Send email	Yes		-
8.7.30	Voltage	12±25%		VDC
8.7.31	Load	0.92		A
8.7.32	Power Maximum	11		W
8.7.33	Connection	Coaxial power plug		-
8.7.34	Connection security	Revers polarity protection		-
8.7.35	PoE	802.3af, Class 3, 36-57V, 0.35-0.22A, max 12.5W		-
8.7.36	Ethernet interface	1 RJ45 10 m/100 M self-adaptive Ethernet port		-
8.7.37	User/Host	Up to 32 users		Nos.
8.7.38	User levels	Administrator+Operator+User		-
8.7.39	Security	Password protection, complicated password, HTTPS encryption, IP address filter, Security Audit Log, basic and digest authentication for HTTP/HTTPS, TLS 1.1/1.2, WSSE and digest authentication for Open Network Video Interface		-
8.7.40	Network storage	NAS (NFS, SMB/CIFS), auto network replenishment (ANR) or trickle back technology		-

8.7.41	On-board storage	Built-in memory card slot, support micro SD card, up to 256 GB		-
8.7.42	SNR	≥52		dB
8.7.43	Image enhancement	BLC, HLC, 3D DNR		-
8.7.44	Dome Camera complete with accessories			
8.7.45	Maker's type and reference	To be stated by Bidder		-
8.7.46	Manufacturer	To be stated by Bidder		-
8.7.47	Country of origin	To be stated by Bidder		-
8.7.48	Video interface	ONVIF		-
8.7.49	Resolution	Full frame rate, full color, H.264/MJPEG, up to 30fps		-
8.7.50	Built-in IR	Effective distance ≥30		-
8.7.51	Image enhancement	Digital Wide Dynamic Range		-
8.7.52	Image quality	Tru day/night with mechanical IR cut filter		-
8.7.53	Resolution/Quality	4Megapixel (1920x1080)		-
8.7.54	Zoom/Focus	Remote		-
8.7.55	Lens type	Motorised vari-focal		-
8.7.56	Focal length	2.7-12		mm
8.7.57	Time	Embedded real-time clock, NTP Client		-
8.7.58	Ingress Protection & Vandal Resistance rating	IP67, IK10		-
8.7.59	<u>Support smart function</u>			
8.7.60	Intrusion detection	Yes		-
8.7.61	Line crossing detection	Yes		-
8.7.62	Motion detection human and vehicle targets classification)	Yes		-
8.7.63	Video tampering alarm	Yes		-
8.7.64	Exception alarm	Yes		-
8.7.65	Face detection	Yes		-
8.7.66	Scene change detection	Yes		-
8.7.67	Audio exception detection	Yes		-
8.7.68	Dynamic analysis as alarm triggering function	Yes		-
8.7.69	Pan Tilt Zoom (PTZ) Camera complete with accessories			
8.7.70	Maker's type and reference	To be stated by Bidder		-
8.7.71	Manufacturer	To be stated by Bidder		-
8.7.72	Country of origin	To be stated by Bidder		-
8.7.73	Video interface	ONVIF		-
8.7.74	Focal length	6.0 - 252		mm
8.7.75	IR light MTBF reach	Up to 30 000		h
8.7.76	IR mode	Smart		-
8.7.77	Minimum illumination	0		lx
8.7.78	Supplement light type	IR		-
8.7.79	Supplement light range	400		m
8.7.80	Defog	Optical defog		-
8.7.81	<u>Basic event</u>			
8.7.82	Motion detection	Yes		-
8.7.83	Video tampering alarm	Yes		-
8.7.84	Alarm input and output	Yes		-
8.7.85	Exception alarm	Yes		-
8.7.86	<u>Smart event</u>			
8.7.87	Line crossing detection	Yes		-
8.7.88	Region entrance detection	Yes		-
8.7.89	Unattended baggage detection	Yes		-
8.7.90	Object removal detection	Yes		-
8.7.91	Intrusion detection	Yes		-
8.7.92	Region exiting detection	Yes		-
8.7.93	Vandal-proof alarm	Yes		-
8.7.94	Audio exception detection	Yes		-
8.7.95	<u>Smart tracking</u>			

8.7.96	Manual tracking	Yes		-
8.7.97	Auto-tracking	Yes		-
8.7.98	Tracking takeover linked tracking capture	Yes		-
8.7.99	<u>Alarm linkage, Alarm actions</u>			
8.7.100	Preset	Yes		-
8.7.101	Patrol scan	Yes		-
8.7.102	Pattern scan	Yes		-
8.7.103	Memory Card Video Record	Yes		-
8.7.104	Trigger recording	Yes		-
8.7.105	Notify surveillance center	Yes		-
8.7.106	Upload to FTP/Memory card/NAS	Yes		-
8.7.107	Send email	Yes		-
8.7.108	3D intelligent positioning function	Yes		-
8.7.109	Ingress protection and vandal resistance rating	IP67, IK10		-
8.7.110	Power-off memory function	Restore PTZ & Lens status after reeboot		-
8.7.111	Thermal & Optical Bi-spectrum Stable PTZ Camera			
8.7.112	Maker's type and reference	To be stated by Bidder		-
8.7.113	Manufacturer	To be stated by Bidder		-
8.7.114	Country of origin	To be stated by Bidder		-
8.7.115	Thermal	640x512, 17 μm		-
8.7.116	Optical	1920x1080		-
8.7.117	Thermal	75 / 100 / 30-150 / 45-180		mm
8.7.118	Optical	H (5.6-208) / C(6.7-330) / E(12.5-775)		mm
8.7.119	<u>VCA</u>			
8.7.120	Line crossing detection	Yes		-
8.7.121	Intrusion detection	Yes		-
8.7.122	Region entrance detection	Yes		-
8.7.123	Region exiting detection	Yes		-
8.7.124	Smart tracking linkage (Thermal+Optical)	Yes		-
8.7.125	Fire detection	Yes		-
8.7.126	Temperature measurement range	-20-150		°C
8.7.127	Working temperature	-40-65		°C
8.7.128	Ingress protection	IP66		-
8.7.129	Management Software			
8.7.130	Maker's type and reference	To be stated by Bidder		-
8.7.131	Manufacturer	To be stated by Bidder		-
8.7.132	Country of origin	To be stated by Bidder		-
8.7.133	PTZ control	turn remote pan/tilt up, down, left or right, adjust lens aperture and focal length		-
8.7.134	Multiple PTZ control modes	use mouse or PC keyboard to make PTZ control; users can choose according their preferences		-
8.7.135	PTZ contention	the system allocates contention privileges to users at the same level to ensure one camera is under the control of one user at one time		-
8.7.136	3D positioning	users can drag the mouse on the surveillance image to control the camera surveillance direction and view angle, zoom in/out or focus on an object		-

8.7.137	Camera parameter configuration	configure parameters of remote cameras such as video parameters (resolution, code stream, frame rate) and alarm parameters (motion detection, privacy mask)		-
8.7.138	One-screen surveillance	multiple remote sites or multiple areas of one site are under real-time surveillance on one screen, 1/4/9 picture and full screen browsing are available		-
8.7.139	Panorama video browsing	click primary equipment or a component on the plane figure to open the real-time videos of its interlinked cameras		-
8.7.140	Dual-service view	both surveillance view (primary equipment view) and maintenance view (site view) are available for direct operations		-
8.7.141	Patrol	all accessed cameras shall support video patrol function with configurable parameters		-
8.7.142	Preset and home preset	each surveillance spot (if only the camera supports preset function) is able to invoke presets during linkage, patrol and video browsing; home preset function is available, that means the pan/tilt returns to its home preset position after a preset timespan		-
8.7.143	Device tree	the device tree function helps in directly locating the surveillance spots and shows device status such as offline, alarm, etc.		-
8.7.144	Video recovery	after checking other functions and users shift back to the real-time surveillance interface, the system shall recover the real-time videos		-
8.7.145	Manual video storage	: users can store real-time videos while browsing if necessary, to save important clues and evidences		-
8.7.146	All-day storage	Important scenarios shall need 24/7 surveillance footages for future investigation and review		-
8.7.147	Timing storage	users can store videos within some specific timespan to save storage space		-
8.7.148	Alarm-storage linkage	external alarms or internal alarms like motion detection alarm will trigger the video recording to keep evidences. It shall be possible to pre-record 5~180s prior to the alarm to keep the whole activity before and after for analysis; pre-record time shall be configurable		-

8.7.149	Footage query	It shall be possible to query footages by surveillance spot, surveillance location, motion/activity, footage storage path, date/time, alarm or combined conditions and to play the wanted footage when it is fetched		-
8.7.150	Video playback	It shall be possible to play video online or after downloading them to the local system according to alarm index, normal play, fast play, slow play, frame play, drag, pause, snapshot or multi-shot the footages		-
8.7.151	Network Switch			
8.7.152	<u>Rackmount Switches</u>			
8.7.153	Maker's type and reference	To be stated by Bidder		-
8.7.154	Manufacturer	To be stated by Bidder		-
8.7.155	Country of origin	To be stated by Bidder		-
8.7.156	Rackmount Managed Gigabit Ethernet/Fibre Optic Switch	Yes		-
8.7.157	Industrial design and compliance	Yes		-
8.7.158	10/100/1000	Yes		Mbps
8.7.159	Support for SFP modules provide uplink connectivity supporting	100BASE-LX, 100BASE-FX, 1000-SX, 1000BASE-LX, 1000BASE-ZX		-
8.7.160	Transparent IT integration with support of Layer 3 functionality in IP Service software	Yes		-
8.7.161	<u>DIN rail Mount Switches</u>			
8.7.162	Maker's type and reference	To be stated by Bidder		-
8.7.163	Manufacturer	To be stated by Bidder		-
8.7.164	Country of origin	To be stated by Bidder		-
8.7.165	Rugged switches in robust industrial design	Yes		-
8.7.166	Built for harsh environments and temperature range	-40-75		°C
8.7.167	Convection cooled without fans or moving parts	Yes		-
8.7.168	Hardened for vibration, shock and surge, and electric noise immunity	Yes		-
8.7.169	Complies with multi-industry specifications for automation and substation	Yes		-
8.7.170	Improves uptime, performance, and safety of industrial systems and equipment	Yes		-
8.7.171	Operator Workstation PC			
8.7.172	Maker's type and reference	To be stated by Bidder		-
8.7.173	Manufacturer	To be stated by Bidder		-
8.7.174	Country of origin	To be stated by Bidder		-
8.7.175	Processor	Intel Core i/, 9 th Generation		-
8.7.176	RAM	16		GB
8.7.177	Operating software	Windows 10 Pro, 64 bit		-
8.7.178	OS Hard Disk	256 GB SSD plus 4 TB 3.5 inch SATA		-
8.7.179	Minimum Dual Graphic Display	Yes		-
8.7.180	Graphic memory	4		GB
8.7.181	HDMI Outputs	4		Nos.
8.7.182	Keyboard and Mouse	Cordless		-
8.7.183	Network interface	100/1000 BaseT RJ45		-
8.7.184	Workstation monitor	24 inch		-

8.7.185	CCTV Surveillance Keyboard			
8.7.186	Maker's type and reference	To be stated by Bidder		-
8.7.187	Manufacturer	To be stated by Bidder		-
8.7.188	Country of origin	To be stated by Bidder		-
8.7.189	ONVIF compliant complete with DC power supply and communication cable	Yes		-
8.7.190	Seamless control of live and recorded video	Yes		-
8.7.191	Desktop keyboard with 3 axis joystick for pan/tilt and zoom	Yes		-
8.7.192	Full variable PTZ control of PTZ domes	Yes		-
8.7.193	Full control of Controle Center virtual matrix	Yes		-
8.7.194	Multi-function keys	Yes		-
8.7.195	LCD graphic display	Yes		-
8.7.196	Display Screen			
8.7.197	Maker's type and reference	To be stated by Bidder		-
8.7.198	Manufacturer	To be stated by Bidder		-
8.7.199	Country of origin	To be stated by Bidder		-
8.7.200	CCTV Display	55 inch UHD		-
8.7.201	Input	HDMI		-
8.7.202	Resolution	1920x1080		-
8.7.203	Speakers	2		Nos.
8.7.204	Connectivity	HDMI, USB		-
8.7.205	System Controller			
8.7.206	Maker's type and reference	To be stated by Bidder		-
8.7.207	Manufacturer	To be stated by Bidder		-
8.7.208	Country of origin	To be stated by Bidder		-
8.7.209	Each system controller/cluster controller shall be capable of storing	10000		tags
8.7.210	Each system controller/cluster controller shall be capable of buffering	100000		transactions
8.7.211	The ACS System Controller shall support physical devices connected via RS485 terminal communication bus, TCP/IP or property solution	64		Nos.
8.7.212	Door Controller			
8.7.213	Shall have the following, or a combination of the following, components built in to facilitate the opening of doors and the monitoring of doors			
8.7.214	Dry contact relays.	Yes		-
8.7.215	Digital inputs.	Yes		-
8.7.216	Ports for connection to ACS readers.	Yes		-
8.7.217	Communications port for 3rd Party readers.	Yes		-
8.7.218	RS485 and SBUS connectivity	Yes		-
8.7.219	Each Door Controller shall support card readers	2		Nos.
8.7.220	<u>The ACS shall support the following connectivity options between System Controllers</u>			
8.7.221	RS485 – with connectivity speed	38400		Baud
8.7.222	Ethernet connectivity support	100		Mbps
8.7.223	Serial BUS connectivity speed	9600		Baud
8.7.224	Electro-magnetic Lock			
8.7.225	Maker's type and reference	To be stated by Bidder		-
8.7.226	Manufacturer	To be stated by Bidder		-
8.7.227	Country of origin	To be stated by Bidder		-
8.7.228	Holding force	300		kg
8.7.229	Ingress protection	Designed to resist ingress of water		-
8.7.230	Power supply	24.Dc		VDC
8.7.231	Status LED indicator	Green-Locked, Red- Unlocked		-
8.7.232	Abrasion-proof material	Yes		-
8.7.233	Equipped with internal voltage dependent resistor (MOV)	Yes		-
8.7.234	Unlock method	Current interruption		-
8.7.235	Suitable for	wooden, Glass, Metal and Fireproof doors		-

8.7.236	Proximity Card Reader			
8.7.237	Maker's type and reference	To be stated by Bidder		-
8.7.238	Manufacturer	To be stated by Bidder		-
8.7.239	Country of origin	To be stated by Bidder		-
8.7.240	Read range Indoor/Outdoor	5/30		cm
8.7.241	Input voltage	5-17		VDC
8.7.242	<u>Key Features</u>			
8.7.243	Single bi-coloured red/green status LED	Yes		-
8.7.244	Read/Write Tag capability for various Tag types	Slim Tags (Read Only), Omega Tags (Read Only), WriTag 128 (Read/Write) and WriTag 2048 (Read/Write)		-
8.7.245	Card Enrollere			
8.7.246	Maker's type and reference	To be stated by Bidder		-
8.7.247	Manufacturer	To be stated by Bidder		-
8.7.248	Country of origin	To be stated by Bidder		-
8.7.249	Contactless passive card writer	Yes		-
8.7.250	Blank check function	Yes		-
8.7.251	Direct connection to Personal Computer	Yes		-
8.7.252	Card Drop Box Unit			
8.7.253	Maker's type and reference	To be stated by Bidder		-
8.7.254	Manufacturer	To be stated by Bidder		-
8.7.255	Country of origin	To be stated by Bidder		-
8.7.256	Connects directly to the RS485 Terminal Bus	Yes		-
8.7.257	Stainless steel, powder coated frame	Yes		-
8.7.258	<u>Unit Includes</u>			
8.7.259	Tag capture unit	Yes		-
8.7.260	Lockable door	Yes		-
8.7.261	Internal 125kHz reader	Yes		-
8.7.262	2 x Relays	Yes		-
8.7.263	4 x Digital inputs (2 x Door Open sensor inputs and 2 x Request to Enter/Exit input)	Yes		-
8.7.264	Buzzer	Yes		-
8.7.265	A second Antenna Reader can be connected for permanent tag holders	Yes		-
8.7.266	<u>Key Futures</u>			
8.7.267	Reads selected third party Credit Card Tags.	Yes		-
8.7.268	Reads Read/Write Tags.	Yes		-
8.7.269	Connection to ONE Antenna Reader, to "Reader 2",	Yes		-
8.7.270	An excellent user interface consisting of 9 LED "Diagnostic Indicators"	Yes		-
8.7.271	An external RS485 Terminal Communications Bus Interface.	Yes		-
8.7.272	A software utility to upgrade Firmware while installed on-site, without removal of the drop box	Yes		-
8.7.273	Proximity Card			
8.7.274	Maker's type and reference	To be stated by Bidder		-
8.7.275	Manufacturer	To be stated by Bidder		-
8.7.276	Country of origin	To be stated by Bidder		-
8.7.277	ISO Credit card size and thickness	Yes		-
8.7.278	Printing company logo with graphics (front & rear)	Yes		-
8.7.279	Read Range: Indoor/Outdoor	5/30		cm
8.7.280	Working Temperature	-5-65		°C
8.7.281	Manual Over-rider key switch			
8.7.282	Maker's type and reference	To be stated by Bidder		-
8.7.283	Manufacturer	To be stated by Bidder		-
8.7.284	Country of origin	To be stated by Bidder		-
8.7.285	Double pole on/off key switch	Yes		-
8.7.286	Key removable in on and off positions.	Yes		-
8.7.287	Radial Key Switch, on/off, opposing double poles	Yes		-
8.7.288	Slim-line key box (25 mm) for easy installation on narrow door frames	25		mm

8.7.289	On/off LED indication	Yes		-
8.7.290	Request to enter/exit button			
8.7.291	Maker's type and reference	To be stated by Bidder		-
8.7.292	Manufacturer	To be stated by Bidder		-
8.7.293	Country of origin	To be stated by Bidder		-
8.7.294	<u>No touch exit sensor</u>			
8.7.295	Operating Voltage	12		VDC
8.7.296	Contacts	NO and NC		-
8.7.297	Touch to exit	Yes		-
8.7.298	Ingress protection	IP68		-
8.7.299	Sensitive distance	3-15		cm
8.7.300	<u>Push exit button</u>			
8.7.301	Heavy duty	Yes		-
8.7.302	Normally open, pulsed push button	Yes		-
8.7.303	Emergency door release			
8.7.304	Maker's type and reference	To be stated by Bidder		-
8.7.305	Manufacturer	To be stated by Bidder		-
8.7.306	Country of origin	To be stated by Bidder		-
8.7.307	Green Call Point	Resettable		-
8.7.308	Mechanical emergency door release switch	Yes		-
8.7.309	Surface mount box with conduit knockout	Yes		-
8.7.310	Manual key resettable actuator	Yes		-
8.7.311	Push-point activation	Yes		-
8.7.312	Includes hinged, clear plastic protective cover	Yes		-
8.7.313	Colour	Green		-
8.7.314	Turnstile			
8.7.315	Maker's type and reference	To be stated by Bidder		-
8.7.316	Manufacturer	To be stated by Bidder		-
8.7.317	Country of origin	To be stated by Bidder		-
8.7.318	Power supply	230		VAC
8.7.319	Protection rating	IP40		-
8.7.320	Operating temperatures	-20-55		°C
8.7.321	Automatic Sliding Gate Motor			
8.7.322	Input Voltage	240 ±10%		VAC
8.7.323	Frequency	50		Hz
8.7.324	Current consumption	250		mA
8.7.325	Battery charger voltage output	27±1%		VDC
8.7.326	Battery charger current output	1.8		A
8.7.327	Minimum number of operations per day	350		Nos.
8.7.328	Duty cycle - Mains present	45		%
8.7.329	Motor voltage	24		VDC
8.7.330	Battery for Motor power supply, Voltage	2x12		VDC
8.7.331	Battery for Motor power supply, Capacity	7.2		Ah
8.7.332	Current consumption (motor at rated load)	8		A
8.7.333	Motor push force – starting	40		kgf
8.7.334	Motor push force – rated	30		kgf
8.7.335	Gate mass – maximum	1000		kg

9. Control and Protection Equipment

9.1. Three Phase Programmable Meter

Item	Description	Required	Tendered	Unit
9.1.1	Maker's name	Bidder to state		-
9.1.2	Maker's type and reference	Bidder to state		-
9.1.3	Country of origin	Bidder to state		-
9.1.4	Description	Energy meter		-
9.1.5	Meter type	Landis + Gyr (E880) or CEWE Prometer 540 or equivalent		-
9.1.6	Meter type for interconnector line	Microstar P2000-T or compatible		-
9.1.7	Standard	IEC61850 compliant		-
9.1.8	Current Rating, In	0,01 -1A OR 0,05-5A User programmable to any CT ratio		-
9.1.9	Accuracy Class	Class 0.2s or better		-
9.1.10	Auxiliary Supply	40 – 240AC, 40 – 300DC		V
9.1.11	Capabilities	Import and Export measuring of; MWh, MVAh, MVArh and the Maximum Demands (MVA, MW, MVAh) with date & time of occurrence		-
9.1.12	Data logging/profiling	YES		-
9.1.13	Register Type	LCD (8 digit electronic display)		-
9.1.14	CT Polarity reversal	Able to detect and record date of occurrence and restoration with phase identification		-
9.1.15	Installation	At least two seals		-
9.1.16	Integrity	Inaccessible without breaking seals		-
9.1.17	Communication Interface	Optical interface, Ethernet		-
9.1.18	Protocol	IEC 62056/IEC 61850		-
9.1.19	Bi-directional and protocol to be of type	Flag as per IEC 62056-21		-
9.1.20	Port for remote communication.	Ethernet, RS485/GPRS/GSM		-
9.1.21	Communication module	IEC 61850 and 4G		-
9.1.22	Applicable electronic Meter software with optical probe	Windows based software for programming and downloading. The3meter should be fully user programmable and downloadable		-
9.1.23	Time of Use Capabilities	YES		-
9.1.24	Historical Data	>12 months of sets of historical data		-
9.1.25	Quality Assurance Certificate	To be provided with the Quotation		-
9.1.26	Applicable standards	IEC 62052-11, 62053-21, 62053-22, 62053-23, 62053-61; 62056, 61850		-
9.1.27	Must be easily integrated into existing system	YES		-

9.2. Three Phase Power Quality Meter

Item	Description	Required	Tendered	Unit
9.2.1	Maker's name	Bidder to state		-
9.2.2	Maker's type and reference	Bidder to state		-
9.2.3	Country of origin	Bidder to state		-
9.2.4	Description	PQM		-
9.2.5	Meter type	Power quality meter as Unipower 2210 or equivalent		-
9.2.6	Accuracy Class	Class 0.2s or better		-
9.2.7	Capabilities	Import and Export measuring of; MWh, MVAh, MVARh and the Maximum Demands (MVA, MW, MVAR) with date & time of occurrence		-
9.2.8	Data logging/profiling	YES		-
9.2.9	Register Type	LCD (8 digit electronic display)		-
9.2.10	Integration Period	User programmable (1 to 60 minutes)		-
9.2.11	System/Circuit Type	3P3W or 3P4W Programmable		-
9.2.12	CT Polarity reversal	Able to detect and record date of occurrence and restoration with phase identification		-
9.2.13	Installation	At least two seals		-
9.2.14	Integrity	Inaccessible without breaking seals		-
9.2.15	Protocol	IEC 62056/IEC 61850		-
9.2.16	Communication Interface	Optical interface, Ethernet		-
9.2.17	Bi-directional and protocol to be of type	Flag as per IEC 62056-21		-
9.2.18	Port for remote communication	Ethernet, RS485/GPRS/GSM		-
9.2.19	Communication module	IEC 61850 and 4G		-
9.2.20	Applicable electronic Meter software with optical probe	Windows based software for programming and downloading. The meter should be fully user programmable and downloadable		-
9.2.21	Time of Use Capabilities	YES		-
9.2.22	Historical Data	>12 months of sets of historical data		-
9.2.23	Quality Assurance Certificate	To be provided with the Bid		-
9.2.24	Applicable standards	IEC 62052-11, 62053-21, 62053-22, 62053-23, 62053- 61, 62056, 61850		-
9.2.25	Must be easily Integrated into existing system	YES		-

9.3. Metering Workstation and Automatic Meter Infrastructure

Item	Description	Required	Tendered	Unit
9.3.1	Maker's name	Bidder to state		-
9.3.2	Maker's type and reference	Bidder to state		-
9.3.3	Country of origin	Bidder to state		-
9.3.4	Description	AM		-
9.3.5	Workstation Make	Bidder to state		-
9.3.6	Single Unit Packaging	Bidder to state		-
9.3.7	Efficient Chassis	Bidder to state		-
9.3.8	Microsoft Windows 11 Ultimate Edition 64bit OS UK	Yes		-
9.3.9	Supported OS lifecycle	Bidder to state		-
9.3.10	Latest version of Windows professional 64 Bit Factory Image Recovery	Yes		-
9.3.11	Intel Xeon E5-1603 2.80Ghz 10MB 1066 4C CPU	Yes		-
9.3.12	32GB DDR3-1600 ECC (3x2GB) RAM	Yes		-
9.3.13	NVIDIA NVS 310 512MB Graphics	Yes		-
9.3.14	NVIDIA NVS 310 512MB 2nd Graphics	Yes		-
9.3.15	2TB Drive	Yes		-
9.3.16	USB Standard Keyboard	Yes		-
9.3.17	USB Optical Scroll Mouse	Yes		-
9.3.18	16X SuperMulti DVDRW SATA 1st ODD	Yes		-
9.3.19	Intel CT x1 PCIe NIC	Yes		-
9.3.20	3/3/3 Warranty EURO	Yes		-
9.3.21	Country Kit	Yes		-
9.3.22	Processor Air Cooling Kit	Yes		-
9.3.23	Operating system	Yes		-
9.3.24	Latest version of Windows Professional is included in HW above.	Yes		-
9.3.25	Latest Version of Microsoft Office	Yes		-
9.3.26	McAfee, 1 year SW updates included	Yes		-
9.3.27	Monitors: HP ZR2440w 61 cm (24") LED Backlit IPS Monitor	Yes		-
9.3.28	Patching policy, hardening and cybersecurity requirements aligned with the IT security requirements	Yes		-
9.3.29	Secure storage of billing data, automated export to ZESCO corporate systems and provision of settlement data to ZESCO	Yes		-
9.3.30	Functions for data validation, estimation and editing (VEE) and audit trails consistent with revenue metering practice	Yes		-

9.4. Station Servers

Item	Description	Required	Tendered	Unit
9.4.1	Maker's name	Bidder to state		-
9.4.2	Maker's type and reference	Bidder to state		-
9.4.3	Country of origin	Bidder to state		-
9.4.4	Description	SAS HMI Server/Client		-
9.4.5	Redundancy	1+1 Hot standby		-
9.4.6	Communication Protocol	IEC 61850-8-2, IEC 61850-8-3		-
9.4.7	HMI Interface with Substation LAN redundancy	Bidder to state		-
9.4.8	Computer Platform/Type	Industrial Computer		-
9.4.9	Processor	Intel Core i7 or Equivalent		-
9.4.10	HMI Display	27-inch LED dual display		-
9.4.11	Storage	2TB SSD RAID-1 Storage		-
9.4.12	HMI Memory (capacity and redundancy)	Server 32GB / Client 16GB		-
9.4.13	HMI Additional Hardware	Bidder to state		-
9.4.14	HMI Mounting	Bidder to state		-
9.4.15	Server Operating System	Windows Server (Version with proven stability and compatibility with SAS Software)		-
9.4.16	HMI Operating System	Windows Professional (version with proven stability)		-
9.4.17	Antivirus Software	Proven Compatibility with SAS Applications		-
9.4.18	Backup Software Utility	Bidder to state		-

9.5. Gateway

Item	Description	Required	Tendered	Unit
9.5.1	Maker's name	Bidder to state		-
9.5.2	Maker's type and reference	Bidder to state		-
9.5.3	Country of origin	Bidder to state		-
9.5.4	Description	SAS Gateway		-
9.5.5	Redundancy	1+1 Hot standby		-
9.5.6	Communication Protocol	IEC 61850-8-2, IEC 61850-8-3, IEC 60870-5-104, Modbus Serial, Modbus TCP, IEC-103.		-
9.5.7	Substation LAN redundancy	Bidder to state		-
9.5.8	Computer Platform/Type	Industrial Computer		-
9.5.9	Processor	Intel Core i7 or Equivalent		-
9.5.10	Storage	2TB SSD RAID-1 Storage		-
9.5.11	Memory (capacity and redundancy)	16GB		-
9.5.12	Additional Hardware	Bidder to state		-
9.5.13	Mounting	Bidder to state		-
9.5.14	Operating System	Windows Professional (version with proven stability)		-
9.5.15	Antivirus Software	Proven Compatibility with SAS Applications		-
9.5.16	Backup Software Utility	Bidder to state		-

9.6. Remote Terminal Unit

Item	Description	Required	Tendered	Unit
9.6.1	Maker's name	Bidder to state		-
9.6.2	Maker's type and reference	Bidder to state		-
9.6.3	Country of origin	Bidder to state		-
9.6.4	Description	RTU		-
9.6.5	Analogue inputs	Bidder to state		Nos.
9.6.6	Digital inputs	Bidder to state		Nos.
9.6.7	Digital outputs	Bidder to state		Nos.
9.6.8	Fibre ports	Bidder to state		Nos.
9.6.9	Upstream communication ports	≥4 Ethernet ports		Nos.
9.6.10	UCP communication protocol support	IEC60870-5-104		-
9.6.11	Downstream communication ports	≥2		Nos.
9.6.12	DCP communication protocol supported	IEC61850-8-2, 61850-8-1 Modbus IEC60870-5-103, 60870-5-104		-

9.7. Engineering Workstation

Item	Description	Required	Tendered	Unit
9.7.1	Maker's name	Bidder to state		-
9.7.2	Maker's type and reference	Bidder to state		-
9.7.3	Country of origin	Bidder to state		-
9.7.4	Description	EWS		-
9.7.5	Standards	IEC618-8-2, 618-8-1		-
9.7.6	EWS Interface with Substation LAN redundancy	Bidder to state		-
9.7.7	Computer Platform/Type	Industrial Computer		-
9.7.8	Processor	Intel Core i7 or Equivalent		-
9.7.9	EWS Display	27-inch LED dual display		-
9.7.10	Storage	2TB SSD RAID-1 Storage		-
9.7.11	EWS Memory (capacity and redundancy)	32GB		-
9.7.12	EWS Additional Hardware	Bidder to state		-
9.7.13	EWS Mounting	Bidder to state		-
9.7.14	EWS Operating System	Windows Professional (version with proven stability)		-
9.7.15	Antivirus Software	Proven Compatibility with SAS Applications		-
9.7.16	Backup Software Utility	Bidder to state		-

9.8. Station LAN

Item	Description	Required	Tendered	Unit
9.8.1	Maker's name	Bidder to state		-
9.8.2	Maker's type and reference	Bidder to state		-
9.8.3	Country of origin	Bidder to state		-
9.8.4	Description	Station Bus Local Area Network		-
9.8.5	Standards and protocols	IEC61850-8-2, 61850-8-1, GOOSE, MMS, IEEE802.1q, 802.1d, NTP, PTP		-
9.8.6	GPS Time Server Manufacturer	Bidder to state		-
9.8.7	GPS Time Server Model Number	Bidder to state		-
9.8.8	GPS Time Server Country of Origin	Bidder to state		-
9.8.9	GPS Time Server Protocol	Bidder to state		-
9.8.10	GPS Time Server Protocol Accuracy	Bidder to state		-
9.8.11	Ethernet Switches Manufacturer	Bidder to state		-
9.8.12	Ethernet Switches Model Number	Bidder to state		-
9.8.13	Ethernet Switches Country or origin	Bidder to state		-
9.8.14	Ethernet Switches Number	Bidder to state		Nos.
9.8.15	Ethernet Switch Layer	3		-

9.9. All Bay Control Units

Item	Description	Required	Tendered	Unit
9.9.1	Maker's name	Bidder to state		-
9.9.2	Maker's type and reference	Bidder to state		-
9.9.3	Country of origin	Bidder to state		-
9.9.4	Description	BCU requirements		-
9.9.5	Functional properties	Multi functional micro processor controlled integrated control and monitoring unit		-
9.9.6	Graphical Man-Machine Interface	Yes		-
9.9.7	Fuse Fail Supervision	Yes		-
9.9.8	Main Trip Circuit Supervision (Dual State)	Yes		-
9.9.9	Backup Trip Circuit Supervision (Dual State)	Yes		-
9.9.10	Circuit Breaker Fail Protection	Yes		-
9.9.11	Voltage and Current Measuring Functions	Yes		-
9.9.12	3 Phase Power Measuring Functions	Yes		-
9.9.13	Circuit Breaker Wear Monitor	Yes		-
9.9.14	Synchro Check function	Yes		-
9.9.15	Electrically operated devices' control	Yes - SCADA & Local selection via relay pushbuttons / switch		-
9.9.16	Local / Remote Control Selection	Yes - SCADA & Local selection via relay pushbuttons / switch		-
9.9.17	Binary opto-input Channels	>96		Nos.
9.9.18	Binary Output Channels	>24		Nos.
9.9.19	Internal hardware and Software Supervision	Internal Alarm variable programmable to a fail-safe Output Contact		-
9.9.20	Internal Relay Fail watchdog potential free contact	Yes		-
9.9.21	Data Communication on dual Ethernet port to Substation LAN	IEC61850-8-2, IEC61850-8-1, IEC61850-9-2 (including send /receive GOOSE) and legacy protocols such as MODBUS, IEC-103, etc		-
9.9.22	Large format Local HMI Display with integrated control functionality	Yes		-
9.9.23	Front-mounted LEDs for alarm or status annunciation	Yes		-
9.9.24	Full Local and Remote Control and Interlocking	Yes		-

9.9.25	Local Data Communication port	Yes (front		-
9.9.26	Attach Data Sheet, Technical Specifications and Type Test certificates	Yes		-
9.9.27	Mechanically Latched	Yes		-
9.9.28	Flagged Indication	Yes		-
9.9.29	Reset	Electrical and Manua		-
9.9.30	Maximum Operation time	25		ms
9.9.31	Attach Data Sheet, Technical Specifications and Type Test certificates	Yes		-

9.10. Bay Control Unit OHL and Reactor

Item	Description	Required	Tendered	Unit
9.10.1	Maker's name	Bidder to state		-
9.10.2	Maker's type and reference	Bidder to state		-
9.10.3	Country of origin	Bidder to state		-
9.10.4	Description	BCU		-
9.10.5	Functional properties	Multi functional micro processor controlled integrated control and monitoring unit		-
9.10.6	Model	Schneider Micom C264 or equivalent, Bidder to state tendered		-
9.10.7	Graphical Man-Machine Interface	Yes		-
9.10.8	Fuse Fail Supervision	Yes		-
9.10.9	Main Trip Circuit Supervision (Dual State)	Yes		-
9.10.10	Backup Trip Circuit Supervision (Dual State)	Yes		-
9.10.11	Circuit Breaker Fail Protection	Yes		-
9.10.12	Voltage and Current Measuring Functions	Yes		-
9.10.13	3 Phase Power Measuring Functions	Yes		-
9.10.14	Circuit Breaker Wear Monitor	Yes		-
9.10.15	Synchro Check function	Yes		-
9.10.16	Electrically operated devices' control	Yes - SCADA & Local selection via relay pushbuttons / switch		-
9.10.17	Local / Remote Control Selection	Yes - SCADA & Local selection via relay pushbuttons / switch		-
9.10.18	Binary opto-input Channels	>96		-
9.10.19	Binary Output Channels	>24		-
9.10.20	Binary Input Voltage Range	60-220		-
9.10.21	Rated Auxiliary Supply Voltage	60-220		-
9.10.22	Rated Auxiliary Supply Voltage Operation Range	80 - 120		-
9.10.23	Internal hardware and Software Supervision	Internal Alarm variable programmable to a fail-safe Output Contact		-
9.10.24	Internal Relay Fail watchdog potential free contact	Yes		-
9.10.25	Data Communication on dual Ethernet port to Substation LAN – IEC61850 (including send /receive GOOSE) and legacy protocols such as MODBUS, IEC-103, DNP.3, etc	Yes		-
9.10.26	Time Synchronization capable (SNTP/PTP)	Yes		-
9.10.27	Large format Local HMI Display with integrated control functionality	Yes		-
9.10.28	Front-mounted LEDs for alarm or status annunciation	Yes		-
9.10.29	Full Local and Remote Control and Interlocking	Yes		-
9.10.30	Local Data Communication port	Yes (front		-
9.10.31	Communication requirements	In line with IEC 61850		-
9.10.32	Type test	Authority, year, Doc.no		-
9.10.33	Standards	IEC		-

9.11. Busbar protection 330 and 132 kV - Main I

Item	Description	Required	Tendered	Unit
9.11.1	Maker's name	Bidder to state		-
9.11.2	Maker's type and reference	Bidder to state		-
9.11.3	Country of origin	Bidder to state		-
9.11.4	Description	Zone protection relay		-
9.11.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.11.6	Communication requirements	In line with IEC 61850		-
9.11.7	Type test	Authority, year, Doc.no		-
9.11.8	Standards	IEC 61850		-
9.11.9	Protection Functions supported	Low impedance differential with integral check zone and ≥ 6 unique protection zones		-
9.11.10	Minimum number of bays supported	18		Nos.
9.11.11	Communication medium supported	Fibre Optic		-
9.11.12	Number of user-definable sitting groups available	Bidder to State		Nos.
9.11.13	Internal sequence of event recording with an accuracy of 1ms	Yes		-
9.11.14	Relay operating time for an in-zone fault	<20		ms
9.11.15	Operating voltages of digital inputs	< 80% of V nominal		V
9.11.16	Electrical environmental tests required	IV (severe)		-
9.11.17	Included protection functions:			
9.11.18	1. Differential Protection, 87B	Yes		-
9.11.19	Additional Functions:			
9.11.20	- Event recording	Yes		-
9.11.21	- Disturbance recorder	Yes		-

9.12. Line Protection 330 and 132 kV - Main I Diff. Protection

Item	Description	Required	Tendered	Unit
9.12.1	Maker's name	Bidder to state		-
9.12.2	Maker's type and reference	Bidder to state		-
9.12.3	Country of origin	Bidder to state		-
9.12.4	Description	Current differential protection		-
9.12.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.12.6	Communication requirements	In line with IEC 61850		-
9.12.7	Type test	Authority, year, Doc.no		-
9.12.8	Standards	IEC61850		-
9.12.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.12.10	Number of minimum user-definable setting groups available	2		Nos.
9.12.11	Integral sequence of event recording with an accuracy of 1ms	Yes		-
9.12.12	Integral Fault Recorder	Yes		-
9.12.13	Integral Fault Locator	Yes		-
9.12.14	Phase segregated protection	Yes		-
9.12.15	Adjustable biased differential protection characteristic	Yes		-
9.12.16	Trip Mode	1 or 3 pole (selectable)		-
9.12.17	Relay operating time for an in- zone fault	<30		ms
9.12.18	Operating voltages of digital inputs	< 80% of V nominal		%
9.12.19	Electrical environmental tests required	IV (severe)		-
9.12.20	Differential current pickup values	0.1 to 2.0 x In; steps of 0.05 x In Timer: 0 to 20s Steps of 0.01s		-
9.12.21	Differential pickup/trip times	< 30 ms		-
9.12.22	Line Charge Compensation	Yes		-
9.12.23	Full scheme distance - all phase to phase and all phase to earth loop impedances shall be simultaneously computed and compared with each zone limit.	Yes		-
9.12.24	4 forward zones ph-ph & ph-E	Yes		-
9.12.25	1 reverse zone ph-ph & ph-E	Yes		-
9.12.26	Phase fault & Earth fault characteristic shapes (Mho, Quad)	Yes		-
9.12.27	Nominal Z1 Operating time	Yes		-
9.12.28	Impedance setting range, reactive reach, positive sequence reactance	Yes		-
9.12.29	Impedance setting range, reactive reach, zero sequence reactance	Yes		-
9.12.30	Impedance setting range, resistive reach, positive sequence resistance	Yes		-
9.12.31	Impedance setting range, resistive reach, zero sequence resistance	Yes		-
9.12.32	Phase selection logic	Yes		-
9.12.33	SOFT	Yes		-
9.12.34	Power Swing Blocking	Yes		-
9.12.35	Mutual zero sequence compensation	Yes		-
9.12.36	Voltage Transformer Supervision	Yes		-
9.12.37	Time delays for all Zones	Yes		-
9.12.38	Auto reclose 1 or 3 pole (selectable)	Yes		-
9.12.39	Check Synchronism	Yes		-
9.12.40	Breaker Fail Protection	Yes		-
9.12.41	Undervoltage protection	Yes		-
9.12.42	Overvoltage protection	Yes		-
9.12.43	Trip Circuit supervision	Yes		-
9.12.44	Broken conductor detection	Yes		-

9.13. Line Protection 330 and 132 kV - Main II Distance Protection

Item	Description	Required	Tendered	Unit
9.13.1	Maker's name	Bidder to state		-
9.13.2	Maker's type and reference	Bidder to state		-
9.13.3	Country of origin	Bidder to state		-
9.13.4	Description	Distance protection relay		-
9.13.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.13.6	Communication requirements	In line with IEC 61850		-
9.13.7	Type test	Authority, year, Doc.no		-
9.13.8	Standards	IEC		-
9.13.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.13.10	Number of user-definable setting groups available	2		Nos.
9.13.11	Internal sequence of event recording with an accuracy of 1ms	Yes		-
9.13.12	Binary inputs	≥24		Nos.
9.13.13	Analogue inputs	≥4 CT and ≥4 VT		Nos.
9.13.14	Binary outputs for tripping	≥4		Nos.
9.13.15	Binary outputs for signal	≥16		Nos.
9.13.16	Operating voltages of digital inputs	< 80% of V nominal		V
9.13.17	Electrical environmental tests required	IV (severe)		-
9.13.18	Relay operating time for an in- zone fault	<30		ms
9.13.19	Full scheme distance - all phase to phase and all phase to earth loop impedances shall be simultaneously computed and compared with each zone limit.	Yes		-
9.13.20	4 forward zones ph-ph & ph-E	Yes		-
9.13.21	1 reverse zone ph-ph & ph-E	Yes		-
9.13.22	Time delay for all zones	Yes		-
9.13.23	Zone enable/disable for all zones	Yes		-
9.13.24	Phase fault & Earth fault characteristic shapes (Mho, Quad)	Quad		-
9.13.25	Nominal Z1 Operating time	<30		ms
9.13.26	Impedance setting range, reactive reach, positive sequence reactance	Bidder to state		-
9.13.27	Impedance setting range, reactive reach, zero sequence reactance	Bidder to state		-
9.13.28	Impedance setting range, resistive reach, positive sequence resistance	Bidder to state		-
9.13.29	Impedance setting range, resistive reach, zero sequence resistance	Bidder to state		-
9.13.30	Maximum system impedance ratio at which accuracy is maintained	Bidder to state		-
9.13.31	Distance Tele-protection schemes	DTT, PUTT, POTT, Blocking (selectable)		-
9.13.32	Week-end infeed trip	Yes		-
9.13.33	Current reversal logic	Yes		-
9.13.34	Phase selection logic	Yes		-
9.13.35	SOFT	Yes		-
9.13.36	Power Swing Blocking	Yes		-
9.13.37	Mutual zero sequence compensation	Yes		-
9.13.38	Voltage Transformer Supervision	Yes		-
9.13.39	CT Supervision	Yes		-
9.13.40	Directional Earth Fault (DEF)	Yes		-
9.13.41	DEF tele-protection scheme	None/ Permissive/		-
9.13.42	Auto reclose	Blocking (selectable) 1 or 3 pole (selectable)		-
9.13.43	Check Synchronism	Yes		-
9.13.44	Breaker Fail Protection	Yes		-
9.13.45	Undervoltage protection	Yes		-
9.13.46	Trip Circuit supervision	Yes		-
9.13.47	Disturbance recorder	Yes		-

