ENERGY FIJI LIMITED

BIDDING DOCUMENT

TURNKEY DEVELOPMENT of KALABU TAX FREE ZONE 33kV/11kV SUBSTATION PROJECT

TENDER NO: MR 202/2025

REVISION SCHEDULE:

Revision	Notes	By	Date
1	Completion of Tender Specification	NDPE-C	14/04/25

INVITATION FOR BIDS

Date: 4th June 2025
Tender No: MR 202/2025

The Energy Fiji Limited ("The Employer") invites sealed bids from suitable manufacturers and suppliers for the design, manufacture, supply, installation and commissioning of a new 33kV/11kV step down substation at Kalabu Tax Free Zone, Nasinu.

The substation will house a 33kV indoor switchboard comprising **seven (7) switchgear panels**, two **(2) 12/15 MVA 33kV to 11kV** step down Dyn1 transformers, a 11 kV indoor switchboard comprising **ten (10)** 11kV indoor switchgear panels, SCADA and communications equipment and all associated controls of AC & DC plants. The supply of major equipment shall be from approved suppliers, as outlined in the specifications.

The bidder is required to submit a bid for:

The complete design, manufacture, supply, installation and commissioning of a 33kV indoor switchboard comprising seven (7) 33kV Circuit Breaker panels, 12kV Indoor switchboard comprising ten (10) panels, two (2) 33/11kV 12/15 MVA Dyn1 Transformer, AC & DC controls circuits and other associated requirement of a zone substation at Kalabu Tax Free Zone site.

All bids for the contract shall be submitted on the appropriate forms provided and shall include the completed price schedule, technical schedule and schedules of experience etc. The bid shall be on the basis of a lump sum contract based on firm prices.

Bidders may obtain further information from, and inspect and acquire the bidding documents, at

Turnkey Development of Kalabu Tax Free Zone 33kV/11kV Substation Project
Jitendra Reddy
Manager Procurement, Inventory & Supply Chain
2 Marlow Street, Suva, FIJI.
Phone: 679 3224 185
Email: JReddy@efl.com.fj

The deadline for submission of bids shall be **1600hrs (Fiji Time) on Wednesday 23rd July 2025.**

During evaluation of bids EFL may invite a bidder or bidders for discussions, presentations and any necessary clarification before awarding the contract price proposal.

A site visit is planned for **18th June 2025**. Interested bidders are required to meet at the **proposed Kalabu Tax Free Zone Substation site in Nasinu at 11.00am**. The GPS coordinates of the proposed site is Latitude – 18.092339°S and Longitude – 178.480453°E.

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Section 1 - Instructions to Bidders

A. General

1. Scope of Bid

1.1 The Energy Fiji Limited (hereinafter referred to as "the Employer"), wishes to receive bids for design-build and completion of 33kV/11kV substation at Kalabu Tax Free Zone, Nasinu as defined in these bidding documents (hereinafter referred to as "the Works").

1.2 The successful bidder will be expected to complete the Works within sixteen (16) months from the date of commencement of the Works. The commissioning of substation should be completed by **December 2026.**

2. Source of Funds

2.1 The Energy Fiji Limited has a capital works program which is self-funded and intends to use part of the funds for the contract ("the Contract") for which this Invitation to Bid is issued.

3. Eligible Bidders

3.1 **Bidders shall be manufacturers of the major plant and equipment specified.**

3.2 Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer as the Employer shall reasonably request.

3.3 Bidders shall not be under a declaration of ineligibility for corrupt or fraudulent.

3.4 This Invitation to Bid is open to bidders who have sound financial background and have previous experience in handling such turnkey projects.

4. Eligible Materials, Equipment and Services

4.1 The materials, equipment, and services to be supplied under the Contract shall have their origin from reputable companies from various countries and all expenditures made under the Contract will be limited to such materials, equipment, and services. At the Employer's request, bidders may be required to provide evidence of the origin of materials, equipment, and services. A list of preferred suppliers is attached in Section 7.

4.2 For purposes of Sub-Clause 4.1 above, "services" means the works and all project-related services including design services.

4.3 For purposes of Sub-Clause 4.1 above, "origin" means the place where the materials and equipment are mined, grown, produced or manufactured, and from which the services are provided. Materials and equipment are produced when, through manufacturing, processing or substantial or major assembling of components, a commercial recognized product results that is substantially different in basic characteristics or in purpose or utility from its components.

4.4 The materials, equipment and services to be supplied under the Contract shall not infringe or violate any industrial property or

intellectual property rights or claim of any third party.