9.14. Line Protection 330 and 132 kV - Back-up

Item	Description	Required	Tendered	Unit
9.14.1	Maker's name	Bidder to state		-
9.14.2	Maker's type and reference	Bidder to state		-
9.14.3	Country of origin	Bidder to state		-
9.14.4	Description	Feeder management relay		-
9.14.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.14.6	Communication requirements	In line with IEC 61850		-
9.14.7	Type test	Authority, year, Doc.no		-
9.14.8	Standards	IEC		-
9.14.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.14.10	Number of user-definable sitting groups available	2		Nos.
9.14.11	Internal sequence of event recording with an accuracy of 1ms	Yes		-
9.14.12	Binary inputs	≥8		Nos.
9.14.13	Analogue inputs	≥5 CT and ≥3 VT		Nos.
9.14.14	Binary outputs for tripping	≥7		Nos.
9.14.15	Binary outputs for signal	≥4		Nos.
9.14.16	Operating voltages of digital inputs	< 80% of V nominal		V
9.14.17	Electrical environmental tests required	IV (severe)		-
9.14.18	Definite Time and IDMT Overcurrent	0.08 to 4 x In; steps of 0.01 x In Timer: 0 to 100s steps of 0.01 s TMS 0.025 to 1.200		-
9.14.19	Highset Overcurrent	0.08 to 32 x In; steps of 0.01 x In Timer: 0.00 to 100s steps of 0.01 s		-
9.14.20	Definite Time and IDMT Earth Fault	0.08 to 4 x In; steps of 0.01 x In Timer: 0 to 200s steps of 0.01 s TMS 0.025 to 1.200		-
9.14.21	Highset Earth Fault	0.08 to 32 x In; steps of 0.01 x In Timer: 0.00 to 200s steps of 0.01 s		-
9.14.22	67/67N MTA:	-95° to +95°		-
9.14.23	Minimum operating range	7 VP-P or VP-N		-
9.14.24	Breaker Fail	Yes		-
9.14.25	Over Voltage	Yes		-
9.14.26	Under Voltage	Yes		-
9.14.27	Under/Over Frequency	Yes		-
9.14.28	Direct Transfer Trip	Yes		-
9.14.29	CT Supervision	Yes		-
9.14.30	VT Supervision	Yes		-
9.14.31	SOTF	Yes		-
9.14.32	Additional Functions:			
9.14.33	- Event recording	Yes		-
9.14.34	- Disturbance recorder	Yes		-

9.15. Transformer Automatic Voltage Control

Item	Description	Required	Tendered	Unit
9.15.1	Maker's name	Bidder to state		-
9.15.2	Maker's type and reference	Bidder to state		-
9.15.3	Country of origin	Bidder to state		-
9.15.4	Description	TC control		-
9.15.5	Functional properties	Multi functional micro processor controlled relay		-
9.15.6	Communication requirements	In line with IEC 61850		-
9.15.7	Type test	Authority, year, Doc.no		-
9.15.8	Standards	IEC		-
9.15.9	Paralleling control	Master Follower & Limiting of Circulating Current (selectable)		-
9.15.10	Local / Remote control selection	Yes - Local selection via relay pushbuttons / Switch		-
9.15.11	Manual / Auto control selection	Yes - SCADA & Local selection via relay pushbuttons		-
9.15.12	Manual Raise / Lower control	Yes - SCADA & Local selection via relay pushbuttons		-
9.15.13	Definite and Inverse time Voltage control characteristic	Yes		-
9.15.14	External Blocking Input	Yes		-
9.15.15	"Tap Position"-Interface to Transformer	BCD		-
9.15.16	Data Communication port to Substation LAN – IEC61850 (including send/receive GOOSE)	Yes		-
9.15.17	Local Data Communication Port	Yes		-

9.16. Transformer, Reactor Protection 330 and 132 kV - Main I

Item	Description	Required	Tendered	Unit
9.16.1	Maker's name	To be stated by Bidder		-
9.16.2	Maker's type and reference	To be stated by Bidder		-
9.16.3	Country of origin	To be stated by Bidder		-
9.16.4	Description	Biased Differential Protection Relay		-
9.16.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.16.6	Communication requirements	In line with IEC 61850		-
9.16.7	Type test	Authority, year, Doc.no		-
9.16.8	Standards	IEC		-
9.16.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.16.10	Number of minimum user-definable setting groups available	2		Nos.
9.16.11	Integral sequence of event recording with an accuracy of 1ms	Yes		-
9.16.12	Integral Fault Recorder	Yes		-
9.16.13	g) Relay operating time for an in- zone fault	<30		ms
9.16.14	Binary inputs	≥12		Nos.
9.16.15	Analogue inputs CT / VT	≥8 / 2		Nos.
9.16.16	Binary outputs for tripping	≥4		Nos.
9.16.17	Binary outputs for signal	≥8		Nos.
9.16.18	Operating voltages of digital inputs	< 80% of V nominal		%
9.16.19	Electrical environmental tests required	IV (severe)		-
9.16.20	Differential current pickup values	0.1 to 1.5 x I _n ; steps of 0.05 x I _n Timer: 0 to 20s steps of 0.01s		-
9.16.21	Differential pickup/trip times	< 30		ms
9.16.22	High Set Differential pickup / trip times	< 20		ms
9.16.23	Differential Current IREF Values	0.1 to 1.5 x I _n ; steps of 0.05 x I _n Timer: 0 to 20s steps of 0.01s		-
9.16.24	IREF Differential pickup / trip times @ 2.5 x Setting	< 30		ms
9.16.25	Definite Time Overcurrent	1 to 20 x I _n ; steps of 1 x I _n Timer: 0 to 20s steps of 0.01s		-
9.16.26	IDMT Overcurrent	0,5 to 5 x I _n ; steps of 0.05 x I _n In Time multiplier: 0.05 to 3s steps of 0.01s		-
9.16.27	Overexcitation protection (v/Hz)	Yes		-

9.17. Transformer, Reactor Protection 330 and 132 kV - Main II

Item	Description	Required	Tendered	Unit
9.17.1	Maker's name	To be stated by Bidder		-
9.17.2	Maker's type and reference	To be stated by Bidder		-
9.17.3	Country of origin	To be stated by Bidder		-
9.17.4	Description	Biased Differential Protection Relay		-
9.17.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.17.6	Communication requirements	In line with IEC 61850		-
9.17.7	Type test	Authority, year, Doc.no		-
9.17.8	Standards	IEC		-
9.17.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.17.10	Number of minimum user-definable setting groups available	2		Nos.
9.17.11	Integral sequence of event recording with an accuracy of 1ms	Yes		-
9.17.12	Integral Fault Recorder	Yes		-
9.17.13	Binary inputs	≥12		Nos.
9.17.14	Analogue inputs CT / VT	≥8 / 2		Nos.
9.17.15	Binary outputs for tripping	≥4		Nos.
9.17.16	Binary outputs for signal	≥8		Nos.
9.17.17	Operating voltages of digital inputs	< 80% of V nominal		%
9.17.18	Differential current pickup values	0.1 to 1.5 x I _n ; steps of 0.05 x I _n Timer: 0 to 20s steps of 0.01s		-
9.17.19	Differential pickup/trip times	< 30		ms
9.17.20	High Set Differential pickup / trip times	< 20		ms
9.17.21	Differential Current IREF Values	0.1 to 1.5 x I _n ; steps of 0.05 x I _n Timer: 0 to 20s steps of 0.01s		-
9.17.22	IREF Differential pickup / trip times @ 2.5 x Setting	< 30		ms
9.17.23	Definite Time Overcurrent	1 to 20 x I _n ; steps of 1 x I _n Timer: 0 to 20s steps of 0.01s		-
9.17.24	IDMT Overcurrent	0.5 to 5 x I _n ; steps of 0.05 x I _n In Time multiplier: 0.05 to 3s steps of 0.01s		-
9.17.25	Overexcitation protection (v/Hz)	Yes		-

9.18. Transformer, Reactor and Neutral Reactor Protection 330 and 132 kV - Back-up

Item	Description	Required	Tendered	Unit
9.18.1	Maker's name	To be stated by Bidder		-
9.18.2	Maker's type and reference	To be stated by Bidder		-
9.18.3	Country of origin	To be stated by Bidder		-
9.18.4	Description	OC/EF relay		-
9.18.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.18.6	Communication requirements	In line with IEC 61850		-
9.18.7	Type test	Authority, year, Doc.no		-
9.18.8	Standards	IEC		-
9.18.9	Applicable Setting, Engineering, Disturbance Recording Software	Yes		-
9.18.10	Number of minimum user-definable setting groups available	2		Nos.
9.18.11	Integral sequence of event recording with an accuracy of 1ms	Yes		-
9.18.12	Integral Fault Recorder	Yes		-
9.18.13	Binary inputs	≥8		Nos.
9.18.14	Analogue inputs CT / VT	≥5 / 3		Nos.
9.18.15	Binary outputs for tripping	≥4		Nos.
9.18.16	Binary outputs for signal	≥7		Nos.
9.18.17	Operating voltages of digital inputs	< 80% of V nominal		%
9.18.18	Definite Time Overcurrent	1 to 20 x In; steps of 1 x In Timer: 0 to 20s steps of 0.01s		-
9.18.19	IDMT Overcurrent	0,5 to 5 x In; steps of 0.05 x In In Time multiplier: 0.05 to 3s steps of 0.01s		-

9.19. Transformer Protection 11/0.4 kV

Item	Description	Required	Tendered	Unit
9.19.1	Maker's name	Bidder to state		-
9.19.2	Maker's type and reference	Bidder to state		-
9.19.3	Country of origin	Bidder to state		-
9.19.4	Description	OC/EF protection		-
9.19.5	Functional properties	Multi functional micro processor controlled protection relay		-
9.19.6	Communication requirements	In line with IEC 61850		-
9.19.7	Type test	Authority, year, Doc.no		-
9.19.8	Standards	IEC		-
9.19.9	Overcurrent Protection, 50/51	Yes		-
9.19.10	Earth Fault Protection, 50N/51N	Yes		-
9.19.11	Circuit Breaker Failure Protection, 50BF	Yes		-

9.20. Digital Metering

Item	Description	Required	Tendered	Unit
9.20.1	Maker's name	Bidder to state		-
9.20.2	Maker's type and reference	Bidder to state		-
9.20.3	Country of origin	Bidder to state		-
9.20.4	Description	Digital energy meter		-
9.20.5	Type test	Authority, year, Doc.no		-
9.20.6	Nominal system voltage	110		V
9.20.7	Capabilities	Time of use metering, Import and Export measuring, shall record the active energy (MWh), apparent energy (MVAh), reactive energy (MVArh) and the Maximum Demands (MVA, MW, MVAh) with date & time of occurrence for both import and export directions. The Maximum Demand shall be user programmable to MVA, MW or MVAh. ALL READINGS TO BE PRIMARY VALUES. Instrument Transformer CT and VT ratios shall be programmable on the meter. Programmable scaling of readings to Mega or Kilo and number of decimals.		-
9.20.8	Measuring voltage range	80-120		%U _n
9.20.9	Tolerance	±20		%
9.20.10	Auxiliary supply voltage	Dual application, 40 – 250 AC/DC. DC auxiliary supply voltage use is first priority.		V
9.20.11	Current rating	1/5 programmable to any CT ratio		A
9.20.12	Starting current (0.002 I _n)	2/10		mA
9.20.13	Maximum power consumption	15/3		VA/W
9.20.14	Demand load profiling and Integration Period	Load profiling of active power, reactive power and apparent power demand. Average demand shall be selectable to be either by block demand or rolling demand. The integration period shall be user programmable (1 to 60 minutes), default 30 minutes. Window for rolling demand shall also be programmable.		-
9.20.15	System	3 phase 3 wire, 3 Phase, 4 wire. The meter shall be programmable between the two systems.		-
9.20.16	Accuracy class line bay and reactor bay	0.2		-
9.20.17	Accuracy class transformer bay and gen-set	0.25		-
9.20.18	Short circuit rating	20 I _n		A
9.20.19	Impulse withstand voltage	3		kV
9.20.20	Installation	At least two seals		-
9.20.21	Meter Display Information and measurements	8 digit display		-

9.20.22	Communication Interface: Optical interface, Ethernet, Protocol: IEC 62056	bi-directional and protocol to be of type Flag as per IEC 62056-21 for site communication, Functional Ethernet port for remote communication and remote reading		-
9.20.23	Over-current protection with a short circuit current	20 I _{max}		A
9.20.24	Meter shall have provision for the user to view a pre-configured cycle	Yes		-
9.20.25	Lightning protection according to	BS 1524 and IEC62053-21		-
9.20.26	Anti-Tampering Features	Tamper protection Anti-tamper switch Tamper logging/indications AMR functionalities		-
9.20.27	Applicable electronic Meter software	Windows based software for programming and downloading. The meter should be fully user programmable and downloadable. Copies of CDs for the meter software with labelling showing software name, version, etc		-
9.20.28	Time of Use Registers	8		Nos.
9.20.29	Maximum Demand Registers	8		Nos.
9.20.30	Volt Free Output Relays (Internal & normally open)	4		Nos.
9.20.31	Casing	House Service Pattern Case, extended Terminal Cover		-
9.20.32	Historical Data	Average demand Load Profiling (MW, MVar, MVA) (450 days, 1 Channel, 30 minutes), at least twelve months historical active energy (MWh), reactive energy (MVarh), apparent energy (MVAh) and maximum demand billing data logging in meter memory. The average demand load profiling should be programmable between block demand and sliding demand. At least twelve months of sets of historical data		-
9.20.33	Quality Assurance Certificate	To be provided with the bid		-
9.20.34	Routine test results	To be provided on delivery of meters for each meter		-
9.20.35	Previous Type test results	To be provided with the bid		-
9.20.36	Drawings showing dimensions of meters	To be provided with the bid		-
9.20.37	Applicable standards	IEC 62052-11, 62053-21, 62053-22, 62053-23, 62053-61; 62056		-
9.20.38	Operators manual Hard copy	To be provided with meters, 5 copies		-
9.20.39	Technical manual Hard copy	To be provided with meters, 5 copies		-

9.21. Meters, indicating Instrument*To be filled in for each instrument type used*

Item	Description	Required	Tendered	Unit
9.21.1	Kind of meter	Bidder to state		-
9.21.2	Range	Bidder to state		-
9.21.3	Maker’s name	Bidder to state		-
9.21.4	Maker’s type and reference	Bidder to state		-
9.21.5	Country of origin	Bidder to state		-
9.21.6	Description	Bidder to state		-
9.21.7	Type test	Authority, year, Doc.no		-
9.21.8	Standards	IEC		-
9.21.9	Kind of meter	Bidder to state		-
9.21.10	Range	Bidder to state		-
9.21.11	Maker’s name	Bidder to state		-
9.21.12	Maker’s type and reference	Bidder to state		-
9.21.13	Country of origin	Bidder to state		-
9.21.14	Description	Bidder to state		-
9.21.15	Type test	Authority, year, Doc.no		-
9.21.16	Standards	IEC		-
9.21.17	Kind of meter	Bidder to state		-
9.21.18	Range	Bidder to state		-
9.21.19	Maker’s name	Bidder to state		-
9.21.20	Maker’s type and reference	Bidder to state		-
9.21.21	Country of origin	Bidder to state		-
9.21.22	Description	Bidder to state		-
9.21.23	Type test	Authority, year, Doc.no		-
9.21.24	Standards	IEC		-
9.21.25	Kind of meter	Bidder to state		-
9.21.26	Range	Bidder to state		-
9.21.27	Maker’s name	Bidder to state		-
9.21.28	Maker’s type and reference	Bidder to state		-
9.21.29	Country of origin	Bidder to state		-
9.21.30	Description	Bidder to state		-
9.21.31	Type test	Authority, year, Doc.no		-
9.21.32	Standards	IEC		-
9.21.33	Kind of meter	Bidder to state		-
9.21.34	Range	Bidder to state		-
9.21.35	Maker’s name	Bidder to state		-
9.21.36	Maker’s type and reference	Bidder to state		-
9.21.37	Country of origin	Bidder to state		-
9.21.38	Description	Bidder to state		-
9.21.39	Type test	Authority, year, Doc.no		-
9.21.40	Standards	IEC		-
9.21.41	Kind of meter	Bidder to state		-
9.21.42	Range	Bidder to state		-
9.21.43	Maker’s name	Bidder to state		-
9.21.44	Maker’s type and reference	Bidder to state		-
9.21.45	Country of origin	Bidder to state		-
9.21.46	Description	Bidder to state		-
9.21.47	Type test	Authority, year, Doc.no		-
9.21.48	Standards	IEC		-

9.21.49	Kind of meter	Bidder to state		-
9.21.50	Range	Bidder to state		-
9.21.51	Maker's name	Bidder to state		-
9.21.52	Maker's type and reference	Bidder to state		-
9.21.53	Country of origin	Bidder to state		-
9.21.54	Description	Bidder to state		-
9.21.55	Type test	Authority, year, Doc.no		-
9.21.56	Standards	IEC		-

9.22. OFC Approach Fibre Cable

Item	Description	Required	Tendered	Unit
9.22.1	Maker's name	Bidder to state		-
9.22.2	Maker's type and reference	Bidder to state		-
9.22.3	Country of origin	Bidder to state		-
9.22.4	Description	Fibre optic cable		-
9.22.5	Type test	Authority, year, Doc.no		-
9.22.6	Standards	ITU-T G.655, ITU-T G.652, EIA/TIA 598, IEC 60794-1- 1, 60794-1-2, 60974-4-10, 60793-2-50		-
9.22.7	Number of fibres	48		-
9.22.8	Field mode wave length	1310		nm
9.22.9	Nominal cladding diameter	125.0		µm
9.22.10	Cable cut-off wavelength, maximum	1260		nm
9.22.11	Rodent proof	Yes		-
9.22.12	Tensile strength	2000		N
9.22.13	Crush strength per 100mm	2000		N
9.22.14	Attenuation coefficient maximum (1310-1625)	0.4		db/km
9.22.15	Minimum bending radius times of cable diameter Dynamic/Static	20/10		-
9.22.16	Cable-length/drum	Bidder to state		m
9.22.17	Weight/drum	Bidder to state		kg

9.23. Optical Distribution Frame (ODF)

Item	Description	Required	Tendered	Unit
9.23.1	Maker's name	Bidder to state		-
9.23.2	Maker's type and reference	Bidder to state		-
9.23.3	Country of origin	Bidder to state		-
9.23.4	Description	Bidder to state		-
9.23.5	Type test	Authority, year, Doc.no		-
9.23.6	Standards	Contacts IEC 61754-4		-
9.23.7	Insertion loss	<0.3		dB
9.23.8	Attenuation variation at repeated connection/disconnection 500 times	0.2		dB
9.23.9	IP-class (Installed)	IP 54		-
9.23.10	Life Time	>30		years

9.24. Optical Transport Network (OTN)

Item	Description	Required	Tendered	Unit
9.24.1	Maker's type and reference	To be stated by Bidder		
9.24.2	Manufacturer	To be stated by Bidder		
9.24.3	Country of origin	To be stated by Bidder		
9.24.4	OTN Characteristics			
9.24.5	Equipment Type	OTN		
9.24.6	Auxiliary power supply, voltage range	-48 to -54		V DC
9.24.7	Transmission Capacity	4000G or better		
9.24.8	Local/Remote Management	Open for integration, managing and monitoring on the already operational ZTE Network Management System (NMS)		
9.24.9	Transmission Distance without Signal Degradation	200		km
9.24.10	Support 40 x 100/200G Lambda System	Yes		
9.24.11	Supported Switching Granularity	ODU0/1/2/2e/3/4/Flex/ Packet/VC		
9.24.12	Unified management	Yes		
9.24.13	Reliability design (Supports 1+1 protection of main control, clock and power)	Yes		
9.24.14	Intelligent Optical Network	Yes		
9.24.15	Intelligent ROADM	Yes		
9.24.16	Smooth Expansion and Upgrade	Yes		
9.24.17	ODUK Protection	ODUK1 + 2		
9.24.18	Provided Service	Not less than 4 x 100G Capacity per direction in Line Side		
9.24.19	Provided Service	Not less than 10 x 10G and 10 x GE as Access		
9.24.20	OTDR			
9.24.21	Built-in OTDR Function	Yes		
9.24.22	Measure Optical Fiber Attenuation	Yes		
9.24.23	Measure Connector Loss	Yes		
9.24.24	Locate Optical Fiber Faults	Yes		
9.24.25	Learn about Optical Fiber Loss along the Length	Yes		

9.25. Optical Transport Network Equipment

Item	Description	Required	Tendered	Unit
9.25.1	Type	DWDM		
9.25.2	Manufacturer	Bidder to state		
9.25.3	Country of origin	Bidder to state		
9.25.4	Manufacturer's type designation	Bidder to state		
9.25.5	Catalogue number	Bidder to state		
9.25.6	Firmware version	Bidder to state		
9.25.7	Functions supported			
9.25.8	FOADM (Fixed Optical Add/Drop Multiplexer) and ROADM (Reconfigurable Optical Add/Drop Multiplexer) based on the support for ROADM optical layer wavelength service grooming	Yes		
9.25.9	ODUK electrical switching, Packet switching and TDM switching	Yes		
9.25.10	80x10G/40G/100G and 53 400G large capacity transmission	Yes		
9.25.11	100Gbit/s System			

9.25.12	80/96/120 wavelengths	Yes		
9.25.13	80/96/120 100GE transmission	Yes		
9.25.14	PM-QPSK Coherent Rx modulation for ULH transmission	Yes		
9.25.15	Forward Error Correction (FEC), Advanced Forward Error Correction (AFEC), Soft Decision FEC (SD-FEC), Electrical Return-to-Zero (ERZ) and adaptive receiver etc.	Yes		
9.25.16	Flexible add/drop of 1 to 80 wave-length with 50GHz channel spacing, and adjustable channel spacing (Gridless, $n \times 12.5\text{GHz}$)	Yes		
9.25.17	4 types of electrical switching sub-racks(S1, S2, S3 and S6), which can implement ODU0/1/2/2e/3/4/flex/packet/VC based centralized non-blocking cell switching and realize flexible service scheduling in electrical layer	Yes		

9.26. Packet Transport Network Equipment

Item	Description	Required	Tendered	Unit
9.26.1	Type	Bidder to state		
9.26.2	Manufacturer	Bidder to state		
9.26.3	Country of origin	Bidder to state		
9.26.4	Manufacturer's type designation	Bidder to state		
9.26.5	Catalogue number	Bidder to state		
9.26.6	Firmware version	Bidder to state		
9.26.7	Functions supported			
9.26.8	L2 switching (Ethernet/MPLS)	Yes		
9.26.9	L1 switching (OTN/SDH)	Yes		
9.26.10	Static MS-PW mode	Yes		
9.26.11	TDM services via TDM E1 interface and Ch STM-N interface	Yes		
9.26.12	OTN circuit service, as well as ODU0, ODU1, and ODU2/2E crossing granularity	Yes		
9.26.13	Multiple virtual Ethernet connections such as E-LINE, E-LAN and E-TREE with traffic monitoring, QoS, OAM and protection function corresponding based on specification	Yes		
9.26.14	ingress and egress port mirroring	Yes		
9.26.15	port rate, duplex mode and forced/self-negotiation query	Yes		
9.26.16	storm suppression of broadcast/multicast/unknown unicast packets	Yes		
9.26.17	powerful VLAN function to divide virtual working groups(such as VLAN, QinQ)	Yes		
9.26.18	Link aggregation	Yes		
9.26.19	L2VPN multi-cast	Yes		
9.26.20	VPWS/VPWS/H-VPLS	Yes		
9.26.21	MAC address floating prohibition	Yes		
9.26.22	Standard-based DiffServ, including traffic classification, policing, shaping, congestion control, queue scheduling	Yes		
9.26.23	Multiple OAM mechanism such as MPLS-TP OAM, and Ethernet OAM, link OAM	Yes		
9.26.24	network-level clock synchronization Multi-Service Bearer platform	Yes		
9.26.25	PWE3 circuit emulation of E1, STM-N, and ETHERNET port	Yes		
9.26.26	MPLS-TP tunnel	Yes		

9.27. Synchronous Digital Hierarchy (SDH) Equipment STM-64

Item	Description	Required	Tendered	Unit
9.27.1	Type	Bidder to state		
9.27.2	Manufacturer	Bidder to state		
9.27.3	Country of origin	Bidder to state		
9.27.4	Manufacturer's type designation	Bidder to state		
9.27.5	Catalogue number	Bidder to state		
9.27.6	Firmware version	Bidder to state		
9.27.7	Functions supported			
9.27.8	L2 switching (Ethernet/MPLS)	Yes		
9.27.9	L1 switching (SDH VCs)	Yes		
9.27.10	Static MS-PW mode	Yes		
9.27.11	TDM services via TDM E1 interface and Ch STM-N interface	Yes		
9.27.12	SDH circuit service, as well as VC12, VC3, and VC4 crossing granularity	Yes		
9.27.13	Multiple virtual Ethernet connections such as E-LINE, E-LAN and E-TREE with traffic monitoring, QoS, OAM and protection function corresponding based on specification	Yes		
9.27.14	ingress and egress port mirroring	Yes		
9.27.15	port rate, duplex mode and forced/self-negotiation query	Yes		
9.27.16	storm suppression of broadcast/multicast/unknown unicast packets	Yes		
9.27.17	powerful VLAN function to divide virtual working groups (such as VLAN, QinQ)	Yes		
9.27.18	Link aggregation	Yes		
9.27.19	L2VPN multi-cast	Yes		
9.27.20	VPLS/VPWS/H-VPLS	Yes		
9.27.21	MAC address floating prohibition	Yes		
9.27.22	Standard-based DiffServ, including traffic classification, policing, shaping, congestion control, queue scheduling	Yes		
9.27.23	Multiple OAM mechanism such as MPLS-TP OAM, and Ethernet OAM, link OAM	Yes		
9.27.24	network-level clock synchronization Multi-Service Bearer platform	Yes		
9.27.25	PWE3 circuit emulation of E1, STM-N, and ETHERNET port	Yes		
9.27.26	MPLS-TP tunnel	Yes		

9.28. FOX 615 Equipment STM-16

Item	Description	Required	Tendered	Unit
9.28.1	Type	Bidder to state		
9.28.2	Manufacturer	Bidder to state		
9.28.3	Country of origin	Bidder to state		
9.28.4	Manufacturer's type designation	Bidder to state		
9.28.5	Catalogue number	Bidder to state		
9.28.6	Firmware version	Bidder to state		
9.28.7	Functions supported			
9.28.8	L2 switching (Ethernet/MPLS)	Yes		
9.28.9	L1 switching (SDH (KLMs))	Yes		
9.28.10	Static MS-PW mode	Yes		
9.28.11	TDM services via TDM E1 interface and Ch STM-N interface	Yes		
9.28.12	SDH circuit service, as well as (KLMs) or VC12, VC3, and VC4 crossing granularity	Yes		
9.28.13	Multiple virtual Ethernet connections such as E-LINE, E-LAN and E-TREE with traffic monitoring, QoS, OAM and protection function corresponding based on specification	Yes		
9.28.14	ingress and egress port mirroring	Yes		
9.28.15	port rate, duplex mode and forced/self-negotiation query	Yes		
9.28.16	storm suppression of broadcast/multicast/unknown unicast packets	Yes		

9.28.17	powerful VLAN function to divide virtual working groups(such as VLAN, QinQ)	Yes		
9.28.18	Link aggregation	Yes		
9.28.19	L2VPN multi-cast	Yes		
9.28.20	VPLS/VPWS/H-VPLS	Yes		
9.28.21	MAC address floating prohibition	Yes		
9.28.22	Standard-based DiffServ, including traffic classification, policing, shaping, congestion control, queue scheduling	Yes		
9.28.23	Multiple OAM mechanism such as MPLS-TP OAM, and Ethernet OAM, link OAM	Yes		
9.28.24	network-level clock synchronization Multi-Service Bearer platform	Yes		
9.28.25	PWE3 circuit emulation of E1, STM-N, and ETHERNET port	Yes		
9.28.26	OPIC (differential protection)	Yes		
9.28.27	TEPI (Distance protection)	Yes		

9.29. PABX Equipment

Item	Description	Required	Tendered	Unit
9.29.1	Type	Bidder to state		
9.29.2	Manufacturer	Bidder to state		
9.29.3	Country of origin	Bidder to state		
9.29.4	Manufacturer's type designation	Bidder to state		
9.29.5	Catalogue number	Bidder to state		
9.29.6	Firmware version	Bidder to state		
9.29.7	Functions supported			
9.29.8	L2 switching (Ethernet/MPLS)	Yes		
9.29.9	Console cable supported Corporate	Yes		
9.29.10	wide network Licensing IP telephone	Yes		
9.29.11	Availability	Yes		
9.29.12	SIP telephone Licensing	Yes		
9.29.13	Digital telephone intergration	Yes		
9.29.14	Analogue telephone intergration	Yes		
9.29.15	ABC-F Intergration	Yes		

9.30. Laptop Computer

Item	Description	Required	Tendered	Unit
9.30.1	Maker's name	Bidder to state		-
9.30.2	Maker's type and reference	Bidder to state		-
9.30.3	Country of origin	Bidder to state		-
9.30.4	Processor	intel Core i7 10th generation		-
9.30.5	Integrated camera	HD 720p with IR with microphone		-
9.30.6	Display	14" diagonal FHD IPS eDP+PSR anti-glare with ambient light sensor (1920x1080) 400 nits		-
9.30.7	Graphics	Integrated Intel UHD Graphics 620 Discrete AMD Radeon Pro WX 3200 (4GB GDDR5 dedicated)		-
9.30.8	System memory	8		GB
9.30.9	Internal storage SSD	1		TB
9.30.10	Communication WLAN and Bluetooth	Intel 8265 ac 2x2 + Bluetooth 4.2 WW with 2 antennas		-
9.30.11	Wireless WAN	No WWAN		-
9.30.12	Fingerprint sensor	Yes		-
9.30.13	Smart card reader	1		No.
9.30.14	Battery	Min. 50		Wh
9.30.15	AC adapter	65 W Fast charge		-
9.30.16	Warranty	1		Year
9.30.17	Country/Hardware kit	Country localisation AFRC-B		-
9.30.18	Keyboard	Dual point Backlit spill-resistant Collaboration AFRC-B		-
9.30.19	Chassi type	All metal		-
9.30.20	Back pack	Executive		-

10. Wide Area Monitoring Protection and Control

10.1. WAMPACS

Item	Description	Required	Tendered	Unit
10.1.1	Stability Control Sub-System	The following shall be the system performance requirements		-
		i. Control Function Not rely on GPS		-
		ii. Data refresh rate ≥ 6 times per cycle		-
		iii. Trip generation/load in 278 ms or less following fault inception		-
		iv. Distributed decision-making		-
		v. Full-IED Embedded hardware		-
		vi. Be hardware independent		-
		vii. Be upgradeable with standard industry products		-
		viii. Real-time Operation System, Non-windows, non-Linux		-
10.1.2	Stability Data Management System	The following shall be the software requirements;		-
		i. Standard C++, C, or java shall be used		-
		ii. Data Base used by the system must be ORACLE		-
		iii. Support expansion of processing capacity		-
		iv. Operation System is windows or Linux		-
10.1.3	Monitoring	1. Non volatile memory for		-
		i. Event recording		-
		ii. Disturbance recording		-
		iii. Remote viewing report		-
		iv. Acquire the oscillography files in COMTRADE format		-
		2. Inbuilt		-
		i. Voltage Transformer Supervision		-
		ii. Current Transformer Supervision		-
		iii. Trip circuit Supervision		-
10.1.4	Communication	The following shall be the communication requirements;		-
		i. Front port for direct PC – IED administration PC-IED debugging.		-
		ii. All relay interrogation hardware and software		-
10.1.5	AC current inputs	1. The following shall be the CT requirements;		-
		i. 1A or 5A		-
		ii. Continuous withstand – 4 times the nominal		-
		iii. 10 second withstand – 30 times the nominal value		-

		iv. 1 second withstand – 100 times the nominal value		-
10.1.6	AC voltage inputs	The following shall be the VT requirements;		-
		i. 110V AC nominal phase to phase input		-
		ii. Operating voltage of 1 to 170V AC		-
		iii. A continuous withstand of 2 times the nominal voltage		-
		iv. A short time (1 second) withstand of at least 3 times the nominal voltage		-
10.1.7	DC power supply	The following shall be the DC power supply requirements		-
		i. Normal operation at 80%~120% rated voltage		-
		ii. Static power consumption ≤ 50W		-
10.1.8	Frequency	The following shall be the frequency requirements;		-
		i. 50Hz will be used		-
10.1.9	Binary inputs	The binary inputs shall		-
		i. Optically be coupled		-
		ii. Have DC input range of 24 to 250V DC with a software/HMI selectable nominal value		-
		iii. Be programmable to internal logic functions		-
10.1.10	Binary outputs	The following specifications shall apply for relay binary outputs		-
		i. Trip action time ≤ 8ms		-
		ii. Trip return time ≤ 5ms		-
		iii. Signal action time ≤ 10ms		-
		iv. Signal return time ≤ 10ms		-
10.1.11	Product version	The IEDs shall be the top of range commercially produced and market proven reliability of service		-
10.1.12	environment condition	The following specifications shall be the environment condition requirements;		-
		i. Operating temperature : 10°C~+55°C		-
		ii. Storage temperature : -25°C~+55°C		-
		iii. Transport temperature : -1°C~+70°C		-
		iv. Relative humidity : 5%~95%		-
10.1.13	measurement accuracy	The following specifications shall be the measurement accuracy requirements;		-
		i. AC voltage effective value measuring relative error ≤±1%		-
		ii. AC current effective value measuring relative error ≤±1%		-
		iii. Active power measuring relative error ≤±2%		-

10.1.14	Print interface	Configure with print interface		-
10.1.15	Synchronous clock interface	Configure with synchronous clock interface		-
10.1.16	User Interface	The following specifications shall be the UI requirements;		-
		i. Monitoring, and management		-
		ii. Display, reporting, and data modifications		-
		iii. Installation of new analytics and modifications of UI configurations		-
10.1.17	Reference	Shall have installed the same system in three different countries. The system shall have been put in operation at least 2 years		-

11. Distribution

11.1. Wooden poles 12m

Item	Description	Required	Tendered	Unit
11.1.1	Name of manufacturer	Bidder to state		-
11.1.2	Country of manufacture	Bidder to state		-
11.1.3	Timber species	Bidder to state		-
11.1.4	Standard	SANS 754		-
11.1.5	Class	Bidder to state		-
11.1.6	Minimum fibre stress	55		Mpa
11.1.7	Preservative			
11.1.8	- kind	CCA		-
11.1.9	- according to standard	BS 1990: Part 1, BS 144		-
11.1.10	Length	12		m
11.1.11	Circumference at 1.8 m from the butt			cm
11.1.12	Circumference at 1.8 m from the top			cm
11.1.13	Rated load (at 30 cm from top, planting depth H1)			kN

11.2. ABC 3x120+70

Item	Description	Required	Tendered	Unit
11.2.1	Name of Manufacturer	Bidder to state		-
11.2.2	Country of origin	Bidder to state		-
11.2.3	Standard	Bidder to state		-
11.2.4	Type	Bidder to state		-
11.2.5	Rated voltage	1		kV
11.2.6	Manufacturer's type designation	Bidder to state		-
11.2.7	Cross-sectional area of phase conductor	120		mm ²
11.2.8	Cross-sectional area of supporting core	70		mm ²
11.2.9	Overall diameter	Bidder to state		mm
11.2.10	Insulation material	XLPE		-
11.2.11	Insulation thickness	Bidder to state		mm
11.2.12	Weight	Bidder to state		kg/km
11.2.13	Calculated breaking load	8		kN
11.2.14	Calculated Current-carrying capacity +800 at +400	283		A
11.2.15	Short-circuit capacity (1 sec.)	11		kA
11.2.16	Rated DC resistance at 200 C	Bidder to state		Ω/km

11.3. 33 kV Single-phase Load Break Fuse

Item	Description	Required	Tendered	Unit
11.3.1	Make	Bidder to state		-
11.3.2	Manufacturer's type designation	Bidder to state		-
11.3.3	Description	Bidder to state		-
11.3.4	Type	Bidder to state		-
11.3.5	Standard	Bidder to state		-
11.3.6	Rated current	min. 100		A
11.3.7	Rated voltage	36		kV
11.3.8	Rated short-time (1 sec.) withstand current, I _{th}	25		kAr.m.s
11.3.9	Creepage distance	1324		mm

11.4. 33/0.4 kV Housing Distribution Transformer

Item	Description	Required	Tendered	Unit
11.4.1	Type	3-phase oil immersed		-
11.4.2	Manufacturer	Bidder to state		-
11.4.3	Country of origin	Bidder to state		-
11.4.4	Manufacturer's type designation	Bidder to state		-
11.4.5	Standard	IEC 60076, EN HD 428, EN 50216		-
11.4.6	Type test report	Authority, year, Doc.no		-
11.4.7	Installation	Outdoor		-
11.4.8	Rated power	100		kVA
11.4.9	Rated voltage	33/0.4		kV
11.4.10	Off-circuit tap changer	$\pm 2 \times 2,5 \%$		-
11.4.11	Impedance	4		%
11.4.12	Connection	Dyn11		-
11.4.13	Short-circuit voltage	Bidder to state		%
11.4.14	Zero-sequence impedance	Bidder to state		ohm
11.4.15	No-load losses	Bidder to state		W
11.4.16	Load losses	Bidder to state		W
11.4.17	Temperature rise, oil	50		K
11.4.18	Temperature rise, winding	55		K
11.4.19	Type of cooling	ONAN		-
11.4.20	Sound level	Bidder to state		dB(A)
11.4.21	Type of tank	Sealed, bolted lid		-
11.4.22	Total weight	Bidder to state		kg
11.4.23	Dimensions (length x width x height)	Bidder to state		mm

12. Civil**12.1. Gabions** (for substation perimeter; Refer to drawing PP-ZTIP-P04-ODSS-C109_Nakonde SS GA_R00_30062026 Note 4)

Item	Description	Required	Tendered	Unit
12.1.1	Manufacturer	Bidder to state		-
12.1.2	Country of origin	Bidder to state		-
12.1.3	Description	Welded gabions		-
12.1.4	Wire, Hard Drawn Steel, Electrically Welded	4		mm
12.1.5	Weld mesh aperture	75x75		mm
12.1.6	Size	1x1x2		m
12.1.20	Life Time	>50		years

13. Tools

13.1. Splicing Machine

Item	Description	Required	Tendered	Unit
13.1.1	Fibre alignment method	Active core alignment		
13.1.2	Applicable fibre			
13.1.3	-Fibre Type	Single Mode		
		Multi-Mode		
13.1.4	-Cladding diameter	Bidder to state		
13.1.5	Applicable coating			
13.1.6	-Sheath clamp	Coating diameter: max. 3000 µm cleave length: 5 mm - 16 mm		
13.1.7	Fibre splice performance			
13.1.8	-Splice loss	ITU-T G.652: avg. 0.02 dB ITU-T G.651: avg. 0.01 dB ITU-T G.653: avg. 0.04 dB ITU-T G.655: avg. 0.04 dB ITU-T G.657: avg. 0.02 dB		
13.1.9	-Splice time	SM FAST mode: avg. 7 sec - 9 sec AUTO mode: 14 sec - 16 sec		
13.1.10	Applicable protection sleeve			
13.1.11	-Sleeve type	Heat shrinkable sleeve		
13.1.12	-Sleeve length	Max. 66 mm		
13.1.13	-Sleeve diameter	Max. 6.0 mm before shrinking		
13.1.14	Sleeve heat performance			
13.1.15	-Heat time	60 mm slim mode: avg. 9 sec - 10 sec 60 mm mode: avg. 13 sec - 15 sec		
13.1.16	Fibre tensile test force	Approx. 2.0 N		
13.1.17	Electrode life	5000		
13.1.18	Dimensions (W × D × H)	Within 170×173×150 mm		
13.1.19	Weight	2.8 kg (with battery)		
13.1.20	Environmental condition			
13.1.21	-Temperature	Operate: -10 - +50 °C Storage: -40 - +80 °C		
13.1.22	-Humidity	Operate: 0 - 95 non condensing % RH Storage: 0 - 95 non condensing % RH		
13.1.23	-Altitude	1600 masl		
13.1.24	AC adaptor Input	AC 100 to 240 V, 50/60 Hz, max. 1.5 A		
13.1.25	Battery pack			
13.1.26	-Type	Rechargeable lithium-ion		
13.1.27	-Output	Approx. DC 14.4 V / 6,380 mAh		
13.1.28	-Capacity	Approx. 300 splice and heat cycle		
13.1.29	-Temperature	Recharge: 0°C - 40°C		
13.1.30		Storage: -20°C - +30°C		
13.1.31	-Battery life	Approx. 500 recharge cycle		
13.1.32	Display			
13.1.33	LCD monitor	TFT 5 inches with touch screen		
13.1.34	Magnification	200 to 300x		

13.1.35	Illumination V-grooves	LED lamp		
13.1.36	Interface			
13.1.37	-PC	USB2.0 Mini B type		
13.1.38	-External LED lamp	USB2.0 A type approx. DC 5 V, 500 mA		
13.1.39	-Ribbon stripper	Mini DIN 6 pin DC 12 V, max. 1 A		
13.1.40	-Wireless	Bluetooth 4.1 LE		
13.1.41	Data storage			
13.1.42	-Splice mode	100 splice mode		
13.1.43	-Heat mode	30 heat mode		
13.1.44	-Splice result	20 000 splice		
13.1.45	-Splice image	100 image		
13.1.46	Screw hole for tripod	1/4-20UNC		
13.1.47	Other features			
13.1.48	-Automatic functions	Splice mode select by fibre type analysis		
		Discharge power calibration		
		Wind protector: open/close		
		Sheath clamp: open/close		
		Heater lid: open/close		
		Heater clamp: open/close		
13.1.49	-Reference guide	Video and PDF file stored in splice		
13.1.50	-Sheath clamp	Easy sleeve positioning clamp		
13.1.51	-Electrode	Replaceable without tool		
13.1.52	Cleaver/Stripper/Alcohol Dispenser	Set/Lo		

13.2. Circuit Breaker Analyser

Item	Description	Required	Tendered	Unit
13.2.1	Make	Megger TM1800 Expert		
13.2.2	Dual Ground Timing Circuit Breaker Analyze	Yes		
13.2.3	CABA Software	Yes		
13.2.4	USB communication interface	Yes		
13.2.5	Transducers for motion, vibration, timing, contact, resistance and DRM, including all accessories	Yes		
13.2.6	Mains input (nominal)	240		VAC
13.2.7	Frequency	50		Hz
13.2.8	Power consumption	<250		VA
13.2.9	Dimensions	Bidder to state		
13.2.10	Weight	Bidder to state		
13.2.11	External input - TRIG IN			
13.2.12	-Voltage mode			
13.2.13	-Input range	0 – 250 AC, 0 – ± 300 DC		V
13.2.14	-Threshold level	User configurable in software in steps of 1		V
13.2.15	-Contact mode			
13.2.16	-Open circuit voltage	35 ±20%		VDC
13.2.17	-Short circuit current	10-40		mA
13.2.18	-Threshold level	1-2k		Ω
13.2.19	External outputs -TRIG OUT			
13.2.20	-Pulse duration	1 – 999, user configurable in steps of 1		ms
13.2.21	-Voltage mode			
13.2.22	-Open circuit voltage	12 ±5%		VDC
13.2.23	-Voltage at 0.5 A	9 ±10%		VDC
13.2.24	-Max. short circuit current	1.5		A
13.2.25	-Contact mode			
13.2.26	-Max. switching current	0.5-1 at 12V and resistive load		A
13.2.27	-Voltage drop at 0.5 A	4.5 ±10%		VDC
13.2.28	-Short circuit protection	Fuse 1 fast acting type (F1H250V)		ADC
13.2.29	Communication interfaces			
13.2.30	USB	Universal Serial Bus ver. 2.0		
13.2.31	Ethernet	100 base-Tx Fast Ethernet		
13.2.32	External screen	SVGA, up to 800 x 600 at 24 bit color, 32 MB SDRAM		
13.2.33	CABA Local	Circuit breaker analyzing software		
13.2.34	Available languages	English, French, German, Spanish, Swedish Translation kit available		
13.2.35	Display	Super-Bright for good visibility in direct Sunlight		
13.2.36	Diagonal size	21 cm (8")		
13.2.37	Keyboard	Built-in		
13.2.38	Modules			
13.2.39	Control module	Yes		
13.2.40	-Number of channels	3		Nos.
13.2.41	-Time base inaccuracy	±0.01 of reading ±1 sample interval		%
13.2.42	-Max. sample rate	10		Hz
		45 at 10 kHz sample rate		s