5. Qualification of the Bidder

5.1 To be qualified for award of Contract, bidders shall:

(a) submit a written power of attorney authorizing the signatory of the bid to commit the bidder; and

(b) Specify joint venture memberships, certification and qualification as equipment manufacturer, financial capability, technical capability, supplies and installation facilities with comparable technical parameters, manufacturing and installation capability, work in hand, future commitments and current litigation.

(c) Submit proposals regarding work methods, scheduling and resourcing which shall be, provided in sufficient detail to confirm the bidder's capability to complete the works in accordance with the specifications and the time for completion.

5.2 Bidders shall also submit proposals of work methods and schedule in sufficient details to demonstrate the adequacy of the bidders' proposals to meet the Employer's Requirements and the completion time referred to in Sub-Clause 1.2 above.

6. One Bid per Bidder

6.1 Each bidder shall submit only one bid either by itself, or as a partner in a joint venture. A bidder who submits or participates in more than one bid will cause all those bids to be rejected.

7. Cost of Bidding

7.1 The bidder shall bear all costs associated with the preparation and submission of its bid and the Employer will in no case be responsible or liable for those costs.

8. Site Visit

8.1 The bidder is advised to visit and examine the Site of Works 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 design-build and completion of the Works. The costs of visiting the Site shall be at the bidder's own expense.

8.2 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 inspection, 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.

B. Bidding Documents

9. Content of Bidding Documents

9.1 The bidding documents are those stated below, and should be read in conjunction with any Addendum issued in accordance with Clause 11:

		Invitation for Bids
Section	1	Instructions to Bidders
	2	Part I - General Conditions
	3	Part II - Conditions of Particular Application
	4	Employer's Requirements
	5	Forms of Proposals and Appendices
	6	Sample Forms
	7	Schedules
	8	Drawings

9.2 The bidder is expected to examine carefully the contents of the Bidding documents. Failure to comply with the requirements of bid submission will be at the bidder's own risk. Pursuant to Clause 27, bids which are not substantially responsive to the requirements of the bidding documents will be rejected.

10. Clarification of Bidding Documents

10.1 A prospective bidder requiring any clarification of the bidding documents may notify the Employer in writing by fax (hereinafter the term “fax" is deemed to include electronic transmission such as facsimile, cable and telex), or email at the Employer's address indicated in the Invitation for Bids. The Employer will respond to any request for clarification which it receives earlier than 10 days prior to the deadline for submission of bids.

11. Amendment of Bidding Documents

11.1 At any time prior to the deadline for submission of bids, the Employer may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective bidder, modify the bidding documents by issuing addendum.

11.2 Any addendum thus issued shall be part of the bidding documents pursuant to Sub-Clause 9.1, and shall be communicated in writing or by fax to all purchasers of the bidding documents. Prospective bidders shall acknowledge receipt of each addendum by email and fax to the Employer.

11.3 To afford prospective bidders reasonable time in which to take an addendum into account in preparing their bids, the Employer may extend the deadline for submission of bids, in accordance with Clause 23.

C. Preparation of Bids

12. Language of Bid

12.1 The bid, and all correspondence and documents related to the bid, exchanged between the bidder and the Employer shall be written in the English language.

13. Folder Comprising the Bid

13.1 The bidder shall upload main folder with two separate folders for the technical proposal and the price proposal.

13.2 The technical proposal shall contain the following:

(i) Bid Form for Technical Proposal and Appendix to Technical Proposal;
(ii) Power of Attorney;
(iii) Information on Qualification;
(iv) Confirmation of Eligibility;
(v) Schedule of Major Items of Equipment (without prices);
(vi) Schedule of Manufacturers, Place of Manufacture and Testing
(vii) Schedule of Technical Particulars & Guarantees
(viii) Schedule of Work Programme
(ix) Schedule of Departures from Specification
(x) Schedule of Bidder's Statement of Experience
(xi) Schedule of Financial Information
(xii) Schedule of Bio Data for Bidder's Personnel to be engaged in Project
(xiii) Schedule of Bidders Tools & Equipment
(xiv) Schedule of Other Documents and Drawings to be submitted with the bid
(xv) Any other materials required to be completed and submitted by bidders in accordance with these Instructions to Bidders.

13.3 The Financial proposal shall contain the following

(i) Bid Form for Price Proposal and Appendix to Price Proposal;
(ii) Schedules of Prices (as per Section 7, Part I):

I. Price Schedule of Main Items
II. Alternative Offers
III. Recommended Tools & Spare Parts
IV. Summary of Prices

(iii) Any other materials required to be completed and submitted by bidders in accordance with these Instructions to Bidders.

14. Bid Form and Price Schedules

14.1 The Bidder shall complete the Bid Form and the appropriate Price Schedules furnished in the bidding documents in the manner and detail indicated therein, following the requirements of Clauses 15 and 16.

15. Bid Prices

15.1 Unless specified otherwise in Employer's Requirements, Bidders shall quote for the entire facilities on a "single responsibility" basis such that the total bid price covers all the Contractor's obligations mentioned in or to be reasonably inferred from the bidding documents in respect of the design, manufacture, including procurement and subcontracting (if any), delivery, construction, installation and completion of the facilities. This includes all requirements under the Contractor's responsibilities for testing, pre-commissioning and commissioning of the facilities and, where so required by the bidding documents, the acquisition of all permits, approvals and licenses, etc., operation maintenance and training services and such other

items and services as may be specified in the bidding documents, all in accordance with the requirements of the Conditions of Contract.

15.2 Bidders shall give a breakdown of the prices in the manner and detail called for in the Schedules of Prices.

15.3 In the Schedules, Bidders shall give the required details and a breakdown of their prices, including all taxes, duties, levies, and charges payable in the Employer's country as of twenty eight (28) days prior to the deadline for submission of bids, as follows:

(a) Design including all necessary drawings and documentation for the Work.

(b) Plant and equipment to be supplied from outside the Employer's country (Schedules of Prices) shall be quoted on a DDU to Suva Port, Fiji. In addition, estimated ocean freight charges, insurance, installation charges, the FOB price shall also be indicated separately in foreign currency and in local currency. Installation works and Other. **After customs clearance, additional freight should be included to allow transfer from Suva Port to project site at Kalabu Tax Free Zone in Nasinu.** Services shall include rates or prices for all labour, contractor's equipment, materials, consumables and all matters and things of whatsoever nature, the provision of operations and maintenance manuals, training, etc. where identified In the bidding documents, as necessary for the proper execution of the Installation works and Other Services.

(c) Recommended spare parts shall be quoted separately (Schedules of Prices: Part 2) as specified in subparagraph (b) above in accordance with the origin of the spare parts.

15.4 The term DDU shall be governed by the rules prescribed in the current edition of Incoterms, published by the International Chamber of Commerce, Paris.

15.5 Prices quoted by the bidder shall be on a fixed lump sum basis and shall not be adjusted for changes in the cost of labour, material or other matters except only for changes in legislation in accordance to Sub-Clause 13.16 of the General Conditions of Contract.

16. Bid Currencies

16.1 Prices shall be quoted in the following currencies:

(a) the prices shall be quoted in the Fijian currency and either in the currency of the bidder's home country.

(b) a bidder expecting to incur a portion of its expenditures in the performance of the Contract in more than one currency, and wishing to be paid accordingly, shall so indicate in its Bid; and.

16.2 Bidders shall indicate their expected foreign currency requirements in the Appendix to Price Proposal.

16.3 Bidders may be required by the Employer to clarify their local and foreign currency requirements, and to substantiate that the amounts included in the Schedule of Prices and shown in the Appendix to Price Proposal are reasonable and responsive to Sub-Clause 15.1 in which case a detailed breakdown of its foreign currency requirements shall be provided by the bidder.

16.4 During the progress of the Works, the foreign currency portions of the outstanding balance of the Contract Price may be adjusted by agreement between the Employer and the Contractor to reflect any changes in foreign currency requirements for the Contract, in accordance with Clause 13.15 of the Conditions of Particular Application. Any such adjustment shall be effected by comparing the amounts quoted in the bid with the amounts already used in the Works and the Contractor's future needs for imported items.

17. Bid Validity

17.1 Bids shall remain valid for a period of **180 days** after the date of opening of technical proposals specified in Sub-Clause 24.1.

17.2 In exceptional circumstances, prior to expiry of the original bid validity period, the Employer may request that the bidders extend the period of validity for a specified additional period. The request and the responses thereto shall be made in writing or by cable. A bidder may refuse the request without forfeiting its bid security. A bidder agreeing to the request will not be required or permitted to modify its bid, but will be required to extend the validity of its bid security for the period of the extension, and in compliance with Clause 18 in all respects.

18. Alternative Proposals by Bidders

18.1 Bidders wishing to offer technical alternatives to the Employer's Requirements of the bidding documents must first price the Employer's Requirements as described in the bidding documents and shall further provide all information necessary for a complete evaluation of the alternative by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, and proposed construction methods. Only the technical alternatives, if any, of the lowest evaluated bidder conforming to the basic technical requirements shall be considered by the Employer.

19. Format and Signing of Bid

19.1 The bidder shall prepare one original and three copies of the technical and financial proposals, clearly marking each one as: "ORIGINAL ", "COPY NO. I", "COPY NO. 2 ", etc. as appropriate. In the event of discrepancy between the original and any copy, the original shall prevail.