13.2.43	-Measurement time	90 at 5 kHz sample rate		s
		200 at 10 kHz sample rate using datacompression		s
13.2.44	Timing M/R module	Yes		
13.2.45	-No. of channels	6		Nos.
13.2.46	-Time base inaccuracy	±0.01 of reading ±1 sample interval		%
13.2.47	-Min. resolution	0.05		ms
13.2.48	-Max. sample rate	40k		Hz
13.2.49	-Measurement time	8 at 40 kHz sample rate		s
		32 at 10 kHz sample rate		s
		200 at 10 kHz sample rate using data compression		s
		Data compression available at samplerates up to 20 kHz		
13.2.50	DCM module	Yes		
13.2.51	-No. of channels	6		Nos.
13.2.52	-Voltage	0 - 5 rms AC		VACrms
13.2.53	-Current	0 - 70 rms AC		mA ACrms
13.2.54	DCM module – Dual Ground testing	Yes		
13.2.55	-No. of channels	6		Nos.
13.2.56	-Voltage	V		VACrms
13.2.57	-Current	mA		mA ACrms
13.2.58	Analog module	Yes		
13.2.59	-No. of channels	3		Nos.
13.2.60	-Time base inaccuracy	±0.01 of reading ±1 sample interval		%
13.2.61	-Max. sample rate	40		Hz
13.2.62	-Measurement time	35 at 40 kHz sample rate		s
		70 at 20 kHz sample rate		s
		200 at 10 kHz sample rate using data compression		s
13.2.63	-Transducer resistance	500 – 10k at 10 V output		Ω
13.2.64	Digital module	Yes		
13.2.65	-No. of channels	6		Nos.
13.2.66	-Supported types	Incremental transducers, RS422		
13.2.67	-Time base inaccuracy	±0.01 of reading ±1 sample interval		%
13.2.68	-Max. sample rate	20k		Hz
13.2.69	-Measurement time	35 at 20 kHz sample rate		s
		70 at 10 kHz sample rate		s
		200 at 10 kHz sample rate using data compression		s
13.2.70	Timing Aux module	Yes		
13.2.71	-No. of channels	6		Nos.
13.2.72	-Time base inaccuracy	±0.01 of reading ±1 sample interval		%
13.2.73	-Max. sample rate	20		kHz
13.2.74	-Measurement time	35 at 20 kHz sample rate		s
		70 at 10 kHz sample rate		s
		200 at 10 kHz sample rate using data compression		s
13.2.75	Transducers with mounting kits	Yes		
13.2.76	All Cables for testing	Yes		

13.2.77	Accessories to be included	Yes		
13.2.78	HDD module	Yes		
13.2.79	Environment			
13.2.80	Application field	For use in high-voltage substations and industrial environment		
13.2.81	Operating Temperature	-1 to +50		°C
13.2.82	Storage & transport	-55 to +70		°C
13.2.83	Humidity	85		%
13.2.84	Altitude	1400		m
13.2.85	Manufacturers Authorization to be provided with bid	Yes		
13.2.86	Calibration certificate to be provided on delivery	Yes		
13.2.87	Brochure to be provided with bid	Yes		
13.2.88	User Manual to be provided on delivery	Yes		
13.2.89	IEC standards	Yes		

13.3. Omicron CT Analyser

Item	Description	Required	Tendered	Unit
13.3.1	Omicron CT Analyzer			
13.3.2	Measure CT ratio, composite error, excitation and knee point, winding resistance.			
13.3.3	Measure and assesseCTs with accuracy classes ≥ 0.3 according to IEC and IEEE standards			
13.3.4	standard package to accuracy classes ≥ 0.1 and additional assessment standards			
13.3.5	Measures protection CTs according to IEEE C57.13 (does not support metering CTs)			
13.3.6	Firmware Features			
13.3.7	CT secondary wiring phase and polarity measurements			
13.3.8	Composite error measurements for nominal current			
13.3.9	Ratio error and phase displacement measurement for no load and rated load			
13.3.10	Measurement of excitation characteristics (voltage/current)			
13.3.11	Knee point voltage from 1 V up to 4 kV			
13.3.12	Knee point voltage from 0.1 V up to 40 kV			
13.3.13	Automated calculation of knee points according to IEC and IEEE			
13.3.14	Comparison of excitation curve to a reference curve			
13.3.15	CT winding resistance measurement (primary and secondary)			
13.3.16	CT accuracy measurements (ratio 1...25000) (ratio error and phase displacement depending on burden and current)			
13.3.17	IEC 61869 / 60044, or IEEE C57.13 classes ≥ 0.3			
13.3.18	IEC 61869 / 60044, or IEEE C57.13 classes ≥ 0.1			
13.3.19	Customized standards or local / national standards			
13.3.20	Automatic assessment of CT performance according to the selected standard			
13.3.21	Customization of assessment rules (for example implementation of national standards)			
13.3.22	Composite error measurement for overcurrent conditions (ALF/ALFi, FS/FSi for IEC and Vb for IEEE)			
13.3.23	Determination of ALF and FS for IEC or Vb for IEEE			
13.3.24	Secondary burden measurement			
13.3.25	Nameplate guesser "function for CTs with unknown data			
13.3.26	Simulation of measured data			
13.3.27	Measurement of transient behavior of TPS, TPX, TPY and TPZ type CTs			
13.3.28	Determination of the transient dimensioning factor (Ktd)			
13.3.29	Considering Duty Cycles C-O / C-O-C-O, for example auto-reclosure system			
13.3.30	Automatic demagnetization of the CT after the test			
13.3.31	Remote control with CT Analyzer Suite software			
13.3.32	Flexible manual current and voltage source (QuickTest)			
13.3.33	Testing of CTs for line frequencies of 50 Hz			

13.3.34	CT SB2 (switch box) for measurements of CTs with up to 6 taps, including accessories			
13.3.35	CPOL3 for verifying the correct polarity of the secondary wiring along all connection points			
13.3.36	RemAnalyzer software for measuring the residual magnetism in CTs			
13.3.37	Firmware Upgrades			
13.3.38	Basic -> Standard Upgrades Basic to Standard Package P0006569			
13.3.39	Basic -> Advanced Upgrades Basic to Advanced Package P0006570			
13.3.40	Standard -> Advanced Upgrades Standard to Advanced Package P0006566			
13.3.41	IEEE Protection -> Advanced Upgrades IEEE Protection to Advanced Package P0006567			
13.3.42	Additional features			
13.3.43	Simulate different burdens and currents			
13.3.44	Analyze the effect of CT saturation			
13.3.45	Measure VT ratio			
13.3.46	Multimeter			

13.4. OTDR

Item	Description	Required	Tendered	Unit
13.4.1	Dimensions	270 (W) × 165 (H) × 61 (D) mm		
13.4.2	Mass (without protection)	Without battery 1.6 kg, 1.9 kg including battery		
13.4.3	Mass (with protection)	2.6 kg including battery		
13.4.4	Display	8-inch touch screen TFT- Colour LCD		
13.4.5	Interface	USB 1.1, Type A × 1 (memory), Type B × 1 (USB mass storage)		
13.4.6	Data Storage	Internal memory: Not less than1		
		GB (50,000 traces)		
		External memory (USB): up to 32 GB		
13.4.7	Power Supply	12 V(dc), 100 V(ac) to 240 V(ac), Allowable input voltage range: 90 V to 264 V, 50 Hz/60 Hz		
13.4.8	Battery	Type: Lithium-ion		
		Operating Time: 12 hours, Telcordia GR-196-CORE		
		Recharge Time: <5 hours (power off)		
13.4.9	Power Saving Functions	Backlight off: Disable/1 to 99 minutes		
		Auto shutdown: Disable/1 to 99 minutes		
13.4.10	Power Consumption	20W max (recharging), 4W standard (low backlight, sweep stopped)		
13.4.11	Vertical Scale	0.13, 0.33, 0.65, 1.3, 3.25, 6.5, 13 dB/div		
13.4.12	IOR Setting	1.300000 to 1.699999 (0.000001 steps)		
13.4.13	Units	km, m, kft, ft, m		
13.4.14	Languages	User selectable (English a must)		
13.4.15	Sampling Points*2	Normal: 5001		
		High density: 20001 or 25001, Very high density: 100,001 or 150,001		

13.4.16	Sampling Resolution	0.05m to 60m		
13.4.17	Reflectance Accuracy	Single mode: ± 2 dB, multimode: ± 4 dB		
13.4.18	Distance Accuracy	14- 15- ± 1 m $\pm 3 \times$ measurement distance $\times$ 10-5 $\pm$ marker resolution (excluding IOR uncertainty)		
13.4.19	Distance Range	Single mode: 0.5 to 300 km Multimode: 0.5 to 100 km		
13.4.20	Testing Modes	1-Fibre Visualizer: Provides end/break location, end to end loss, fibre length, easy graphical summary, PDF report, PDF viewer		
		2-Standard OTDR: User selectable automatic or manual set-up		
		3-Construction OTDR: Automated, multi- wavelength testing		
		4-Light source: Stabilized Light source (CW, 270 Hz, 1 kHz, 2 kHz output)		
		5-Loss test set: Power meter and Light source		
		6- Connector Video Inspection Probe		
		7-Visual fault locator (optional): Visible red light for fibre identification and troubleshooting		
13.4.21	Fibre Event Analysis	A- Auto or manual operation, displayed in table format		
		B- User defined PASS/FAIL thresholds:		
		- Reflective and non- reflective events: 0.01 to 9.99 dB (0.01 dB steps)		
		- Reflectance: -70.0 to -20.0 dB (0.1 dB steps)		
		- Fibre end/break: 1 to 99 dB (1 dB steps)		
		C- Number of detected events: up to 99		
13.4.22	OTDR Trace Format	Telcordia universal. SOR, issue 2 (SR-4731)		
13.4.23	Other Functions			
13.4.24	-Real time sweep*3	0.15 sec		
13.4.25	-Loss modes	2-point loss, dB/km, 2-point LSA, splice loss, ORL		
13.4.26	-Averaging modes	Timed (1 to 3600 sec.)		
13.4.27	-Live fibre detect	Verifies presence of communication light in optical Fibre		
13.4.28	-Connection check	Automatic check of OTDR to FUT connection quality		
13.4.29	-Connectivity	Bluetooth, Wi-Fi and Ethernet		
13.4.30	Environmental Conditions			
13.4.31	-Operating temperature and humidity	-10° to +50°C, <80% (non- condensing)		
13.4.32	-Storage temperature and humidity	-20° to +60°C, <80% (non- condensing)		
13.4.33	-Vibration	Conforming to MIL-1 28800E Class 3		
13.4.34	-Dust proof	MIL-T-28800E (Dust Exposure) Class 2		

13.4.35	-Drip proof	IP51 (IEC 60529), JIS C 0920 TYPE		
13.4.36	-CE	EMC: EN61326-1		
		EN61000-3-2		
		LVD: EN61010-1		
		RoHS: EN50581		

13.5. Earth Resistance Tester

Item	Description	Required	Tendered	Unit
13.5.1	Description	Megger DET2/3 Earth Resistance Tester suitable for testing of earth electrodes and measuring earth resistivity.		
13.5.2	Earth Resistance Test Ranges	0.01 to 19.99 Ω		Ω
		0.1 to 199.9 Ω		Ω
		0.001k to 1.999k Ω		Ω
		0.01k to 19.99 k Ω		Ω
13.5.3	Accuracy (at 23°C)	$\pm 7.5\% \pm 3$ digits ($\pm 10\%$ at >0.5 ohms and ± 0.05 ohm at <0.5 ohms for KEMA K85B requirements.		%
13.5.4	Maximum service error	$\pm 7.5\% \pm 3$ digits ($\pm 10\%$ at >0.5 ohms and ± 0.05 ohm at <0.5 ohms for KEMA K85B requirements.		%
13.5.5	Display Type	3 1/2 digit L.C.D. with Ω , k Ω and low battery voltage indicators. LEDs for high noise, high voltage probe resistance and high current loop resistance.		
13.5.6	Test Frequency	Variable including 128 ± 0.5 Hz		Hz
13.5.7	Test voltage	Maximum 50 V peak		V
	Test Current	10 @ 20 Ω		mA ACrms
		1 @ 200 Ω		mA ACrms
		100 @ 2k Ω and 20k Ω		μ A ACrms
13.5.8	IP rating	IP54		
13.5.9	Battery type	6 x 1.5 V (AA) IEC LR6 cells giving 600 typical 15 s tests at 20°C		
13.5.10	Voltage Withstand	250 between any two terminals		VAC
13.5.11	Flash Test	Tested to 2.3 kV		kVrms
13.5.12	Potential Circuit Interference	Voltages of 40 V pk to pk at 50 Hz, 60 Hz, 200 Hz or 162/3 Hz in the potential circuit must have a maximum effect of typically 1% on the reading in the 20 Ω to 2 k Ω ranges. If the 'NOISE' LED is not showing, the maximum error due to noise on these ranges shall not exceed 2%. In the 20 k Ω range this is reduced to 32V pk to pk		V

13.5.13	Current Loop Interference	Voltages of 60 V pk to pk, 50 Hz, 60 Hz, 200 Hz or 162/3 Hz in the current loop must have a maximum effect of 1% on the reading with minimal current loop resistance		mA
13.5.14	Dimensions	243 x 161 x 70		mm
13.5.15	Weight	0.82 to 1.27		kg
13.5.16	Maximum Current Loop Resistance	An additional error of typically 1% may be introduced for current loop resistances of		
		20 Ω		Ω
		200 Ω		Ω
		2k Ω and 20k Ω		Ω
13.5.17	Environmental Conditions			
13.5.18	Altitude above sea level	1400		m
13.5.19	Humidity	90% relative humidity max. at 45°C		%
13.5.20	Operating Temperature	-20 to +45		°C
13.5.21	Storage temperature range	-40 to +70		°C
13.5.22	Temperature Coefficient	±0,1% per °C over the temperature range -15 to +45		%/°C
13.5.23	Other Requirements			
13.5.24	Brochures in colour to be provided with the Bid	Yes		
13.5.25	Display Backlight	Yes		
13.5.26	Previous test report to the relevant standards to be provided with the bid	Yes		
13.5.27	Quality assurance certificate to be provided with the Bid	Yes		

13.6. Micro-Ohmmeter

Item	Description	Required	Tendered	Unit
13.6.1	Micro-Ohmmeter	Megger Micro-Ohmmeter or its equivalent		
13.6.2	Measurement range	0.1 μ – 1.999		Ω
13.6.3	Resolution	0.1 μ		Ω
13.6.4	Noise rejection	Differential 100 @ 50-60 Hz on test leads		mV
13.6.5	DC output	Smooth DC		
13.6.6	IP rating	IP54 Lid open / IP65 Lid closed		
13.6.7	Operating temperature range	-20 up to 50		$^{\circ}\text{C}$
13.6.8	Storage temperature range	-30 up to 70		$^{\circ}\text{C}$
13.6.9	Humidity	<85 R.H. non-condensing		%
13.6.10	Battery life	200 single 100 A tests or up to 2x 10 minutes continuous 100 A output		
13.6.11	Battery type	User replaceable Li-ion battery pack		
13.6.12	Battery charge time	Full charge in 2.5 Hrs from flat		Hrs
13.6.13	Maximum output voltage	2V (battery), 3V(AC)		V
13.6.14	EMC	IEC61326-1		
13.6.15	Safety	IEC61010		
		CAT IV 600 VAC / 500 VDC up to 2000 m		
		CAT IV 300 V up to 4000 m		
13.6.16	Accuracy at			
13.6.17	50 – 110 A / 0-100.00 m	Typical $\pm$ (0.2% + 0.2 $\mu\Omega$)		
		Max. $\pm$ (0.2% + 0.8 $\mu\Omega$)		
13.6.18	11 – 49 A / 10 μ – 100.00 m	Typical $\pm$ (0.2% + 0.5 $\mu\Omega$)		
		Max. $\pm$ (0.2% + 2.0 $\mu\Omega$)		
13.6.19	10:00:00 / 10 μ – 1000.0 m	Typical $\pm$ (0.2% + 1.0 $\mu\Omega$)		
		Max. $\pm$ (0.2% + 2.5 $\mu\Omega$)		
13.6.20	Standard test leads, with separate Current & Potential leads	5m Current Lead, 5m potential lead - CAT IV 600		
13.6.21	Test Modes	Auto, Continuous mode and Manual		
13.6.22	Internal memory	Yes		
	-Storage with USB			
	-Download capability			
13.6.25	Dual Ground TM capability with the DC clamp	Yes		
13.6.26	Display clearly showing large digits for test results and visible in all light conditions	Yes		
13.6.27	Back light display	Yes		
13.6.28	Manufacturers Authorisation to be provided with bid	Yes		
13.6.29	Calibration certificate to be provided on delivery	Yes		
13.6.30	Brochure to be provided with bid	Yes		
13.6.31	All accessories to be included	Yes		
13.6.32	User Manual to be provided on delivery	Yes		

13.7. Dielectric Oil Tester

Item	Description	Required	Tendered	Unit
13.7.1	Make	Megger OTS 100AF		
13.7.2	Power Supply	220 (50 Hz)		VAC
13.7.3	Power Consumption	max. 75 VA		VA
13.7.4	Output Voltage	0.....100		kV _{eff} Symetric
13.7.5	For insulating liquids with tan delta values	< 4.5 or specific resistance $\rho > 30 \text{ M}\Omega\text{m}$		
13.7.6	Voltage slew rate	0.5 10		kV/s
13.7.7	Switch off time	< 10		μs
13.7.8	Voltage control	Real breakdown Monitoring		
13.7.9	Internal measurement of the oil sample temperature	0....99		°C
13.7.10	Temperature resolution	1		°C
13.7.11	Display	LCD colour display		
13.7.12	Voltage measurement Accuracy	0 100 $\pm$ 1		kV
13.7.13	Resolution	0.1		kV
13.7.14	Languages	English		
13.7.15	Pre- programmed standards	ASTM D 1816-04 1mm, ASTM D 1816-04 2mm, ASTM D 877 / 87 PA, ASTM D 877 / 87 PB, BS EN 60156, CEI EN 60156, CSSR RVHP / 85, IEC 60156 / 1995 – 05, IRAM 2341 / 72, JIS C2101 / 78, PN 77 / E -04408, PA SEV EN 60156, UNE EN 60156, NF EN 60156, SABS EN 60156, VDE 0370 PART 5 / 96, AS1767.2.1, Individual measurement		
13.7.16	Customer – specific programs	10		
13.7.17	Interface	USB 2.0		
13.7.18	Printer	2" Thermal paper printer (minimal)		
13.7.19	Ambient temperature	-10 55		°C
13.7.20	Storage temperature	-20 +60		°C
13.7.21	Relative humidity	Non-condensing		
13.7.22	Dimensions (w x H x D)	< 545 x 460 x 380		mm
13.7.23	Weight	40		kg
13.7.24	Degree of protection	IP 32		
13.7.25	Designed and manufactured in acc. With the following Equipment standards	IEC 61010 – 1, EN 61010- 1, VDE 0411 part 1		
13.7.26	Brochure	To be provided with bid		
13.7.27	Delivery to Include			
13.7.28	-Oil Tester	Yes		
13.7.29	-Integrated printer	Yes		
13.7.30	-Magnetic Oil Stirrer	Yes		
13.7.31	-Lifting stick for magnetic stirrer	Yes		
13.7.32	-Setting gauges	Yes		
13.7.33	-Test vessel	Yes		
13.7.34	-Mains connection cable	Yes		
13.7.35	-User manual	Yes		
13.7.36	-Rugged Transport case	Yes		
13.7.37	-Paper roll for printer	Yes		
13.7.38	-Ring nut wrench for disassembling the test vessel	Yes		

13.8. SF6 Gas Leak Detector

Item	Description	Required	Tendered	Unit
13.8.1	Measuring Principle	Ion - Vacuum - Principle		
13.8.2	Power Supply	3V DC, two "C" cell Alkaline batteries		
13.8.3	Ultimate Sensitivity	14		gm/year
13.8.4	Operating Temperature	0 - 52		°C
13.8.5	Battery Life Approximately	30		Hour
13.8.6	Duty Cycle	Continuous, no limitation		
13.8.7	Response Time	Instantaneously		
13.8.8	Reset Time	1		s
13.8.9	Warm-Up Time Approximately	2		s

13.9. SF6 Gas Filling kits

Item	Description	Required	Tendered	Unit
13.9.1	High-Quality Hoses: They should have proper fittings on each end to create leak-proof connections with the gas cylinder and the circuit breaker.	Yes		
13.9.2	Pressure Gauges: These are instruments with dials or displays that show the pressure of the gas inside the hoses or circuit breakers.	Yes		
13.9.3	Valves: These are controllable openings that regulate the flow of gas within the filling system.	Yes		
13.9.4	Safety Devices:			
13.9.5	o Pressure Relief Valves: These are automatic safety mechanisms that release excess pressure if it builds up beyond a safe limit. This prevents damage to equipment and potential injury.	Yes		
13.9.6	o Emergency Shut-Off Mechanisms: These are manual or automatic systems that can quickly stop the flow of gas in case of an emergency. This can be a button on the control panel or a valve that can be closed manually.	Yes		
13.9.7	Clear Labeling and Instructions: The kit should have clear labels on all components, indicating their function and proper usage. Additionally, the kit should come with detailed instructions that outline the safe setup and operation of the entire filling system.	Yes		

13.10. Secondary Injection Test Set

Item	Description	Required	Tendered	Unit
13.10.1	Make	CMC500 (356		
13.10.2	Environmental conditions			
13.10.3	Temperature			
13.10.4	Operating temperature	–25 ... +50		°C
13.10.5	Storage temperature	–40 ... +70		°C
13.10.6	Operating altitude, max	2,000		m
13.10.7	Storage altitude, max	15,000		m
13.10.8	Humidity	5 ... 95		%RH
13.10.9	Shock	15 g @ 11 ms 30 g @ 6 ms		
13.10.10	Vibration (not in operation)	10 ... 500 Hz, 1 g 20 sweep cycles		
13.10.11	Vibration (in operation)	10 ... 500 Hz, 0.5 g 1 sweep cycle		
13.10.13	Drop	10		cm
13.10.14	Standards			
13.10.15	-Europe	EN 60068-2-1, EN 60068-2-2, EN 60068-2-6, EN 60068-2-14, EN 60068-2-27, EN 60068-2-30, EN 60068-2-31, EN 60068-2-78		
13.10.16	-International	IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-14, IEC 60068-2-27, IEC 60068-2-30, IEC 60068-2-31, IEC 60068-2-78		
13.10.17	Mechanical data			
13.10.18	Weight	15.6		kg
13.10.19	Dimensions without handles (W × H × D)	364 × 263 × 225		mm
13.10.20	Protection class	IP20		
13.10.21	Standards			
13.10.22	-International	IEC 60068-2-6, 10 Hz–500 Hz, 1 g/20 sweeps not operating, 10 Hz–500 Hz, 0.5 g/20 sweeps operating IEC 60068-2-27, 15g/11 ms 30 g/6 ms, IEC 60068-2-31 0.1 m, IEC 60721-3-7 (7M2)		
13.10.23	Electromagnetic compatibility (EMC)			
13.10.24	Emission			
13.10.25	-International	IEC 61326-1, IEC 55032 (Class A), IEC 61000-3-2/3		
13.10.26	Immunity			
13.10.27	-International	IEC 61326-1, IEC 61000-4 2/3/4/5/6/8/11, IEC 61000-6 5, installation category II, IEC 61326-3-1		

13.10.28	Safety standards			
13.10.29	Certified standards			
13.10.30	-International	IEC 61010-1, IEC 61010-2-030, ISO 13849-1		
13.10.31	Electrical insulation			
13.10.32	Protection	class		
13.10.33	Power supply			
13.10.34	Connection	C14 connector according to EN IEC/IEC 60320-1		
13.10.35	Voltage (single phase)			
13.10.36	-Nominal voltage	100 ... 240 V ($\pm 10\%$)		V
13.10.37	-Operational range	85 ... 264 V		V
13.10.38	Nominal current	10 ... 15 A (configurable, see Power supply plug types)		
13.10.39	Frequency	50/60 Hz		
		47 ... 63 Hz		
13.10.41	Overvoltage category	II		

13.11. Tool Box

Item	Description	Required	Tendered	Unit
13.11.1	½" Socket 8mm			
13.11.2	½" Socket 9mm			
13.11.3	½" Socket 10mm			
13.11.4	½" Socket 11mm			
13.11.5	½" Socket 12mm			
13.11.6	½" Socket 13mm			
13.11.7	½" Socket 14mm			
13.11.8	½" Socket 15mm			
13.11.9	½" Socket 16mm			
13.11.10	½" Socket 17mm			
13.11.11	½" Socket 18mm			
13.11.12	½" Socket 19mm			
13.11.13	½" Socket 20mm			
13.11.14	½" Socket 21mm			
13.11.15	½" Socket 22mm			
13.11.16	½" Socket 24mm			
13.11.17	½" Ratchet			
13.11.18	½" Extension 125mm			
13.11.19	Club Hammer			
13.11.20	Hammer			
13.11.21	Pliers 180mm			
13.11.22	Tape Measure 5mtrs			
13.11.23	Hacksaw			
13.11.24	Cold Chisels (Set)			
13.11.25	Water Pump Pliers			
13.11.26	Shifting Spanners Heavy 150mm			
13.11.27	Utility Knife			
13.11.28	Combination Spanner 6mm			
13.11.29	Combination Spanner 8mm			
13.11.30	Combination Spanner 9mm			
13.11.31	Combination Spanner 10m			
13.11.32	Combination Spanner 11mm			
13.11.33	Combination Spanner 12mm			
13.11.34	Combination Spanner 13mm			
13.11.35	Combination Spanner 14mm			
13.11.36	Combination Spanner 15mm			
13.11.37	Combination Spanner 16mm			
13.11.38	Combination Spanner 17mm			

13.11.39	Combination Spanner 18mm			
13.11.40	Combination Spanner 19mm			
13.11.41	Combination Spanner 20mm			
13.11.42	Combination Spanner 21mm			
13.11.43	Combination Spanner 22mm			
13.11.44	Combination Spanner 23mm			
13.11.45	Combination Spanner 24mm			
13.11.46	Long Nose Pliers 160mm			
13.11.47	Hex Key – Set			
13.11.48	Diagonal Cutter			
13.11.49	Drive Pin Punch (Set)			
13.11.50	Screw Driver (Set)			

13.12. Disturbance fault recorder

Item	Description	Required	Tendered	Unit
13.12.1	Maker's name	Bidder to state		
13.12.2	Maker's type and reference	Bidder to state		
13.12.3	Country of origin	Bidder to state		
13.12.4	Description	Fault Recorder		
13.12.5	Type test	Authority, year, Doc.no		
13.12.6	Standards	IEC 60794-1-1, 60794-1-2, 60974-4-10, 60793-2-50		
13.12.7	GENERAL - ELECTRICAL			
13.12.8	Channel capacity	64 analog inputs (voltage, current, DC transducers)		
		12 high-speed analog inputs for Traveling Wave Fault Location		
		256 opto-isolated digital inputs; Up to 8 fiber-optic links to connect to remote acquisition modules		
13.12.9	Acquisition system	16-bit opto-isolated analog-to-digital converters, independent for each channel (50 Hz channels)		
		256 points-per-cycle sampling rates (50 Hz channels)		
		Frequency response of DC to 3.0 kHz		
13.12.10	GOOSE messaging	320 binary inputs in 61850-8-1 GOOSE messages		
13.12.11	Sampled Values	Reading and recording up to 8 streams of Sampled Values IEC 61850-9-2LE simultaneously with up to 64 analog conventional channels		
		Monitoring and recording DC measurement from IEC 61850-9-2LE Sampled Values		
13.12.12	Hard Drive	60 GB SSD (solid-state drive) capacity. 33,5 GB reserved for recordings;		
13.12.13	Trigger Waveform	Trigger waveform recorder at 256, 128, or 64 samples/cycle;		
13.12.14	Waveform recording	Continuous waveform recorder at 16 samples/cycle;		
13.12.15	Disturbance recorder	Continuous disturbance recorder and triggered disturbance recorder at 1 sample/cycle		
13.12.16	Time synchronization	IRIGB-004 and SNTP/NTP (version 2, 3 or 4) time synchronization		
13.12.17	Travelling waves	Automatic Traveling Wave Fault Location functionality with voltage from VT		
13.12.18		MODBUS and DNP3 interface for SCADA integration		

13.12.19	Synchrophasor measurement	Synchrophasor measurement and transmission as per IEEE C37.118.1a-2014 and IEEE C37.118.2-2011		
13.12.20	Transmission of synchrophasors	Capable of transmitting synchrophasors (IEEE C37.118.1a-2014 and IEEE C37.118.2-2011) from Sampled Values IEC 61850- 9-2 LE and conventional analog channels measurements simultaneously;		
13.12.21	Historical Values	Historical average at aggregation intervals of 1 or 10 minutes		
13.12.22	Harmonic measurement	Measurement and recording of harmonics up to the 50th order as per IEC 61000-4-7		
13.12.23	Cross trigger	Cross-trigger using standard network connection		
13.12.24	MECHANICAL SPECIFICATIONS			
13.12.25	Design	The device shall have a modular design i.e. where the entire DFR scheme has one common set of processing and control cards/units and where analog and binary data input cards/units (acquisition units) can be added as separate modules to expand the number of analog and binary inputs that can be monitored		
		The processing unit shall be presented in a 3U case height format (133,55 mm), and the acquisition units shall be presented in a 5U case height format (222,0 mm).		
		The processing unit shall be housed in a 19" case width (482,6 mm), and the acquisition units shall be housed in a ½ 19" (222,0 mm).		
		The solution design shall be fan-less and have no rotating parts		
13.12.26	Processing Unit	The degree of protection offered shall be as per IEC 60529: 2002:		
		• IP 40 Protection for the front panel;		
		• IP 20 Protection for the sides and rear of the case;		
13.12.27	Acquisition system	• The device shall be housed in a metallic case wrapper;		
		• IP 54 Protection for the front panel;		
		• IP 20 Protection for the sides and rear of the case;		
		• IP 10 Protection for the sides of the case;		
		• The device shall be housed in a metallic case wrapper		

13.12.28	General input/ Output	CT terminals shall be ring lug screw type for security and robustness		
13.12.29	Communication and alarming	• Two 10/100BaseT electrical Ethernet interfaces for communication, configuration, download and GOOSE reading		
		• Two embedded electrical-to-optical Ethernet converters with ST connectors		
		• RS232 serial port for modem connection;		
		• One RJ45 Ethernet interface for Process Bus (IEC 61850-9-2LE Sampled Values) connection		
		• Local HMI interface on the front panel for monitoring		
13.12.30	Power Supply Specification	• 4 dry-contact relays for remote signaling of alarms;		
		• Fax and e-mail message after detection of a trigger. The fax can be sent to two different destinations and the e-mail to four different destinations.		
		• Nominal range: 100-250 V dc, 110-240 V ac		
13.12.31	Environmental Conditions - Ambient Temperature Range	• Maximum voltage range: 80-300 V dc, 88-264 V ac		
		• Frequency: 50 Hz, ± 3 Hz		
		Operating temperature range: -40°C to +55°C (or 40°F to +131°F)		
13.12.32	Standards Compliance / Type Tests	Tested as per IEC 60068-2- 1 -40°C operation (16 hours)		
		Tested as per IEC 60068-2- 2 +85°C operation (16 hours)		
13.12.33	Product Safety	EMC Compliance; As a minimum, the equipment shall use the IEC 60255-26 standard to establish EMC conformity		
13.12.34	Mechanical Robustness	As minimum, the equipment shall use the IEC 61010-1 standard to ensure product safety. The device shall meet the IEC 60255-5, ensuring insulation resistance greater than 100MΩ when applying 500 Vdc		
13.12.35	Vibration Test	The device shall comply with vibration, shock and seismic tests as described in IEC 60255-21 standard		
13.12.36	Shock	As per IEC 60255-21-1 Class 2		
13.12.37	Seismic tests	As per IEC 60255-21-2 Class 2		
		As per IEC 60255-21-3 Class 2		

13.13. Vacuum Pump for Transformer Drying

Item	Description	Required	Tendered	Unit
13.13.1	Nominal suction capacity	3500		m ³ /hr
13.13.2	Ultimate vacuum pressure	10		mbar
13.13.3	Input power	23		kW
13.13.4	Cooling system	Air Natural		
13.13.5	Operating temperature	90		°C
13.13.6	Connections	Intake: 2"		Inch
		Outlet: 1.5"		Inch
13.13.8	Noise	72		dB (A)
13.13.9	Accessories	Vacuum Hoses to be provided with Vacuum Plant (2 x 20m)		
		Gauges to be provided		
13.13.10	Outline dimensions (LxWxH) and Drawing	Bidder to indicate		
13.13.11	Electrical supply	3 Ph., 400V, AC, 50Hz		

13.14. Insulation Resistance Tester 15000V

Item	Description	Required	Tendered	Unit
13.14.1	Description	Megger MIT 1025 Insulation Resistance Tester able to perform insulation resistance tests up to 15 kV		
13.14.2	Maximum output voltage	15000		V
13.14.3	Max. resistance	20		TΩ
13.14.4	Accuracy from 1 MΩ to ≤ 2 TΩ	±5		%
13.14.5	Accuracy from 1 MΩ to 20 TΩ	±20		%
13.14.6	Test voltages	500, 1000, 2500, 5000, 10000		V
13.14.7	Industry standard tests	Auto IR, PI, DAR, SV, and DD		
13.14.8	AC voltage range	90 - 264		V
13.14.9	Frequency range	47 - 63		Hz
13.14.10	Short circuit/charge current	3		mA
13.14.11	Maximum noise rejection	3		mA
13.14.12	IP rating Lid open	IP40		
13.14.13	IP rating Lid closed	IP65		
13.14.14	Storage temperature range	-25 up to 65		°C
13.14.15	Battery life single charge	4.5 hours (typical) continuous testing at 10 kV with a 100 MΩ load		
13.14.16	Battery type	Rechargeable Li-ion battery		
13.14.17	Battery charge time	Full charge in 2.5 Hours from dead		
13.14.18	Display type	Large character digital display		
13.14.19	Memory storage	Provides memory storage for test results up to 200 records retrievable		
13.14.20	Discharge	Automatic discharge after test		
13.14.21	Detection of External Voltage	Visual or audible warning if external voltage is present		
13.14.22	Data transfer via USB interface	Required		
13.14.23	Display Backlight	Required		
13.14.24	Easy rotary switch operation	Required		
13.14.25	Voltage output measurement	Required		
13.14.26	Anti-skid/vibration absorbing	Required		
13.14.27	Interference rejection	2 mA rms at 200 V and above		
13.14.28	Guard Terminal	2 % error guarding 500kΩ leakage with 100MΩ load		
13.14.29	Environmental Conditions			
13.14.30	Altitude above sea level	1400		m
13.14.31	Humidity	85		%
13.14.32	Operating Temperature	-1 to 45		°C
13.14.33	Other Requirements			
13.14.34	Brochures in colour to be provided with the bid	Required		
13.14.35	Previous test report to the relevant standards to be provided with the bid	Required		
13.14.36	CAT IV 600V certification to be provided with the bid	Required		
13.14.37	Quality assurance certificate to be provided with the bid	Required		
13.14.38	Calibration certificate to be provided on delivery	Required		
13.14.39	Routine test results to be provided on delivery	Required		
13.14.37	Applicable standard (s)	IEC 61326-1, IEC 61010		

13.15. OMICRON CPC100

Item	Description	Required	Tendered	Unit
13.15.1	<u>CURRENT TRANSFORMER TESTING</u>			
13.15.2	CT ratio (with burden) up to 800 A or 2 000 A with CP CB2, 5 kVA output power			
13.15.3	CT burden up to 6 AAC secondary			
13.15.4	CT excitation curve (knee point) up to 2 kVAC			
13.15.5	Polarity check with CPOL3 up to 800 A or up to 2 000 A with CP CB2			
13.15.6	Accuracy limiting factor (ALF) test			
13.15.7	CT ratio with voltage up to 130 VAC bushing CTs			
13.15.8	CT winding resistance up to 6 ADC			
13.15.9	CT demagnetization and remanence			
13.15.10	CT voltage withstand test up to 2 kVAC			
13.15.11	CT ratio Rogowski and CT ratio low power up to 800 A or up to 2 000 A with CP CB2, 5 kVA output power			
13.15.12	Power/dissipation factor test up to 12kV/15 kV, 300 mA with CP TD12/15			
13.15.13	IEC 61850 Sampled Values testing			
13.15.14				
13.15.15	<u>VOLTAGE TRANSFORMER TESTING</u>			
13.15.16	VT ratio up to 2 kVAC polarity and burden			
13.15.17	VT burden up to 130 VAC secondary			
13.15.18	VT secondary voltage withstand test up to 2 Kvac			
13.15.19	Polarity check with CPOL3 up to 2 kVAC			
13.15.20	VT electronics up to 2 kVAC			
13.15.21	VT voltage withstand test up to 2 kVAC			
13.15.22	IEC 61850 Sampled Values testing			
13.15.23	Power/dissipation factor test up to 12 kV/15kV, 300 mA with CP TD12/15			
13.15.24				
13.15.25	<u>POWER AND DISTRIBUTION TRANSFORMER TESTING</u>			
13.15.26	DC winding resistance up to 100 ADC			
13.15.27	Transformer demagnetization with CP SB1			
13.15.28	Dynamic load tap changer diagnostics (on load tap changer test) up to 100 ADC optionally with CP SB1			
13.15.29	Transformer turns ratio (TTR) per tap up to 2 kVAC including polarity and excitation current IEC 61387-1 support for transformer with unconventional vector groups			
13.15.30	Automatic determination of the transformer's vector group with CP SB1 Leakage reactance / short circuit impedance up to 6 AAC Transformer, bushing: power/dissipation factor + insulation capacitance up to 12 kV/15kV, 300 mA frequency from 15 Hz to 400 Hz with CP TD12/15 Insulating fluids: power/dissipation factor up to 12 kV/15kV, 300 mA with CP TD12/15 and CP TC12			
13.15.31	Excitation current per tap up to 12 kV/15kV, 300 mA with CP TD12/15			
13.15.32	Frequency response of stray losses (FRSL) Surge arrestors: leakage current and watt losses up to 12 kV/15kV, 300 mA with CP TD12/15			
13.15.33	HV source for voltage withstand test up to 15 kVA with 3 CPCs + TRC1			
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14. Transformer and Reactor Mechanical Protection

14.1. Sergi Fire Protection or Equivalent

Item	Description	Required	Tendered	Unit
14.1.1	Maker's name	To be stated by Bidder		
14.1.2	Maker's type and reference	To be stated by Bidder		
14.1.3	Country of origin	To be stated by Bidder		
14.1.4	System type	Fast Depressurization & Nitrogen Injection System (NIFPS)		
14.1.5	Standards compliance	NFPA 850		
14.1.6	Type test (Authority, year, Doc.no)	To be stated by Bidder		
14.1.7	[Deleted]			
14.1.8	Coverage area per module	Per transformer unit (0.1 MVA to 1,000 MVA+)		m ²
14.1.9	Response time (detection-to-discharge)	0.5 to 20 milliseconds		ms
14.1.10	Detection system	Passive mechanical		
14.1.11	Control panel compatibility	EN 54-20, Modbus interface		
14.1.12	[Deleted]			
14.1.13	Piping material	Carbon steel / stainless steel depressurization sets and oil-gas separation tank		
14.1.14	Nozzle material/life	Rupture disc and mechanical valve — long service life, project-specific		
14.1.15	Environmental rating (IP)	IP65 (outdoor)		
14.1.16	Fire classes covered	Oil transformer fires (Class B — flammable liquid)		
14.1.17	Certifications	NFPA 850 compliant		
14.1.18	compatibility	0.1 MVA to 1,000 MVA+ (all voltage levels including HV/EHV)		
14.1.19	Gross weight	To be stated by Bidder		

14.2. Kelman Online Dissolve Gas Analysis or Equivalent

Item	Description	Required	Tendered	Unit
14.2.1	Manufacturer's name	To be stated by Bidder		
14.2.2	Model and series	To be stated by Bidder		
14.2.3	Country of origin	To be stated by Bidder		
14.2.4	System type	Online continuous DGA monitor		
14.2.5	Standards compliance	IEC 60567, IEEE C57.104, IEC 62271		
14.2.6	Type test certification	To be stated by Bidder (Authority, year)		
14.2.7	Measurement technology	Gas chromatography or equivalent		
14.2.8	Measured gases	H ₂ , CH ₄ , C ₂ H ₂ , C ₂ H ₄ , C ₂ H ₆ , CO, CO ₂ , O ₂ , N ₂		
14.2.9	Detection range	H ₂ : 1-2000 ppm, C ₂ H ₂ : 0.1-100 ppm (full ranges to be specified)		ppm
14.2.10	Measurement accuracy	±10% or better of reading		%
14.2.11	Sampling frequency	Continuous (real-time) with adjustable intervals		
14.2.12	Communication protocols	Modbus RTU/TCP, IEC 61850, DNP3, OPC UA		
14.2.13	Alarm functionality	Programmable thresholds with relay outputs		
14.2.14	Power supply	100-240V AC, 50/60Hz with battery backup		
14.2.15	Environmental rating	IP65		
14.2.16	Operating temperature	-20°C to +55°C		°C
14.2.17	Calibration	Automatic self-calibration with manual override		
14.2.18	Maintenance interval	≥6 months between required servicing		months
14.2.19	Data storage	Minimum 2 years of historical data		
14.2.20	Warranty period	Minimum 2 years		

PART 3 - Conditions of Contract and Contract Forms

Section VIII - General Conditions of Contract

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Section VIII – General Conditions of Contract**A. Contract and Interpretation****1. Definitions**

1.1 The following words and expressions shall have the meanings hereby assigned to them:

“Contract” means the Contract Agreement entered into between the Employer and the Contractor, together with the Contract Documents referred to therein; they shall constitute the Contract, and the term “the Contract” shall in all such documents be construed accordingly.

“Contract Documents” means the documents listed in Article 1.1 (Contract Documents) of the Contract Agreement (including any amendments thereto).

“GCC” means the General Conditions of Contract hereof.

“PCC” means the Particular Conditions of Contract.

“day” means calendar day.

“year” means 365 days.

“month” means calendar month.

“Party” means the Employer or the Contractor, as the context requires, and “Parties” means both of them.

“Employer” means the person **named as such in the PCC** and includes the legal successors or permitted assigns of the Employer.

“Project Manager” means the person appointed by the Employer in the manner provided in GCC Sub-Clause 17.1 (Project Manager) hereof and **named as such in the PCC** to perform the duties delegated by the Employer.

“Contractor” means the person(s) whose Bid to perform the Contract has been accepted by the Employer and is named as Contractor in the Contract Agreement, and includes the legal successors or permitted assigns of the Contractor.

“Contractor’s Representative” means any person nominated by the Contractor and approved by the Employer in the manner provided in

GCC Sub-Clause 17.2 (Contractor's Representative and Construction Manager) hereof to perform the duties delegated by the Contractor.

"Construction Manager" means the person appointed by the Contractor's Representative in the manner provided in GCC Sub-Clause 17.2.4.

"Subcontractor," including manufacturers, means any person to whom execution of any part of the Facilities, including preparation of any design or supply of any Plant, is sub-contracted directly or indirectly by the Contractor, and includes its legal successors or permitted assigns.

"Dispute Board" (DB) means the person or persons named as such in the PCC appointed by agreement between the Employer and the Contractor to make a decision with respect to any dispute or difference between the Employer and the Contractor referred to him or her by the Parties pursuant to GCC Sub-Clause 46.1 (Dispute Board) hereof.

"The Bank" means the financing institution **named in the PCC.**

"Contract Price" means the sum specified in Article 2.1 (Contract Price) of the Contract Agreement, subject to such additions and adjustments thereto or deductions therefrom, as may be made pursuant to the Contract.

"Facilities" means the Plant to be supplied and installed, as well as all the Installation Services to be carried out by the Contractor under the Contract.

"Plant" means permanent plant, equipment, machinery, apparatus, materials, articles and things of all kinds to be provided and incorporated in the Facilities by the Contractor under the Contract (including the spare parts to be supplied by the Contractor under GCC Sub-Clause 7.3 hereof), but does not include Contractor's Equipment.