19.2 The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, Photostats are also acceptable) and shall be signed by a person or persons duly authorized to sign on behalf of the bidder, pursuant to Sub-Clauses 5.1 (a) or 5.2 (b), as the case may be. All pages of the bid where entries or amendments have been made shall be initialled by the person or persons signing the bid.

19.3 The bidder shall provide one electronic copy of the Technical and Financial proposals in addition to sub-clause 19.1, on a portable memory stick.

19.4 The bid shall contain no alterations, omissions or additions, except those to comply with instructions issued by the Employer, or as necessary to correct errors made by the bidder, in which case such corrections shall be initialled by the person or persons signing the bid.

19.5 The bidder shall furnish information as described in the Form of Bid on commission or gratuities, if any, paid or to be paid relating to this Bid, and to Contract execution if the bidder is awarded the Contract.

D. Submission of Bids

20. Submission of Bids

20.1 An electronic copy of the bid shall be submitted via EFL's electronic tendering platform, Tenderlink.

20.2 The bidders must ensure that their bid is inclusive of all Taxes payable under Fiji Income Tax Act. The lowest bid will not necessarily be accepted as the successful bid. The Tender Bids particularly the "Price" must be typed and not hand written. Any request for the extension of the closing date must be addressed to EFL in writing three (3) working days prior to the tender closing date. Tender Submission via email or fax will not be accepted

21. Deadline for Submission of Bids

21.1 Bids must be received by the Employer at the address specified above no later than **1600 hours (Fiji Time) Wednesday 23rd July 2025.**

21.2 The Employer may, at its discretion, extend the deadline for submission of bids by issuing an addendum in accordance with Clause 11, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will thereafter be subject to the deadlines extended.

22. Late Bids

22.1 Any bid received by the Employer after the deadline for submission of bids prescribed in Clause 23 will be rejected and returned unopened to the bidder.

23. Withdrawal of Bids

23.1 The bidder may withdraw its bid after bid submission, provided that written notice of the withdrawal is received by the Employer prior to the deadline for submission of bids.

23.2 No bid may be modified by the bidder after the deadline for submission of bids, except in accordance with Sub-Clauses 23.2 and 28.2.

E. Bid Opening and Evaluation

24. Opening of Technical Proposals

24.1 The Employer will open the bids, including modifications made pursuant to Clause 23, at the earliest suitable date and time after closing of the bids, at the following location:

Energy Fiji Limited
2 Marlow St,
Suva
Fiji

25. Process to Be Confidential

25.1 Information relating to the examination, clarification, evaluation and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process. Any effort by a bidder to influence the Employer's processing of bids or award decisions may result in the rejection of the bidder's bid.

26. Clarification of Bids and Contacting the Employer

26.1 To assist in the examination, evaluation and comparison of bids, the Employer may, at its discretion, ask any bidder for clarification of its bid. The request for clarification and the response shall be in writing or by fax, but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the bids in, accordance with Clause 28.

26.2 Subject to Sub-clause 28.1, no bidder shall contact the Employer on any matter relating to its bid from the time of the bid opening to the time the Contract is awarded. If the bidder wishes to bring additional information to the notice of the Employer, it should do so in writing.

26.3 Any effort by the bidder to influence the Employer in the Employer's bid evaluation, bid comparison or Contract award decisions may result in the rejection of the bidder's bid.

27. Preliminary Examination of Bids and Determination of Responsiveness

27.1 Prior to the detailed evaluation of bids, the Employer will determine whether each bid (i) meets the eligibility criteria; (ii) has been properly signed; (iii) is accompanied by the required securities; (iv) is substantially responsive to the requirements of the bidding documents; (v) is conforming to Clause 13; and (vi) provides any clarification and/or substantiation that the Employer may require pursuant to Clause 26.

27.2 A substantially responsive bid is one which conforms to all the terms, conditions and requirements of the bidding documents, without material deviation or reservation. A material deviation of reservation is one (i) which affects in any substantial way the scope, quality or performance of the Works; (ii) which limits in any substantial way, inconsistent with the bidding documents, the Employer’s rights or the bidder's obligations under the Contract; or (iii) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

27.3 If a bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.

28. Correction of Errors

28.1 Bids determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Arithmetic errors will be rectified on the following basis. If there is a discrepancy between the unit rate and the total cost that is obtained by multiplying the unit rate and quantity, the unit rate shall prevail and the total cost will be corrected unless in the opinion of the Employer there is an obvious misplacement of the decimal point in the unit rate, in which case the total cost as quoted will govern and the unit rate corrected. If there is a discrepancy between the total bid amount and the sum of total costs, the sum of the total costs shall prevail and the total bid amount will be corrected.

28.2 The amount stated in the Form of Bid will be adjusted by the Employer in accordance with the above procedure for the correction of errors and, shall be considered as binding upon the bidder. If the bidder does not accept the corrected amount of bid, its bid will be rejected.

29. Conversion to Single Currency

29.1 The Employer will convert the amounts in various currencies in which the Bid Price is payable to the currency of the Employer's country at the selling exchange rates officially prescribed for similar transactions as established by the Reserve Bank of Fiji on the date of opening of bids.

30. Evaluation and Comparison of Bid

30.1 The Employer will evaluate and compare only the bids determined to be substantially responsive in accordance with Clause 27.

30.2 For plant and equipment, the comparison shall be of the DDU to Site price of plant and equipment offered. The Employer's comparison will also include the costs resulting from application of the evaluation procedures described in Sub-Clause 30.4.

30.3 The Employer will carry out a detailed evaluation of the bids in order to determine whether the bidders confirm to meet the prequalification requirements and whether the bids are substantially responsive to the requirements set forth in the bidding documents. In order to reach such a determination, the Employer will employ the criteria listed in **Section 7, Part II, Schedule 9.**

30.4 Pursuant to Sub-Clause 30.3, the following evaluation methods will be followed:

(a) **Contractual and commercial deviations:** The evaluation shall be based on the evaluated cost for fulfilling the Contract in compliance with all commercial, contractual and technical obligations under this bidding document. The Employer will make its own assessment of the cost of any deviations for the purpose of ensuring fair comparison.

(b) **Time Schedule:** The plant and equipment covered by this bidding are required to be shipped, installed, tested and commissioned and all other associated works completed within the period specified in Sub-Clause 1.2 and the Appendix to the Bid.

Bidders submitting bids which deviate from the time schedule specified will be rejected.

(c) The price of recommended spare parts quoted in Schedule of Prices shall not be considered for evaluation.

(d) **Functional Guarantee of the facilities:**

(i) Bidders shall state the functional guarantees (e.g. performance, efficiency, consumption) of the proposed facilities in response to the Employer's Requirements. Plant and equipment offered shall have a minimum (or a maximum, as the case may be) level of functional guarantees specified in the Employer's Requirements to be considered responsive. Bids offering plant and equipment with functional guarantees less (or more) than the minimum (or maximum) specified shall be rejected.

(e) **Work, services, facilities etc., to be provided by the Employer:** Where bids include for the undertaking of work or the provision of services or facilities by the Employer in excess of the provisions allowed for in the bidding documents, the Employer shall assess the costs of such additional work, services and/or facilities during the duration of the Contract. Such costs shall be added to the bid price for evaluation.

30.5 (a) Any adjustments in price which result from the above procedures shall be added, for purposes of Comparative evaluation only, to arrive at an "Evaluated Bid Price" Bid prices quoted by Bidders shall remain unaltered.

(b) The Employer reserves the right to accept or reject any variation, deviation or alternative offer. Variations, deviations, and other factors which are in excess of the requirements of the bidding documents or otherwise result in the accrual of unsolicited benefits to the Employer shall not be taken into account in bid evaluation.

(c) The estimated effect of the price adjustment provisions of the Conditions of Particular Application, applied over the period or execution of the Contract, shall not be taken into account in bid evaluation.

(d) If the bid of the successful bidder is substantially below the Employer's estimate for the Contract, the Employer may require the bidder to produce detailed price analyses to demonstrate the internal consistency of those prices. After evaluation of the price analysis, the Employer may require that the amount of the performance security set forth in Clause 38 be increased at the expense of the successful bidder to a level sufficient to protect the Employer against

financial loss in the event of default of the successful bidder under the Contract.

31. Domestic Preference	31.1	No preference shall be given for domestic contractor or joint venture partners.
32. Award	32.1	Subject to Clause 33, the Employer will award the Contract to the bidder whose bid has been determined to be substantially responsive to the bidding documents and who has offered the Best Value for Money, provided that such bidder has been determined to be (i) eligible in accordance with the provisions of Clause 3; and (ii) qualified in accordance with the provisions of Clause 5.
	32.2	The bidder may be required to attend meetings at the Employer's office for techno-commercial discussions prior to the signing of the Contract at no cost to the Employer.
33. Employer's Right to Accept any Bid and to Reject any or all Bids	33.1	Notwithstanding Clause 32, the Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the grounds for the Employer's action.
34. Notification of Award	34.1	Prior to expiration of the period of bid validity prescribed by the Employer, the Employer will notify the successful bidder by fax, confirmed by registered letter, that its bid has been accepted. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") shall name the sum which the Employer will pay the Contractor in consideration of the execution, completion and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called "the Contract Price").
	34.2	The notification of award will constitute the formation of the Contract.
	34.3	Upon the furnishing by the successful bidder of a performance security, the Employer will promptly notify the other bidders that their bids have been unsuccessful
35. Signing of Contract Agreement	35.1	At the same time that he notifies the successful bidder that its bid has been accepted, the Employer will send the bidder the Form of Contract Agreement provided in the bidding documents, incorporating all agreements between the parties.
	35.2	Within 28 days of receipt of the Form of Agreement, the successful bidder shall sign the Form and return it to the Employer.
36. Performance Security	36.1	Within 28 days of receipt of the notification of award from the Employer, the successful bidder shall furnish to the Employer a performance security in an amount of 10 percent of the Contract Price in accordance with the Conditions of Contract. The form of performance security provided in Section 6 of the bidding documents shall be used.