"Installation Services" means all those services ancillary to the supply of the Plant for the Facilities, to be provided by the Contractor under the Contract, such as transportation and provision of marine or other similar insurance, inspection, expediting, site preparation works (including the provision and use of Contractor's Equipment and the supply of all construction materials required), installation, testing, precommissioning, commissioning, operations, maintenance, the

provision of operations and maintenance manuals, training, etc... as the case may require.

“Contractor’s Equipment” means all facilities, equipment, machinery, tools, apparatus, appliances or things of every kind required in or for installation, completion and maintenance of Facilities that are to be provided by the Contractor, but does not include Plant, or other things intended to form or forming part of the Facilities.

“Country of Origin” means the countries and territories eligible under the rules of the Bank as further **elaborated in the PCC**.

“Site” means the land and other places upon which the Facilities are to be installed, and such other land or places as may be specified in the Contract as forming part of the Site.

“Effective Date” means the date of fulfillment of all conditions stated in Article 3 (Effective Date) of the Contract Agreement, from which the Time for Completion shall be counted.

“Time for Completion” means the time within which Completion of the Facilities as a whole (or of a part of the Facilities where a separate Time for Completion of such part has been prescribed) is to be attained, as referred to in GCC Clause 8 and in accordance with the relevant provisions of the Contract.

“Completion” means that the Facilities (or a specific part thereof where specific parts are specified in the Contract) have been completed operationally and structurally and put in a tight and clean condition, that all work in respect of Precommissioning of the Facilities or such specific part thereof has been completed, and that the Facilities or specific part thereof are ready for Commissioning as provided in GCC Clause 24 (Completion) hereof.

“Precommissioning” means the testing, checking and other requirements specified in the Employer’s Requirements that are to be carried out by the Contractor in preparation for Commissioning as provided in GCC Clause 24 (Completion) hereof.

“Commissioning” means operation of the Facilities or any part thereof by the Contractor following Completion, which operation is to be carried out by the Contractor as provided in GCC Sub-Clause 25.1

(Commissioning) hereof, for the purpose of carrying out Guarantee Test(s).

“Guarantee Test(s)” means the test(s) specified in the Employer’s Requirements to be carried out to ascertain whether the Facilities or a specified part thereof is able to attain the Functional Guarantees specified in the Appendix to the Contract Agreement titled Functional Guarantees, in accordance with the provisions of GCC Sub-Clause 25.2 (Guarantee Test) hereof.

“Operational Acceptance” means the acceptance by the Employer of the Facilities (or any part of the Facilities where the Contract provides for acceptance of the Facilities in parts), which certifies the Contractor’s fulfillment of the Contract in respect of Functional Guarantees of the Facilities (or the relevant part thereof) in accordance with the provisions of GCC Clause 28 (Functional Guarantees) hereof and shall include deemed acceptance in accordance with GCC Clause 25 (Commissioning and Operational Acceptance) hereof.

“Defect Liability Period” means the period of validity of the warranties given by the Contractor commencing at Completion of the Facilities or a part thereof, during which the Contractor is responsible for defects with respect to the Facilities (or the relevant part thereof) as provided in GCC Clause 27 (Defect Liability) hereof.

“ES” means Environmental and Social (including Sexual Exploitation and Abuse (SEA), and Sexual Harassment (SH)).

“Sexual Exploitation and Abuse” “(SEA)” means the following:

Sexual Exploitation is defined as any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

Sexual Abuse is defined as the actual or threatened physical intrusion of a sexual nature, whether by force or under unequal or coercive conditions;

“Sexual Harassment” “(SH)” is defined as unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature by the Contractor’s Personnel with other Contractor’s Personnel or Employer’s Personnel.

“Contractor’s Personnel” means all personnel whom the Contractor utilizes in the execution of the Contract, including the staff, labor and other employees of the Contractor and each Subcontractor; and any other personnel assisting the Contractor in the execution of the Contract; and

“Employer’s Personnel” means all staff, labor and other employees of the Project Manager and of the Employer engaged in fulfilling the Employer’s obligations under the Contract; and any other personnel identified as Employer’s Personnel, by a notice from the Employer to the Contractor.

2. Contract Documents

2.1 Subject to Article 1.2 (Order of Precedence) of the Contract Agreement, all documents forming part of the Contract (and all parts thereof) are intended to be correlative, complementary and mutually explanatory. The Contract shall be read as a whole.

3. Interpretation

3.1 In the Contract, except where the context requires otherwise:

- (a) words indicating one gender include all genders;
- (b) words indicating the singular also include the plural and words indicating the plural also include the singular;
- (c) provisions including the word “agree,” “agreed,” or “agreement” require the agreement to be recorded in writing;
- (d) the word “tender” is synonymous with “Bid,” “tenderer,” with “Bidder,” and “tender documents” with “Bidding Document,” and
- (e) “written” or “in writing” means hand-written, type-written, printed or electronically made, and resulting in a permanent record.

The marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.

3.2 Incoterms

Unless inconsistent with any provision of the Contract, the meaning of any trade term and the rights and obligations of Parties thereunder shall be as prescribed by *Incoterms*.

Incoterms means international rules for interpreting trade terms published by the International Chamber of Commerce (latest edition), 38 Cours Albert 1^{er}, 75008 Paris, France.

3.3 Entire Agreement

Subject to GCC Sub-Clause 16.4 hereof, the Contract constitutes the entire agreement between the Employer and Contractor with respect to the subject matter of Contract and supersedes all communications, negotiations and agreements (whether written or oral) of Parties with respect thereto made prior to the date of Contract.

3.4 Amendment

No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by a duly authorized representative of each Party hereto.

3.5 Independent Contractor

The Contractor shall be an independent contractor performing the Contract. The Contract does not create any agency, partnership, joint venture or other joint relationship between the Parties hereto. Subject to the provisions of the Contract, the Contractor shall be solely responsible for the manner in which the Contract is performed. All employees, representatives or Subcontractors engaged by the Contractor in connection with the performance of the Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the Employer, and nothing contained in the Contract or in any subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees, representatives or Subcontractors and the Employer.

3.6 Non-Waiver

3.6.1 Subject to GCC Sub-Clause 3.6.2 below, no relaxation, forbearance, delay or indulgence by either Party in enforcing any of the terms and conditions of the Contract or the granting of time by either Party to the other shall prejudice, affect or restrict the rights of that Party under the Contract, nor shall any waiver by either Party of any breach of Contract operate as waiver of any subsequent or continuing breach of Contract.

3.6.2 Any waiver of a Party's rights, powers or remedies under the Contract must be in writing, must be dated and signed by an authorized representative of the Party granting such waiver, and must specify the right and the extent to which it is being waived.

3.7 Severability

If any provision or condition of the Contract is prohibited or rendered invalid or unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of the Contract.

3.8 Country of Origin

"Origin" means the place where the plant and component parts thereof are mined, grown, produced or manufactured, and from which the services are provided. Plant components are produced when, through manufacturing, processing, or substantial or major assembling of components, a commercially recognized product results that is substantially different in its basic characteristics or in purpose or utility from its components.

4. **Communications**

4.1 Wherever these Conditions provide for the giving or issuing of approvals, certificates, consents, determinations, notices, requests and discharges, these communications shall be:

- (a) in writing and delivered against receipt; and
- (b) delivered, sent or transmitted to the address for the recipient's communications as stated in the Contract Agreement.

When a certificate is issued to a Party, the certifier shall send a copy to the other Party. When a notice is issued to a Party, by the other Party or the Project Manager, a copy shall be sent to the Project Manager or the other Party, as the case may be.

5. **Law and Language**

5.1 The Contract shall be governed by and interpreted in accordance with laws of the country **specified in the PCC.**

5.2 The ruling language of the Contract shall be that **stated in the PCC.**

5.3 The language for communications shall be the ruling language unless otherwise **stated in the PCC.**

6. Fraud and Corruption

- 6.1 The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Appendix B to the GCC.
- 6.2 The Employer requires the Contractor to disclose any commissions or fees that may have been paid or are to be paid to agents or any other party with respect to the Bidding process or execution of the Contract. The information disclosed must include at least the name and address of the agent or other party, the amount and currency, and the purpose of the commission, gratuity or fee.

B. Subject Matter of Contract**7. Scope of Facilities**

- 7.1 Unless otherwise expressly limited in the Employer's Requirements, the Contractor's obligations cover the provision of all Plant and the performance of all Installation Services required for the design, and the manufacture (including procurement, quality assurance, construction, installation, associated civil works, Precommissioning and delivery) of the Plant, and the installation, completion and commissioning of the Facilities in accordance with the plans, procedures, specifications, drawings, codes and any other documents as specified in the Section, Employer's Requirements. Such specifications include, but are not limited to, the provision of supervision and engineering services; the supply of labor, materials, equipment, spare parts (as specified in GCC Sub-Clause 7.3 below) and accessories; Contractor's Equipment; construction utilities and supplies; temporary materials, structures and facilities; transportation (including, without limitation, unloading and hauling to, from and at the Site); and storage, except for those supplies, works and services that will be provided or performed by the Employer, as set forth in the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer.
- 7.2 The Contractor shall, unless specifically excluded in the Contract, perform all such work and/or supply all such items and materials not specifically mentioned in the Contract but that can be reasonably inferred from the Contract as being required for attaining

Completion of the Facilities as if such work and/or items and materials were expressly mentioned in the Contract.

- 7.3 In addition to the supply of Mandatory Spare Parts included in the Contract, the Contractor agrees to supply spare parts required for the operation and maintenance of the Facilities for the period **specified in the PCC** and the provisions, if any, **specified in the PCC**. However, the identity, specifications and quantities of such spare parts and the terms and conditions relating to the supply thereof are to be agreed between the Employer and the Contractor, and the price of such spare parts shall be that given in Price Schedule No. 6, which shall be added to the Contract Price. The price of such spare parts shall include the purchase price therefor and other costs and expenses (including the Contractor's fees) relating to the supply of spare parts.

**8. Time
for
Commence-
ment
and
Completion**

- 8.1 The Contractor shall commence work on the Facilities within the period **specified in the PCC** and without prejudice to GCC Sub-Clauses 9.9 and 26.2 hereof, the Contractor shall thereafter proceed with the Facilities in accordance with the time schedule specified in the Appendix to the Contract Agreement titled Time Schedule.
- 8.2 The Contractor shall attain Completion of the Facilities or of a part where a separate time for Completion of such part is specified in the Contract, within the time **stated in the PCC** or within such extended time to which the Contractor shall be entitled under GCC Clause 40 hereof.

**9. Contractor's
Responsibilities**

- 9.1 The Contractor shall design, manufacture including associated purchases and/or subcontracting, install and complete the Facilities in accordance with the Contract. When completed, the Facilities should be fit for the purposes for which they are intended as defined in the Contract.
- 9.2 The Contractor confirms that it has entered into this Contract on the basis of a proper examination of the data relating to the Facilities including any data as to boring tests provided by the Employer, and on the basis of information that the Contractor could have obtained from a visual inspection of the Site if access thereto was available and of other data readily available to it relating to the Facilities as of

the date twenty-eight (28) days prior to Bid submission. The Contractor acknowledges that any failure to acquaint itself with all such data and information shall not relieve its responsibility for properly estimating the difficulty or cost of successfully performing the Facilities.

- 9.3 The Contractor shall acquire and pay for all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located which such authorities or undertakings require the Contractor to obtain in its name and which are necessary for the performance of the Contract, including, without limitation, visas for the Contractor's Personnel and entry permits for all imported Contractor's Equipment. The Contractor shall acquire all other permits, approvals and/or licenses that are not the responsibility of the Employer under GCC Sub-Clause 10.3 hereof and that are necessary for the performance of the Contract.
- 9.4 The Contractor shall comply with all laws in force in the country where the Facilities are to be implemented. The laws will include all local, state, national or other laws that affect the performance of the Contract and bind upon the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel, including the Subcontractors and their personnel, but without prejudice to GCC Sub-Clause 10.1 hereof.
- 9.5 Any Plant and Installation Services that will be incorporated in or be required for the Facilities and other supplies shall have their origin as specified under GCC Clause 1 (Country of Origin). Any subcontractors retained by the Contractor shall be from a country as specified in GCC Clause 1 (Country of Origin).
- 9.6 If the Contractor is a joint venture, or association (JV) of two or more persons, all such persons shall be jointly and severally bound to the Employer for the fulfillment of the provisions of the Contract, and shall designate one of such persons to act as a leader with authority

to bind the JV. The composition or the constitution of the JV shall not be altered without the prior consent of the Employer.

- 9.7 Pursuant to paragraph 2.2 e. of Appendix B to the General Conditions the Contractor shall permit and shall cause its agents (where declared or not), subcontractors, subconsultants, service providers, suppliers, and personnel, to permit, the Bank and/or persons appointed by the Bank to inspect the site and/or the accounts, records and other documents relating to the procurement process, selection and/or contract execution, and to have such accounts, records and other documents audited by auditors appointed by the Bank. The Contractor's and its Subcontractors' and subconsultants' attention is drawn to Sub-Clause 6.1 (Fraud and Corruption) which provides, inter alia, that acts intended to materially impede the exercise of the Bank's inspection and audit rights constitute a prohibited practice subject to contract termination (as well as to a determination of ineligibility pursuant to the Bank's prevailing sanctions procedures).

- 9.8 The Contractor shall conform to the sustainable procurement contractual provisions, if and as specified in the PCC.

- 9.9 Contractor's Environmental and Social Management Plan (C-ESMP)

The Contractor shall not carry out mobilization to Site unless the Project Manager gives approval, an approval that shall not be unreasonably delayed, to the measures the Contractor proposes to address environmental and social risks and impacts including the code of conduct, in accordance with GCC Sub-Clause 22.4.

The Contractor shall submit, to the Project Manager for Review, any additional Management Strategies and Implementation Plans as are necessary to manage the ES risks and impacts of the Facilities. These Management Strategies and Implementation Plans collectively comprise the Contractor's Environmental and Social Management Plan (C-ESMP).

The Contractor shall review the C-ESMP, periodically (but not less than every six (6) months), and update it as required to ensure that it contains measures appropriate to the Facilities. The updated C-ESMP shall be submitted to the Project Manager for its approval.

9.10 Training of Contractor's Personnel

The Contractor shall provide appropriate training to relevant Contractor's Personnel on ES aspects of the Contract, including appropriate sensitization on prohibition of SEA and health and safety training referred to in GCC Sub-Clause 22.2.7.

As stated in the Employer's Requirements or as instructed by the Project Manager, the Contractor shall also allow appropriate opportunities for the relevant Contractor's Personnel to be trained on ES aspects of the Contract by the Employer's personnel and/or other personnel assigned by the Employer.

9.11 Stakeholder engagements

The Contractor shall provide relevant contract- related information, as the Employer and/or Project Manager may reasonably request to conduct contract stakeholder engagement. "Stakeholder" refers to individuals or groups who:

- (a) are affected or likely to be affected by the Contract; and
- (b) may have an interest in the Contract.

The Contractor may also directly participate in contract stakeholder engagements, as the Employer and/or Project Manager may reasonably request.

9.12 Forced Labor

The Contractor, including its Subcontractors, shall not employ or engage forced labour. Forced labour consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements.

No persons shall be employed or engaged who have been subject to trafficking. Trafficking in persons is defined as the recruitment, transportation, transfer, harbouring or receipt of persons by means of the threat or use of force or other forms of coercion, abduction, fraud, deception, abuse of power, or of a position of vulnerability, or of the giving or receiving of payments or benefits to achieve the

consent of a person having control over another person, for the purposes of exploitation.

The Contractor shall also take measures to require its suppliers (other than Subcontractors) not to employ or engage forced labour including trafficked persons. If forced labour/trafficking cases are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks.

9.13 Child Labor

The Contractor, including its Subcontractors, shall not employ or engage a child under the age of 14 unless the national law specifies a higher age (the minimum age).

The Contractor, including its Subcontractors, shall not employ or engage a child between the minimum age and the age of 18 in a manner that is likely to be hazardous, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development.

The Contractor including its Subcontractors, shall only employ or engage children between the minimum age and the age of 18 after an appropriate risk assessment has been conducted by the Contractor with the Engineer's consent. The Contractor shall be subject to regular monitoring by the Project Manager that includes monitoring of health, working conditions and hours of work.

Work considered hazardous for children is work that, by its nature or the circumstances in which it is carried out, is likely to jeopardize the health, safety, or morals of children. Such work activities prohibited for children include work:

- (a) with exposure to physical, psychological or sexual abuse;
- (b) underground, underwater, working at heights or in confined spaces;
- (c) with dangerous machinery, equipment or tools, or involving handling or transport of heavy loads;

- (d) in unhealthy environments exposing children to hazardous substances, agents, or processes, or to temperatures, noise or vibration damaging to health; or
- (e) under difficult conditions such as work for long hours, during the night or in confinement on the premises of the employer.

The Contractor shall also take measures to require its suppliers (other than Subcontractors) not to employ or engage child labor. If child labor cases are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks.

9.14 Serious Safety Issues

The Contractor, including its Subcontractors, shall comply with all applicable safety obligations. The Contractor shall also take measures to require its suppliers (other than Subcontractors) to adopt procedures and mitigation measures adequate to address safety issues related to their personnel. If serious safety issues are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks.

9.15 Obtaining natural resource materials

The Contractor shall obtain natural resource materials from suppliers that can demonstrate, through compliance with the applicable verification and/ or certification requirements, that obtaining such materials is not contributing to the risk of significant conversion or significant degradation of natural or critical habitats such as unsustainably harvested wood products, gravel or sand extraction from riverbeds or beaches.

If a supplier cannot continue to demonstrate that obtaining such materials is not contributing to the risk of significant conversion or significant degradation of natural or critical habitats, the Contractor shall within a reasonable period substitute the supplier with a

supplier that is able to demonstrate that they are not significantly adversely impacting the habitats.

9.16 Site Signage

The Contractor shall not post and shall ensure that its Subcontractors/suppliers/manufacturers and Contractors' Personnel shall not post, any signage on the Site, or in any other place where the Works will be carried out, except such signage as is required under the Contract, including by the Laws of the Country, or has been approved by the Employer. For the purposes of this sub-clause, signage shall include, inter alia, flags, billboards, advertising materials and any other similar item separately posted on the Site.

10. Employer's Responsibilities

- 10.1 All information and/or data to be supplied by the Employer as described in the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer, shall be deemed to be accurate, except when the Employer expressly states otherwise.
- 10.2 The Employer shall be responsible for acquiring and providing legal and physical possession of the Site and access thereto, and for providing possession of and access to all other areas reasonably required for the proper execution of the Contract, including all requisite rights of way, as specified in the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer. The Employer shall give full possession of and accord all rights of access thereto on or before the date(s) specified in that Appendix.
- 10.3 The Employer shall acquire and pay for all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located which (a) such authorities or undertakings require the Employer to obtain in the Employer's name, (b) are necessary for the execution of the Contract, including those required for the performance by both the Contractor and the Employer of their respective obligations under the Contract, and (c) are specified in the Appendix (Scope of Works and Supply by the Employer).
- 10.4 If requested by the Contractor, the Employer shall use its best endeavors to assist the Contractor in obtaining in a timely and expeditious manner all permits, approvals and/or licenses necessary

for the execution of the Contract from all local, state or national government authorities or public service undertakings that such authorities or undertakings require the Contractor or Subcontractors or the personnel of the Contractor or Subcontractors, as the case may be, to obtain.

- 10.5 Unless otherwise specified in the Contract or agreed upon by the Employer and the Contractor, the Employer shall provide sufficient, properly qualified operating and maintenance personnel; shall supply and make available all raw materials, utilities, lubricants, chemicals, catalysts, other materials and facilities; and shall perform all work and services of whatsoever nature, including those required by the Contractor to properly carry out Precommissioning, Commissioning and Guarantee Tests, all in accordance with the provisions of the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer, at or before the time specified in the program furnished by the Contractor under GCC Sub-Clause 18.2 hereof and in the manner thereupon specified or as otherwise agreed upon by the Employer and the Contractor.
- 10.6 The Employer shall be responsible for the continued operation of the Facilities after Completion, in accordance with GCC Sub-Clause 24.8, and shall be responsible for facilitating the Guarantee Test(s) for the Facilities, in accordance with GCC Sub-Clause 25.2.
- 10.7 All costs and expenses involved in the performance of the obligations under this GCC Clause 10 shall be the responsibility of the Employer, save those to be incurred by the Contractor with respect to the performance of Guarantee Tests, in accordance with GCC Sub-Clause 25.2.
- 10.8 In the event that the Employer shall be in breach of any of his obligations under this Clause, the additional cost incurred by the Contractor in consequence thereof shall be determined by the Project Manager and added to the Contract Price.

C. Payment

- 11. Contract Price**
- 11.1 The Contract Price shall be as specified in Article 2 (Contract Price and Terms of Payment) of the Contract Agreement.
- 11.2 Unless an adjustment clause is **provided for in the PCC**, the Contract Price shall be a firm lump sum not subject to any alteration, except in the event of a Change in the Facilities or as otherwise provided in the Contract.
- 11.3 Subject to GCC Sub-Clauses 9.2, 10.1 and 35 hereof, the Contractor shall be deemed to have satisfied itself as to the correctness and sufficiency of the Contract Price, which shall, except as otherwise provided for in the Contract, cover all its obligations under the Contract.
- 12. Terms of Payment**
- 12.1 The Contract Price shall be paid as specified in Article 2 (Contract Price and Terms of Payment) of the Contract Agreement and in the Appendix to the Contract Agreement titled Terms and Procedures of Payment, which also outlines the procedures to be followed in making application for and processing payments.
- 12.2 No payment made by the Employer herein shall be deemed to constitute acceptance by the Employer of the Facilities or any part(s) thereof.
- 12.3 In the event that the Employer fails to make any payment by its respective due date or within the period set forth in the Contract, the Employer shall pay to the Contractor interest on the amount of such delayed payment at the rate(s) shown in the Appendix to the Contract Agreement titled Terms and Procedures of Payment, for the period of delay until payment has been made in full, whether before or after judgment or arbitration award.
- 12.4 The currency or currencies in which payments are made to the Contractor under this Contract shall be specified in the Appendix to the Contract Agreement titled Terms and Procedures of Payment, subject to the general principle that payments will be made in the currency or currencies in which the Contract Price has been stated in the Contractor's Bid.

- 12.5 **As specified in the PCC**, if the Contractor fails to perform its cyber security obligations under the Contract, an assessed amount, as determined by the Project Manager, may be withheld until the obligation has been performed.

13. Securities

13.1 Issuance of Securities

The Contractor shall provide the securities specified below in favor of the Employer at the times, and in the amount, manner and form specified below.

13.2 Advance Payment Security

13.2.1 The Contractor shall, within twenty-eight (28) days of the notification of contract award, provide a security in an amount equal to the advance payment calculated in accordance with the Appendix to the Contract Agreement titled Terms and Procedures of Payment, and in the same currency or currencies.

13.2.2 The security shall be in the form provided in the Bidding documents or in another form acceptable to the Employer. The amount of the security shall be reduced in proportion to the value of the Facilities executed by and paid to the Contractor from time to time, and shall automatically become null and void when the full amount of the advance payment has been recovered by the Employer. The security shall be returned to the Contractor immediately after its expiration.

13.3 Performance Security

13.3.1 The Contractor shall, within twenty-eight (28) days of the notification of contract award, provide a security for the due performance of the Contract in the amount **specified in the PCC**.

13.3.2 The Performance Security shall be denominated in the currency or currencies of the Contract, or in a freely convertible currency acceptable to the Employer, and shall be in the form provided in Section X, Contract Forms, corresponding to the type of bank guarantee stipulated by

the Employer in the PCC, or in another form acceptable to the Employer.

13.3.3 Unless otherwise specified in the PCC, the security shall be reduced by half on the date of the Operational Acceptance. The Security shall become null and void, or shall be reduced pro rata to the Contract Price of a part of the Facilities for which a separate Time for Completion is provided, five hundred and forty (540) days after Completion of the Facilities or three hundred and sixty five (365) days after Operational Acceptance of the Facilities, whichever occurs first; provided, however, that if the Defects Liability Period has been extended on any part of the Facilities pursuant to GCC Sub-Clause 27.8 hereof, the Contractor shall issue an additional security in an amount proportionate to the Contract Price of that part. The security shall be returned to the Contractor immediately after its expiration, provided, however, that if the Contractor, pursuant to GCC Sub-Clause 27.10, is liable for an extended defect liability obligation, the Performance Security shall be extended for the period specified in the PCC pursuant to GCC Sub-Clause 27.10 and up to the amount specified in the PCC.

13.3.4 The Employer shall not make a claim under the Performance Security, except for amounts to which the Employer is entitled under the Contract. The Employer shall indemnify and hold the Contractor harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from a claim under the Performance Security to the extent to which the Employer was not entitled to make the claim.

14. Taxes and Duties

14.1 Except as otherwise specifically provided in the Contract, the Contractor shall bear and pay all taxes, duties, levies and charges assessed on the Contractor, its Subcontractors or their employees by all municipal, state or national government authorities in connection with the Facilities in and outside of the country where the Site is located.

14.2 Notwithstanding GCC Sub-Clause 14.1 above, the Employer shall bear and promptly pay

- (a) all customs and import duties for the Plant specified in Price Schedule No. 1; and
 - (b) other domestic taxes such as, sales tax and value added tax (VAT) on the Plant specified in Price Schedules No. 1 and No. 2 and that is to be incorporated into the Facilities, and on the finished goods, imposed by the law of the country where the Site is located.
- 14.3 If any tax exemptions, reductions, allowances or privileges may be available to the Contractor in the country where the Site is located, the Employer shall use its best endeavors to enable the Contractor to benefit from any such tax savings to the maximum allowable extent.
- 14.4 For the purpose of the Contract, it is agreed that the Contract Price specified in Article 2 (Contract Price and Terms of Payment) of the Contract Agreement is based on the taxes, duties, levies and charges prevailing at the date twenty-eight (28) days prior to the date of Bid submission in the country where the Site is located (hereinafter called "Tax" in this GCC Sub-Clause 14.4). If any rates of Tax are increased or decreased, a new Tax is introduced, an existing Tax is abolished, or any change in interpretation or application of any Tax occurs in the course of the performance of Contract, which was or will be assessed on the Contractor, Subcontractors or their employees in connection with performance of the Contract, an equitable adjustment of the Contract Price shall be made to fully take into account any such change by addition to the Contract Price or deduction therefrom, as the case may be, in accordance with GCC Clause 36 hereof.

D. Intellectual Property

15. License/Use of Technical Information

- 15.1 For the operation and maintenance of the Plant, the Contractor hereby grants a non-exclusive and non-transferable license (without the right to sub-license) to the Employer under the patents, utility models or other industrial property rights owned by the Contractor or by a third Party from whom the Contractor has received the right to grant licenses thereunder, and shall also grant to the Employer a non-exclusive and non-transferable right (without the right to sub-license) to use the know-how and other

technical information disclosed to the Employer under the Contract. Nothing contained herein shall be construed as transferring ownership of any patent, utility model, trademark, design, copyright, know-how or other intellectual property right from the Contractor or any third Party to the Employer.

15.2 The copyright in all drawings, documents and other materials containing data and information furnished to the Employer by the Contractor herein shall remain vested in the Contractor or, if they are furnished to the Employer directly or through the Contractor by any third Party, including suppliers of materials, the copyright in such materials shall remain vested in such third Party.

16. Confidential al Informati on

16.1 The Employer and the Contractor shall keep confidential and shall not, without the written consent of the other Party hereto, divulge to any third Party any documents, data or other information furnished directly or indirectly by the other Party hereto in connection with the Contract, whether such information has been furnished prior to, during or following termination of the Contract. Notwithstanding the above, the Contractor may furnish to its Subcontractor(s) such documents, data and other information it receives from the Employer to the extent required for the Subcontractor(s) to perform its work under the Contract, in which event the Contractor shall obtain from such Subcontractor(s) an undertaking of confidentiality similar to that imposed on the Contractor under this GCC Clause 16.

16.2 The Employer shall not use such documents, data and other information received from the Contractor for any purpose other than the operation and maintenance of the Facilities. Similarly, the Contractor shall not use such documents, data and other information received from the Employer for any purpose other than the design, procurement of Plant, construction or such other work and services as are required for the performance of the Contract.

16.3 The obligation of a Party under GCC Sub-Clauses 16.1 and 16.2 above, however, shall not apply to that information which

(a) now or hereafter enters the public domain through no fault of that Party

- (b) can be proven to have been possessed by that Party at the time of disclosure and which was not previously obtained, directly or indirectly, from the other Party hereto
- (c) otherwise lawfully becomes available to that Party from a third Party that has no obligation of confidentiality
- (d) is being provided to the Bank.

16.4 The above provisions of this GCC Clause 16 shall not in any way modify any undertaking of confidentiality given by either of the Parties hereto prior to the date of the Contract in respect of the Facilities or any part thereof.

16.5 The provisions of this GCC Clause 16 shall survive termination, for whatever reason, of the Contract.

E. Execution of the Facilities

17. Representatives 17.1 Project Manager

If the Project Manager is not named in the Contract, then within fourteen (14) days of the Effective Date, the Employer shall appoint and notify the Contractor in writing of the name of the Project Manager. The Employer may from time to time appoint some other person as the Project Manager in place of the person previously so appointed, and shall give a notice of the name of such other person to the Contractor without delay. No such appointment shall be made at such a time or in such a manner as to impede the progress of work on the Facilities. Such appointment shall only take effect upon receipt of such notice by the Contractor. The Project Manager shall represent and act for the Employer at all times during the performance of the Contract. All notices, instructions, orders, certificates, approvals and all other communications under the Contract shall be given by the Project Manager, except as herein otherwise provided.

All notices, instructions, information and other communications given by the Contractor to the Employer under the Contract shall be given to the Project Manager, except as herein otherwise provided.

17.2 Contractor's Representative & Construction Manager

17.2.1 If the Contractor's Representative is not named in the Contract, then within fourteen (14) days of the Effective Date, the Contractor shall appoint the Contractor's Representative and shall request the Employer in writing to approve the person so appointed. If the Employer makes no objection to the appointment within fourteen (14) days, the Contractor's Representative shall be deemed to have been approved. If the Employer objects to the appointment within fourteen (14) days giving the reason therefor, then the Contractor shall appoint a replacement within fourteen (14) days of such objection, and the foregoing provisions of this GCC Sub-Clause 17.2.1 shall apply thereto.

17.2.2 The Contractor's Representative shall represent and act for the Contractor at all times during the performance of the Contract and shall give to the Project Manager all the Contractor's notices, instructions, information and all other communications under the Contract.

All notices, instructions, information and all other communications given by the Employer or the Project Manager to the Contractor under the Contract shall be given to the Contractor's Representative or, in its absence, its deputy, except as herein otherwise provided.

The Contractor shall not revoke the appointment of the Contractor's Representative without the Employer's prior written consent, which shall not be unreasonably withheld. If the Employer consents thereto, the Contractor shall appoint some other person as the Contractor's Representative, pursuant to the procedure set out in GCC Sub-Clause 17.2.1.

17.2.3 The Contractor's Representative may, subject to the approval of the Employer which shall not be unreasonably withheld, at any time delegate to any person any of the powers, functions and authorities vested in him or her.

Any such delegation may be revoked at any time. Any such delegation or revocation shall be subject to a prior notice signed by the Contractor's Representative, and shall specify the powers, functions and authorities thereby delegated or revoked. No such delegation or revocation shall take effect unless and until a copy thereof has been delivered to the Employer and the Project Manager.

Any act or exercise by any person of powers, functions and authorities so delegated to him or her in accordance with this GCC Sub-Clause 17.2.3 shall be deemed to be an act or exercise by the Contractor's Representative.

17.2.4 From the commencement of installation of the Facilities at the Site until Completion, the Contractor's Representative shall appoint a suitable person as the Construction Manager. The Construction Manager shall supervise all work done at the Site by the Contractor and shall be present at the Site throughout normal working hours except when on leave, sick or absent for reasons connected with the proper performance of the Contract. Whenever the Construction Manager is absent from the Site, a suitable person shall be appointed to act as the Construction Manager's deputy.

17.2.5 The Project Manager may require the Contractor to remove (or cause to be removed) the Contractor's Representative or any other person employed by the Contractor in the execution of the Contract, who:

- (a) persists in any misconduct or lack of care;
- (b) carries out duties incompetently or negligently;
- (c) fails to comply with any provision of the Contract;
- (d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment;
- (e) based on reasonable evidence, is determined to have engaged in Fraud and Corruption during the execution of the Contract;

- (f) has been recruited from the Employer's Personnel in breach of GCC Sub-Clause 22.2.2;
- (g) undertakes behaviour which breaches the Code of Conduct (ES), as applicable;

If appropriate, the Contractor shall then promptly appoint (or cause to be appointed) a suitable replacement with equivalent skills and experience.

Notwithstanding any requirement from the Project Manager to remove or cause to remove any person, the Contractor shall take immediate action as appropriate in response to any violation of (a) through (g) above. Such immediate action shall include removing (or causing to be removed) from the Site or other places where the Contract is being executed, any Contractor's Personnel who engages in (a), (b), (c), (d), (e) or (g) above or has been recruited as stated in (f) above..

- 17.2.6 If any representative or person employed by the Contractor is removed in accordance with GCC Sub-Clause 17.2.5, the Contractor shall, where required, promptly appoint a suitable replacement with equivalent skills and experience.

18. Work Program

18.1 Contractor's Organization

The Contractor shall supply to the Employer and the Project Manager a chart showing the proposed organization to be established by the Contractor for carrying out work on the Facilities within twenty-one (21) days of the Effective Date. The chart shall include the identities of the key personnel and the curricula vitae of such key personnel to be employed shall be supplied together with the chart. The Contractor shall promptly inform the Employer and the Project Manager in writing of any revision or alteration of such an organization chart.

18.2 Program of Performance

Within twenty-eight (28) days after the Effective Date, the Contractor shall submit to the Project Manager a detailed program of performance of the Contract, made in a form

acceptable to the Project Manager and showing the sequence in which it proposes to design, manufacture, transport, assemble, install and precommission the Facilities, as well as the date by which the Contractor reasonably requires that the Employer shall have fulfilled its obligations under the Contract so as to enable the Contractor to execute the Contract in accordance with the program and to achieve Completion, Commissioning and Acceptance of the Facilities in accordance with the Contract. The program so submitted by the Contractor shall accord with the Time Schedule included in the Appendix to the Contract Agreement titled Time Schedule, and any other dates and periods specified in the Contract. The Contractor shall update and revise the program as and when appropriate or when required by the Project Manager, but without modification in the Times for Completion specified in the PCC pursuant to Sub-Clause 8.2 and any extension granted in accordance with GCC Clause 40, and shall submit all such revisions to the Project Manager.

18.3 Progress Report

The Contractor shall monitor progress of all the activities specified in the program referred to in GCC Sub-Clause 18.2 above, and supply a progress report to the Project Manager every month.

The progress report shall be in a form acceptable to the Project Manager and shall indicate: (a) percentage completion achieved compared with the planned percentage completion for each activity; and (b) where any activity is behind the program, giving comments and likely consequences and stating the corrective action being taken.

Unless otherwise stated in the Employer's Requirements, each progress report shall include the Environmental and Social (ES) metrics set out in Appendix C.

If stated in the PCC, progress report shall include status of compliance to cyber security risks management, and any foreseeable cyber security risk and mitigation.

In addition to the progress reports, the Contractor shall inform the Project Manager immediately of any allegation, incident or accident in the Site, which has or is likely to have a significant adverse effect on the environment, the affected communities, the public, Employer's Personnel or Contractor's Personnel. This includes, but is not limited to, any incident or accident causing fatality or serious injury; significant adverse effects or damage to private property; any cyber security incidents **as specified in the PCC**; or any allegation of SEA and/or SH. In case of SEA and/or SH, while maintaining confidentiality as appropriate, the type of allegation (sexual exploitation, sexual abuse or sexual harassment), gender and age of the person who experienced the alleged incident should be included in the information.

The Contractor, upon becoming aware of the allegation, incident or accident, shall also immediately inform the Project Manager of any such incident or accident on the Subcontractors' or suppliers' premises relating to the Facilities which has or is likely to have a significant adverse effect on the environment, the affected communities, the public, Employer's Personnel, or Contractor's, its Subcontractors' and suppliers' personnel. The notification shall provide sufficient detail regarding such incidents or accidents. The Contractor shall provide full details of such incidents or accidents to the Project Manager within the timeframe agreed with the Project Manager.

The Contractor shall require its Subcontractors and suppliers to immediately notify the Contractor of any incidents or accidents referred to in this Subclause.

18.4 Progress of Performance

If at any time the Contractor's actual progress falls behind the program referred to in GCC Sub-Clause 18.2, or it becomes apparent that it will so fall behind, the Contractor shall, at the request of the Employer or the Project Manager, prepare and submit to the Project Manager a revised program, taking into account the prevailing circumstances, and shall notify the Project Manager of the steps being taken to expedite progress so as to attain Completion of the Facilities within the Time for Completion

under GCC Sub-Clause 8.2, any extension thereof entitled under GCC Sub-Clause 40.1, or any extended period as may otherwise be agreed upon between the Employer and the Contractor.

18.5 Procedures

The Contract shall be executed in accordance with the Contract Documents including the procedures given in the Forms and Procedures of the Employer's Requirements.

The Contractor may execute the Contract in accordance with its own standard project execution plans and procedures to the extent that they do not conflict with the provisions contained in the Contract.

19. Subcontracting

19.1 The Appendix to the Contract Agreement titled List of Major Items of Plant and Installation Services and List of Approved Subcontractors, specifies major items of supply or services and a list of approved Subcontractors against each item, including manufacturers. Insofar as no Subcontractors are listed against any such item, the Contractor shall prepare a list of Subcontractors for such item for inclusion in such list. The Contractor may from time to time propose any addition to or deletion from any such list. The Contractor shall submit any such list or any modification thereto to the Employer for its approval in sufficient time so as not to impede the progress of work on the Facilities. Submission by the Contractor, for addition of any Subcontractor not named in the Contract, shall also include the Subcontractor's declaration in accordance with Appendix D- Sexual exploitation and Abuse (SEA) and/or Sexual Harassment (SH) Performance Declaration. Approval by the Employer for any of the Subcontractors shall not relieve the Contractor from any of its obligations, duties or responsibilities under the Contract.

19.2 The Contractor shall select and employ its Subcontractors for such major items from those listed in the lists referred to in GCC Sub-Clause 19.1.

19.3 For items or parts of the Facilities not specified in the Appendix to the Contract Agreement titled List of Major Items of Plant

and Installation Services and List of Approved Subcontractors, the Contractor may employ such Subcontractors as it may select, at its discretion.

- 19.4 Each sub-contract shall include provisions which would entitle the Employer to require the sub-contract to be assigned to the Employer under GCC 19.5 (if and when applicable), or in event of termination by the Employer under GCC 42.2.
- 19.5 If a Subcontractor's obligations extend beyond the expiry date of the relevant Defects Liability Period and the Project Manager, prior to that date, instructs the Contractor to assign the benefits of such obligations to the Employer, then the Contractor shall do so.
- 19.6 The Contractor shall ensure that its Subcontractors execute the Facilities in accordance with the Contract, including complying with the relevant ES requirements and the obligations set out in GCC Sub-Clause 22.4.

20. Design and Engineering **20.1 Specifications and Drawings**

- 20.1.1 The Contractor shall execute the basic and detailed design and the engineering work in compliance with the provisions of the Contract, or where not so specified, in accordance with good engineering practice.

The Contractor shall be responsible for any discrepancies, errors or omissions in the specifications, drawings and other technical documents that it has prepared, whether such specifications, drawings and other documents have been approved by the Project Manager or not, provided that such discrepancies, errors or omissions are not because of inaccurate information furnished in writing to the Contractor by or on behalf of the Employer.

- 20.1.2 The Contractor shall be entitled to disclaim responsibility for any design, data, drawing, specification or other document, or any modification thereof provided or designated by or on behalf of the Employer, by giving a notice of such disclaimer to the Project Manager.

20.2 Codes and Standards

Wherever references are made in the Contract to codes and standards in accordance with which the Contract shall be executed, the edition or the revised version of such codes and standards current at the date twenty-eight (28) days prior to date of Bid submission shall apply unless otherwise specified. During Contract execution, any changes in such codes and standards shall be applied subject to approval by the Employer and shall be treated in accordance with GCC Clause 39.

20.3 Approval/Review of Technical Documents by Project Manager

- 20.3.1 The Contractor shall prepare or cause its Subcontractors to prepare, and furnish to the Project Manager the documents listed in the Appendix to the Contract Agreement titled List of Documents for Approval or Review, for its approval or review as specified and in accordance with the requirements of GCC Sub-Clause 18.2 (Program of Performance).

Any part of the Facilities covered by or related to the documents to be approved by the Project Manager shall be executed only after the Project Manager's approval thereof.

GCC Sub-Clauses 20.3.2 through 20.3.7 shall apply to those documents requiring the Project Manager's approval, but not to those furnished to the Project Manager for its review only.

- 20.3.2 Within fourteen (14) days after receipt by the Project Manager of any document requiring the Project Manager's approval in accordance with GCC Sub-Clause 20.3.1, the Project Manager shall either return one copy thereof to the Contractor with its approval endorsed thereon or shall notify the Contractor in writing of its disapproval thereof and the reasons therefor and the modifications that the Project Manager proposes.

If the Project Manager fails to take such action within the said fourteen (14) days, then the said document shall be deemed to have been approved by the Project Manager.

- 20.3.3 The Project Manager shall not disapprove any document, except on the grounds that the document does not comply with the Contract or that it is contrary to good engineering practice.
- 20.3.4 If the Project Manager disapproves the document, the Contractor shall modify the document and resubmit it for the Project Manager's approval in accordance with GCC Sub-Clause 20.3.2. If the Project Manager approves the document subject to modification(s), the Contractor shall make the required modification(s), whereupon the document shall be deemed to have been approved.
- 20.3.5 If any dispute or difference occurs between the Employer and the Contractor in connection with or arising out of the disapproval by the Project Manager of any document and/or any modification(s) thereto that cannot be settled between the Parties within a reasonable period, then such dispute or difference may be referred to a Dispute Board for determination in accordance with GCC Sub-Clause 46.1 hereof. If such dispute or difference is referred to a Dispute Board, the Project Manager shall give instructions as to whether and if so, how, performance of the Contract is to proceed. The Contractor shall proceed with the Contract in accordance with the Project Manager's instructions, provided that if the Dispute Board upholds the Contractor's view on the dispute and if the Employer has not given notice under GCC Sub-Clause 46.3 hereof, then the Contractor shall be reimbursed by the Employer for any additional costs incurred by reason of such instructions and shall be relieved of such responsibility or liability in connection with the dispute and the execution of the instructions as the Dispute Board shall decide, and the Time for Completion shall be extended accordingly.

20.3.6 The Project Manager's approval, with or without modification of the document furnished by the Contractor, shall not relieve the Contractor of any responsibility or liability imposed upon it by any provisions of the Contract except to the extent that any subsequent failure results from modifications required by the Project Manager.

20.3.7 The Contractor shall not depart from any approved document unless the Contractor has first submitted to the Project Manager an amended document and obtained the Project Manager's approval thereof, pursuant to the provisions of this GCC Sub-Clause 20.3.

If the Project Manager requests any change in any already approved document and/or in any document based thereon, the provisions of GCC Clause 39 shall apply to such request.

21. Procurement

21.1 Plant

Subject to GCC Sub-Clause 14.2, the Contractor shall procure and transport all Plant in an expeditious and orderly manner to the Site.

21.2 Employer-Supplied Plant

If the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer, provides that the Employer shall furnish any specific items to the Contractor, the following provisions shall apply:

21.2.1 The Employer shall, at its own risk and expense, transport each item to the place on or near the Site as agreed upon by the Parties and make such item available to the Contractor at the time specified in the program furnished by the Contractor, pursuant to GCC Sub-Clause 18.2, unless otherwise mutually agreed.

21.2.2 Upon receipt of such item, the Contractor shall inspect the same visually and notify the Project Manager of any detected shortage, defect or default. The Employer shall immediately remedy any shortage, defect or default, or

the Contractor shall, if practicable and possible, at the request of the Employer, remedy such shortage, defect or default at the Employer's cost and expense. After inspection, such item shall fall under the care, custody and control of the Contractor. The provision of this GCC Sub-Clause 21.2.2 shall apply to any item supplied to remedy any such shortage or default or to substitute for any defective item, or shall apply to defective items that have been repaired.