36.2 Failure of the successful bidder to comply with the requirements of Clauses 35 or 36 shall constitute sufficient grounds for the annulment of the award.

37. Corrupt or Fraudulent Practices

39.1 The Employer requires that the Contractor observe the highest standard of ethics during the procurement and execution of such contracts. In Pursuance of this policy, the Employer:

(a) defines, for the purposes of this provision, the terms set forth below as follows:

(i) "corrupt practice" means behaviour on the part of officials in the public or private sectors by which they improperly and unlawfully enrich themselves and/or those close to them, or induce others to do so, by misusing the position in which they are placed, and it includes the offering, giving, receiving or soliciting of anything of value to influence the action of any such official in the procurement process or in contract execution; and

(ii) "fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Employer, and includes collusive practice among bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Employer of the benefits of free and open competition;

(b) will reject a proposal for award if it determines that the bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question;

37.2 Furthermore, bidders shall be aware of the provision stated in Sub-Clause 1.16 and Sub-Clause 15.5 of the Conditions of Contract, Part II - Conditions of Particular Application.

Section 2
General Conditions of Contract

FIDIC

CONDITIONS OF CONTRACT FOR DESIGN-BUILD & TURNKEY

First Edition, 1995

A Publication of The International Federation of Consulting Engineers

Notes on the Conditions of Contract

The Conditions of Contract comprise two parts: Part I – General Conditions (Section 2 of this document), and Part II – Conditions of Particular Application (Section 3 of this document).

The International Federation of Consulting Engineers (FIDIC), has recently prepared the First Edition (1995) of Conditions of Contract for Design-Build and Turnkey Contracts. FIDIC Part I – General Conditions is included herein, complete and without any changes as Section 2 of these documents.

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

FIDIC Secretariat
P.O. Box 86
1000 Lausanne 12
Switzerland
Facsimile: 41 21 653 5432
Telephone: 41 21 653 5003

Section 3
Conditions of Particular Applications

Section 3
Conditions of Particular Application

Sub-Clause 1.1 Definitions

Amend subpara 1.1.1.3 of Sub-Clause 1.1 by adding the following words at the end:

"The word 'tender' is synonymous with bid'."

Amend subpara 1.1.1.4 of Sub-Clause 1.1 by adding the following words at the end:

"The words 'Appendix to Tender' are synonymous with the words 'Appendix to Technical Proposal' and 'Appendix to Price Proposal'."

Add the following subparagraph to Sub-Clause 1.1:

"1.1.2.7 "EFL" means the Energy Fiji Limited."

Sub-Clause 1.4 Law and Language

Replace the text of Sub-Clause 1.4 and add the following:

"The Contract shall be governed by and construed in accordance with the Laws of Fiji.
The language is the English language."

Sub-Clause 1.5 Contract Agreement

Substitute the wordings in Part I with the following:

"A Contract Agreement in the form annexed, with such modifications as may be necessary to record the agreement reached shall be executed. The costs of stamp duties and similar charges imposed by the law shall be borne by the Employer."

Sub-Clause 1.6 Priority of Documents

Replace the list of documents listed under (a) to (h) and add the following:

"(a) the Contract Agreement;
(b) the Letter of Acceptance;
(c) the Employer's Requirements;
(d) the Bid;
(e) the Conditions of Contract, Part II;
(f) the Conditions of Contract, Part I;
(g) the Schedules;
(h) the Drawings;
(i) the Correspondences During Tender Evaluation;
(j) the Contractor's Proposal. "

Sub-Clause 1.15 Confidentiality

Additional sub-clause:

"The Contractor shall treat the details of the Contract as private and confidential, except to the extent necessary to carry out its obligations under it. The Contractor shall not publish, permit to be published or disclose any particulars of the Contract in any trade or technical paper or elsewhere without the prior consent in writing of the Employer."