- 21.2.3 The foregoing responsibilities of the Contractor and its obligations of care, custody and control shall not relieve the Employer of liability for any undetected shortage, defect or default, nor place the Contractor under any liability for any such shortage, defect or default whether under GCC Clause 27 or under any other provision of Contract.

21.3 Transportation

- 21.3.1 The Contractor shall at its own risk and expense transport all the materials and the Contractor's Equipment to the Site by the mode of transport that the Contractor judges most suitable under all the circumstances.
- 21.3.2 Unless otherwise provided in the Contract, the Contractor shall be entitled to select any safe mode of transport operated by any person to carry the materials and the Contractor's Equipment.
- 21.3.3 Upon dispatch of each shipment of materials and the Contractor's Equipment, the Contractor shall notify the Employer by telex, cable, facsimile or electronic means, of the description of the materials and of the Contractor's Equipment, the point and means of dispatch, and the estimated time and point of arrival in the country where the Site is located, if applicable, and at the Site. The Contractor shall furnish the Employer with relevant shipping documents to be agreed upon between the Parties.

21.3.4 The Contractor shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the materials and the Contractor's Equipment to the Site. The Employer shall use its best endeavors in a timely and expeditious manner to assist the Contractor in obtaining such approvals, if requested by the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any claim for damage to roads, bridges or any other traffic facilities that may be caused by the transport of the materials and the Contractor's Equipment to the Site.

21.4 Customs Clearance

The Contractor shall, at its own expense, handle all imported materials and Contractor's Equipment at the point(s) of import and shall handle any formalities for customs clearance, subject to the Employer's obligations under GCC Sub-Clause 14.2, provided that if applicable laws or regulations require any application or act to be made by or in the name of the Employer, the Employer shall take all necessary steps to comply with such laws or regulations. In the event of delays in customs clearance that are not the fault of the Contractor, the Contractor shall be entitled to an extension in the Time for Completion, pursuant to GCC Clause 40.

22. Installation**22.1 Setting Out/Supervision**

- 22.1.1 Bench Mark: The Contractor shall be responsible for the true and proper setting-out of the Facilities in relation to bench marks, reference marks and lines provided to it in writing by or on behalf of the Employer.

If, at any time during the progress of installation of the Facilities, any error shall appear in the position, level or alignment of the Facilities, the Contractor shall forthwith notify the Project Manager of such error and, at its own expense, immediately rectify such error to the reasonable satisfaction of the Project Manager. If such error is based on incorrect data provided in writing by or on behalf of the Employer, the expense of rectifying the same shall be borne by the Employer.

- 22.1.2 Contractor's Supervision: The Contractor shall give or provide all necessary superintendence during the installation of the Facilities, and the Construction Manager or its deputy shall be constantly on the Site to provide full-time superintendence of the installation. The Contractor shall provide and employ only technical personnel who are skilled and experienced in their respective callings and supervisory staff who are competent to adequately supervise the work at hand.

22.2 Labor:**22.2.1 Engagement of Staff and Labor**

Except as otherwise stated in the Employer's Requirements, the Contractor shall make arrangements for the engagement of all staff and labor, local or otherwise, and for their payment, housing, feeding and transport.

The Contractor shall provide and employ on the Site in the installation of the Facilities such skilled, semi-skilled and unskilled labor as is necessary for the proper and timely execution of the Contract. The Contractor is encouraged to use local labor that has the necessary skills.

The Contractor shall be responsible for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labor and personnel to be employed on the Site into the country where the Site is located. The Employer will, if requested by the Contractor, use his best endeavors in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national or government permission required for bringing in the Contractor's Personnel.

The Contractor shall at its own expense provide the means of repatriation to all of its Contractor's Personnel employed for the execution of the Contract at the Site or other places where the Installation Services are carried out to the place where they were recruited or to their domicile. It shall also provide suitable temporary maintenance of all such persons from the cessation of their employment on the Contract to the date programmed for their departure. In the event that the Contractor defaults in providing such means of transportation and temporary maintenance, the Employer may provide the same to such personnel and recover the cost of doing so from the Contractor.

The Contractor shall provide Contractor's Personnel employed for the execution of the Contract at the Site or other places where the Installation Services are carried out, relevant information and documentation that are clear and understandable regarding their terms and conditions of employment. The information and documentation shall set out their rights under relevant labor laws applicable to the Contractor's Personnel (which will include any applicable collective agreements), including their rights related to hours of work, wages, overtime, compensation and benefits, as well as those arising from any requirements in the Employer's Requirements. The Contractor's Personnel shall be informed when any material changes to their terms or conditions of employment occur.

22.2.2 Persons in the Service of Employer

The Contractor shall not recruit, or attempt to recruit, staff and labor from amongst the Employer's Personnel.

22.2.3 Labor Laws

The Contractor shall comply with all the relevant labor laws applicable to the Contractor's Personnel, including laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights.

The Contractor shall at all times during the progress of the Contract use its best endeavors to prevent any unlawful, riotous or disorderly conduct or behavior by or amongst its employees and the labor of its Subcontractors.

The Contractor shall, in all dealings with its labor and the labor of its Subcontractors currently employed on or connected with the Contract, pay due regard to all recognized festivals, official holidays, religious or other customs and all local laws and regulations pertaining to the employment of labor.

22.2.4 Rates of Wages and Conditions of Labor

The Contractor shall pay rates of wages, and observe conditions of labor, which are not lower than those established for the trade or industry where the work is carried out. If no established rates or conditions are applicable, the Contractor shall pay rates of wages and observe conditions which are not lower than the general level of wages and conditions observed locally by employers whose trade or industry is similar to that of the Contractor.

The Contractor shall inform the Contractor's Personnel about:

- (a) any deduction to their payment and the conditions of such deductions in accordance with

the applicable laws or as stated in the Employer's Requirements; and

- (b) their liability to pay personal income taxes in the Country in respect of such of their salaries, wages, allowances and any benefits as are subject to tax under the laws of the Country for the time being in force.

The Contractor shall perform such duties in regard to such deductions thereof as may be imposed on him by such laws.

Where required by applicable Laws or as stated in the Employer's Requirements, the Contractor and its Subcontractors shall provide their personnel written notice of termination of employment and details of severance payments in a timely manner. The Contractor and its Subcontractors shall have paid their personnel (either directly or where appropriate for their benefit) all due wages and entitlements including, as applicable, social security benefits and pension contributions, on or before the end of their engagement/ employment.

22.2.5 Working Hours

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

- (a) otherwise stated in the Contract,
- (b) the Project Manager gives consent, or
- (c) the work is unavoidable, or necessary for the protection of life or property or for the safety of the Facilities, in which case the Contractor shall immediately advise the Project Manager.

If and when the Contractor considers it necessary to carry out work at night or on public holidays so as to meet the Time for Completion and requests the Project Manager's consent thereto, the Project Manager shall not unreasonably withhold such consent.

This Sub-Clause shall not apply to any work which is customarily carried out by rotary or double-shifts.

22.2.6 Facilities for Staff and Labor

Except as otherwise stated in the Employer's Requirements, the Contractor shall provide and maintain all necessary accommodation and welfare facilities for the Contractor's Personnel employed for the execution of the Contract at the Site or other places where the Installation Services are carried out. The Contractor shall also provide facilities for the Employer's Personnel as stated in the Employer's Requirements.

If stated in the Employer's Requirements, the Contractor shall give access to or provide services that accommodate the physical, social and cultural needs of the Contractor's Personnel. The Contractor shall also provide similar facilities for the Employer's Personnel as stated in the Employer's Requirements.

The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the Facilities.

22.2.7 Health and Safety

The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel employed for the execution of Installation Services at the Site (or other places in the country where the Site is located).

Subject to GCC Sub-Clause 9.9, the Contractor shall submit to the Project Manager for its approval a health and safety manual which sets out all the health and safety requirements under the Contract.

The health and safety manual shall be in addition to any other similar document required under applicable health and safety regulations and Laws.

The Contractor shall:

- (a) comply with all applicable health and safety regulations and laws;
- (b) comply with all applicable health and safety obligations specified in the Contract;
- (c) develop and implement procedures to establish and maintain a safe working environment without risk to health at all workplaces, machinery, equipment and processes under the control of the Contractor, including control measures for chemical, physical and biological substances and agents;
- (d) provide health and safety training of the Contractor's Personnel as appropriate and maintain training records;
- (e) actively engage the Contractor's Personnel in promoting understanding, and methods for, implementation of health and safety requirements, as well as in providing information to such personnel, and provision of personal protective equipment without expense to the personnel;
- (f) put in place workplace processes for the Contractor's Personnel to report work situations that they believe are not safe or healthy, and to remove themselves from a work situation which they have reasonable justification to believe presents an imminent and serious danger to their life or health; Contractor's Personnel who remove themselves from such work situations shall not be required to return to work until necessary remedial action to correct the situation has been taken. Such personnel shall not be retaliated against or otherwise subject to reprisal or negative action for such reporting or removal;
- (g) in collaboration with local health authorities, ensure that medical staff, first aid facilities, sick bay and

ambulance service are available at all times at the Site and at any accommodation for Contractor's and Employer's Personnel;

- (h) appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents. This person shall be qualified for this responsibility and shall have the authority to issue instructions and take protective measures to prevent accidents. Throughout the performance of the Contract, the Contractor shall provide whatever is required by this person to exercise this responsibility and authority;
- (i) put in place measures to avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases;
- (j) put in place measures to be implemented to avoid or minimize the spread of communicable diseases (including transfer of Sexually Transmitted Diseases or Infections (STDs), such as HIV virus) and non-communicable diseases associated with the Installation Services, taking into consideration differentiated exposure to and higher sensitivity of vulnerable groups. This includes taking measures to avoid or minimize the transmission of communicable diseases that may be associated with the influx of temporary or permanent Contract-related labor;
- (k) have in place procedures for prevention, preparedness and response activities to be implemented in the case of an emergency event (i.e. an unanticipated incident, arising from both natural and man-made hazards, typically in the form of fire, explosions, leaks or spills, which may occur for a variety of different reasons including failure to implement operating procedures that are designed

to prevent their occurrence, extreme weather or lack of early warning);

- (l) collaborate, as applicable, with the Employer's Personnel, any other contractors employed by the Employer, and/or personnel of any legally constituted public authorities and private utility companies that are employed in carrying out, on or near the site, of any work not included in the Contract, in applying the health and safety requirements. This is without prejudice to the responsibility of the relevant entities for the health and safety of their own personnel; and
- (m) put in place a system for regular review of health and safety performance and the working environment.

22.2.8 Funeral Arrangements

In the event of the death of any of the Contractor's Personnel or accompanying members of their families, the Contractor shall be responsible for making the appropriate arrangements for their return or burial, unless otherwise specified in the PCC.

22.2.9 Records of Contractor's Personnel

The Contractor shall keep accurate records of the Contractor's Personnel, including the number of each class of Contractor's personnel on the Site and the names, ages, genders, hours worked and wages paid to all workers. These records shall be summarized on a monthly basis in a form approved by the Project Manager and shall be available for inspection by the Project Manager until the Contractor has completed all work.

22.2.10 Supply of Foodstuffs

The Contractor shall arrange for the provision of a sufficient supply of suitable food as may be stated in the Employer's Requirements at reasonable prices for the

Contractor's personnel for the purposes of or in connection with the Contract.

22.2.11 Supply of Water

The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of drinking and other water for the use of the Contractor's personnel.

22.2.12 Measures against Insect and Pest Nuisance

The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce their danger to health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.

22.2.13 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the laws of the Country, import, sell, give barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift barter or disposal by Contractor's Personnel.

22.2.14 Arms and Ammunition

The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's Personnel to do so.

22.2.15 Workers' Organizations

In countries where the relevant labor laws recognize workers' rights to form and to join workers' organizations of their choosing and to bargain collectively without interference, the Contractor shall comply with such laws. In such circumstances, the role of legally established workers' organizations and legitimate workers' representatives will be respected, and they will be provided with information needed for meaningful negotiation in a timely manner. Where the relevant labor laws substantially restrict workers'

organizations, the Contractor shall enable alternative means for the Contractor's Personnel to express their grievances and protect their rights regarding working conditions and terms of employment. The Contractor shall not seek to influence or control these alternative means. The Contractor shall not discriminate or retaliate against the Contractor's Personnel who participate, or seek to participate, in such organizations and collective bargaining or alternative mechanisms. Workers' organizations are expected to fairly represent the workers in the workforce.

22.2.16 Non-Discrimination and Equal Opportunity

The Contractor shall not make decisions relating to the employment or treatment of Contractor's Personnel on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment of Contractor's Personnel on the principle of equal opportunity and fair treatment, and shall not discriminate with respect to any aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, job assignment, promotion, termination of employment or retirement, and disciplinary practices.

Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination. The Contractor shall provide protection and assistance as necessary to ensure non-discrimination and equal opportunity, including for specific groups such as women, people with disabilities, migrant workers and children (of working age in accordance with GCC Sub-Clause 9.13).

22.2.17 Contractor's Personnel Grievance Mechanism

The Contractor shall have a grievance mechanism for the Contractor's Personnel, and where relevant the workers'

organizations stated in subclause 22.2.15, to raise workplace concerns. The grievance mechanism shall be proportionate to the nature, scale, risks and impacts of the Contract. The mechanism shall address concerns promptly, using an understandable and transparent process that provides timely feedback to those concerned in a language they understand, without any retribution, and shall operate in an independent and objective manner.

The Contractor's Personnel shall be informed of the grievance mechanism at the time of engagement for the Contract, and the measures put in place to protect them against any reprisal for its use. Measures will be put in place to make the grievance mechanism easily accessible to all Contractor's Personnel.

The grievance mechanism shall not impede access to other judicial or administrative remedies that might be available, or substitute for grievance mechanisms provided through collective agreements.

The grievance mechanism may utilize existing grievance mechanisms, providing that they are properly designed and implemented, address concerns promptly, and are readily accessible to such project workers. Existing grievance mechanisms may be supplemented as needed with Contract-specific arrangements.

22.3 Contractor's Equipment

22.3.1 All Contractor's Equipment brought by the Contractor onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Contractor shall not remove the same from the Site without the Project Manager's consent that such Contractor's Equipment is no longer required for the execution of the Contract.

22.3.2 Unless otherwise specified in the Contract, upon completion of the Facilities, the Contractor shall remove from the Site all Equipment brought by the Contractor

onto the Site and any surplus materials remaining thereon.

22.3.3 The Employer will, if requested, use its best endeavors to assist the Contractor in obtaining any local, state or national government permission required by the Contractor for the export of the Contractor's Equipment imported by the Contractor for use in the execution of the Contract that is no longer required for the execution of the Contract.

22.4 Site Regulations

The Employer and the Contractor shall establish Site regulations setting out the rules to be observed in the execution of the Contract at the Site and shall comply therewith. The Contractor shall prepare and submit to the Project Manager with a copy to the Employer, proposed Site regulations for the Project Manager's approval, which approval shall not be unreasonably withheld.

Such Site regulations shall include, but shall not be limited to, Code of Conduct for environmental and social aspects submitted as part of the Bid and agreed to by the Employer, , security arrangements in accordance with GCC Sub-Clause 22.8, safety of the Facilities, gate control, sanitation, medical care, and fire prevention.

The Contractor shall take all necessary measures to ensure that each Contractor's Personnel, employed for the execution of the Contract at the Site or other places where the Installation Services are carried out, is made aware of the Code of Conduct including specific behaviors that are prohibited, and understands the consequences of engaging in such prohibited behaviors.

These measures include providing instructions and documentation that can be understood by the Contractor's Personnel and seeking to obtain that person's signature acknowledging receipt of such instructions and/or documentation, as appropriate.

The Contractor shall also ensure that the Code of Conduct is visibly displayed in multiple locations on the Site and any other place where the Installation Services will be carried out, as well as in areas outside the Site accessible to the local community and project affected people. The posted Code of Conduct shall be provided in languages comprehensible to Contractor's Personnel, Employer's Personnel and the local community.

The Contractor's Management Strategy and Implementation Plans shall include appropriate processes for the Contractor to verify compliance with these obligations.

22.5 Opportunities for Other Contractors

22.5.1 The Contractor shall, upon written request from the Employer or the Project Manager, give all reasonable opportunities for carrying out the work to any other contractors employed by the Employer on or near the Site.

22.5.2 If the Contractor, upon written request from the Employer or the Project Manager, makes available to other contractors any roads or ways the maintenance for which the Contractor is responsible, permits the use by such other contractors of the Contractor's Equipment, or provides any other service of whatsoever nature for such other contractors, the Employer shall fully compensate the Contractor for any loss or damage caused or occasioned by such other contractors in respect of any such use or service, and shall pay to the Contractor reasonable remuneration for the use of such equipment or the provision of such services.

22.5.3 The Contractor shall also so arrange to perform its work as to minimize, to the extent possible, interference with the work of other contractors. The Project Manager shall determine the resolution of any difference or conflict that may arise between the Contractor and other contractors and the workers of the Employer in regard to their work.

22.5.4 The Contractor shall notify the Project Manager promptly of any defects in the other contractors' work that come to its notice, and that could affect the Contractor's work. The Project Manager shall determine the corrective measures, if any, required to rectify the situation after inspection of the Facilities. Decisions made by the Project Manager shall be binding on the Contractor.

22.6 Emergency Work

If, by reason of an emergency arising in connection with and during the execution of the Contract, any protective or remedial work is necessary as a matter of urgency to prevent damage to the Facilities, the Contractor shall immediately carry out such work.

If the Contractor is unable or unwilling to do such work immediately, the Employer may do or cause such work to be done as the Employer may determine is necessary in order to prevent damage to the Facilities. In such event the Employer shall, as soon as practicable after the occurrence of any such emergency, notify the Contractor in writing of such emergency, the work done and the reasons therefor. If the work done or caused to be done by the Employer is work that the Contractor was liable to do at its own expense under the Contract, the reasonable costs incurred by the Employer in connection therewith shall be paid by the Contractor to the Employer. Otherwise, the cost of such remedial work shall be borne by the Employer.

22.7 Site Clearance

22.7.1 Site Clearance in Course of Performance: In the course of carrying out the Contract, the Contractor shall keep the Site reasonably free from all unnecessary obstruction, store or remove any surplus materials, clear away any wreckage, rubbish or temporary works from the Site, and remove any Contractor's Equipment no longer required for execution of the Contract.

22.7.2 Clearance of Site after Completion: After Completion of all parts of the Facilities, the Contractor shall clear away and remove all wreckage, rubbish and debris of any kind from the Site, and shall leave the Site and Facilities in a clean and safe condition.

22.8 Security of the Site

The Contractor shall be responsible for the security of the Site including providing and maintaining at its own expense all lighting, fencing, and watching when and where necessary for the proper execution and the protection of the Facilities, or for the safety of the owners and occupiers of adjacent property and for the safety of the public.

If required in the Employer's Requirements, the Contractor shall submit for the Project Manager's No-objection a security management plan that sets the security arrangements for the Site.

In making security arrangements, the Contractor shall be guided by applicable laws and any other requirements stated in the Employer's Requirements.

The Contractor shall (i) conduct appropriate background checks on any personnel retained to provide security; (ii) train the security personnel adequately (or determine that they are properly trained) in the use of force (and where applicable, firearms), and appropriate conduct towards Contractor's Personnel, Employer's personnel and affected communities; and (iii) require the security personnel to act within the applicable Laws and any requirements set out in the Employer's Requirements.

The Contractor shall not permit any use of force by security personnel in providing security except when used for preventive and defensive purposes in proportion to the nature and extent of the threat.

22.9 Protection of the Environment

The Contractor shall take all necessary measures to:

- i. protect the environment (both on and off the Site); and
- ii. limit damage and nuisance to people and property resulting from pollution, noise and other results of the Contractor's operations and/ or activities.

The Contractor shall ensure that emissions, surface discharges, effluent and any other pollutants from the Contractor's activities shall exceed neither the values indicated in the Employer's Requirements, nor those prescribed by applicable laws.

In the event of damage to the environment, property and/or nuisance to people, on or off Site as a result of the Contractor's operations, the Contractor shall agree with the Project Manager the appropriate actions and time scale to remedy, as practicable, the damaged environment to its former condition. The Contractor shall implement such remedies at its cost to the satisfaction of the Project Manager.

22.10 Traffic and Road Safety

The Contractor shall take all necessary safety measures to avoid the occurrence of incidents and injuries to any third party associated with the use of Contractor's Equipment on public roads or other public infrastructure.

The Contractor shall monitor and use road safety incidents and accidents reports to identify negative safety issues, and establish and implement necessary measures to resolve them.

22.11 Cultural Heritage Findings

All fossils, coins, articles of value or antiquity, structures, groups of structures, and other remains or items of geological, archaeological, paleontological, historical, architectural, religious interest found on the Site shall be placed under the care and custody of the Employer.

The Contractor shall:

- (a) take all reasonable precautions, including fencing-off the area or site of the finding, to avoid further disturbance and prevent Contractor's Personnel or other persons from removing or damaging any of these findings;

- (b) as soon as practicable after discovery of any such finding, give a notice to the Project Manager, to give the Project Manager the opportunity to promptly inspect and/or investigate the finding before it is disturbed and to issue instructions for dealing with it;
- (c) train relevant Contractor's Personnel on the procedures for handling such findings; and
- (d) implement any other action consistent with the requirements of the Employer's Requirements and relevant laws.

If the Contractor suffers delay and/or incurs extra costs from complying with the Project Manager instructions, the Contractor shall be entitled to an extension of time under GCC Sub-Clause 40.1, and the amount of such extra costs shall be added to the Contract Price.

23. Test and Inspection

- 23.1 The Contractor shall at its own expense carry out at the place of manufacture and/or on the Site all such tests and/or inspections of the Plant and any part of the Facilities as are specified in the Contract.
- 23.2 The Employer and the Project Manager or their designated representatives shall be entitled to attend the aforesaid test and/or inspection, provided that the Employer shall bear all costs and expenses incurred in connection with such attendance including, but not limited to, all traveling and board and lodging expenses.
- 23.3 Whenever the Contractor is ready to carry out any such test and/or inspection, the Contractor shall give a reasonable advance notice of such test and/or inspection and of the place and time thereof to the Project Manager. The Contractor shall obtain from any relevant third Party or manufacturer any necessary permission or consent to enable the Employer and

the Project Manager or their designated representatives to attend the test and/or inspection.

- 23.4 The Contractor shall provide the Project Manager with a certified report of the results of any such test and/or inspection.

If the Employer or Project Manager or their designated representatives fails to attend the test and/or inspection, or if it is agreed between the Parties that such persons shall not do so, then the Contractor may proceed with the test and/or inspection in the absence of such persons, and may provide the Project Manager with a certified report of the results thereof.

- 23.5 The Project Manager may require the Contractor to carry out any test and/or inspection not required by the Contract, provided that the Contractor's reasonable costs and expenses incurred in the carrying out of such test and/or inspection shall be added to the Contract Price. Further, if such test and/or inspection impede the progress of work on the Facilities and/or the Contractor's performance of its other obligations under the Contract, due allowance will be made in respect of the Time for Completion and the other obligations so affected.

- 23.6 If any Plant or any part of the Facilities fails to pass any test and/or inspection, the Contractor shall either rectify or replace such Plant or part of the Facilities and shall repeat the test and/or inspection upon giving a notice under GCC Sub-Clause 23.3.

- 23.7 If any dispute or difference of opinion shall arise between the Parties in connection with or arising out of the test and/or inspection of the Plant or part of the Facilities that cannot be settled between the Parties within a reasonable period of time, it may be referred to an Dispute Board for determination in accordance with GCC Sub-Clause 46.3.

- 23.8 The Contractor shall afford the Employer and the Project Manager, at the Employer's expense, access at any reasonable time to any place where the Plant are being manufactured or the Facilities are being installed, in order to inspect the progress and the manner of manufacture or installation, provided that the Project Manager shall give the Contractor a reasonable

prior notice. Without prejudice to GCC Sub-Clause 9.7, as instructed by the Project Manager, the Contractor shall also afford other relevant entities (at the Employer's or their respective entities' expense, as appropriate) access to the Facilities, to inspect progress and the manner of the execution of the Facilities, carry out environmental and social audit, as appropriate, or carry out any other duty as stated in the Employer's Requirements or as instructed by the Project Manager.

23.9 The Contractor agrees that neither the execution of a test and/or inspection of Plant or any part of the Facilities, nor the attendance by the Employer or the Project Manager, nor the issue of any test certificate pursuant to GCC Sub-Clause 23.4, shall release the Contractor from any other responsibilities under the Contract.

23.10 No part of the Facilities or foundations shall be covered up on the Site without the Contractor carrying out any test and/or inspection required under the Contract. The Contractor shall give a reasonable notice to the Project Manager whenever any such parts of the Facilities or foundations are ready or about to be ready for test and/or inspection; such test and/or inspection and notice thereof shall be subject to the requirements of the Contract.

23.11 The Contractor shall uncover any part of the Facilities or foundations, or shall make openings in or through the same as the Project Manager may from time to time require at the Site, and shall reinstate and make good such part or parts.

If any parts of the Facilities or foundations have been covered up at the Site after compliance with the requirement of GCC Sub-Clause 23.10 and are found to be executed in accordance with the Contract, the expenses of uncovering, making openings in or through, reinstating, and making good the same shall be borne by the Employer, and the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been delayed or impeded in the performance of any of its obligations under the Contract.

24. Completion of the Facilities

24.1 As soon as the Facilities or any part thereof has, in the opinion of the Contractor, been completed operationally and structurally and put in a tight and clean condition as specified in the Employer's Requirements, excluding minor items not materially affecting the operation or safety of the Facilities, the Contractor shall so notify the Employer in writing.

24.2 Within seven (7) days after receipt of the notice from the Contractor under GCC Sub-Clause 24.1, the Employer shall supply the operating and maintenance personnel specified in the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer for Precommissioning of the Facilities or any part thereof.

Pursuant to the Appendix to the Contract Agreement titled Scope of Works and Supply by the Employer, the Employer shall also provide, within the said seven (7) day period, the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for Precommissioning of the Facilities or any part thereof.

24.3 As soon as reasonably practicable after the operating and maintenance personnel have been supplied by the Employer and the raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters have been provided by the Employer in accordance with GCC Sub-Clause 24.2, the Contractor shall commence Precommissioning of the Facilities or the relevant part thereof in preparation for Commissioning, subject to GCC Sub-Clause 25.5.

24.4 As soon as all works in respect of Precommissioning are completed and, in the opinion of the Contractor, the Facilities or any part thereof is ready for Commissioning, the Contractor shall so notify the Project Manager in writing.

24.5 The Project Manager shall, within fourteen (14) days after receipt of the Contractor's notice under GCC Sub-Clause 24.4, either issue a Completion Certificate in the form specified in the Employer's Requirements (Forms and Procedures), stating that the Facilities or that part thereof have reached Completion as of the date of the Contractor's notice under GCC Sub-Clause

24.4, or notify the Contractor in writing of any defects and/or deficiencies.

If the Project Manager notifies the Contractor of any defects and/or deficiencies, the Contractor shall then correct such defects and/or deficiencies, and shall repeat the procedure described in GCC Sub-Clause 24.4.

If the Project Manager is satisfied that the Facilities or that part thereof have reached Completion, the Project Manager shall, within seven (7) days after receipt of the Contractor's repeated notice, issue a Completion Certificate stating that the Facilities or that part thereof have reached Completion as of the date of the Contractor's repeated notice.

If the Project Manager is not so satisfied, then it shall notify the Contractor in writing of any defects and/or deficiencies within seven (7) days after receipt of the Contractor's repeated notice, and the above procedure shall be repeated.

- 24.6 If the Project Manager fails to issue the Completion Certificate and fails to inform the Contractor of any defects and/or deficiencies within fourteen (14) days after receipt of the Contractor's notice under GCC Sub-Clause 24.4 or within seven (7) days after receipt of the Contractor's repeated notice under GCC Sub-Clause 24.5, or if the Employer makes use of the Facilities or part thereof, then the Facilities or that part thereof shall be deemed to have reached Completion as of the date of the Contractor's notice or repeated notice, or as of the Employer's use of the Facilities, as the case may be.
- 24.7 As soon as possible after Completion, the Contractor shall complete all outstanding minor items so that the Facilities are fully in accordance with the requirements of the Contract, failing which the Employer will undertake such completion and deduct the costs thereof from any monies owing to the Contractor.
- 24.8 Upon Completion, the Employer shall be responsible for the care and custody of the Facilities or the relevant part thereof,

together with the risk of loss or damage thereto, and shall thereafter take over the Facilities or the relevant part thereof.

**25. Commissioning
and Operational
Acceptance**

25.1 Commissioning

25.1.1 Commissioning of the Facilities or any part thereof shall be commenced by the Contractor immediately after issue of the Completion Certificate by the Project Manager, pursuant to GCC Sub-Clause 24.5, or immediately after the date of the deemed Completion, under GCC Sub-Clause 24.6.

25.1.2 The Employer shall supply the operating and maintenance personnel and all raw materials, utilities, lubricants, chemicals, catalysts, facilities, services and other matters required for Commissioning.

25.1.3 In accordance with the requirements of the Contract, the Contractor's and Project Manager's advisory personnel shall attend the Commissioning, including the Guarantee Test, and shall advise and assist the Employer.

25.2 Guarantee Test

25.2.1 Subject to GCC Sub-Clause 25.5, the Guarantee Test and repeats thereof shall be conducted by the Contractor during Commissioning of the Facilities or the relevant part thereof to ascertain whether the Facilities or the relevant part can attain the Functional Guarantees specified in the Appendix to the Contract Agreement titled Functional Guarantees. The Employer shall promptly provide the Contractor with such information as the Contractor may reasonably require in relation to the conduct and results of the Guarantee Test and any repeats thereof.

25.2.2 If for reasons not attributable to the Contractor, the Guarantee Test of the Facilities or the relevant part thereof cannot be successfully completed within the period from the date of Completion **specified in the PCC** or any other period agreed upon by the Employer and the Contractor, the Contractor shall be deemed to have

fulfilled its obligations with respect to the Functional Guarantees, and GCC Sub-Clauses 28.2 and 28.3 shall not apply.

25.3 Operational Acceptance

25.3.1 Subject to GCC Sub-Clause 25.4 below, Operational Acceptance shall occur in respect of the Facilities or any part thereof when

- (a) the Guarantee Test has been successfully completed and the Functional Guarantees are met; or
- (b) the Guarantee Test has not been successfully completed or has not been carried out for reasons not attributable to the Contractor within the period from the date of Completion specified in the PCC pursuant to GCC Sub-Clause 25.2.2 above or any other period agreed upon by the Employer and the Contractor; or
- (c) the Contractor has paid the liquidated damages specified in GCC Sub-Clause 28.3 hereof; and
- (d) any minor items mentioned in GCC Sub-Clause 24.7 hereof relevant to the Facilities or that part thereof have been completed.

25.3.2 At any time after any of the events set out in GCC Sub-Clause 25.3.1 have occurred, the Contractor may give a notice to the Project Manager requesting the issue of an Operational Acceptance Certificate in the form provided in the Employer's Requirements (Forms and Procedures) in respect of the Facilities or the part thereof specified in such notice as of the date of such notice.

25.3.3 The Project Manager shall, after consultation with the Employer, and within seven (7) days after receipt of the Contractor's notice, issue an Operational Acceptance Certificate.

25.3.4 If within seven (7) days after receipt of the Contractor's notice, the Project Manager fails to issue the

Operational Acceptance Certificate or fails to inform the Contractor in writing of the justifiable reasons why the Project Manager has not issued the Operational Acceptance Certificate, the Facilities or the relevant part thereof shall be deemed to have been accepted as of the date of the Contractor's said notice.

25.4 Partial Acceptance

25.4.1 If the Contract specifies that Completion and Commissioning shall be carried out in respect of parts of the Facilities, the provisions relating to Completion and Commissioning including the Guarantee Test shall apply to each such part of the Facilities individually, and the Operational Acceptance Certificate shall be issued accordingly for each such part of the Facilities.

25.4.2 If a part of the Facilities comprises facilities such as buildings, for which no Commissioning or Guarantee Test is required, then the Project Manager shall issue the Operational Acceptance Certificate for such facility when it attains Completion, provided that the Contractor shall thereafter complete any outstanding minor items that are listed in the Operational Acceptance Certificate.

25.5 Delayed Precommissioning and/or Guarantee Test

25.5.1 In the event that the Contractor is unable to proceed with the Precommissioning of the Facilities pursuant to Sub-Clause 24.3, or with the Guarantee Test pursuant to Sub-Clause 25.2, for reasons attributable to the Employer either on account of non availability of other facilities under the responsibilities of other contractor(s), or for reasons beyond the Contractor's control, the provisions leading to "deemed" completion of activities such as Completion, pursuant to GCC Sub-Clause 24.6, and Operational Acceptance, pursuant to GCC Sub-Clause 25.3.4, and Contractor's obligations regarding Defect Liability Period, pursuant to GCC Sub-Clause 27.2, Functional Guarantee, pursuant to GCC Clause 28, and Care of Facilities, pursuant to GCC Clause

32, and GCC Clause 41.1, Suspension, shall not apply. In this case, the following provisions shall apply.

25.5.2 When the Contractor is notified by the Project Manager that he will be unable to proceed with the activities and obligations pursuant to above Sub-Clause 25.5.1, the Contractor shall be entitled to the following:

- (a) the Time of Completion shall be extended for the period of suspension without imposition of liquidated damages pursuant to GCC Sub-Clause 26.2;
- (b) payments due to the Contractor in accordance with the provision specified in the Appendix to the Contract Agreement titled Terms and Procedures of Payment, which would not have been payable in normal circumstances due to non-completion of the subject activities, shall be released to the Contractor against submission of a security in the form of a bank guarantee of equivalent amount acceptable to the Employer, and which shall become null and void when the Contractor will have complied with its obligations regarding those payments, subject to the provision of Sub-Clause 25.5.3 below;
- (c) the expenses towards the above security and extension of other securities under the contract, of which validity needs to be extended, shall be reimbursed to the Contractor by the Employer;
- (d) the additional charges towards the care of the Facilities pursuant to GCC Sub-Clause 32.1 shall be reimbursed to the Contractor by the Employer for the period between the notification mentioned above and the notification mentioned in Sub-Clause 25.5.4 below. The provision of GCC Sub-Clause 33.2 shall apply to the Facilities during the same period.

25.5.3 In the event that the period of suspension under above Sub-Clause 25.5.1 actually exceeds one hundred eighty (180) days, the Employer and Contractor shall mutually agree to any additional compensation payable to the Contractor.

25.5.4 When the Contractor is notified by the Project Manager that the Plant is ready for Precommissioning, the Contractor shall proceed without delay in performing Precommissioning in accordance with Clause 24.

F. Guarantees and Liabilities

26. Completion Time Guarantee

26.1 The Contractor guarantees that it shall attain Completion of the Facilities (or a part for which a separate time for completion is specified) within the Time for Completion specified in the PCC pursuant to GCC Sub-Clause 8.2, or within such extended time to which the Contractor shall be entitled under GCC Clause 40 hereof.

26.2 If the Contractor fails to attain Completion of the Facilities or any part thereof within the Time for Completion or any extension thereof under GCC Clause 40, the Contractor shall pay to the Employer liquidated damages in the amount **specified in the PCC** as a percentage rate of the Contract Price or the relevant part thereof. The aggregate amount of such

liquidated damages shall in no event exceed the amount **specified as “Maximum” in the PCC** as a percentage rate of the Contract Price. Once the “Maximum” is reached, the Employer may consider termination of the Contract, pursuant to GCC Sub-Clause 42.2.2.

Such payment shall completely satisfy the Contractor’s obligation to attain Completion of the Facilities or the relevant part thereof within the Time for Completion or any extension thereof under GCC Clause 40. The Contractor shall have no further liability whatsoever to the Employer in respect thereof.

However, the payment of liquidated damages shall not in any way relieve the Contractor from any of its obligations to complete the Facilities or from any other obligations and liabilities of the Contractor under the Contract.

Save for liquidated damages payable under this GCC Sub-Clause 26.2, the failure by the Contractor to attain any milestone or other act, matter or thing by any date specified in the Appendix to the Contract Agreement titled Time Schedule, and/or other program of work prepared pursuant to GCC Sub-Clause 18.2 shall not render the Contractor liable for any loss or damage thereby suffered by the Employer.

- 26.3 If the Contractor attains Completion of the Facilities or any part thereof before the Time for Completion or any extension thereof under GCC Clause 40, the Employer shall pay to the Contractor a bonus in the amount **specified in the PCC**. The aggregate amount of such bonus shall in no event exceed the amount **specified as “Maximum” in the PCC**.

27. Defect Liability

- 27.1 The Contractor warrants that the Facilities or any part thereof shall be free from defects in the design, engineering, materials and workmanship of the Plant supplied and of the work executed.
- 27.2 The Defect Liability Period shall be five hundred and forty (540) days from the date of Completion of the Facilities (or any part thereof) or one year from the date of Operational Acceptance of the Facilities (or any part thereof), whichever first occurs,

unless specified otherwise in the PCC pursuant to GCC Sub-Clause 27.10.

If during the Defect Liability Period any defect should be found in the design, engineering, materials and workmanship of the Plant supplied or of the work executed by the Contractor, the Contractor shall promptly, in consultation and agreement with the Employer regarding appropriate remedying of the defects, and at its cost, repair, replace or otherwise make good as the Contractor shall determine at its discretion, such defect as well as any damage to the Facilities caused by such defect. The Contractor shall not be responsible for the repair, replacement or making good of any defect or of any damage to the Facilities arising out of or resulting from any of the following causes:

- (a) improper operation or maintenance of the Facilities by the Employer;
- (b) operation of the Facilities outside specifications provided in the Contract; or
- (c) normal wear and tear.

27.3 The Contractor's obligations under this GCC Clause 27 shall not apply to:

- (a) any materials that are supplied by the Employer under GCC Sub-Clause 21.2, are normally consumed in operation, or have a normal life shorter than the Defect Liability Period stated herein;
- (b) any designs, specifications or other data designed, supplied or specified by or on behalf of the Employer or any matters for which the Contractor has disclaimed responsibility herein; or
- (c) any other materials supplied or any other work executed by or on behalf of the Employer, except for the work executed by the Employer under GCC Sub-Clause 27.7.

27.4 The Employer shall give the Contractor a notice stating the nature of any such defect together with all available evidence thereof, promptly following the discovery thereof. The

Employer shall afford all reasonable opportunity for the Contractor to inspect any such defect.

- 27.5 The Employer shall afford the Contractor all necessary access to the Facilities and the Site to enable the Contractor to perform its obligations under this GCC Clause 27.

The Contractor may, with the consent of the Employer, remove from the Site any Plant or any part of the Facilities that are defective if the nature of the defect, and/or any damage to the Facilities caused by the defect, is such that repairs cannot be expeditiously carried out at the Site.

- 27.6 If the repair, replacement or making good is of such a character that it may affect the efficiency of the Facilities or any part thereof, the Employer may give to the Contractor a notice requiring that tests of the defective part of the Facilities shall be made by the Contractor immediately upon completion of such remedial work, whereupon the Contractor shall carry out such tests.

If such part fails the tests, the Contractor shall carry out further repair, replacement or making good, as the case may be, until that part of the Facilities passes such tests. The tests shall be agreed upon by the Employer and the Contractor.

- 27.7 If the Contractor fails to commence the work necessary to remedy such defect or any damage to the Facilities caused by such defect within a reasonable time (which shall in no event be considered to be less than fifteen (15) days), the Employer may, following notice to the Contractor, proceed to do such work, and the reasonable costs incurred by the Employer in connection therewith shall be paid to the Employer by the Contractor or may be deducted by the Employer from any monies due the Contractor or claimed under the Performance Security.

- 27.8 If the Facilities or any part thereof cannot be used by reason of such defect and/or making good of such defect, the Defect Liability Period of the Facilities or such part, as the case may be, shall be extended by a period equal to the period during which

the Facilities or such part cannot be used by the Employer because of any of the aforesaid reasons.

27.9 Except as provided in GCC Clauses 27 and 33, the Contractor shall be under no liability whatsoever and howsoever arising, and whether under the Contract or at law, in respect of defects in the Facilities or any part thereof, the Plant, design or engineering or work executed that appear after Completion of the Facilities or any part thereof, except where such defects are the result of the gross negligence, fraud, or criminal or willful action of the Contractor.

27.10 In addition, any such component of the Facilities, and during the period of time as may be **specified in the PCC**, shall be subject to an extended defect liability period. Such obligation of the Contractor shall be in addition to the defect liability period specified under GCC Sub-Clause 27.2.

28. Functional Guarantees

28.1 The Contractor guarantees that during the Guarantee Test, the Facilities and all parts thereof shall attain the Functional Guarantees specified in the Appendix to the Contract Agreement titled Functional Guarantees, subject to and upon the conditions therein specified.

28.2 If, for reasons attributable to the Contractor, the minimum level of the Functional Guarantees specified in the Appendix to the Contract Agreement titled Functional Guarantees, are not met either in whole or in part, the Contractor shall at its cost and expense make such changes, modifications and/or additions to the Plant or any part thereof as may be necessary to meet at least the minimum level of such Guarantees. The Contractor shall notify the Employer upon completion of the necessary changes, modifications and/or additions, and shall request the Employer to repeat the Guarantee Test until the minimum level of the Guarantees has been met. If the Contractor eventually fails to meet the minimum level of Functional Guarantees, the Employer may consider termination of the Contract, pursuant to GCC Sub-Clause 42.2.2.

28.3 If, for reasons attributable to the Contractor, the Functional Guarantees specified in the Appendix to the Contract

Agreement titled Functional Guarantees, are not attained either in whole or in part, but the minimum level of the Functional Guarantees specified in the said Appendix to the Contract Agreement is met, the Contractor shall, at the Contractor's option, either

- (a) make such changes, modifications and/or additions to the Facilities or any part thereof that are necessary to attain the Functional Guarantees at its cost and expense, and shall request the Employer to repeat the Guarantee Test or
- (b) pay liquidated damages to the Employer in respect of the failure to meet the Functional Guarantees in accordance with the provisions in the Appendix to the Contract Agreement titled Functional Guarantees.

28.4 The payment of liquidated damages under GCC Sub-Clause 28.3, up to the limitation of liability specified in the Appendix to the Contract Agreement titled Functional Guarantees, shall completely satisfy the Contractor's guarantees under GCC Sub-Clause 28.3, and the Contractor shall have no further liability whatsoever to the Employer in respect thereof. Upon the payment of such liquidated damages by the Contractor, the Project Manager shall issue the Operational Acceptance Certificate for the Facilities or any part thereof in respect of which the liquidated damages have been so paid.

29. Patent Indemnity

29.1 The Contractor shall, subject to the Employer's compliance with GCC Sub-Clause 29.2, indemnify and hold harmless the Employer and its employees and officers from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Employer may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract by reason of: (a) the installation of the Facilities by the Contractor or the use of the Facilities in the country where the Site is

located; and (b) the sale of the products produced by the Facilities in any country.

Such indemnity shall not cover any use of the Facilities or any part thereof other than for the purpose indicated by or to be reasonably inferred from the Contract, any infringement resulting from the use of the Facilities or any part thereof, or any products produced thereby in association or combination with any other equipment, Plant or materials not supplied by the Contractor, pursuant to the Contract Agreement.

- 29.2 If any proceedings are brought or any claim is made against the Employer arising out of the matters referred to in GCC Sub-Clause 29.1, the Employer shall promptly give the Contractor a notice thereof, and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

If the Contractor fails to notify the Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the twenty-eight (28) day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim.

The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

- 29.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers and Subcontractors from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, which the Contractor may suffer as a result of any infringement or alleged infringement of any patent, utility model, registered design, trademark, copyright or other intellectual property right registered or otherwise existing at the date of the Contract

arising out of or in connection with any design, data, drawing, specification, or other documents or materials provided or designed by or on behalf of the Employer.

**30. Limitation
Liability**

- 30.1 Except in cases of criminal negligence or willful misconduct,
- (a) neither Party shall be liable to the other Party, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, which may be suffered by the other Party in connection with the Contract, other than specifically provided as any obligation of the Party in the Contract, and
 - (b) the aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed the amount resulting from the application of the multiplier specified in the PCC, to the Contract Price or, if a multiplier is not so specified, the total Contract Price, provided that this limitation shall not apply to the cost of repairing or replacing defective equipment, or to any obligation of the Contractor to indemnify the Employer with respect to patent infringement.