Sub Clause 2.5 Customs and Import Duties

(a) The Employer shall pay for all Fiji customs and import duties including clearing, handling charges, port dues and demurrage except only for customs and import duties in respect of tools required for installation, testing and commissioning, which shall be the responsibility of the Contractor.

(b) Customs and import duties if any in respect of the Contractor's Equipment shall not be borne by the Employer.

Sub-Clause 3.1 Employer Representative's Duties and Authority

Add the following clause as required:

"The Employer's Representative shall obtain the specific approval of the Employer before taking action under the following clauses of the Conditions of Contract Part I.

(a) approving sub-contracting of any part of the Works under Sub-Clause 4.5.

(b) certifying additional cost to the Contract Price.

(c) granting an extension of time for completion under Sub-Clause 8.3.

(d) suspending progress of part or all of the Works under Sub-Clause 8.8.

(e) issuing a variation under Clause 14, except if such a variation would increase the Contract Price by no more than FJD 50,000.

(f) issuing Taking-Over Certificate for the whole of the Works under Sub-Clause 10.1.

(g) issuing Performance Certificate for the Works under Sub-Clause 12.9.

Notwithstanding the obligation to obtain approval as set out above, if in the opinion of the Employer's Representative, an emergency occurs affecting the safety of life or of the Works or of adjoining property, it may, without relieving the Contractor of any of its duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Employer's Representative be necessary to abate or reduce the risk. The Contractor shall forthwith comply with the instructions of the Employer's Representative despite the absence of approval of the Employer. The Employer's Representative shall determine the extra cost to the Contractor for carrying out of such instruction and obtain the Employer's approval for an addition to the Contract Price."

Sub-Clause 4.1 General Obligations

Add the following sentence to precede the existing text under Sub-Clause 4.1:

"Notwithstanding any other provision to the contrary, the Contractor is required to check the design criteria and calculations (if any) included in the Employer's Requirements, to confirm their correctness, in its bid and to assume full responsibility for them."

Sub-Clause 4.2 Performance Security

Replace the first paragraph of Sub-Clause 4.2 with the following:

"The Contractor Shall provide security for its proper performance of the Contract to the Employer within 28 days after the receipt of the Letter of Acceptance. The performance security shall be in the form of a bank guarantee, issued either (a) by a bank located in the country of the Employer or a foreign bank through a correspondent bank located in the country of the Employer, or (b) directly by a foreign bank acceptable to the Employer. The performance security shall be denominated in the types and proportions of currencies in which the Contract Price is payable. When providing such security to the Employer, the Contractor shall notify the Employer's Representative of so doing."

Sub-Clause 4.3 Contractor's Representative

At the end of Sub-Clause 4.3 add:

"The Contractor's Representative must be fluent (both spoken and written) in the English language."

Sub-Clause 4.4 Co-ordination of the Works

Modify the first sentence of Sub-Clause 4.4 to read:

"The Contractor shall be responsible for the co-ordination and proper execution of the Works, including co-ordination with other contractors and organizations to the extent specified in the Employer's Requirements."

Sub-Clause 4.9 Site Data

Modify the last sentence of paragraph 1 of Sub-Clause 4.9 to read:

"The Contractor shall be responsible for interpreting all data including data listed elsewhere in the Contract as open for inspection at EFL, Kinoya Depot, Suva, Fiji".

Sub-Clause 4.14 Programme

Delete the third sentence of Sub-Clause 4.14 indicated below:

"Unless otherwise stated ……. and late finish dates".

Sub-Clause 5.2 Construction Documents

In the fifth line of the second paragraph of sub-clause 5.2 replace "21" with "28".

In Sub-Clause 5.2 delete sub-paragraph (a) and substitute:

"(a) Construction shall not commence until the Contractor receives from the Employer's Representative approval of the Construction Documents relevant to the design and construction of such parts; provided always that:

(i) if the Employer's Representative fails to give his ruling within 21 days, the Contractor shall give written notice (for the purpose of this sub-clause "Contractor's Notice") to the Employer's Representative of such failure; and

(ii) if the Employer's Representative fails to give his ruling within 7 days of receipt of the Contractor's Notice, then the Contractor may proceed with the construction as though approval had been given".

Sub-Clause 5.4 Technical Standards & Regulations

Add the following sentence to the end of the Sub-Clause 5.4:

"In respect of technical specifications and standards, IEC (International Electrotechincal Commission based in 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland) standards are to be adopted in general. Any

national or international standards which promise to confer equal or better quality than the standards specified will also be acceptable. In all instances a copy of the relevant standards should be forwarded to the Employer's Representative".