G. Risk Distribution

**31. Transfer
Ownership**

- 31.1 Ownership of the Plant (including spare parts) to be imported into the country where the Site is located shall be transferred to the Employer upon loading on to the mode of transport to be used to convey the Plant from the country of origin to that country.
- 31.2 Ownership of the Plant (including spare parts) procured in the country where the Site is located shall be transferred to the Employer when the Plant are brought on to the Site.
- 31.3 Ownership of the Contractor's Equipment used by the Contractor and its Subcontractors in connection with the Contract shall remain with the Contractor or its Subcontractors.
- 31.4 Ownership of any Plant in excess of the requirements for the Facilities shall revert to the Contractor upon Completion of the

Facilities or at such earlier time when the Employer and the Contractor agree that the Plant in question are no longer required for the Facilities.

31.5 Notwithstanding the transfer of ownership of the Plant, the responsibility for care and custody thereof together with the risk of loss or damage thereto shall remain with the Contractor pursuant to GCC Clause 32 (Care of Facilities) hereof until Completion of the Facilities or the part thereof in which such Plant are incorporated.

**32. Care
of Facilities**

32.1 The Contractor shall be responsible for the care and custody of the Facilities or any part thereof until the date of Completion of the Facilities pursuant to GCC Clause 24 or, where the Contract provides for Completion of the Facilities in parts, until the date of Completion of the relevant part, and shall make good at its own cost any loss or damage that may occur to the Facilities or the relevant part thereof from any cause whatsoever during such period. The Contractor shall also be responsible for any loss or damage to the Facilities caused by the Contractor or its Subcontractors in the course of any work carried out, pursuant to GCC Clause 27. Notwithstanding the foregoing, the Contractor shall not be liable for any loss or damage to the Facilities or that part thereof caused by reason of any of the matters specified or referred to in paragraphs (a), (b) and (c) of GCC Sub-Clauses 32.2 and 38.1.

32.2 If any loss or damage occurs to the Facilities or any part thereof or to the Contractor's temporary facilities by reason of

- (a) insofar as they relate to the country where the Site is located, nuclear reaction, nuclear radiation, radioactive contamination, pressure wave caused by aircraft or other aerial objects, or any other occurrences that an experienced contractor could not reasonably foresee, or if reasonably foreseeable could not reasonably make provision for or insure against, insofar as such risks are not normally insurable on the insurance market and are mentioned in the general exclusions of the policy of insurance, including War Risks and Political Risks, taken out under GCC Clause 34 hereof; or

- (b) any use or occupation by the Employer or any third Party other than a Subcontractor, authorized by the Employer of any part of the Facilities; or
- (c) any use of or reliance upon any design, data or specification provided or designated by or on behalf of the Employer, or any such matter for which the Contractor has disclaimed responsibility herein,

the Employer shall pay to the Contractor all sums payable in respect of the Facilities executed, notwithstanding that the same be lost, destroyed or damaged, and will pay to the Contractor the replacement value of all temporary facilities and all parts thereof lost, destroyed or damaged. If the Employer requests the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Contractor shall make good the same at the cost of the Employer in accordance with GCC Clause 39. If the Employer does not request the Contractor in writing to make good any loss or damage to the Facilities thereby occasioned, the Employer shall either request a change in accordance with GCC Clause 39, excluding the performance of that part of the Facilities thereby lost, destroyed or damaged, or, where the loss or damage affects a substantial part of the Facilities, the Employer shall terminate the Contract pursuant to GCC Sub-Clause 42.1 hereof.

32.3 The Contractor shall be liable for any loss of or damage to any Contractor's Equipment, or any other property of the Contractor used or intended to be used for purposes of the Facilities, except (i) as mentioned in GCC Sub-Clause 32.2 with respect to the Contractor's temporary facilities, and (ii) where such loss or damage arises by reason of any of the matters specified in GCC Sub-Clauses 32.2 (b) and (c) and 38.1.

32.4 With respect to any loss or damage caused to the Facilities or any part thereof or to the Contractor's Equipment by reason of any of the matters specified in GCC Sub-Clause 38.1, the provisions of GCC Sub-Clause 38.3 shall apply.

33. Loss of or Damage to 33.1 Subject to GCC Sub-Clause 33.3, the Contractor shall indemnify and hold harmless the Employer and its employees and officers

**Property;
Accident or
Injury to
Workers;
Indemnifica-
tion**

from and against any and all suits, actions or administrative proceedings, claims, demands, losses, damages, costs, and expenses of whatsoever nature, including attorney's fees and expenses, in respect of the death or injury of any person or loss of or damage to any property other than the Facilities whether accepted or not, arising in connection with the supply and installation of the Facilities and by reason of the negligence of the Contractor or its Subcontractors, or their employees, officers or agents, except any injury, death or property damage caused by the negligence of the Employer, its contractors, employees, officers or agents.

- 33.2 If any proceedings are brought or any claim is made against the Employer that might subject the Contractor to liability under GCC Sub-Clause 33.1, the Employer shall promptly give the Contractor a notice thereof and the Contractor may at its own expense and in the Employer's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

If the Contractor fails to notify the Employer within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Employer shall be free to conduct the same on its own behalf. Unless the Contractor has so failed to notify the Employer within the twenty-eight (28) day period, the Employer shall make no admission that may be prejudicial to the defense of any such proceedings or claim.

The Employer shall, at the Contractor's request, afford all available assistance to the Contractor in conducting such proceedings or claim, and shall be reimbursed by the Contractor for all reasonable expenses incurred in so doing.

- 33.3 The Employer shall indemnify and hold harmless the Contractor and its employees, officers and Subcontractors from any liability for loss of or damage to property of the Employer, other than the Facilities not yet taken over, that is caused by fire, explosion or any other perils, in excess of the amount recoverable from insurances procured under GCC Clause 34, provided that such

fire, explosion or other perils were not caused by any act or failure of the Contractor.

- 33.4 The Party entitled to the benefit of an indemnity under this GCC Clause 33 shall take all reasonable measures to mitigate any loss or damage which has occurred. If the Party fails to take such measures, the other Party's liabilities shall be correspondingly reduced.

34. Insurance

- 34.1 To the extent specified in the Appendix to the Contract Agreement titled Insurance Requirements, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified in the said Appendix. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, who should not unreasonably withhold such approval.

(a) Cargo Insurance During Transport

Covering loss or damage occurring while in transit from the Contractor's or Subcontractor's works or stores until arrival at the Site, to the Plant (including spare parts therefor) and to the Contractor's Equipment.

(b) Installation All Risks Insurance

Covering physical loss or damage to the Facilities at the Site, occurring prior to Completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the Defect Liability Period while the Contractor is on the Site for the purpose of performing its obligations during the Defect Liability Period.

(c) Third Party Liability Insurance

Covering bodily injury or death suffered by third Parties including the Employer's personnel, and loss of or damage to property occurring in connection with the supply and installation of the Facilities.

(d) Automobile Liability Insurance

Covering use of all vehicles used by the Contractor or its Subcontractors, whether or not owned by them, in connection with the execution of the Contract.

(e) Workers' Compensation

In accordance with the statutory requirements applicable in any country where the Contract or any part thereof is executed.

(f) Employer's Liability

In accordance with the statutory requirements applicable in any country where the Contract or any part thereof is executed.

(g) Other Insurances

Such other insurances as may be specifically agreed upon by the Parties hereto as listed in the Appendix to the Contract Agreement titled Insurance Requirements.

34.2 The Employer shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to GCC Sub-Clause 34.1, except for the Third Party Liability, Workers' Compensation and Employer's Liability Insurances, and the Contractor's Subcontractors shall be named as co-insureds under all insurance policies taken out by the Contractor pursuant to GCC Sub-Clause 34.1 except for the Cargo Insurance During Transport, Workers' Compensation and Employer's Liability Insurances. All insurer's rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies.

34.3 The Contractor shall, in accordance with the provisions of the Appendix to the Contract Agreement titled Insurance Requirements, deliver to the Employer certificates of insurance or copies of the insurance policies as evidence that the required policies are in full force and effect. The certificates shall provide that no less than twenty-one (21) days' notice shall be given to

the Employer by insurers prior to cancellation or material modification of a policy.

34.4 The Contractor shall ensure that, where applicable, its Subcontractor(s) shall take out and maintain in effect adequate insurance policies for their personnel and vehicles and for work executed by them under the Contract, unless such Subcontractors are covered by the policies taken out by the Contractor.

34.5 The Employer shall at its expense take out and maintain in effect during the performance of the Contract those insurances specified in the Appendix to the Contract Agreement titled Insurance Requirements, in the sums and with the deductibles and other conditions specified in the said Appendix. The Contractor and the Contractor's Subcontractors shall be named as co-insureds under all such policies. All insurers' rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies. The Employer shall deliver to the Contractor satisfactory evidence that the required insurances are in full force and effect. The policies shall provide that not less than twenty-one (21) days' notice shall be given to the Contractor by all insurers prior to any cancellation or material modification of the policies. If so requested by the Contractor, the Employer shall provide copies of the policies taken out by the Employer under this GCC Sub-Clause 34.5.

34.6 If the Contractor fails to take out and/or maintain in effect the insurances referred to in GCC Sub-Clause 34.1, the Employer may take out and maintain in effect any such insurances and may from time to time deduct from any amount due the Contractor under the Contract any premium that the Employer shall have paid to the insurer, or may otherwise recover such amount as a debt due from the Contractor. If the Employer fails to take out and/or maintain in effect the insurances referred to in GCC 34.5, the Contractor may take out and maintain in effect any such insurances and may from time to time deduct from any amount due the Employer under the Contract any premium that the Contractor shall have paid to the insurer, or may otherwise

recover such amount as a debt due from the Employer. If the Contractor fails to or is unable to take out and maintain in effect any such insurances, the Contractor shall nevertheless have no liability or responsibility towards the Employer, and the Contractor shall have full recourse against the Employer for any and all liabilities of the Employer herein.

- 34.7 Unless otherwise provided in the Contract, the Contractor shall prepare and conduct all and any claims made under the policies effected by it pursuant to this GCC Clause 34, and all monies payable by any insurers shall be paid to the Contractor. The Employer shall give to the Contractor all such reasonable assistance as may be required by the Contractor. With respect to insurance claims in which the Employer's interest is involved, the Contractor shall not give any release or make any compromise with the insurer without the prior written consent of the Employer. With respect to insurance claims in which the Contractor's interest is involved, the Employer shall not give any release or make any compromise with the insurer without the prior written consent of the Contractor.

**35. Unforeseen
Conditions**

- 35.1 If, during the execution of the Contract, the Contractor shall encounter on the Site any physical conditions other than climatic conditions, or artificial obstructions that could not have been reasonably foreseen prior to the date of the Contract Agreement by an experienced contractor on the basis of reasonable examination of the data relating to the Facilities including any data as to boring tests, provided by the Employer, and on the basis of information that it could have obtained from a visual inspection of the Site if access thereto was available, or other data readily available to it relating to the Facilities, and if the Contractor determines that it will in consequence of such conditions or obstructions incur additional cost and expense or require additional time to perform its obligations under the Contract that would not have been required if such physical conditions or artificial obstructions had not been encountered, the Contractor shall promptly, and before performing additional

work or using additional Plant or Contractor's Equipment, notify the Project Manager in writing of

- (a) the physical conditions or artificial obstructions on the Site that could not have been reasonably foreseen;
- (b) the additional work and/or Plant and/or Contractor's Equipment required, including the steps which the Contractor will or proposes to take to overcome such conditions or obstructions;
- (c) the extent of the anticipated delay; and
- (d) the additional cost and expense that the Contractor is likely to incur.

On receiving any notice from the Contractor under this GCC Sub-Clause 35.1, the Project Manager shall promptly consult with the Employer and Contractor and decide upon the actions to be taken to overcome the physical conditions or artificial obstructions encountered. Following such consultations, the Project Manager shall instruct the Contractor, with a copy to the Employer, of the actions to be taken.

35.2 Any reasonable additional cost and expense incurred by the Contractor in following the instructions from the Project Manager to overcome such physical conditions or artificial obstructions referred to in GCC Sub-Clause 35.1 shall be paid by the Employer to the Contractor as an addition to the Contract Price.

If the Contractor is delayed or impeded in the performance of the Contract because of any such physical conditions or artificial obstructions referred to in GCC Sub-Clause 35.1, the Time for Completion shall be extended in accordance with GCC Clause 40.

36. Change in Laws and Regulations

36.1 If, after the date twenty-eight (28) days prior to the date of Bid submission, in the country where the Site is located, any law, regulation, ordinance, order or by-law having the force of law is enacted, promulgated, abrogated or changed which shall be deemed to include any change in interpretation or application by the competent authorities, that subsequently affects the costs and expenses of the Contractor and/or the Time for Completion, the Contract Price shall be correspondingly increased or decreased, and/or the Time for Completion shall be reasonably adjusted to the extent that the Contractor has thereby been affected in the performance of any of its obligations under the Contract. Notwithstanding the foregoing, such additional or reduced costs shall not be separately paid or credited if the same has already been accounted for in the price adjustment provisions where applicable, in accordance with the PCC pursuant to GCC Sub-Clause 11.2.

37. Force Majeure

37.1 “Force Majeure” shall mean any event beyond the reasonable control of the Employer or of the Contractor, as the case may be, and which is unavoidable notwithstanding the reasonable care of the Party affected, and shall include, without limitation, the following:

- (a) war, hostilities or warlike operations whether a state of war be declared or not, invasion, act of foreign enemy and civil war
- (b) rebellion, revolution, insurrection, mutiny, usurpation of civil or military government, conspiracy, riot, civil commotion and terrorist acts
- (c) confiscation, nationalization, mobilization, commandeering or requisition by or under the order of any government or de jure or de facto authority or ruler or any other act or failure to act of any local state or national government authority
- (d) strike, sabotage, lockout, embargo, import restriction, port congestion, lack of usual means of public transportation and communication, industrial dispute, shipwreck,

shortage or restriction of power supply, epidemics, quarantine and plague

- (e) earthquake, landslide, volcanic activity, fire, flood or inundation, tidal wave, typhoon or cyclone, hurricane, storm, lightning, or other inclement weather condition, nuclear and pressure waves or other natural or physical disaster
- (f) shortage of labor, materials or utilities where caused by circumstances that are themselves Force Majeure.

37.2 If either Party is prevented, hindered or delayed from or in performing any of its obligations under the Contract by an event of Force Majeure, then it shall notify the other in writing of the occurrence of such event and the circumstances thereof within fourteen (14) days after the occurrence of such event.

37.3 The Party who has given such notice shall be excused from the performance or punctual performance of its obligations under the Contract for so long as the relevant event of Force Majeure continues and to the extent that such Party's performance is prevented, hindered or delayed. The Time for Completion shall be extended in accordance with GCC Clause 40.

37.4 The Party or Parties affected by the event of Force Majeure shall use reasonable efforts to mitigate the effect thereof upon its or their performance of the Contract and to fulfill its or their obligations under the Contract, but without prejudice to either Party's right to terminate the Contract under GCC Sub-Clauses 37.6 and 38.5.

37.5 No delay or nonperformance by either Party hereto caused by the occurrence of any event of Force Majeure shall

- (a) constitute a default or breach of the Contract, or
- (b) give rise to any claim for damages or additional cost or expense occasioned thereby, subject to GCC Sub-Clauses 32.2, 38.3 and 38.4

if and to the extent that such delay or nonperformance is caused by the occurrence of an event of Force Majeure.

- 37.6 If the performance of the Contract is substantially prevented, hindered or delayed for a single period of more than sixty (60) days or an aggregate period of more than one hundred and twenty (120) days on account of one or more events of Force Majeure during the currency of the Contract, the Parties will attempt to develop a mutually satisfactory solution, failing which either Party may terminate the Contract by giving a notice to the other, but without prejudice to either Party's right to terminate the Contract under GCC Sub-Clause 38.5.
- 37.7 In the event of termination pursuant to GCC Sub-Clause 37.6, the rights and obligations of the Employer and the Contractor shall be as specified in GCC Sub-Clauses 42.1.2 and 42.1.3.
- 37.8 Notwithstanding GCC Sub-Clause 37.5, Force Majeure shall not apply to any obligation of the Employer to make payments to the Contractor herein.

38. War Risks

- 38.1 "War Risks" shall mean any event specified in paragraphs (a) and (b) of GCC Sub-Clause 37.1 and any explosion or impact of any mine, bomb, shell, grenade or other projectile, missile, munitions or explosive of war, occurring or existing in or near the country (or countries) where the Site is located.
- 38.2 Notwithstanding anything contained in the Contract, the Contractor shall have no liability whatsoever for or with respect to
- (a) destruction of or damage to Facilities, Plant, or any part thereof;
 - (b) destruction of or damage to property of the Employer or any third Party; or
 - (c) injury or loss of life
- if such destruction, damage, injury or loss of life is caused by any War Risks, and the Employer shall indemnify and hold the Contractor harmless from and against any and all claims, liabilities, actions, lawsuits, damages, costs, charges or expenses arising in consequence of or in connection with the same.
- 38.3 If the Facilities or any Plant or Contractor's Equipment or any other property of the Contractor used or intended to be used for

the purposes of the Facilities shall sustain destruction or damage by reason of any War Risks, the Employer shall pay the Contractor for

- (a) any part of the Facilities or the Plant so destroyed or damaged to the extent not already paid for by the Employer

and so far as may be required by the Employer, and as may be necessary for completion of the Facilities

- (b) replacing or making good any Contractor's Equipment or other property of the Contractor so destroyed or damaged
- (c) replacing or making good any such destruction or damage to the Facilities or the Plant or any part thereof .

If the Employer does not require the Contractor to replace or make good any such destruction or damage to the Facilities, the Employer shall either request a change in accordance with GCC Clause 39, excluding the performance of that part of the Facilities thereby destroyed or damaged or, where the loss, destruction or damage affects a substantial part of the Facilities, shall terminate the Contract, pursuant to GCC Sub-Clause 42.1.

If the Employer requires the Contractor to replace or make good on any such destruction or damage to the Facilities, the Time for Completion shall be extended in accordance with GCC 40.

38.4 Notwithstanding anything contained in the Contract, the Employer shall pay the Contractor for any increased costs or incidentals to the execution of the Contract that are in any way attributable to, consequent on, resulting from, or in any way connected with any War Risks, provided that the Contractor shall as soon as practicable notify the Employer in writing of any such increased cost.

38.5 If during the performance of the Contract any War Risks shall occur that financially or otherwise materially affect the execution of the Contract by the Contractor, the Contractor shall use its reasonable efforts to execute the Contract with due and proper consideration given to the safety of its and its Subcontractors' personnel engaged in the work on the Facilities, provided,

however, that if the execution of the work on the Facilities becomes impossible or is substantially prevented for a single period of more than sixty (60) days or an aggregate period of more than one hundred and twenty (120) days on account of any War Risks, the Parties will attempt to develop a mutually satisfactory solution, failing which either Party may terminate the Contract by giving a notice to the other.

- 38.6 In the event of termination pursuant to GCC Sub-Clauses 38.3 or 38.5, the rights and obligations of the Employer and the Contractor shall be specified in GCC Sub-Clauses 42.1.2 and 42.1.3.

H. Change in Contract Elements

39. Change in the Facilities

39.1 Introducing a Change

39.1.1 Subject to GCC Sub-Clauses 39.2.5 and 39.2.7, the Employer shall have the right to propose, and subsequently require, that the Project Manager order the Contractor from time to time during the performance of the Contract to make any change, modification, addition or deletion to, in or from the Facilities hereinafter called “Change”, provided that such Change falls within the general scope of the Facilities and does not constitute unrelated work and that it is technically practicable, taking into account both the state of advancement of the Facilities and the technical compatibility of the Change envisaged with the nature of the Facilities as specified in the Contract.

39.1.2 Value Engineering: The Contractor may prepare, at its own cost, a value engineering proposal at any time during the performance of the contract. The value engineering proposal shall, at a minimum, include the following;

- (a) the proposed change(s), and a description of the difference to the existing contract requirements;
- (b) a full cost/benefit analysis of the proposed change(s) including a description and estimate of costs (including life cycle costs) the Employer may incur in implementing the value engineering proposal; and
- (c) a description of any effect(s) of the change on performance/functionality.

The Employer may accept the value engineering proposal if the proposal demonstrates benefits that:

- (a) accelerates the delivery period; or
- (b) reduces the Contract Price or the life cycle costs to the Employer; or
- (c) improves the quality, efficiency, safety or sustainability of the Facilities; or
- (d) yields any other benefits to the Employer,

without compromising the necessary functions of the Facilities.

If the value engineering proposal is approved by the Employer and results in:

- (a) a reduction of the Contract Price; the amount to be paid to the Contractor shall be the percentage specified in the PCC of the reduction in the Contract Price; or
- (b) an increase in the Contract Price; but results in a reduction in life cycle costs due to any benefit described in (a) to (d) above, the amount to be paid to the Contractor shall be the full increase in the Contract Price.

39.1.3 Notwithstanding GCC Sub-Clauses 39.1.1 and 39.1.2, no change made necessary because of any default of the Contractor in the performance of its obligations under the Contract shall be deemed to be a Change, and such

change shall not result in any adjustment of the Contract Price or the Time for Completion.

39.1.4 The procedure on how to proceed with and execute Changes is specified in GCC Sub-Clauses 39.2 and 39.3, and further details and forms are provided in the Employer's Requirements (Forms and Procedures).

39.2 Changes Originating from Employer

39.2.1 If the Employer proposes a Change pursuant to GCC Sub-Clause 39.1.1, it shall send to the Contractor a "Request for Change Proposal," requiring the Contractor to prepare and furnish to the Project Manager as soon as reasonably practicable a "Change Proposal," which shall include the following:

- (a) brief description of the Change
- (b) effect on the Time for Completion
- (c) estimated cost of the Change
- (d) effect on Functional Guarantees (if any)
- (e) effect on the Facilities
- (f) effect on any other provisions of the Contract: and
- (g) any additional documents as **specified in the PCC**.

39.2.2 Prior to preparing and submitting the "Change Proposal," the Contractor shall submit to the Project Manager an "Estimate for Change Proposal," which shall be an estimate of the cost of preparing and submitting the Change Proposal.

Upon receipt of the Contractor's Estimate for Change Proposal, the Employer shall do one of the following:

- (a) accept the Contractor's estimate with instructions to the Contractor to proceed with the preparation of the Change Proposal

- (b) advise the Contractor of any part of its Estimate for Change Proposal that is unacceptable and request the Contractor to review its estimate
- (c) advise the Contractor that the Employer does not intend to proceed with the Change.

39.2.3 Upon receipt of the Employer's instruction to proceed under GCC Sub-Clause 39.2.2 (a), the Contractor shall, with proper expedition, proceed with the preparation of the Change Proposal, in accordance with GCC Sub-Clause 39.2.1.

39.2.4 The pricing of any Change shall, as far as practicable, be calculated in accordance with the rates and prices included in the Contract. If such rates and prices are inequitable, the Parties thereto shall agree on specific rates for the valuation of the Change.

39.2.5 If before or during the preparation of the Change Proposal it becomes apparent that the aggregate effect of compliance therewith and with all other Change Orders that have already become binding upon the Contractor under this GCC Clause 39 would be to increase or decrease the Contract Price as originally set forth in Article 2 (Contract Price) of the Contract Agreement by more than fifteen percent (15%), the Contractor may give a written notice of objection thereto prior to furnishing the Change Proposal as aforesaid. If the Employer accepts the Contractor's objection, the Employer shall withdraw the proposed Change and shall notify the Contractor in writing thereof.

The Contractor's failure to so object shall neither affect its right to object to any subsequent requested Changes or Change Orders herein, nor affect its right to take into account, when making such subsequent objection, the percentage increase or decrease in the Contract Price that any Change not objected to by the Contractor represents.

39.2.6 Upon receipt of the Change Proposal, the Employer and the Contractor shall mutually agree upon all matters

therein contained. Within fourteen (14) days after such agreement, the Employer shall, if it intends to proceed with the Change, issue the Contractor with a Change Order.

If the Employer is unable to reach a decision within fourteen (14) days, it shall notify the Contractor with details of when the Contractor can expect a decision.

If the Employer decides not to proceed with the Change for whatever reason, it shall, within the said period of fourteen (14) days, notify the Contractor accordingly. Under such circumstances, the Contractor shall be entitled to reimbursement of all costs reasonably incurred by it in the preparation of the Change Proposal, provided that these do not exceed the amount given by the Contractor in its Estimate for Change Proposal submitted in accordance with GCC Sub-Clause 39.2.2.

39.2.7 If the Employer and the Contractor cannot reach agreement on the price for the Change, an equitable adjustment to the Time for Completion, or any other matters identified in the Change Proposal, the Employer may nevertheless instruct the Contractor to proceed with the Change by issue of a "Pending Agreement Change Order."

Upon receipt of a Pending Agreement Change Order, the Contractor shall immediately proceed with effecting the Changes covered by such Order. The Parties shall thereafter attempt to reach agreement on the outstanding issues under the Change Proposal.

If the Parties cannot reach agreement within sixty (60) days from the date of issue of the Pending Agreement Change Order, then the matter may be referred to the Dispute Board in accordance with the provisions of GCC Sub-Clause 46.1.

39.3 Changes Originating from Contractor

39.3.1 If the Contractor proposes a Change pursuant to GCC Sub-Clause 39.1.2, the Contractor shall submit to the Project Manager a written “Application for Change Proposal,” giving reasons for the proposed Change and including the information specified in GCC Sub-Clause 39.1.2.

Upon receipt of the Application for Change Proposal, the Parties shall follow the procedures outlined in GCC Sub-Clauses 39.2.6 and 39.2.7. However, the Contractor shall not be entitled to recover the costs of preparing the Application for Change Proposal.

- 40. Extension of Time for Completion**
- 40.1 The Time(s) for Completion specified in the PCC pursuant to GCC Sub-Clause 8.2 shall be extended if the Contractor is delayed or impeded in the performance of any of its obligations under the Contract by reason of any of the following:
- (a) any Change in the Facilities as provided in GCC Clause 39
 - (b) any occurrence of Force Majeure as provided in GCC Clause 37, unforeseen conditions as provided in GCC Clause 35, or other occurrence of any of the matters specified or referred to in paragraphs (a), (b) and (c) of GCC Sub-Clause 32.2
 - (c) any suspension order given by the Employer under GCC Clause 41 hereof or reduction in the rate of progress pursuant to GCC Sub-Clause 41.2 or
 - (d) any changes in laws and regulations as provided in GCC Clause 36 or
 - (e) any default or breach of the Contract by the Employer, Appendix to the Contract Agreement titled ,or any activity, act or omission of the Employer, or the Project Manager, or any other contractors employed by the Employer, or
 - (f) any delay on the part of a Subcontractor, provided such delay is due to a cause for which the Contractor himself would have been entitled to an extension of time under this sub-clause, or
 - (g) delays attributable to the Employer or caused by customs, or

(h) any other matter specifically mentioned in the Contract

by such period as shall be fair and reasonable in all the circumstances and as shall fairly reflect the delay or impediment sustained by the Contractor.

40.2 Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Project Manager a notice of a claim for an extension of the Time for Completion, together with particulars of the event or circumstance justifying such extension as soon as reasonably practicable after the commencement of such event or circumstance. As soon as reasonably practicable after receipt of such notice and supporting particulars of the claim, the Employer and the Contractor shall agree upon the period of such extension. In the event that the Contractor does not accept the Employer's estimate of a fair and reasonable time extension, the Contractor shall be entitled to refer the matter to a Dispute Board, pursuant to GCC Sub-Clause 46.1.

40.3 The Contractor shall at all times use its reasonable efforts to minimize any delay in the performance of its obligations under the Contract.

40.4 In all cases where the Contractor has given a notice of a claim for an extension of time under GCC 40.2, the Contractor shall consult with the Project Manager in order to determine the steps (if any) which can be taken to overcome or minimize the actual or anticipated delay. The Contractor shall there after comply with all reasonable instructions which the Project Manager shall give in order to minimize such delay. If compliance with such instructions shall cause the Contractor to incur extra costs and the Contractor is entitled to an extension of time under GCC 40.1, the amount of such extra costs shall be added to the Contract Price.

41. Suspension

41.1 The Employer may request the Project Manager, by notice to the Contractor, to order the Contractor to suspend performance of any or all of its obligations under the Contract. Such notice shall specify the obligation of which performance is to be suspended, the effective date of the suspension and the reasons therefor. The Contractor shall thereupon suspend performance of such obligation, except those obligations necessary for the care or

preservation of the Facilities, until ordered in writing to resume such performance by the Project Manager.

If, by virtue of a suspension order given by the Project Manager, other than by reason of the Contractor's default or breach of the Contract, the Contractor's performance of any of its obligations is suspended for an aggregate period of more than ninety (90) days, then at any time thereafter and provided that at that time such performance is still suspended, the Contractor may give a notice to the Project Manager requiring that the Employer shall, within twenty-eight (28) days of receipt of the notice, order the resumption of such performance or request and subsequently order a change in accordance with GCC Clause 39, excluding the performance of the suspended obligations from the Contract.

If the Employer fails to do so within such period, the Contractor may, by a further notice to the Project Manager, elect to treat the suspension, where it affects a part only of the Facilities, as a deletion of such part in accordance with GCC Clause 39 or, where it affects the whole of the Facilities, as termination of the Contract under GCC Sub-Clause 42.1.

41.2 If

- (a) the Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to the Appendix to the Contract Agreement titled Terms and Procedures of Payment, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in GCC Sub-Clause 12.3, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, or fails to remedy the breach or take steps to

remedy the breach within fourteen (14) days after receipt of the Contractor's notice or

- (b) the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to the Employer, including but not limited to the Employer's failure to provide possession of or access to the Site or other areas in accordance with GCC Sub-Clause 10.2, or failure to obtain any governmental permit necessary for the execution and/or completion of the Facilities,

then the Contractor may by fourteen (14) days' notice to the Employer suspend performance of all or any of its obligations under the Contract, or reduce the rate of progress.

41.3 If the Contractor's performance of its obligations is suspended or the rate of progress is reduced pursuant to this GCC Clause 41, then the Time for Completion shall be extended in accordance with GCC Sub-Clause 40.1, and any and all additional costs or expenses incurred by the Contractor as a result of such suspension or reduction shall be paid by the Employer to the Contractor in addition to the Contract Price, except in the case of suspension order or reduction in the rate of progress by reason of the Contractor's default or breach of the Contract.

41.4 During the period of suspension, the Contractor shall not remove from the Site any Plant, any part of the Facilities or any Contractor's Equipment, without the prior written consent of the Employer.

42. Termination

42.1 Termination for Employer's Convenience

42.1.1 The Employer may at any time terminate the Contract for any reason by giving the Contractor a notice of termination that refers to this GCC Sub-Clause 42.1.

42.1.2 Upon receipt of the notice of termination under GCC Sub-Clause 42.1.1, the Contractor shall either immediately or upon the date specified in the notice of termination

- (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the

Facilities already executed, or any work required to leave the Site in a clean and safe condition

- (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) (ii) below
- (c) remove all Contractor's Equipment from the Site, repatriate the Contractor's Personnel from the Site, remove from the Site any wreckage, rubbish and debris of any kind, and leave the whole of the Site in a clean and safe condition, and
- (d) subject to the payment specified in GCC Sub-Clause 42.1.3,
 - (i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination
 - (ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors; and
 - (iii) deliver to the Employer all non-proprietary drawings, specifications and other documents prepared by the Contractor or its Subcontractors as at the date of termination in connection with the Facilities.

42.1.3 In the event of termination of the Contract under GCC Sub-Clause 42.1.1, the Employer shall pay to the Contractor the following amounts:

- (a) the Contract Price, properly attributable to the parts of the Facilities executed by the Contractor as of the date of termination
- (b) the costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment from the

Site and in the repatriation of the Contractor's Personnel

- (c) any amounts to be paid by the Contractor to its Subcontractors in connection with the termination of any subcontracts, including any cancellation charges
- (d) costs incurred by the Contractor in protecting the Facilities and leaving the Site in a clean and safe condition pursuant to paragraph (a) of GCC Sub-Clause 42.1.2
- (e) the cost of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with third Parties in connection with the Contract and that are not covered by paragraphs (a) through (d) above.

42.2 Termination for Contractor's Default

42.2.1 The Employer, without prejudice to any other rights or remedies it may possess, may terminate the Contract forthwith in the following circumstances by giving a notice of termination and its reasons therefor to the Contractor, referring to this GCC Sub-Clause 42.2:

- (a) if the Contractor becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, if the Contractor is a corporation, a resolution is passed or order is made for its winding up, other than a voluntary liquidation for the purposes of amalgamation or reconstruction, a receiver is appointed over any part of its undertaking or assets, or if the Contractor takes or suffers any other analogous action in consequence of debt
- (b) if the Contractor assigns or transfers the Contract or any right or interest therein in violation of the provision of GCC Clause 43.
- (c) if the Contractor, in the judgment of the Employer has engaged in Fraud and Corruption, as defined in

paragrph 2.2 a. of Appendix B to the GCC, in competing for or in executing the Contract.

42.2.2 If the Contractor

- (a) has abandoned or repudiated the Contract
- (b) has without valid reason failed to commence work on the Facilities promptly or has suspended, other than pursuant to GCC Sub-Clause 41.2, the progress of Contract performance for more than twenty-eight (28) days after receiving a written instruction from the Employer to proceed
- (c) persistently fails to execute the Contract in accordance with the Contract or persistently neglects to carry out its obligations under the Contract without just cause
- (d) refuses or is unable to provide sufficient materials, services or labor to execute and complete the Facilities in the manner specified in the program furnished under GCC Sub-Clause 18.2 at rates of progress that give reasonable assurance to the Employer that the Contractor can attain Completion of the Facilities by the Time for Completion as extended,

then the Employer may, without prejudice to any other rights it may possess under the Contract, give a notice to the Contractor stating the nature of the default and requiring the Contractor to remedy the same. If the Contractor fails to remedy or to take steps to remedy the same within fourteen (14) days of its receipt of such notice, then the Employer may terminate the Contract forthwith by giving a notice of termination to the Contractor that refers to this GCC Sub-Clause 42.2.

42.2.3 Upon receipt of the notice of termination under GCC Sub-Clauses 42.2.1 or 42.2.2, the Contractor shall, either immediately or upon such date as is specified in the notice of termination,

- (a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition
- (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) below
- (c) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination
- (d) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of termination, and, as may be required by the Employer, in any subcontracts concluded between the Contractor and its Subcontractors
- (e) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as of the date of termination in connection with the Facilities.

42.2.4 The Employer may enter upon the Site, expel the Contractor, and complete the Facilities itself or by employing any third Party. The Employer may, to the exclusion of any right of the Contractor over the same, take over and use with the payment of a fair rental rate to the Contractor, with all the maintenance costs to the account of the Employer and with an indemnification by the Employer for all liability including damage or injury to persons arising out of the Employer's use of such equipment, any Contractor's Equipment owned by the Contractor and on the Site in connection with the Facilities for such reasonable period as the Employer considers expedient for the supply and installation of the Facilities.

Upon completion of the Facilities or at such earlier date as the Employer thinks appropriate, the Employer shall

give notice to the Contractor that such Contractor's Equipment will be returned to the Contractor at or near the Site and shall return such Contractor's Equipment to the Contractor in accordance with such notice. The Contractor shall thereafter without delay and at its cost remove or arrange removal of the same from the Site.

42.2.5 Subject to GCC Sub-Clause 42.2.6, the Contractor shall be entitled to be paid the Contract Price attributable to the Facilities executed as of the date of termination, the value of any unused or partially used Plant on the Site, and the costs, if any, incurred in protecting the Facilities and in leaving the Site in a clean and safe condition pursuant to paragraph (a) of GCC Sub-Clause 42.2.3. Any sums due the Employer from the Contractor accruing prior to the date of termination shall be deducted from the amount to be paid to the Contractor under this Contract.

42.2.6 If the Employer completes the Facilities, the cost of completing the Facilities by the Employer shall be determined.

If the sum that the Contractor is entitled to be paid, pursuant to GCC Sub-Clause 42.2.5, plus the reasonable costs incurred by the Employer in completing the Facilities, exceeds the Contract Price, the Contractor shall be liable for such excess.

If such excess is greater than the sums due the Contractor under GCC Sub-Clause 42.2.5, the Contractor shall pay the balance to the Employer, and if such excess is less than the sums due the Contractor under GCC Sub-Clause 42.2.5, the Employer shall pay the balance to the Contractor.

The Employer and the Contractor shall agree, in writing, on the computation described above and the manner in which any sums shall be paid.

42.3 Termination by the Contractor

42.3.1 If

- (a) the Employer has failed to pay the Contractor any sum due under the Contract within the specified period, has failed to approve any invoice or supporting documents without just cause pursuant to the Appendix to the Contract Agreement titled Terms and Procedures of Payment, or commits a substantial breach of the Contract, the Contractor may give a notice to the Employer that requires payment of such sum, with interest thereon as stipulated in GCC Sub-Clause 12.3, requires approval of such invoice or supporting documents, or specifies the breach and requires the Employer to remedy the same, as the case may be. If the Employer fails to pay such sum together with such interest, fails to approve such invoice or supporting documents or give its reasons for withholding such approval, fails to remedy the breach or take steps to remedy the breach within fourteen (14) days after receipt of the Contractor's notice, or
- (b) the Contractor is unable to carry out any of its obligations under the Contract for any reason attributable to the Employer, including but not limited to the Employer's failure to provide possession of or access to the Site or other areas or failure to obtain any governmental permit necessary for the execution and/or completion of the Facilities,

then the Contractor may give a notice to the Employer thereof, and if the Employer has failed to pay the outstanding sum, to approve the invoice or supporting documents, to give its reasons for withholding such approval, or to remedy the breach within twenty-eight (28) days of such notice, or if the Contractor is still unable to carry out any of its obligations under the Contract for any reason attributable to the Employer within twenty-eight (28) days of the said notice, the Contractor may by a further notice to the Employer referring to this GCC Sub-Clause 42.3.1, forthwith terminate the Contract.

42.3.2 The Contractor may terminate the Contract forthwith by giving a notice to the Employer to that effect, referring to this GCC Sub-Clause 42.3.2, if the Employer becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, being a corporation, if a resolution is passed or order is made for its winding up (other than a voluntary liquidation for the purposes of amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the Employer takes or suffers any other analogous action in consequence of debt.

42.3.3 If the Contract is terminated under GCC Sub-Clauses 42.3.1 or 42.3.2, then the Contractor shall immediately

- (a) cease all further work, except for such work as may be necessary for the purpose of protecting that part of the Facilities already executed, or any work required to leave the Site in a clean and safe condition
- (b) terminate all subcontracts, except those to be assigned to the Employer pursuant to paragraph (d) (ii)
- (c) remove all Contractor's Equipment from the Site and repatriate the Contractor's Personnel from the Site, and
- (d) subject to the payment specified in GCC Sub-Clause 42.3.4,
 - (i) deliver to the Employer the parts of the Facilities executed by the Contractor up to the date of termination
 - (ii) to the extent legally possible, assign to the Employer all right, title and benefit of the Contractor to the Facilities and to the Plant as of the date of termination, and, as may be required by the Employer, in any subcontracts

concluded between the Contractor and its Subcontractors, and

- (iii) deliver to the Employer all drawings, specifications and other documents prepared by the Contractor or its Subcontractors as of the date of termination in connection with the Facilities.

42.3.4 If the Contract is terminated under GCC Sub-Clauses 42.3.1 or 42.3.2, the Employer shall pay to the Contractor all payments specified in GCC Sub-Clause 42.1.3, and reasonable compensation for all loss, except for loss of profit, or damage sustained by the Contractor arising out of, in connection with or in consequence of such termination.

42.3.5 Termination by the Contractor pursuant to this GCC Sub-Clause 42.3 is without prejudice to any other rights or remedies of the Contractor that may be exercised in lieu of or in addition to rights conferred by GCC Sub-Clause 42.3.

42.4 In this GCC Clause 42, the expression “Facilities executed” shall include all work executed, Installation Services provided, and all Plant acquired, or subject to a legally binding obligation to purchase, by the Contractor and used or intended to be used for the purpose of the Facilities, up to and including the date of termination.

42.5 In this GCC Clause 42, in calculating any monies due from the Employer to the Contractor, account shall be taken of any sum previously paid by the Employer to the Contractor under the Contract, including any advance payment paid pursuant to the Appendix to the Contract Agreement titled Terms and Procedures of Payment.

43. Assignment

43.1 Neither the Employer nor the Contractor shall, without the express prior written consent of the other Party, which consent shall not be unreasonably withheld, assign to any third Party the Contract or any part thereof, or any right, benefit, obligation or

interest therein or thereunder, except that the Contractor shall be entitled to assign either absolutely or by way of charge any monies due and payable to it or that may become due and payable to it under the Contract.

**44. Export
Restrictions**

44.1 Notwithstanding any obligation under the Contract to complete all export formalities, any export restrictions attributable to the Employer, to the country of the Employer or to the use of the Plant and Installation Services to be supplied which arise from trade regulations from a country supplying those Plant and Installation Services, and which substantially impede the Contractor from meeting its obligations under the Contract, shall release the Contractor from the obligation to provide deliveries or services, always provided, however, that the Contractor can demonstrate to the satisfaction of the Employer and of the Bank that it has completed all formalities in a timely manner, including applying for permits, authorizations and licenses necessary for the export of the Plant and Installation Services under the terms of the Contract. Termination of the Contract on this basis shall be for the Employer's convenience pursuant to Sub-Clause 42.1.

I. Claims, Disputes and Arbitration

**45. Contractor's
Claims**

45.1 If the Contractor considers himself to be entitled to any extension of the Time for Completion and/or any additional payment, under any Clause of these Conditions or otherwise in connection with the Contract, the Contractor shall submit a notice to the Project Manager, describing the event or circumstance giving rise to the claim. The notice shall be given as soon as practicable, and not later than 28 days after the Contractor became aware, or should have become aware, of the event or circumstance.

If the Contractor fails to give notice of a claim within such period of 28 days, the Time for Completion shall not be extended, the Contractor shall not be entitled to additional payment, and the Employer shall be discharged from all liability in connection with the claim. Otherwise, the following provisions of this Sub-Clause shall apply.

The Contractor shall also submit any other notices which are required by the Contract, and supporting particulars for the claim, all as relevant to such event or circumstance.

The Contractor shall keep such contemporary records as may be necessary to substantiate any claim, either on the Site or at another location acceptable to the Project Manager. Without admitting the Employer's liability, the Project Manager may, after receiving any notice under this Sub-Clause, monitor the record-keeping and/or instruct the Contractor to keep further contemporary records. The Contractor shall permit the Project Manager to inspect all these records, and shall (if instructed) submit copies to the Project Manager.

Within 42 days after the Contractor became aware (or should have become aware) of the event or circumstance giving rise to the claim, or within such other period as may be proposed by the Contractor and approved by the Project Manager, the Contractor shall send to the Project Manager a fully detailed claim which includes full supporting particulars of the basis of the claim and of the extension of time and/or additional payment claimed. If the event or circumstance giving rise to the claim has a continuing effect:

- (a) this fully detailed claim shall be considered as interim;
- (b) the Contractor shall send further interim claims at monthly intervals, giving the accumulated delay and/or amount claimed, and such further particulars as the Project Manager may reasonably require; and
- (c) the Contractor shall send a final claim within 28 days after the end of the effects resulting from the event or circumstance, or within such other period as may be proposed by the Contractor and approved by the Project Manager.

Within 42 days after receiving a claim or any further particulars supporting a previous claim, or within such other period as may be proposed by the Project Manager and approved by the Contractor, the Project Manager shall respond with approval, or with disapproval and detailed comments. He may also request any

necessary further particulars, but shall nevertheless give his response on the principles of the claim within such time.

Each Payment Certificate shall include such amounts for any claim as have been reasonably substantiated as due under the relevant provision of the Contract. Unless and until the particulars supplied are sufficient to substantiate the whole of the claim, the Contractor shall only be entitled to payment for such part of the claim as he has been able to substantiate.

The Project Manager shall agree with the Contractor or estimate: (i) the extension (if any) of the Time for Completion (before or after its expiry) in accordance with GCC Clause 40, and/or (ii) the additional payment (if any) to which the Contractor is entitled under the Contract.

The requirements of this Sub-Clause are in addition to those of any other Sub-Clause which may apply to a claim. If the Contractor fails to comply with this or another Sub-Clause in relation to any claim, any extension of time and/or additional payment shall take account of the extent (if any) to which the failure has prevented or prejudiced proper investigation of the claim, unless the claim is excluded under the second paragraph of this Sub-Clause.

In the event that the Contractor and the Employer cannot agree on any matter relating to a claim, either Party may refer the matter to the Dispute Board pursuant to GCC 46 hereof.

46. Disputes and Arbitration 46.1 Appointment of the Dispute Board

Disputes shall be referred to a DB for decision in accordance with GCC Sub-Clause 46.3. The Parties shall appoint a DB by the date stated in the PCC.

The DB shall comprise, as stated in the PCC, either one or three suitably qualified persons (“the members”), each of whom shall meet the criteria set forth in Sub-Clause 3 of Appendix A-1- General Conditions of Dispute Board Agreement. If the number is not so stated and the Parties do not agree otherwise, the DB shall comprise three persons, one of whom shall serve as chairman.

If the Contract is with a foreign Contractor, the DB members shall not have the same nationality as the Employer or the Contractor.

If the Parties have not jointly appointed the DB 21 days before the date stated in the PCC and the DB is to comprise three persons, each Party shall nominate one member for the approval of the other Party. The first two members shall recommend and the Parties shall agree upon the third member, who shall act as chairman.

However, if a list of potential members is included in the PCC, the members shall be selected from those on the list, other than anyone who is unable or unwilling to accept appointment to the DB.

The agreement between the Parties and either the sole member or each of the three members shall incorporate by reference the General Conditions of Dispute Board Agreement contained in the Appendix to these General Conditions, with such amendments as are agreed between them.

The DB shall be deemed to be constituted on the date the Parties and the sole member or the three members (as the case may be) of the DB have all signed a DB agreement.

The terms of the remuneration of either the sole member or each of the three members, including the remuneration of any expert whom the DB consults, shall be mutually agreed upon by the Parties when agreeing the terms of appointment of the member or such expert (as the case may be). Each Party shall be responsible for paying one-half of this remuneration.

If a member declines to act or is unable to act as a result of death, disability, resignation or termination of appointment, a replacement shall be appointed in the same manner as the replaced person was required to have been nominated or agreed upon, as described in this Sub-Clause.

The appointment of any member may be terminated by mutual agreement of both Parties, but not by the Employer or the Contractor acting alone. Unless otherwise agreed by both Parties, the appointment of the DB (including each member) shall expire

when the Operational Acceptance Certificate has been issued in accordance with GCC Sub-Clause 25.3.

46.2 Failure to Agree on the Composition of the Dispute Board

If any of the following conditions apply, namely:

- (a) the Parties fail to agree upon the appointment of the sole member of the DB by the date stated in the first paragraph of GCC Sub-Clause 46.1,
- (b) either Party fails to nominate a member (for approval by the other Party) of a DB of three persons by such date,
- (c) the Parties fail to agree upon the appointment of the third member (to act as chairman) of the DB by such date, or
- (d) the Parties fail to agree upon the appointment of a replacement person within 42 days after the date on which the sole member or one of the three members declines to act or is unable to act as a result of death, disability, resignation or termination of appointment,

then the appointing entity or official **named in the PCC** shall, upon the request of either or both of the Parties and after due consultation with both Parties, appoint this member of the DB. This appointment shall be final and conclusive. Each Party shall be responsible for paying one-half of the remuneration of the appointing entity or official.

46.3 Obtaining Dispute Board's Decision

If a dispute (of any kind whatsoever) arises between the Parties in connection with the performance of the Contract, including any dispute as to any certificate, determination, instruction, opinion or valuation of the Project Manager, either Party may refer the dispute in writing to the DB for its decision, with copies to the other Party and the Project Manager. Such reference shall state that it is given under this Sub-Clause.

For a DB of three persons, the DB shall be deemed to have received such reference on the date when it is received by the chairman of the DB.

Both Parties shall promptly make available to the DB all such additional information, further access to the Site, and appropriate

facilities, as the DB may require for the purposes of making a decision on such dispute. The DB shall be deemed to be not acting as arbitrator(s).

Within 84 days after receiving such reference, or within such other period as may be proposed by the DB and approved by both Parties, the DB shall give its decision, which shall be reasoned and shall state that it is given under this Sub-Clause. The decision shall be binding on both Parties, who shall promptly give effect to it unless and until it shall be revised in an amicable settlement or an arbitral award as described below. Unless the Contract has already been abandoned, repudiated or terminated, the Contractor shall continue with the performance of the Facilities in accordance with the Contract.

If either Party is dissatisfied with the DB's decision, then either Party may, within 28 days after receiving the decision, give notice to the other Party of its dissatisfaction and intention to commence arbitration. If the DB fails to give its decision within the period of 84 days (or as otherwise approved) after receiving such reference, then either Party may, within 28 days after this period has expired, give notice to the other Party of its dissatisfaction and intention to commence arbitration.

In either event, this notice of dissatisfaction shall state that it is given under this Sub-Clause, and shall set out the matter in dispute and the reason(s) for dissatisfaction. Except as stated in GCC Sub-Clauses 46.6 and 46.7, neither Party shall be entitled to commence arbitration of a dispute unless a notice of dissatisfaction has been given in accordance with this Sub-Clause.

If the DB has given its decision as to a matter in dispute to both Parties, and no notice of dissatisfaction has been given by either Party within 28 days after it received the DB's decision, then the decision shall become final and binding upon both Parties.

46.4 Amicable Settlement

Where notice of dissatisfaction has been given under GCC Sub-Clause 46.3 above, both Parties shall attempt to settle the dispute amicably before the commencement of arbitration. However,

unless both Parties agree otherwise, arbitration may be commenced on or after the fifty-sixth day after the day on which notice of dissatisfaction and intention to commence arbitration was given, even if no attempt at amicable settlement has been made.

46.5 Arbitration

Unless **indicated otherwise in the PCC**, any dispute not settled amicably and in respect of which the DB's decision (if any) has not become final and binding shall be finally settled by arbitration. Unless otherwise agreed by both Parties, arbitration shall be conducted as follows:

(a) For contracts with foreign contractors:

unless otherwise specified in the PCC; the dispute shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce; by one or three arbitrators appointed in accordance with these Rules. The place of arbitration shall be the neutral location **stated in the PCC**; and the arbitration shall be conducted in the ruling language **stated in the PCC**;

and

(b) For contracts with domestic contractors, arbitration with proceedings conducted in accordance with the laws of the Employer's Country.

The arbitrator(s) shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Project Manager, and any decision of the DB, relevant to the dispute. Nothing shall disqualify the Project Manager from being called as a witness and giving evidence before the arbitrator(s) on any matter whatsoever relevant to the dispute.

Neither Party shall be limited in the proceedings before the arbitrator(s) to the evidence or arguments previously put before the DB to obtain its decision, or to the reasons for dissatisfaction given in its notice of dissatisfaction. Any decision of the DB shall be admissible in evidence in the arbitration.

Arbitration may be commenced prior to or after completion of the Facilities. The obligations of the Parties, the Project Manager and the DB shall not be altered by reason of any arbitration being conducted during the progress of the execution of the Facilities.

46.6 Failure to Comply with Dispute Board's Decision

In the event that a Party fails to comply with a DB decision which has become final and binding, then the other Party may, without prejudice to any other rights it may have, refer the failure itself to arbitration under GCC Sub-Clause 46.5. GCC Sub-Clauses 46.3 and 46.4 shall not apply to this reference.

46.7 Expiry of Dispute Board's Appointment

If a dispute arises between the Parties in connection with the performance of the Contract, and there is no DB in place, whether by reason of the expiry of the DB's appointment or otherwise:

- (a) GCC Sub-Clauses 46.3 and 46.4 shall not apply, and
- (b) the dispute may be referred directly to arbitration under GCC Sub-Clause 46.5

47. Cyber Security

47.1 Pursuant to the PCC, the Contractor including its Subcontractors/ suppliers/ manufacturers shall take all technical and organizational measures necessary to protect the information technology systems and data used in connection with the Contract. Without limiting the foregoing, the Contractor, including its Subcontractors/ suppliers/ manufacturers, shall use all reasonable efforts to establish, maintain, implement and comply with, reasonable information technology, information security, cyber security and data protection controls, policies and procedures, including oversight, access controls, encryption, technological and physical safeguards and business continuity/disaster recovery and security plans that are designed to protect against and prevent breach, destruction, loss, unauthorized distribution, use, access, disablement, misappropriation or modification, or other compromise or misuse of or relating to any information technology system or data used in connection with the Contract.

APPENDIX A-1

General Conditions of Dispute Board Agreement

1. Definitions

Each “Dispute Board Agreement” is a tripartite agreement by and between:

the “Employer”;

the “Contractor”; and

the “Member” who is defined in the Dispute Board Agreement as being:

- (i) the sole member of the “DB” and, where this is the case, all references to the “Other Members” do not apply, or
- (ii) one of the three persons who are jointly called the “DB” (or “dispute board”) and, where this is the case, the other two persons are called the “Other Members”.

The Employer and the Contractor have entered (or intend to enter) into a contract, which is called the “Contract” and is defined in the Dispute Board Agreement, which incorporates this Appendix. In the Dispute Board Agreement, words and expressions which are not otherwise defined shall have the meanings assigned to them in the Contract.

2. General Provisions

Unless otherwise stated in the Dispute Board Agreement, it shall take effect on the latest of the following dates:

- (a) the Commencement Date defined in the Contract,
- (b) when the Employer, the Contractor and the Member have each signed the Dispute Board Agreement, or
- (c) when the Employer, the Contractor and each of the Other Members (if any) have respectively each signed a dispute board agreement.

This employment of the Member is a personal appointment. At any time, the Member may give not less than 70 days’ notice of resignation to the Employer and to the Contractor, and the Dispute Board Agreement shall terminate upon the expiry of this period.

3. Warranties

The Member warrants and agrees that he/she is and shall be impartial and independent of the Employer, the Contractor and the Project Manager. The Member shall promptly disclose, to each of them and to the Other Members (if any), any fact or circumstance which might appear inconsistent with his/her warranty and agreement of impartiality and independence.

- a) When appointing the Member, the Employer and the Contractor relied upon the Member's representations that he/she is/has at least a bachelor's degree in relevant disciplines such as law, engineering, construction management or contract management;
- b) has at least ten years of experience in contract administration/management and dispute resolution, out of which at least five years of experience as an arbitrator or adjudicator in construction-related disputes;
- c) has received formal training as an adjudicator from an internationally recognized organization;
- d) has experience and/or is knowledgeable in the type of work which the Contractor is to carry out under the Contract;
- e) has experience in the interpretation of construction and/or engineering contract documents; and
- f) is fluent in the language for communications defined in GCC Sub-Clause 5.3 (or the language as agreed between the Parties and the DB).

4. General Obligations of the Member

The Member shall:

- (a) have no interest financial or otherwise in the Employer, the Contractor or the Project Manager, nor any financial interest in the Contract except for payment under the Dispute Board Agreement;
- (b) not previously have been employed as a consultant or otherwise by the Employer, the Contractor or the Project Manager, except in such circumstances as were disclosed in writing to the Employer and the Contractor before they signed the Dispute Board Agreement;
- (c) have disclosed in writing to the Employer, the Contractor and the Other Members (if any), before entering into the Dispute Board Agreement and to his/her best knowledge and recollection, any professional or personal relationships with any director, officer or employee of the Employer, the Contractor or the Project Manager, and any previous involvement in the overall project of which the Contract forms part;

- (d) not, for the duration of the Dispute Board Agreement, be employed as a consultant or otherwise by the Employer, the Contractor or the Project Manager, except as may be agreed in writing by the Employer, the Contractor and the Other Members (if any);
- (e) comply with the annexed procedural rules and with GCC Sub-Clause 46.3;
- (f) not give advice to the Employer, the Contractor, the Employer's Personnel or the Contractor's Personnel concerning the conduct of the Contract, other than in accordance with the annexed procedural rules;
- (g) not while a Member enter into discussions or make any agreement with the Employer, the Contractor or the Project Manager regarding employment by any of them, whether as a consultant or otherwise, after ceasing to act under the Dispute Board Agreement;
- (h) ensure his/her availability for all site visits and hearings as are necessary;
- (i) become conversant with the Contract and with the progress of the Facilities (and of any other parts of the project of which the Contract forms part) by studying all documents received which shall be maintained in a current working file;
- (j) treat the details of the Contract and all the DB's activities and hearings as private and confidential, and not publish or disclose them without the prior written consent of the Employer, the Contractor and the Other Members (if any); and
- (k) be available to give advice and opinions, on any matter relevant to the Contract when requested by both the Employer and the Contractor, subject to the agreement of the Other Members (if any).

5. General Obligations of the Employer and the Contractor

The Employer, the Contractor, the Employer's Personnel and the Contractor's Personnel shall not request advice from or consultation with the Member regarding the Contract, otherwise than in the normal course of the DB's activities under the Contract and the Dispute Board Agreement. The Employer and the Contractor shall be responsible for compliance with this provision, by the Employer's Personnel and the Contractor's Personnel respectively.

The Employer and the Contractor undertake to each other and to the Member that the Member shall not, except as otherwise agreed in writing by the Employer, the Contractor, the Member and the Other Members (if any):

- (a) be appointed as an arbitrator in any arbitration under the Contract;
- (b) be called as a witness to give evidence concerning any dispute before arbitrator(s) appointed for any arbitration under the Contract; or
- (c) be liable for any claims for anything done or omitted in the discharge or purported discharge of the Member's functions, unless the act or omission is shown to have been in bad faith.

The Employer and the Contractor hereby jointly and severally indemnify and hold the Member harmless against and from claims from which he is relieved from liability under the preceding paragraph.

Whenever the Employer or the Contractor refers a dispute to the DB under GCC Sub-Clause 46.3, which will require the Member to make a site visit and attend a hearing, the Employer or the Contractor shall provide appropriate security for a sum equivalent to the reasonable expenses to be incurred by the Member. No account shall be taken of any other payments due or paid to the Member.

6. Payment

The Member shall be paid as follows, in the currency named in the Dispute Board Agreement:

- (a) a retainer fee per calendar month, which shall be considered as payment in full for:
 - (i) being available on 28 days' notice for all site visits and hearings;
 - (ii) becoming and remaining conversant with all project developments and maintaining relevant files;
 - (iii) all office and overhead expenses including secretarial services, photocopying and office supplies incurred in connection with his duties; and
 - (iv) all services performed hereunder except those referred to in subparagraphs (b) and (c) of this Clause.

The retainer fee shall be paid with effect from the last day of the calendar month in which the Dispute Board Agreement becomes effective; until the last day of the calendar month in which the Taking-Over Certificate is issued for the whole of the Facilities.

With effect from the first day of the calendar month following the month in which Taking-Over Certificate is issued for the whole of the Facilities, the retainer fee shall be reduced by one third. This reduced fee shall be paid until the first day of the calendar month in which the Member resigns or the Dispute Board Agreement is otherwise terminated.

- (b) a daily fee which shall be considered as payment in full for:
 - (i) each day or part of a day up to a maximum of two days' travel time in each direction for the journey between the Member's home and the site, or another location of a meeting with the Other Members (if any);
 - (ii) each working day on site visits, hearings or preparing decisions; and
 - (iii) each day spent reading submissions in preparation for a hearing.
- (c) all reasonable expenses including necessary travel expenses (air fare in less than first class, hotel and subsistence and other direct travel expenses) incurred in connection with the Member's duties, as well as the cost of telephone calls, courier charges, faxes and telexes: a receipt shall be required for each item in excess of five percent of the daily fee referred to in sub-paragraph (b) of this Clause;
- (d) any taxes properly levied in the Country on payments made to the Member (unless a national or permanent resident of the Country) under this Clause 6.

The retainer and daily fees shall be as specified in the Dispute Board Agreement. Unless it specifies otherwise, these fees shall remain fixed for the first 24 calendar months and shall thereafter be adjusted by agreement between the Employer, the Contractor and the Member, at each anniversary of the date on which the Dispute Board Agreement became effective.

If the Parties fail to agree on the retainer fee or the daily fee the appointing entity or official named in the PCC shall determine the amount of the fees to be used.

The Member shall submit invoices for payment of the monthly retainer and air fares quarterly in advance. Invoices for other expenses and for daily fees shall be submitted following the conclusion of a site visit or hearing. All invoices shall be accompanied by a brief description of activities performed during the relevant period and shall be addressed to the Contractor.

The Contractor shall pay each of the Member's invoices in full within 56 calendar days after receiving each invoice and shall apply to the Employer (in the Statements under the Contract)

for reimbursement of one-half of the amounts of these invoices. The Employer shall then pay the Contractor in accordance with the Contract.

If the Contractor fails to pay to the Member the amount to which he/she is entitled under the Dispute Board Agreement, the Employer shall pay the amount due to the Member and any other amount which may be required to maintain the operation of the DB; and without prejudice to the Employer's rights or remedies. In addition to all other rights arising from this default, the Employer shall be entitled to reimbursement of all sums paid in excess of one-half of these payments, plus all costs of recovering these sums and financing charges calculated at the rate specified in accordance with GCC Sub-Clause 12.3.

If the Member does not receive payment of the amount due within 70 days after submitting a valid invoice, the Member may (i) suspend his/her services (without notice) until the payment is received, and/or (ii) resign his/her appointment by giving notice under Clause 7.

7. Termination

At any time: (i) the Employer and the Contractor may jointly terminate the Dispute Board Agreement by giving 42 days' notice to the Member; or (ii) the Member may resign as provided for in Clause 2.

If the Member fails to comply with the Dispute Board Agreement, the Employer and the Contractor may, without prejudice to their other rights, terminate it by notice to the Member. The notice shall take effect when received by the Member.

If the Employer or the Contractor fails to comply with the Dispute Board Agreement, the Member may, without prejudice to his other rights, terminate it by notice to the Employer and the Contractor. The notice shall take effect when received by them both.

Any such notice, resignation and termination shall be final and binding on the Employer, the Contractor and the Member. However, a notice by the Employer or the Contractor, but not by both, shall be of no effect.

8. Default of the Member

If the Member fails to comply with any of his obligations under Clause 4 concerning his impartiality or independence in relation to the Employer or the Contractor, he/she shall not be entitled to any fees or expenses hereunder and shall, without prejudice to their other rights, reimburse each of the Employer and the Contractor for any fees and expenses received by the Member and the Other Members (if any), for proceedings or decisions (if any) of the DB which are rendered void or ineffective by the said failure to comply.

9. Disputes

Any dispute or claim arising out of or in connection with this Dispute Board Agreement, or the breach, termination or invalidity thereof, shall be finally settled by institutional arbitration. If no other arbitration institute is agreed, the arbitration shall be conducted under the Rules of Arbitration of the International Chamber of Commerce by one arbitrator appointed in accordance with these Rules of Arbitration.

Appendix A-2

DISPUTE BOARD GUIDELINES

1. Unless otherwise agreed by the Employer and the Contractor, the DB shall visit the site at intervals of not more than 140 days, including times of critical construction events, at the request of either the Employer or the Contractor. Unless otherwise agreed by the Employer, the Contractor and the DB, the period between consecutive visits shall not be less than 70 days, except as required to convene a hearing as described below.
2. The timing of and agenda for each site visit shall be as agreed jointly by the DB, the Employer and the Contractor, or in the absence of agreement, shall be decided by the DB. The purpose of site visits is to enable the DB to become and remain acquainted with the progress of the execution of the Contract and of any actual or potential problems or claims, and, as far as reasonable, to prevent potential problems or claims from becoming disputes.
3. Site visits shall be attended by the Employer, the Contractor and the Project Manager and shall be coordinated by the Employer in co-operation with the Contractor. The Employer shall ensure the provision of appropriate conference facilities and secretarial and copying services. At the conclusion of each site visit and before leaving the site, the DB shall prepare a report on its activities during the visit and shall send copies to the Employer and the Contractor.
4. The Employer and the Contractor shall furnish to the DB one copy of all documents which the DB may request, including Contract documents, progress reports, variation instructions, certificates and other documents pertinent to the performance of the Contract. All communications between the DB and the Employer or the Contractor shall be copied to the other Party. If the DB comprises three persons, the Employer and the Contractor shall send copies of these requested documents and these communications to each of these persons.
5. If any dispute is referred to the DB in accordance with GCC Sub-Clause 46.3, the DB shall proceed in accordance with GCC Sub-Clause 46.3 and these Guidelines. Subject to the time allowed to give notice of a decision and other relevant factors, the DB shall:
 - (a) act fairly and impartially as between the Employer and the Contractor, giving each of them a reasonable opportunity of putting his case and responding to the other's case, and
 - (b) adopt procedures suitable to the dispute, avoiding unnecessary delay or expense.
6. The DB may conduct a hearing on the dispute, in which event it will decide on the date and place for the hearing and may request that written documentation and arguments from the Employer and the Contractor be presented to it prior to or at the hearing.
7. Except as otherwise agreed in writing by the Employer and the Contractor, the DB shall have power to adopt an inquisitorial procedure, to refuse admission to hearings or audience at hearings to any persons other than representatives of the Employer, the Contractor and the Project Manager, and to proceed in the absence of any Party who the DB is satisfied received notice of the hearing; but shall have discretion to decide whether and to what extent this power may be exercised.
8. The Employer and the Contractor empower the DB, among other things, to:

- (a) establish the procedure to be applied in deciding a dispute,
- (b) decide upon the DB's own jurisdiction, and as to the scope of any dispute referred to it,
- (c) conduct any hearing as it thinks fit, not being bound by any rules or procedures other than those contained in the Contract and these Guidelines,
- (d) take the initiative in ascertaining the facts and matters required for a decision,
- (e) make use of its own specialist knowledge, if any,
- (f) decide upon the payment of financing charges in accordance with the Contract,
- (g) decide upon any provisional relief such as interim or conservatory measures,
- (h) open up, review and revise any certificate, decision, determination, instruction, opinion or valuation of the Project Manager, relevant to the dispute, and
- (i) appoint, should the DB so consider necessary and the Parties agree, a suitable expert/s (including legal and technical expert(s)) at the cost of the Parties to give advice on a specific matter/s relevant to the dispute.

9. The DB shall not express any opinions during any hearing concerning the merits of any arguments advanced by the Parties. Thereafter, the DB shall make and give its decision in accordance with GCC Sub-Clause 46.3, or as otherwise agreed by the Employer and the Contractor in writing. If the DB comprises three persons:

- (a) it shall convene in private after a hearing, in order to have discussions and prepare its decision;
- (b) it shall endeavor to reach a unanimous decision: if this proves impossible the applicable decision shall be made by a majority of the Members, who may require the minority Member to prepare a written report for submission to the Employer and the Contractor; and
- (c) if a Member fails to attend a meeting or hearing, or to fulfil any required function, the other two Members may nevertheless proceed to make a decision, unless:
 - (i) either the Employer or the Contractor does not agree that they do so, or
 - (ii) the absent Member is the chairman and he/she instructs the other Members to not make a decision.

Appendix B

Fraud and Corruption

(Text in this Appendix shall not be modified)

1. Purpose

1.1 The Bank's Anti-Corruption Guidelines and this annex apply with respect to procurement under Bank Investment Project Financing operations.

2. Requirements

2.1 The Bank requires that Borrowers (including beneficiaries of Bank financing); bidders (applicants/proposers), consultants, contractors and suppliers; any sub-contractors, sub-consultants, service providers or suppliers; any agents (whether declared or not); and any of their personnel, observe the highest standard of ethics during the procurement process, selection and contract execution of Bank-financed contracts, and refrain from Fraud and Corruption.

2.2 To this end, the Bank:

a. Defines, for the purposes of this provision, the terms set forth below as follows:

- i. "corrupt practice" is the offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;
- ii. "fraudulent practice" is any act or omission, including misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain financial or other benefit or to avoid an obligation;
- iii. "collusive practice" is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;
- iv. "coercive practice" is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;
- v. "obstructive practice" is:
 - (a) deliberately destroying, falsifying, altering, or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive, or collusive practice; and/or threatening,

harassing, or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation; or

- (b) acts intended to materially impede the exercise of the Bank's inspection and audit rights provided for under paragraph 2.2 e. below.
- b. Rejects a proposal for award if the Bank determines that the firm or individual recommended for award, any of its personnel, or its agents, or its sub-consultants, sub-contractors, service providers, suppliers and/ or their employees, has, directly or indirectly, engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices in competing for the contract in question;
- c. In addition to the legal remedies set out in the relevant Legal Agreement, may take other appropriate actions, including declaring misprocurement, if the Bank determines at any time that representatives of the Borrower or of a recipient of any part of the proceeds of the loan engaged in corrupt, fraudulent, collusive, coercive, or obstructive practices during the procurement process, selection and/or execution of the contract in question, without the Borrower having taken timely and appropriate action satisfactory to the Bank to address such practices when they occur, including by failing to inform the Bank in a timely manner at the time they knew of the practices;
- d. Pursuant to the Bank's Anti- Corruption Guidelines and in accordance with the Bank's prevailing sanctions policies and procedures, may sanction a firm or individual, either indefinitely or for a stated period of time, including by publicly declaring such firm or individual ineligible (i) to be awarded or otherwise benefit from a Bank-financed contract, financially or in any other manner;¹ (ii) to be a nominated² sub-contractor, consultant, manufacturer or supplier, or service provider of an otherwise eligible firm being awarded a Bank-financed contract; and (iii) to receive the proceeds of any loan

¹ For the avoidance of doubt, a sanctioned party's ineligibility to be awarded a contract shall include, without limitation, (i) applying for pre-qualification, expressing interest in a consultancy, and bidding, either directly or as a nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider, in respect of such contract, and (ii) entering into an addendum or amendment introducing a material modification to any existing contract.

² A nominated sub-contractor, nominated consultant, nominated manufacturer or supplier, or nominated service provider (different names are used depending on the particular bidding document) is one which has been: (i) included by the bidder in its pre-qualification application or bid because it brings specific and critical experience and know-how that allow the bidder to meet the qualification requirements for the particular bid; or (ii) appointed by the Borrower.

made by the Bank or otherwise to participate further in the preparation or implementation of any Bank-financed project;

- e. Requires that a clause be included in bidding/request for proposals documents and in contracts financed by a Bank loan, requiring (i) bidders (applicants/proposers), consultants, contractors, and suppliers, and their sub-contractors, sub-consultants, service providers, suppliers, agents, personnel, permit the Bank to inspect³ all accounts, records and other documents relating to the procurement process, selection and/or contract execution, and to have them audited by auditors appointed by the Bank.

³ Inspections in this context usually are investigative (i.e., forensic) in nature. They involve fact-finding activities undertaken by the Bank or persons appointed by the Bank to address specific matters related to investigations/audits, such as evaluating the veracity of an allegation of possible Fraud and Corruption, through the appropriate mechanisms. Such activity includes but is not limited to: accessing and examining a firm's or individual's financial records and information, and making copies thereof as relevant; accessing and examining any other documents, data and information (whether in hard copy or electronic format) deemed relevant for the investigation/audit, and making copies thereof as relevant; interviewing staff and other relevant individuals; performing physical inspections and site visits; and obtaining third party verification of information.

Appendix C

Metrics for Progress Reports- Environmental and Social (ES)

Metrics for regular reporting:

- a. *environmental incidents or non-compliances with contract requirements, including contamination, pollution or damage to ground or water supplies;*
- b. *health and safety incidents, accidents, injuries that require treatment and all fatalities;*
- c. *interactions with regulators: identify agency, dates, subjects, outcomes (report the negative if none);*
- d. *status of all permits and agreements:*
 - (i) work permits: number required, number received, actions taken for those not received;
 - (ii) status of permits and consents:
 - list areas/facilities with permits required (quarries, asphalt & batch plants), dates of application, dates issued (actions to follow up if not issued), dates submitted to resident engineer (or equivalent), status of area (waiting for permits, working, abandoned without reclamation, decommissioning plan being implemented, etc.);
 - list areas with landowner agreements required (borrow and spoil areas, camp sites), dates of agreements, dates submitted to resident engineer (or equivalent);
 - identify major activities undertaken in each area in the reporting period and highlights of environmental and social protection (land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation);
 - for quarries: status of relocation and compensation (completed, or details of activities and current status in the reporting period).
- e. *health and safety supervision:*
 - (i) safety officer: number days worked, number of full inspections & partial inspections, reports to construction/project management;
 - (ii) number of workers, work hours, metric of PPE use (percentage of workers with full personal protection equipment (PPE), partial, etc.), worker violations observed (by type of violation, PPE or otherwise), warnings given, repeat warnings given, follow-up actions taken (if any);
- f. *worker accommodations:*
 - (i) number of expats housed in accommodations, number of locals;

- (ii) date of last inspection, and highlights of inspection including status of accommodations' compliance with national and local law and good practice, including sanitation, space, etc.;
 - (iii) actions taken to recommend/require improved conditions, or to improve conditions.
- g. *Health services: provider of health services, information and/or training, location of clinic, number of non-safety disease or illness treatments and diagnoses (no names to be provided);*
- h. *gender (for expats and locals separately): number of female workers, percentage of workforce, gender issues raised and dealt with (cross-reference grievances or other sections as needed);*
- i. *training:*
 - (i) number of new workers, number receiving induction training, dates of induction training;
 - (ii) number and dates of toolbox talks, number of workers receiving Occupational Health and Safety (OHS), environmental and social training;
 - (iii) number and dates of communicable diseases (including STDs) sensitization and/or training, no. workers receiving training (in the reporting period and in the past); same questions for gender sensitization, flag person training.
 - (iv) number and date of SEA prevention and SH sensitization and/or training events, including number of workers receiving training on Code of Conduct for Contractor's Personnel (in the reporting period and in the past), etc.
- j. *environmental and social supervision:*
 - (i) environmentalist: days worked, areas inspected and numbers of inspections of each (road section, work camp, accommodations, quarries, borrow areas, spoil areas, swamps, forest crossings, etc.), highlights of activities/findings (including violations of environmental and/or social best practices, actions taken), reports to environmental and/or social specialist/construction/site management;
 - (ii) sociologist: days worked, number of partial and full site inspections (by area: road section, work camp, accommodations, quarries, borrow areas, spoil areas, clinic, HIV/AIDS center, community centers, etc.), highlights of activities (including violations of environmental and/or social requirements observed, actions taken), reports to environmental and/or social specialist/construction/site management; and
 - (iii) community liaison person(s): days worked (hours community center open), number of people met, highlights of activities (issues raised, etc.), reports to environmental and/or social specialist /construction/site management.

- k. *Grievances: list new grievances (e.g., number of allegations of SEA and SH) received in the reporting period and number of unresolved past grievances by date received, complainant's age and sex, how received, to whom referred to for action, resolution and date (if completed), data resolution reported to complainant, any required follow-up (Cross-reference other sections as needed):*
 - (i) Worker grievances;
 - (ii) Community grievances
- l. *Traffic, road safety and vehicles/equipment:*
 - (i) traffic and road safety incidents and accidents involving project vehicles & equipment: provide date, location, damage, cause, follow-up;
 - (ii) traffic and road safety incidents and accidents involving non-project vehicles or property (also reported under immediate metrics): provide date, location, damage, cause, follow-up;
 - (iii) overall condition of vehicles/equipment (subjective judgment by environmentalist); non-routine repairs and maintenance needed to improve safety and/or environmental performance (to control smoke, etc.).
- m. *Environmental mitigations and issues (what has been done):*
 - (i) dust: number of working bowlers, number of waterings/day, number of complaints, warnings given by environmentalist, actions taken to resolve; highlights of quarry dust control (covers, sprays, operational status); % of rock/spoil lorries with covers, actions taken for uncovered vehicles;
 - (ii) erosion control: controls implemented by location, status of water crossings, environmentalist inspections and results, actions taken to resolve issues, emergency repairs needed to control erosion/sedimentation;
 - (iii) quarries, borrow areas, spoil areas, asphalt plants, batch plants: identify major activities undertaken in the reporting period at each, and highlights of environmental and social protection: land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation;
 - (iv) blasting: number of blasts (and locations), status of implementation of blasting plan (including notices, evacuations, etc.), incidents of off-site damage or complaints (cross-reference other sections as needed);
 - (v) spill clean-ups, if any: material spilled, location, amount, actions taken, material disposal (report all spills that result in water or soil contamination);
 - (vi) waste management: types and quantities generated and managed, including amount taken offsite (and by whom) or reused/recycled/disposed on-site;
 - (vii) details of tree plantings and other mitigations required undertaken in the reporting period;

- (viii) details of water and swamp protection mitigations required undertaken in the reporting period.

n. compliance:

- (i) compliance status for conditions of all relevant consents/permits, for the Work, including quarries, etc.): statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance;
- (ii) compliance status of C-ESMP/ESIP requirements: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance
- (iii) compliance status of SEA and SH prevention and response action plan: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance
- (iv) compliance status of Health and Safety Management Plan re: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance
- (v) other unresolved issues from previous reporting periods related to environmental and social: continued violations, continued failure of equipment, continued lack of vehicle covers, spills not dealt with, continued compensation or blasting issues, etc. Cross-reference other sections as needed.

Appendix D

Sexual Exploitation and Abuse (SEA) and/or Sexual Harassment (SH) Performance Declaration for Subcontractors

[The following table shall be filled in by each subcontractor proposed by the Contractor, that was not named in the Contract]

Subcontractor's Name: *[insert full name]*

Date: *[insert day, month, year]*

Contract reference *[insert contract reference]*

Page *[insert page number]* of *[insert total number]* pages

SEA and/or SH Declaration
We: ☐ (a) have not been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations. ☐ (b) are subject to disqualification by the Bank for non-compliance with SEA/ SH obligations. ☐ (c) had been subject to disqualification by the Bank for non-compliance with SEA/ SH obligations. An arbitral award on the disqualification case has been made in our favor.
<i>[If (c) above is applicable, attach evidence of an arbitral award reversing the findings on the issues underlying the disqualification.]</i>

Name of the Subcontractor _____

Name of the person duly authorized to sign on behalf of the Subcontractor _____

Title of the person signing on behalf of the Subcontractor _____

Signature of the person named above _____

Date signed _____ day of _____, _____

Countersignature of authorized representative of the Contractor:

Signature: _____

Date signed _____ day of _____, _____

Section IX - Particular Conditions of Contract

The following Particular Conditions of Contract shall supplement the General Conditions of Contract in Section VIII. Whenever there is a conflict, the provisions herein shall prevail over those in the General Conditions.

Particular Conditions of Contract (PCC)

The following Particular Conditions (PCC) shall supplement the General Conditions (GCC). Whenever there is a conflict, the provisions herein shall prevail over those in the GCC. The clause number of the PCC is the corresponding clause number of the GCC.

PCC 1. Definitions	The Employer is: ZESCO Limited The Project Manager is: Hilner Mulapani The Bank is: World Bank Country of Origin: all countries and territories as indicated in Section V of the bidding document, Eligible Countries.
PCC 5. Law and Language	PCC 5.1 The Contract shall be interpreted in accordance with the laws of: Zambia. PCC 5.2 The ruling language is: English PCC 5.3 The language for communications is: English
PCC 7. Scope of Facilities [Spare Parts] (GCC Clause 7)	PCC 7.3 The Contractor agrees to supply spare parts for a period of years: Ten (10) Years The Contractor shall carry sufficient inventories to ensure an ex-stock supply of consumable spares for the Plant. Other spare parts and components shall be supplied as promptly as possible, but at the most within six (6) months of placing the order and opening the letter of credit. In addition, in the event of termination of the production of spare parts, advance notification will be made to the Employer of the pending termination, with sufficient time to permit the Employer to procure the needed requirement. Following such termination, the Contractor will furnish to the extent possible and at no cost to the Employer the blueprints, drawings and specifications of the spare parts, if requested. The Contractor agrees to warrant that spare parts for the Main Plant (Transformers, Reactors, Switchgear, and Protection Systems) shall be available for a period of ten (10) years following Operational Acceptance. To support this obligation, the Contractor confirms that the Manufacturer's Authorizations submitted in the Bid (Section IV) regarding long-term availability are binding. In the event a

	Manufacturer fails to supply parts during this period, the Contractor shall be liable to supply compatible equivalent parts or the necessary manufacturing drawings to the Employer at no additional cost.
PCC 8. Time for Commencement and Completion	PCC 8.1 The Contractor shall commence work on the Facilities within 15 days (two weeks) from the Effective Date for determining Time for Completion as specified in the Contract Agreement. PCC 8.2 The Time for Completion of the whole of the Facilities shall be Twenty-Four (24) months (two years) from the Effective Date as described in the Contract Agreement.
PCC 9. Contractor's Responsibilities	PCC 9.8 In addition to Contractor's Environmental and Social Management Plan (C-ESMP), the ESF instruments (ESIA/ESMP/BMP/LMP/ESCP/SEP and SEA/SH measures) shall form part of the contract. Whenever there is a conflict between C-ESMP and ESF instruments, the provisions of the ESF instruments shall prevail.
PCC 11. Contract Price	PCC 11.2 The Contract Price shall be adjusted in accordance with the provisions of the Appendix 2 to the Contract Agreement titled Price Adjustment.
PCC 12. Terms of Payment	PCC 12.5 . There are no Special Conditions of Contract applicable to GCC Sub- Clause 12.5"
PCC 13. Securities	PCC 13.3.1 The amount of Performance Security, as a percentage of the Contract Price for the Facility or for the part of the Facility for which a separate Time for Completion is provided, shall be: Ten percent (10%) of the total contract sum PCC 13.3.2 The Performance Security shall be in the form of the Bank Guarantee attached hereto in Section X, Contract Forms. PCC 13.3.3 The Performance Security shall not be reduced on the date of the Operational Acceptance PCC 13.3.3 . The Performance Security shall be reduced to ten percent (10%) of the value of the component covered by the extended defect liability to cover the Contractor's

	extended defect liability in accordance with the provision in the PCC, pursuant to GCC Sub-Clause 27.10.
PCC 18. Progress Report	PCC 18.3 Progress reports shall include status of compliance to cyber security risks management, and any foreseeable cyber security risk and mitigation. Cyber security incidents to be immediately reported. The forestated cybersecurity compliance requirements are mandatory.
PCC 20 Design and Engineering	PCC 20.3.2 Replace fourteen (14) days with twenty-one (21) days
PCC 22 Installation	PCC22.2.5 Working Hours Normal working hours are: 48 Hours per Week
PCC 25. Commissioning and Operational Acceptance	PCC 25.2.2 The Guarantee Test of the Facilities shall be successfully completed within 30 Days from the date of Completion. If the Interconnecting Network (Tanzania/Tunduma) and/or other connecting lines are not available for energization upon completion of the Facilities (Plant) at Nakonde: (i) The Contractor shall perform 'Loop-back tests' (simulating interface inputs and protection signaling) to demonstrate that the Nakonde Substation is fully functional locally; (ii) Upon successful completion of these simulated tests, the Employer shall issue the Operational Acceptance Certificate. The Contractor shall be entitled to the relevant completion payments, and the unavailability of the transmission lines shall not delay the Contractor's payment or result in Liquidated Damages; (iii) The remaining 'End-to-End' live interconnection tests shall be treated as a separate Call-Out Service. The Contractor shall return to site to perform these tests once the transmission lines are ready, paid under a pre-agreed Provisional Sum or Variation Order.

	After the Call-Out Service, Taking-Over shall require successful completion of SAT and commissioning test suite including protection end-to-end tests, SCADA/telecom availability, metering (MOF) accuracy verification, and earthing step/touch compliance. Successful completion of the Guarantee Test does not relieve the Contractor of its obligations during the Defects Liability Period. Final Acceptance should remain subject to expiry of the applicable Defects Liability Period and rectification of all identified defects.
PCC 26. Completion Time Guarantee	PCC 26.2 Applicable rate for liquidated damages: <i>Zero-point five percent (0.5%) of the contract price per week of delay</i> The above rate applies to the price of the part of the Facilities, as quoted in the Price Schedule, for that part for which the Contractor fails to achieve Completion within the particular Time for Completion. Maximum deduction for liquidated damages: 10 % of the Contract Value PCC 26.3 No bonus will be given for earlier Completion of the Facilities or part thereof.
PCC 27. Defect Liability	PCC 27.2 Replace the first paragraph with the following: “The Defect Liability Period shall be twenty-four (24) months from the date of Operational Acceptance of the Facilities (or any part thereof) except for as specified in GCC 27.10.” PCC 27.10 The critical components covered under the extended defect liability are transformers, reactors, circuit breaker, disconnectors instrument transformers, SAS and WAMPACs, and the period shall be 36 .months from the date of Operational Acceptance of the Facilities.
PCC 30. Limitation of Liability	PCC 30.1 (b) The multiplier of the Contract Price is: 1.1 times.

PCC 39. Change in the Facilities	PCC 39.1.2 If the value engineering proposal is approved by the Employer the amount to be paid to the Contractor shall be 50% of the reduction in the Contract Price.
PCC 39.2.1	(g) Sufficient information to enable assessment of cyber security risks.

PCC46. Disputes and Arbitration	PCC 46.1 The DB shall be appointed within 60 days after signature by both parties of the Contract Agreement PCC 46.1 The DB shall be: <i>Three members</i> PCC 46.1 List of potential DB members: Proposed by Employer [Attach CVs to the Contract] 1. _____ 2. _____ 3. _____ Proposed by Contractor [Attach CVs to the Contract] 1. _____ 2. _____ 3. _____ PCC 46.2 Appointment (if not agreed) to be made by: International Chamber of Commerce PCC 46.5 Procedure to settle disputes in respect of DB's decisions: Rules of arbitration GCC Sub-Clause 46.5(a) shall apply. Ruling language shall be: English. The seat of Arbitration shall be Cape Town, Republic of South Africa. GCC Sub-Clause 46.5 (b): shall apply.
PCC 47.	GCC 47.1- Cyber Security applies.

Section X – Contract Forms

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Notification of Intention of Award

[This Notification of Intention to Award shall be sent to each Bidder that submitted a Bid, unless the Bidder has previously received notice of exclusion from the process at an interim stage of the procurement process]

[Send this Notification to the Bidder's Authorized Representative named in the Bidder Information Form]

For the attention of Bidder's Authorized Representative

Name: *[insert Authorized Representative's name]*

Address: *[insert Authorized Representative's Address]*

Telephone/Fax numbers: *[insert Authorized Representative's telephone/fax numbers]*

Email Address: *[insert Authorized Representative's email address]*

[IMPORTANT: insert the date that this Notification is transmitted to all participating Bidders. The Notification must be sent to all Bidders simultaneously. This means on the same date and as close to the same time as possible.]

DATE OF TRANSMISSION: This Notification is sent by: *[email/fax]* on *[date]* (local time)

Notification of Intention to Award

Employer: *[insert the name of the Employer]*

Project: *[insert name of project]*

Contract title: *[insert the name of the contract]*

Country: *[insert country where RFB is issued]*

Loan No. /Credit No. / Grant No.: *[insert reference number for loan/credit/grant]*

RFB No: *[insert RFB reference number from Procurement Plan]*

This Notification of Intention to Award (Notification) notifies you of our decision to award the above contract. The transmission of this Notification begins the Standstill Period. During the Standstill Period, you may:

- a) request a debriefing in relation to the evaluation of your Bid, and/or
- b) submit a Procurement-related Complaint in relation to the decision to award the contract.

The successful Bidder

Name:	<i>[insert name of successful Bidder]</i>
Address:	<i>[insert address of the successful Bidder]</i>
Contract price:	<i>[insert contract price of the successful Bid]</i>
Total combined score:	<i>[insert the total combined score of the successful Bidder]</i>

Other Bidders [INSTRUCTIONS: insert names of all Bidders that submitted a Bid, Bid prices as read out and evaluated, technical scores and combined scores.]

Name of Bidder	Technical Score	Bid Price	Evaluated Bid Cost	Combined Score
<i>[insert name]</i>	<i>[insert Technical score]</i>	<i>[insert Bid price]</i>	<i>[insert evaluated cost]</i>	<i>[insert combined score]</i>
<i>[insert name]</i>	<i>[insert Technical score]</i>	<i>[insert Bid price]</i>	<i>[insert evaluated cost]</i>	<i>[insert combined score]</i>
<i>[insert name]</i>	<i>[insert Technical score]</i>	<i>[insert Bid price]</i>	<i>[insert evaluated cost]</i>	<i>[insert combined score]</i>
<i>[insert name]</i>	<i>[insert Technical score]</i>	<i>[insert Bid price]</i>	<i>[insert evaluated cost]</i>	<i>[insert combined score]</i>
<i>[insert name]</i>	<i>[insert Technical score]</i>	<i>[insert Bid price]</i>	<i>[insert evaluated cost]</i>	<i>[insert combined score]</i>

Reason/s why your Bid was unsuccessful[Delete if the combined score already reveals the reason]

[INSTRUCTIONS: State the reason/s why this Bidder's Bid was unsuccessful. Do NOT include: (a) a point by point comparison with another Bidder's Bid or (b) information that is marked confidential by the Bidder in its Bid.]

How to request a debriefing

DEADLINE: The deadline to request a debriefing expires at midnight on *[insert date]* (local time).

You may request a debriefing in relation to the results of the evaluation of your Bid. If you decide to request a debriefing, your written request must be made within three (3) Business Days of receipt of this Notification of Intention to Award.

Provide the contract name, reference number, name of the Bidder, contact details; and address the request for debriefing as follows:

Attention: *[insert full name of person, if applicable]*

Title/position: *[insert title/position]*

Agency: *[insert name of Employer]*

Email address: *[insert email address]*

Fax number: *[insert fax number] delete if not used*

If your request for a debriefing is received within the 3 Business Days deadline, we will provide the debriefing within five (5) Business Days of receipt of your request. If we are unable to provide the debriefing within this period, the Standstill Period shall be extended by five (5) Business Days after the date that the debriefing is provided. If this happens, we will notify you and confirm the date that the extended Standstill Period will end.

The debriefing may be in writing, by phone, video conference call or in person. We shall promptly advise you in writing how the debriefing will take place and confirm the date and time.

If the deadline to request a debriefing has expired, you may still request a debriefing. In this case, we will provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of the Contract Award Notice.

How to make a complaint

DEADLINE:: The deadline for submitting a Procurement-related Complaint challenging the decision to award the contract expires on midnight, *[insert date]* (local time).

Provide the contract name, reference number, name of the Bidder, contact details; and address the Procurement-related Complaint as follows:

Attention: *[insert full name of person, if applicable]*

Title/position: *[insert title/position]*

Agency: *[insert name of Employer]*

Email address: *[insert email address]*

Fax number: *[insert fax number]* ***delete if not used***

At this point in the procurement process, you may submit a Procurement-related Complaint challenging the decision to award the contract. You do not need to have requested, or received, a debriefing before making this complaint. Your complaint must be submitted within the Standstill Period and received by us before the Standstill Period ends.

Further information:

For more information see the [Procurement Regulations for IPF Borrowers \(Procurement Regulations\)](#) (Annex III). You should read these provisions before preparing and submitting your complaint. In addition, the World Bank's Guidance "[How to make a Procurement-related Complaint](#)" provides a useful explanation of the process, as well as a sample letter of complaint.

In summary, there are four essential requirements:

1. You must be an 'interested party'. In this case, that means a Bidder who submitted a Bid in this procurement and is the recipient of a Notification of Intention to Award.
2. The complaint can only challenge the decision to award the contract.
3. You must submit the complaint within the deadline stated above.
4. You must include, in your complaint, all of the information required by the Procurement Regulations (as described in Annex III).

Standstill Period

DEADLINE: The Standstill Period is due to end at midnight on *[insert date]* (local time).

The Standstill Period lasts ten (10) Business Days after the date of transmission of this Notification of Intention to Award.

The Standstill Period may be extended. This may happen where we are unable to provide a debriefing within the five (5) Business Day deadline. If this happens we will notify you of the extension

If you have any questions regarding this Notification please do not hesitate to contact us.

On behalf of the Employer:

Signature: _____

Name: _____

Title/position: _____

Telephone: _____

Email: _____

Beneficial Ownership Disclosure Form

INSTRUCTIONS TO BIDDERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE FORM

This Beneficial Ownership Disclosure Form ("Form") is to be completed by the successful Bidder. In case of joint venture, the Bidder must submit a separate Form for each member. The beneficial ownership information to be submitted in this Form shall be current as of the date of its submission.

For the purposes of this Form, a Beneficial Owner of a Bidder is any natural person who ultimately owns or controls the Bidder by meeting one or more of the following conditions:

- directly or indirectly holding 25% or more of the shares*
- directly or indirectly holding 25% or more of the voting rights*
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder*

RFB No.: *[insert number of RFB process]*

Request for Bid No.: *[insert identification]*

To: *[insert complete name of Employer]*

In response to your request in the Letter of Acceptance dated *[insert date of letter of Acceptance]* to furnish additional information on beneficial ownership: *[select one option as applicable and delete the options that are not applicable]*

(i) we hereby provide the following beneficial ownership information.

Details of beneficial ownership

Identity of Beneficial Owner	Directly or indirectly holding 25% or more of the shares (Yes / No)	Directly or indirectly holding 25 % or more of the Voting Rights (Yes / No)	Directly or indirectly having the right to appoint a majority of the board of the directors or an equivalent governing body of the Bidder (Yes / No)
<i>[include full name (last, middle, first), nationality, country of residence]</i>			

OR

(ii) *We declare that there is no Beneficial Owner meeting one or more of the following conditions:*

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder

OR

(iii) *We declare that we are unable to identify any Beneficial Owner meeting one or more of the following conditions. [If this option is selected, the Bidder shall provide explanation on why it is unable to identify any Beneficial Owner]*

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights

- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Bidder]”

Name of the Bidder: *[insert complete name of the Bidder]

Name of the person duly authorized to sign the Bid on behalf of the Bidder: **[insert complete name of person duly authorized to sign the Bid]

Title of the person signing the Bid: [insert complete title of the person signing the Bid]

Signature of the person named above: [insert signature of person whose name and capacity are shown above]

Date signed [insert date of signing] **day of** [insert month], [insert year]

* In the case of the Bid submitted by a Joint Venture specify the name of the Joint Venture as Bidder. In the event that the Bidder is a joint venture, each reference to “Bidder” in the Beneficial Ownership Disclosure Form (including this Introduction thereto) shall be read to refer to the joint venture member.

** Person signing the Bid shall have the power of attorney given by the Bidder. The power of attorney shall be attached with the Bid Schedules.

Letter of Acceptance

To: _____

This is to notify you that your Bid dated _____ for execution of the

_____ for the Contract Price in the aggregate of _____
_____, as corrected and modified in accordance with the Instructions to Bidders is
hereby accepted by our Agency.

You are requested to furnish (i) the Performance Security within 28 days in accordance with the Conditions of Contract, using for that purpose one of the Performance Security Forms and (ii) the additional information on beneficial ownership in accordance with ITB 46.1, within eight (8) Business days using the Beneficial Ownership Disclosure Form, included in Section X, - Contract Forms, of the bidding document.

Authorized Signature: _____

Name and Title of Signatory: _____

Name of Agency: _____

Attachment: Contract Agreement

Contract Agreement

THIS AGREEMENT is made the _____ day of _____, _____,

BETWEEN

(1) _____, a corporation incorporated under the laws of _____ and having its principal place of business at _____ (hereinafter called "the Employer"), and (2) _____, a corporation incorporated under the laws of _____ and having its principal place of business at _____ (hereinafter called "the Contractor").

WHEREAS the Employer desires to engage the Contractor to design, manufacture, test, deliver, install, complete and commission certain Facilities, viz. _____ ("the Facilities"), and the Contractor has agreed to such engagement upon and subject to the terms and conditions hereinafter appearing.

NOW IT IS HEREBY AGREED as follows:

Article 1. Contract Documents

1.1 Contract Documents (Reference GCC Clause 2)

The following documents shall constitute the Contract between the Employer and the Contractor, and each shall be read and construed as an integral part of the Contract:

- (a) This Contract Agreement and the Appendices hereto
- (b) Letter of Bid and Price Schedules submitted by the Contractor
- (c) Particular Conditions
- (d) General Conditions
- (e) Employer's Requirements

- (f) Drawings
- (g) Other completed Bidding forms submitted with the Bid
- (i) Any other documents forming part of the contract, including, but not limited to:
 - i. the ES Management Strategies and Implementation Plans; and
 - ii. Code of Conduct for Contractor's Personnel (ES).

[Any other documents shall be added here.]

1.2 Order of Precedence (Reference GCC Clause 2)

In the event of any ambiguity or conflict between the Contract Documents listed above, the order of precedence shall be the order in which the Contract Documents are listed in Article 1.1 (Contract Documents) above.

1.3 Definitions (Reference GCC Clause 1)

Capitalized words and phrases used herein shall have the same meanings as are ascribed to them in the General Conditions.

**Article 2. Contract Price
and Terms of
Payment**

2.1 Contract Price (Reference GCC Clause 11)

The Employer hereby agrees to pay to the Contractor the Contract Price in consideration of the performance by the Contractor of its obligations hereunder. The Contract Price shall be the aggregate of: _____, _____ as specified in Price Schedule No. 5 (Grand Summary), and _____, _____, or such other sums as may be determined in accordance with the terms and conditions of the Contract.

2.2 Terms of Payment (Reference GCC Clause 12)

The terms and procedures of payment according to which the Employer will reimburse the Contractor are given in the Appendix (Terms and Procedures of Payment) hereto.

The Employer may instruct its bank to issue an irrevocable confirmed documentary credit made available to the Contractor in a bank in the country of the Contractor. The credit shall be for an amount of _____; and shall be subject

to the Uniform Customs and Practice for Documentary Credits 2007 Revision, ICC Publication No. 600.

In the event that the amount payable under Schedule No. 1 is adjusted in accordance with GCC 11.2 or with any of the other terms of the Contract, the Employer shall arrange for the documentary credit to be amended accordingly.

Article 3. Effective Date

3.1 Effective Date (Reference GCC Clause 1)

The Effective Date from which the Time for Completion of the Facilities shall be counted is the date when all of the following conditions have been fulfilled:

- (a) This Contract Agreement has been duly executed for and on behalf of the Employer and the Contractor;
- (b) The Contractor has submitted to the Employer the Performance Security and the Advance Payment Guarantee;
- (c) The Employer has paid the Contractor the advance payment;
- (d) The Contractor has been advised that the documentary credit, if applicable, referred to in Article 2.2 above has been issued in its favor;
- (e) constitution of the DB.

Each party shall use its best efforts to fulfill the above conditions for which it is responsible as soon as practicable.

- 3.2 If the conditions listed under 3.1 are not fulfilled within two (2) months from the date of this Contract notification because of reasons not attributable to the Contractor, the Parties shall discuss and agree on an equitable adjustment to the Contract Price (if Fixed Price contract) and the Time for Completion and/or other relevant conditions of the Contract.

Article 4. Communications

- 4.1 The address of the Employer for notice purposes, pursuant to GCC 4.1 is: _____.
- 4.2 The address of the Contractor for notice purposes, pursuant to GCC 4.1 is: _____.

- Article 5. Appendices**
- 5.1 The Appendices listed in the attached List of Appendices shall be deemed to form an integral part of this Contract Agreement.
- 5.2 Reference in the Contract to any Appendix shall mean the Appendices attached hereto, and the Contract shall be read and construed accordingly.

IN WITNESS WHEREOF the Employer and the Contractor have caused this Agreement to be duly executed by their duly authorized representatives the day and year first above written.

Signed by, for and on behalf of the Employer

[Signature]

[Title]

in the presence of _____

Signed by, for and on behalf of the Contractor

[Signature]

[Title]

in the presence of _____

APPENDICES

- Appendix 1 Terms and Procedures of Payment
- Appendix 2 Price Adjustment
- Appendix 3 Insurance Requirements
- Appendix 4 Time Schedule
- Appendix 5 List of Major Items of Plant and Installation Services and List of Approved Subcontractors
- Appendix 6 Scope of Works and Supply by the Employer
- Appendix 7 List of Documents for Approval or Review
- Appendix 8 Functional Guarantees

Appendix 1 – Terms and Procedures of Payment

In accordance with the provisions of GCC Clause 12 (Terms of Payment), the Employer shall pay the Contractor in the following manner and at the following times, on the basis of the Price Breakdown given in the section on Price Schedules. Payments will be made in the currencies quoted by the Bidder unless otherwise agreed between the Parties. Applications for payment in respect of part deliveries may be made by the Contractor as work proceeds.

TERMS OF PAYMENT

Schedule No. 1. Plant and Equipment Supplied from Abroad

In respect of plant and equipment supplied from abroad, the following payments shall be made:

Ten percent (10%) of the total CIP amount as an advance payment against receipt of invoice and an irrevocable advance payment security for the equivalent amount made out in favor of the Employer. The advance payment security may be reduced in proportion to the value of the plant and equipment delivered to the site, as evidenced by shipping and delivery documents.

Eighty percent (80%) of the total or pro rata CIP amount upon Incoterm “CIP”, upon delivery to the carrier within forty-five (45) days after receipt of documents.

Five percent (5%) of the total or pro rata CIP amount upon issue of the Completion Certificate, within forty-five (45) days after receipt of invoice.

Five percent (5%) of the total or pro rata CIP amount upon issue of the Operational Acceptance Certificate, within forty-five (45) days after receipt of invoice.

Schedule No. 2. Plant and Equipment Supplied from within the Employer’s Country

In respect of plant and equipment supplied from within the Employer’s Country, the following payments shall be made:

Ten percent (10%) of the total EXW amount as an advance payment against receipt of invoice, and an irrevocable advance payment security for the equivalent amount made out in favor of the Employer. The advance payment security may be reduced in proportion to the value of the plant and equipment delivered to the site, as evidenced by shipping and delivery documents.

Eighty percent (80%) of the total or pro rata EXW amount upon Incoterm “Ex-Works,” upon delivery to the carrier within forty-five (45) days after receipt of invoice and documents.

Five percent (5%) of the total or pro rata EXW amount upon issue of the Completion Certificate, within forty-five (45) days after receipt of invoice.

Five percent (5%) of the total or pro rata EXW amount upon issue of the Operational Acceptance Certificate, within forty-five (45) days after receipt of invoice.

Schedule No. 3. Design Services

In respect of design services for both the foreign currency and the local currency portions, the following payments shall be made:

Ten percent (10%) of the total design services amount as an advance payment against receipt of invoice, and an irrevocable advance payment security for the equivalent amount made out in favor of the Employer.

Ninety percent (90%) of the total or pro rata design services amount upon acceptance of design in accordance with GCC Clause 20 by the Project Manager within forty-five (45) days after receipt of invoice.

Schedule No. 4. Installation Services

In respect of installation services for both the foreign and local currency portions, the following payments shall be made:

Ten percent (10%) of the total installation services amount as an advance payment against receipt of invoice, and an irrevocable advance payment security for the equivalent amount made out in favor of the Employer. The advance payment security may be reduced in proportion to the value of work performed by the Contractor as evidenced by the invoices for installation services.

Eighty percent (80%) of the measured value of work performed by the Contractor, as identified in the said Program of Performance, during the preceding month, as evidenced by the Employer’s authorization of the Contractor’s application, will be made monthly within forty-five (45) days after receipt of invoice.

Five percent (5%) of the total or pro rata value of installation services performed by the Contractor as evidenced by the Employer’s authorization of the Contractor’s monthly

applications, upon issue of the Completion Certificate, within forty-five (45) days after receipt of invoice.

Five percent (5%) of the total or pro rata value of installation services performed by the Contractor as evidenced by the Employer's authorization of the Contractor's monthly applications, upon issue of the Operational Acceptance Certificate, within forty-five (45) days after receipt of invoice.

In the event that the Employer fails to make any payment on its respective due date, the Employer shall pay to the Contractor interest on the amount of such delayed payment at the rate of one month **SOFR Plus Two percent (2%)** per annum for period of delay until payment has been made in full (Interest on delayed payment shall be calculated at one-month Term SOFR (or its successor or replacement benchmark) plus two percent (2%) per annum for the period of delay).

PAYMENT PROCEDURES

The procedures to be followed in applying for certification and making payments shall be as follows:

- (i) Contractor Submits Proforma Invoice/s along with application for payment;
- (ii) Project Manager Reviews/Certifies/Approves Payment Application
- (iii) Contractor Submits Tax Invoice to Finance for Payment Processing
- (iv) Payment Processed by Treasury in Accordance with agreed Terms of Payment

The Contractor shall submit a Statement in Six (6) copies to the Project Manager after the end of each month, in a form approved by the Project Manager, showing in detail the amounts to which the Contractor considers himself to be entitled, together with supporting documents including the Billing Breakup.

No amount shall be certified or paid until the Employer has received and approved the Performance Security. Thereafter, the Project Manager shall, within 28 days after receiving a Statement and supporting documents, deliver to the Employer a Payment Certificate which shall state the amount which the Project Manager fairly determines to be due, with all supporting particulars for any reduction or withholding made by the Project Manager on the Statement if any.

The Contractor shall be responsible for any error in the Statement.

Appendix 2 – Price Adjustment

Prices payable to the Contractor, in accordance with the Contract, shall be subject to adjustment during performance of the Contract to reflect changes in the cost of material components, in accordance with the following formula:

$$P_1 = P_0 \times \left(a + b \frac{C_1}{C_0} + c \frac{A_1}{A_0} + d \frac{Al_1}{Al_0} + e \frac{Rs_1}{Rs_0} + f \frac{S_1}{S_0} + g \frac{St_1}{St_0} + h \frac{FU_1}{FU_0} + k \frac{CU_1}{CU_0} + m \frac{Tc_1}{Tc_0} \right) - P_0$$

in which:

P_1 = adjustment amount payable to the Contractor

P_0 = Contract price (base price)

a = Percentage of fixed element in Contract Price ($a = 15\%$)

b = Percentage of Cement component in Contract Price ($b = \%$)

c = Percentage of Aggregate component in Contract Price ($c = \%$)

d = Percentage of Aluminium component in Contract Price ($d = \%$)

e = Percentage of Reinforcing Steel component in Contract Price ($e = \%$)

f = Percentage of Steel component in Contract Price ($f = \%$)

g = Percentage of Structural Steel component in Contract Price ($g = \%$)

h = Percentage of Fuel component in Contract Price ($h = \%$)

k = Percentage of Copper component in Contract Price ($k = \%$)

m = Percentage of Transformer and Reactor Core component in Contract Price ($m = \%$)

C_0, C_1 = Cement indices applicable to the appropriate industry in the country of origin on the base date and the date for adjustment, respectively

A_0, A_1 = Aggregate indices in the country of origin on the base date and the date for adjustment, respectively

- Al_0, Al_1 = Aluminium indices in the country of origin on the base date and the date for adjustment, respectively
- Rs_0, Rs_1 = Reinforcing Steel indices in the country of origin on the base date and the date for adjustment, respectively
- S_0, S_1 = Steel indices in the country of origin on the base date and the date for adjustment, respectively
- St_0, St_1 = Structure Steel indices in the country of origin on the base date and the date for adjustment, respectively
- Fu_0, Fu_1 = Fuel indices in the Employer's country on the base date and the date for adjustment, respectively
- Cu_0, Cu_1 = Copper indices in the country of origin on the base date and the date for adjustment, respectively
- Tc_0, Tc_1 = Transformer/Reactor Core indices in the country of origin on the base date and the date for adjustment, respectively

The material and equipment indices may consist of several components, however for this contract the following material shall be comprised without alteration: **Cement, Aggregate, Aluminium, Steel, Reinforcing Steel, Steel Structure, Fuel, Copper , Transformer and Reactor Core material.**

N.B. $a+b+c+d+e+f+g+h+k+m = 100\%$.

Conditions Applicable To Price Adjustment

The Bidder shall indicate the source of materials indices¹, and source of exchange rate (if applicable) and the base date indices in its Bid. The source(s) of applicable indices shall be

¹ Supply from Abroad must not be linked to Zambian indices.

those from an official and recognisable institution of the country, which the item is purchased from or manufactured in. The indices must be available on a web site to be specified.

<u>Item</u>	<u>Source of Indices Used</u>	<u>Base Date Indices</u>	<u>Web site</u>

The base date shall be the date twenty-eight (28) days prior to the Bid closing date.

The date of adjustment shall be the mid-point of the period of manufacture or installation of component or Plant.

The following conditions shall apply:

(a) No price increase will be allowed beyond the original delivery date unless covered by an extension of time awarded by the Employer under the terms of the Contract. No price increase will be allowed for periods of delay for which the Contractor is responsible. The Employer will, however, be entitled to any price decrease occurring during such periods of delay.

(b) If the currency in which the Contract price, P_0 , is expressed is different from the currency of the country of origin of the labor and/or materials indices, a correction factor will be applied to avoid incorrect adjustments of the Contract price. The correction factor shall be: Z_0 / Z_1 , where,

Z_0 = the number of units of currency of the origin of the indices which equal to one unit of the currency of the Contract Price P_0 on the Base date, and

Z_1 = the number of units of currency of the origin of the indices which equal to one unit of the currency of the Contract Price P_0 on the Date of Adjustment.

(c) No price adjustment shall be payable on the portion of the Contract price paid to the Contractor as an Advance Payment.

Appendix 3 – Insurance Requirements

Insurances to be Taken Out by the Contractor

In accordance with the provisions of GCC Clause 34, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified. The identity of the insurers and the form of the policies shall be subject to the approval of the Employer, such approval not to be unreasonably withheld.

(a) Cargo Insurance

Covering loss or damage occurring, while in transit from the supplier's or manufacturer's works or stores until arrival at the Site, to the Facilities (including spare parts therefor) and to the construction equipment to be provided by the Contractor or its Subcontractors.

Amount	110% of the Contract Price for the Plant and Equipment shipped
Deductible limits	5% of the value of shipment and shall be borne by the contractor
Parties Insured	Contractor plus Employer as co-insured
From	Manufacturers' Works
To	Location(s) of site(s) of the project

(b) Installation All Risks Insurance

Covering physical loss or damage to the Facilities at the Site, occurring prior to completion of the Facilities, with an extended maintenance coverage for the Contractor's liability in respect of any loss or damage occurring during the defect liability period while the Contractor is on the Site for the purpose of performing its obligations during the defect liability period.

Amount	The insuring party shall insure that the Works, Plant, Materials, and

	Contractor's documents for not less than the full reinstatement costs.
Deductible limits	2% of the Contract Price and shall be borne by the contractor.
Parties Insured	Contractor plus Employer and Subcontractor as co-insured
From	Date of arrival of first Plant and Equipment at the site
To	End of Defects Liability Period

(c) Third Party Liability Insurance

Covering bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property (including the Employer's property and any parts of the Facilities that have been accepted by the Employer) occurring in connection with the supply and installation of the Facilities.

Amount	USD 2,500,000
Deductible limits	10% (max.) and shall be borne by the Contractor.
Parties Insured	Contractor plus Subcontractor as co-insured
From	Effective date of the Contract
To	Operational Acceptance

(d) Automobile Liability Insurance

Covering use of all vehicles used by the Contractor or its Subcontractors (whether or not owned by them) in connection with the supply and installation of the Facilities. Comprehensive insurance in accordance with statutory requirements.

(e) Workers' Compensation

In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

(f) Employer's Liability

In accordance with the statutory requirements applicable in any country where the Facilities or any part thereof is executed.

(g) Other Insurances

The Contractor is also required to take out and maintain at its own cost the following insurances:

Details:

Amount	To be indicated by the contractor
Deductible limits	Nil
Parties Insured	Contractor plus Subcontractor as co-insured
From	Receipt at site
To	Up to Defects Liability Period

The Employer shall be named as co-insured under all insurance policies taken out by the Contractor pursuant to GCC Sub-Clause 34.1, except for the Third Party Liability, Workers' Compensation and Employer's Liability Insurances, and the Contractor's Subcontractors shall be named as co-insureds under all insurance policies taken out by the Contractor pursuant to GCC Sub-Clause 34.1, except for the Cargo, Workers' Compensation and Employer's Liability Insurances. All insurer's rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies.

Insurances To Be Taken Out By The Employer

The Employer shall at its expense take out and maintain in effect during the performance of the Contract the following insurances.

Details: **NIL**

Appendix 4 – Time Schedule

4.1. Description of Facilities

S/N	Item Description	Completion Time required by the Employer from the Effective Date	Completion date guaranteed by the Bidder from the effective date
1	Package-4: Design, Supply and Installation for: i) Nakonde 330/(132)66/11kV Substation, ii) Works in Kasama 330 kV substation.	Twenty-four (24) Months	

4.2. The activities under the Contractor's program for Project Completion shall be in the form of a master network (MNW) and shall identify the various activities like design, engineering, manufacturing, supply, installation, factory testing, transportation to site, site testing and commissioning, trial operation and taking over etc. of the facilities or specific part thereof (where specific parts are specified in PCC). The network shall conform to the above Project Completion Schedule. This master network will be discussed and agreed before Kick-off meeting in line with the above. The detailed network(s) and project implementation plans & programs shall preferably be prepared in Primavera or in MS Project or in the latest Project Management tool as convenient to the Employer and shall form part of the contract.

4.3. The Employer reserves the right to request minor changes in the work schedule at the time of Award of Contract to the successful Bidder.

Appendix 5. List of Major Items of Plant and Installation Services and List of Approved Subcontractors

A list of major items of Plant and Installation Services is provided below.

The following Subcontractors and/or manufacturers are approved for carrying out the items of the Facilities indicated below. Where more than one Subcontractor is listed, the Contractor is free to choose between them, but it must notify the Employer of its choice in good time prior to appointing any selected Subcontractor. In accordance with GCC Sub-Clause 19.1, the Contractor is free to submit proposals for Subcontractors for additional items from time to time. No Subcontracts shall be placed with any such Subcontractors for additional items until the Subcontractors have been approved in writing by the Employer and their names have been added to this list of Approved Subcontractors.

Major Items of Plant and Installation Services	Approved Subcontractors/Manufacturers	Nationality
Substation Equipment:		
330kV <u>Phase and Neutral Reactors</u>		
<u>330kV Transformers</u>		
330kV Circuit Breakers		
<u>132kV Breakers</u>		
<u>330kV Isolators</u>		
<u>132kV isolators</u>		
330kV Voltage Transformers		
132kV Voltage Transformers		
330kV Current Transformers		
132kV Current Transformers		
Insulators and Hardware Fittings		
OPGW		

Lattice Steel Tower Structures		
Surge Arresters		
Control & Protection Relays		
SCADA & SAS		
Telecommunication Equipment		
Metering Equipment		
Power & Control Cables		
Busbars		
Conductors		
Conductor Accessories & Fittings		
Battery & Battery Charger		
<u>WAMPACs</u>		

Appendix 6 – Scope of Works and Supply by the Employer

The following personnel, facilities, works and supplies will be provided/supplied by the Employer, and the provisions of GCC Clauses 10, 21 and 24 shall apply as appropriate.

All personnel, facilities, works and supplies will be provided by the Employer in good time so as not to delay the performance of the Contractor, in accordance with the approved Time Schedule and Program of Performance pursuant to GCC Sub-Clause 18.2.

Unless otherwise indicated, all personnel, facilities, works and supplies will be provided free of charge to the Contractor.

S/N	Scope of Works and Supply by the Employer	Item Description	Charge to Contractor (if any)
1	Personnel	None	None
2	Facilities	Arrangement of Power Interruption	As per the safety rules and procedures of ZESCO Limited attached.
		The Employer shall assist the Contractor in obtaining all permits, approval and/or Licenses from all Local, State, or National Government authorities or public service undertaking in the country where sites are located.	The expenses to obtain all permits, approval, and/or service licenses mentioned shall be borne by the Contractor.
3	Works	None	None
4	Supplies	Electricity and Water: the Contractor shall be entitled to use for the purpose of the facilities such supplies of electricity and water as may be available on the site and	The Contractor shall pay the Employer at the applicable tariff plus employer's overheads, if any, for such use. Where such supplies are not available, the contractor shall make his own

S/N	Scope of Works and Supply by the Employer	Item Description	Charge to Contractor (if any)
		shall provide any apparatus necessary for such use.	arrangement for provision of any supplies he may require.

Appendix 7 – List of Documents for Approval or Review

Pursuant to GCC Sub-Clause 20.3.1, the Contractor shall prepare, or cause its Subcontractor to prepare, and present to the Project Manager in accordance with the requirements of GCC Sub-Clause 18.2 (Program of Performance), the following documents for

A. Approval

1. Design basis / design criteria and interface assumptions;
2. Major equipment drawings and calculations;
3. Protection/SAS/telecom interface design and commissioning philosophy.

B. Review

1. QA/QC Plan and Inspection & Test Plan;
2. FAT/SAT and commissioning procedures;
3. O&M manuals and as-built drawings.

The Employer, as per its requirements, will ask the contractor to submit an exhaustive list of documents before the signing of the contract for approval by the Employer.

Appendix 8 – Functional Guarantees

1. General

This Appendix sets out

- (a) the functional guarantees referred to in GCC Clause 28 (Functional Guarantees)
- (b) the minimum level of the functional guarantees
- (c) the formula for calculation of liquidated damages for failure to attain the functional guarantees.

2. Preconditions

The Contractor gives the functional guarantees (specified herein) for the facilities, subject to the following preconditions being fully satisfied:

No special preconditions other than the guarantee-test conditions under GCC 25 and the Employer's Requirements.

3. Functional Guarantees

The functional guarantees for this Contract are limited to the transformer and reactor loss and noise values guaranteed by the Contractor in the Guaranteed Technical Schedules (GCC Sub- Clause 28.2).

4. Failure in Guarantees and Liquidated Damages

4.1 Transformer and Reactor Losses (During the Factory Acceptance Test)

The applicable loss/noise adjustments, penalties and rejection margins shall be stated once only and shall be identical to the values below.

Transformer

No Load Losses

If the no load losses of a transformer exceed the guaranteed value, by more than the margins specified hereunder, a penalty as specified for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **12,000 USD/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

On Load Losses

If the on-load losses (plus auxiliary power losses) of a transformer exceed the value guaranteed, by more than the margins specified hereunder, a penalty as indicated for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **7,000 USD/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

Reactor

If the total loss a reactor exceeds the guaranteed value, by not more than the margins specified hereunder, a penalty as specified for each full kW in excess of the guaranteed value will be deducted from the Contract Price.

The penalty will be **12,000 USD/kW**. It is thereby understood that values of 0.5 kW and above will be rounded up to the next full kW.

Noise level

Should the noise level (at maximum power output and at U_{max}) for the transformer and reactor, at the specified distance according to IEC, exceed the guaranteed values but not exceed 3 dB(A), the Contractor must pay liquidated damages (penalty) to the Employer.

The penalty will be **12 000 USD/dB(A)**. It is thereby understood that values of 0.5 dB(A) and above will be rounded up to the next full dB.

Rejection of the Transformers and Reactors

The Employer shall have the right to reject any transformer and reactor (after Factory Acceptance Test) if the actual values are in excess of the guaranteed values by more than the margins specified hereunder:

• No-load losses	+ 10%
• Load losses (forced cooling)	+ 10%
• Total losses	+ 10%
• Noise level	+ 3 dB (A)
• Temperature rise limit resulting in rated output	+ 0.0 K (No excess)

For all of the other values the margins stated in IEC standards are applicable, unless specified otherwise elsewhere in these Specifications.

The values for all insulation and test levels shall be obtained from the description of the general technical requirements of these Specifications.

4.2 Limitation of Liability

The Liquidated damages for the short fall in guaranteed parameters and for delay in completion are independent of each other and shall be levied separately and concurrently. Subject to para. 4.1 above, the Contractor's aggregate liability to pay liquidated damages for failure to attain the functional guarantees shall not exceed ten percent (10 %) of the Contract price.

Performance Security Form – Bank Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary: *[insert name and Address of Employer]*

Date: *_ [Insert date of issue]*

PERFORMANCE GUARANTEE No.: *____[Insert guarantee reference number]*

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____(hereinafter called “the Applicant”) has entered into Contract No. _____dated _____with the Beneficiary, for the execution of _____(hereinafter called “the Contract”).

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____(____)², such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary’s complying demand supported by the Beneficiary’s statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for your demand or the sum specified therein.

This guarantee shall be reduced by half upon our receipt of:

- (a) a copy of the Operational Acceptance Certificate; or
 - (b) a registered letter from the Applicant (i) attaching a copy of its notice requesting issuance of the Operational Acceptance Certificate and (ii) stating
- _____

² The Guarantor shall insert an amount representing the percentage of the Contract Price specified in the Contract and denominated either in the currency(ies) of the Contract or a freely convertible currency acceptable to the *Employer*.

that the Project Manager has failed to issue such Certificate within the time required or provide in writing justifiable reasons why such Certificate has not been issued, so that Operational Acceptance is deemed to have occurred.

This guarantee shall expire no later than the earlier of:³

- (a) twenty-four months after our receipt of either (a) or (b) above;
 - (b) eighteen months after our receipt of:
 - (i) a copy of the Completion Certificate; or
 - (ii) a registered letter from the Applicant, attaching a copy of the notice to the Project Manager that the Facilities are ready for commissioning, and stating that fourteen days have elapsed from receipt of such notice (or seven days have elapsed if the notice was a repeated notice) and the Project Manager has failed to issue a Completion Certificate or inform the Applicant in writing of any defects or deficiencies; or
 - (iii) a registered letter from the Applicant stating that no Completion Certificate has been issued but the Employer is making use of the Facilities; or
- (b) the ____ day of ____, 2____.⁴

³ This text shall be revised as and where necessary to take into account (i) partial acceptance of the Facilities in accordance with Sub-Clause 25.4 of the GCC; and (ii) extension of the Performance Security when the Contractor is liable for an extended warranty obligation pursuant to Sub-Clause 27.10 of the GCC (although in this latter case the *Employer* might want to consider an extended warranty security in lieu of the extension of the Performance Security).

⁴ Insert the date twenty-eight days after the expected expiration date of the Defect Liability Period. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Employer's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."

Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

Advance Payment Security**Demand Guarantee***[Guarantor letterhead or SWIFT identifier code]***Beneficiary:** **Name and Address of Employer****Date:***[Insert date of issue]***Advance Payment Guarantee No.:***[Insert guarantee reference number]***Guarantor:** *[Insert name and address of place of issue, unless indicated in the letterhead]*

.....

We have been informed that (hereinafter called “the Applicant”) has entered into Contract No. dated with the Beneficiary, for the execution of, ... (hereinafter called “the Contract”).

Furthermore, we understand that, according to the Conditions of the Contract, an advance payment in the sum (.....) is to be made against an advance payment guarantee.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of .

(.)⁵ upon receipt by us of the Beneficiary’s complying demand supported by the Beneficiary’s statement whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the applicant:

- (a) has used the advance payment for purposes other than the costs of mobilization in respect of the Facilities; or
- (b) has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.

⁵*The Guarantor shall insert an amount representing the amount of the advance payment and denominated either in the currency(ies) of the advance payment as specified in the Contract, or in a freely convertible currency acceptable to the Employer.*

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to above has been credited to the Applicant on its account number _____ at _____..

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Applicant as indicated in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of documentation indicating full repayment by the Applicant of the amount of the advance payment, or on the . . . day of, . . .⁶, whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

⁶Insert the expected expiration date of the Time for Completion. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."

Forms and Procedures

**Form of Completion
Certificate**

Date: _____

Loan/Credit N°: _____

RFB N°: _____

To: _____

Dear Ladies and/or Gentlemen,

Pursuant to GCC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated _____, relating to the _____, we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: _____
2. Date of Completion: _____

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

Title

(Project Manager)

Form of Operational Acceptance Certificate

Date: _____

Loan/Credit N°: _____

RFB N°: _____

To: _____

Dear Ladies and/or Gentlemen,

Pursuant to GCC Sub-Clause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated _____, relating to the _____, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: _____
2. Date of Operational Acceptance: _____

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

Title

(Project Manager)

Form of Local Labor Participation Commitment

Bidders shall allocate not less than 30% of the total labor cost under the contract to the employment of local staff and personnel (Local Labor) which shall be confirmed by Employment Records of Workers as per September 2025 World Bank Procurement Guidance and form below.

Project: [Insert Project Name / Contract No.]

Contractor: [Insert Legal Name] Employer/Client: [Insert Legal Name]

Effective Date: [dd mmm yyyy]

1) Local Labor Targets

1.1 Overall Workforce Composition (by average FTE over the Contract):

- Total Local Labor: ≥ []% of total project labor-hours
- Skilled Trades: ≥ []% local
- Supervisory/Foreman Level: ≥ []% local
- Professional/Engineering: ≥ []% local
- Apprentices/Trainees: at least [] persons or ≥ []% of headcount

1.2 Milestone/Phase Targets: (Insert table manually if needed)

1.3 Exemptions: The Contractor may request a written waiver if suitable Local Labor is unavailable despite documented, reasonable efforts.

2) Reporting & Recordkeeping

Monthly Local Labor Report due by the 5th of each month.

Evidence: IDs, payroll summary, timesheets, training registers, subcontractor declarations.

Contractor must retain data for 2 years after completion.

3) Signatures

For the Contractor

Name: _____

Title: _____

Date: ____/____/____

Signature: _____

For the Employer

Name: _____

Title: _____

Date: ____/____/____

Signature: _____

Change Order Procedure and Forms

Date: _____

Loan/Credit N°: _____

RFB N°: _____

CONTENTS

1. General
2. Change Order Log
3. References for Changes

ANNEXES

- Annex 1 Request for Change Proposal
- Annex 2 Estimate for Change Proposal
- Annex 3 Acceptance of Estimate
- Annex 4 Change Proposal
- Annex 5 Change Order
- Annex 6 Pending Agreement Change Order
- Annex 7 Application for Change Proposal

Change Order Procedure

1. General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GCC Clause 39 (Change in the Facilities) of the General Conditions.

2. Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending, as Annex 8. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

3. References for Changes

- (1) Request for Change as referred to in GCC Clause 39 shall be serially numbered CR-X-nnn.
- (2) Estimate for Change Proposal as referred to in GCC Clause 39 shall be serially numbered CN-X-nnn.
- (3) Acceptance of Estimate as referred to in GCC Clause 39 shall be serially numbered CA-X-nnn.
- (4) Change Proposal as referred to in GCC Clause 39 shall be serially numbered CP-X-nnn.
- (5) Change Order as referred to in GCC Clause 39 shall be serially numbered CO-X-nnn.

Note: (a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:

Home Office	CR-H-nnn
Site	CR-S-nnn

- (b) The above number “nnn” is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.

Annex 1. Request for Change Proposal

(Employer's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within _____ days of the date of this letter _____.

1. Title of Change: _____

2. Change Request No. _____

3. Originator of Change: Employer: _____

Contractor (by Application for Change Proposal No. _____⁷:

4. Brief Description of Change: _____

5. Facilities and/or Item No. of equipment related to the requested Change:

6. Reference drawings and/or technical documents for the request of Change:

Drawing No./Document No.Description

7. Detailed conditions or special requirements on the requested Change:

8. General Terms and Conditions:
- (a) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.
 - (b) Your estimate shall include your claim for the additional time, if any, for completion of the requested Change.
 - (c) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us of your opinion in your proposal of revised provisions.
 - (d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.
 - (e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)

Annex 2. Estimate for Change Proposal

(Contractor's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GCC Sub-Clause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub-Clause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: _____
2. Change Request No./Rev.: _____
3. Brief Description of Change: _____
4. Scheduled Impact of Change: _____
5. Cost for Preparation of Change Proposal: _____⁸

(a)	Engineering	(Amount)

(i)	Engineer	_____ hrs x _____ rate/hr = _____

(ii)	Draftsperson	_____ hrs x _____ rate/hr = _____

⁸ Costs shall be in the currencies of the Contract.

Sub-total	_____ hrs	_____
Total Engineering Cost		_____
(b) Other Cost		_____
Total Cost (a) + (b)		_____

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)

Annex 3. Acceptance of Estimate

(Contractor's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GCC Sub-Clause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GCC Sub-Clause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: _____
2. Change Request No./Rev.: _____
3. Brief Description of Change: _____
4. Scheduled Impact of Change: _____
5. Cost for Preparation of Change Proposal: _____⁹

(a) Engineering (Amount)

(i) Engineer _____ hrs x _____ rate/hr = _____

(ii) Draftsperson _____ hrs x _____ rate/hr = _____

⁹ Costs shall be in the currencies of the Contract.

Sub-total	_____ hrs	_____
Total Engineering Cost		_____
(b) Other Cost		_____
Total Cost (a) + (b)		_____

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)

Annex 4. Change Proposal

(Contractor's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

In response to your Request for Change Proposal No. _____, we
hereby submit our proposal as follows:

1. Title of Change: _____
2. Change Proposal No./Rev.: _____
3. Originator of Change: Employer: / _____
Contractor: _____
4. Brief Description of Change: _____
5. Reasons for Change: _____
6. Facilities and/or Item No. of Equipment related to the requested Change:

7. Reference drawings and/or technical documents for the requested Change:

Drawing/Document No.Description

8. Estimate of increase/decrease to the Contract Price resulting from Change Proposal:¹⁰

(Amount)

(a) Direct material _____

(b) Major construction equipment _____

(c) Direct field labor (Total _____ hrs) _____

(d) Subcontracts _____

(e) Indirect material and labor _____

(f) Site supervision _____

(g) Head office technical staff salaries

Process engineer _____ hrs @ _____ rate/hr _____

Project engineer _____ hrs @ _____ rate/hr _____

Equipment engineer _____ hrs @ _____ rate/hr _____

Procurement _____ hrs @ _____ rate/hr _____

Draftsperson _____ hrs @ _____ rate/hr _____

Total _____ hrs _____

(h) Extraordinary costs (computer, travel, etc.) _____

(i) Fee for general administration, _____% of Items _____

(j) Taxes and customs duties _____

Total lump sum cost of Change Proposal _____

*(Sum of items (a) to (j))*¹⁰ Costs shall be in the currencies of the Contract.

Cost to prepare Estimate for Change Proposal _____

(Amount payable if Change is not accepted)

9. Additional time for Completion required due to Change Proposal
10. Effect on the Functional Guarantees
11. Effect on the other terms and conditions of the Contract
12. Validity of this Proposal: within *[Number]* days after receipt of this Proposal by the Employer
13. Other terms and conditions of this Change Proposal:
 - (a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within _____ days from your receipt of this Proposal.
 - (b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.
 - (c) Contractor's cost for preparation of this Change Proposal:²

(Contractor's Name)

(Signature)

(Name of signatory)

(Title of signatory)

² Specify where necessary.

Annex 5. Change Order

(Employer's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

We approve the Change Order for the work specified in the Change Proposal (No. _____), and agree to adjust the Contract Price, Time for Completion and/or other conditions of the Contract in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Change Order No./Rev.: _____

4. Originator of Change: Employer: _____

Contractor: _____

5. Authorized Price:

Ref. No.: _____ Date: _____

Foreign currency portion _____ plus Local currency portion _____

6. Adjustment of Time for Completion

None Increase _____ days Decrease _____ days

7. Other effects, if any

Authorized by: _____
(Employer)

Date: _____

Accepted by: _____
(Contractor)

Date: _____

Annex 6. Pending agreement Change Order

(Employer's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: / _____

Dear Ladies and/or Gentlemen:

We instruct you to carry out the work in the Change Order detailed below in accordance with GCC Clause 39 of the General Conditions.

1. Title of Change: _____
2. Employer's Request for Change Proposal No./Rev.:
_____ dated: _____
3. Contractor's Change Proposal No./Rev.: _____ dated: _____
4. Brief Description of Change: _____
5. Facilities and/or Item No. of equipment related to the requested Change:

6. Reference Drawings and/or technical documents for the requested Change:

<u>Drawing/Document No.</u>	<u>Description</u>
7. Adjustment of Time for Completion:
8. Other change in the Contract terms:
9. Other terms and conditions:

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)

Annex 7. Application for Change Proposal

(Contractor's Letterhead)

To: _____

Date: _____

Attention: _____

Contract Name: _____

Contract Number: _____

Dear Ladies and/or Gentlemen:

We hereby propose that the below-mentioned work be treated as a Change in the Facilities.

1. Title of Change: _____
2. Application for Change Proposal No./Rev.: _____ dated:

3. Brief Description of Change: _____
4. Reasons for Change:
5. Order of Magnitude Estimation (in the currencies of the Contract):
6. Scheduled Impact of Change:
7. Effect on Functional Guarantees, if any:
8. Appendix:

(Contractor’s Name)

(Signature)

(Name of signatory)

(Title of signatory)