Sub-Clause 6.7 Health and Safety

To sub-clause 6.7 add the following paragraph:
The Contractor must, at all times during the execution of the Work, comply with the Health and Safety at Work Act 1996, the Electricity Act Cap 180, the Energy Fiji Limited "Safety Manual" – Safety Rules and First aid For Employees Of the Authority.

Sub-Clause 6.8 Contractor's Superintendence

At the end of Sub-Clause 6.8 add:

"All the Contractors superintending staff shall have a working knowledge of the English language."

Sub-Clause 6.11 Foreign staff and Labour

"The Contractor may import such staff, and labourers as are required in order to execute the Works. The Contractor must ensure that all such staff and labour are provided with the required visas and work permits. The Contractor shall be responsible for the return to the place where they were recruited or to their domicile of all persons whom the Contractor recruited and employed for the purpose of or in connection with the Contract. The Contractor shall be responsible for such persons as are to be returned until they shall have left the Site or, in the case of foreign nationals who have been recruited outside the Country, shall have left it."

Sub-Clause 6.12 Measures against Insect & Pest Nuisance

"The Contractor shall at all times take the necessary precautions to protect all staff and labour employed on the Site from insect and pest nuisance, and to reduce the dangers to health and the general nuisance occasioned by the same. The Contractor shall provide its staff and labour with suitable prophylactics for the prevention of malaria and dengue fever and take steps to prevent the formation of stagnant pools of water. The Contractor shall comply with all the regulations of the local health authorities and shall arrange to spray thoroughly with approved insecticide all buildings erected on the Site. Such treatment shall be carried out at least once a year or as instructed by such authorities."

Sub-Clause 6.13 Epidemics

"In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Government or the local medical or sanitary authorities, for the purpose of dealing and overcoming the same."

Sub-Clause 6.14 Alcoholic Liquors or Drug

"The Contractor shall not import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or suffer any such importation, sale, gift, barter or disposal by his Subcontractors, agents staff or labour."

Sub-Clause 6.15 Arms and Ammunition

"The Contractor shall not give, barter or otherwise dispose of to any person or persons, any arms or ammunition of any kind or permit or suffer to the same as aforesaid."

Sub-Clause 6.16 Burial of the Dead

The Contractor shall make all necessary arrangements for the transport, to any place as required for burial, of any of his expatriate employees or members of their families who may die in the Country.

The Contractor shall also be responsible, to the extent required by local regulations, for making any arrangements with regard to burial of any of his local employees who may die while engaged upon the Works.

Sub-Clause 6.17 Festivals and Religious Customs

"The Contractor shall in all dealings with his staff and labour have due regard to all recognized festivals, days of rest and religious or other customs."

Sub-Clause 7.3 Inspection

To sub – clause 7.3 add the following paragraphs:

The Employer and the Contractor shall carry out a joint walk through inspection to identify and document any defects/ deficiencies of the Works prior to commissioning, after which the Contractor shall rectify all the identified defects.

The Employer and the Employer's Representative shall be entitled at any time during the term of this Contract to inspect any part of the Works and the Contractor shall give them full opportunity and access to conduct such inspection.

Sub-Clause 7.7 Restriction on Eligibility

(a) Any materials, equipment, services or design services which will be incorporated in or required for the Contract, as well as the Contractor's Equipment and other supplies, shall have their origin from reputable source countries acceptable to the Employer.

(b) For the purpose of this clause, "services" means the works and all project-related services including design services.

(c) For the purposes of this clause, "origin" means the place where the materials and equipment were mined, grown, produced, or manufactured, or from which the services are provided.

(d) The origin of Goods and Services is distinct from the nationality of the Supplier."

Sub-Clause 12.11 Warranty

"The Employer shall be entitled to all applicable manufacturers' warranties for the Plant and equipment supplied by the Contractor. The Contractor warrants the Equipment to be free from defects in workmanship and material used in their manufacture and installation. This warranty will cover Equipment for claims for such defects and workmanship made during the Warranty Period, being 12 months from completion of defects liability period and issuing of performance certificate

Sub-Clause 13.2 Advance Payment

Modify the third sentence of this Sub-Clause to read:

"The Employer's Representative shall issue an Interim Payment Certificate for the first instalment after (i) execution of the Contract Agreement by the parties hereto (ii) provision of the Performance Security in accordance with Sub-Clause 4.2 by the Contractor and (iii) provision of an unconditional bank guarantee by the Contractor in a form and by a bank acceptable to the Employer in amounts and currencies equal to the advance payment."

Sub-Clause 13.4 Schedule of Payments

To Sub-Clause 13.4 add:

The payments will be made according to the following schedule:

*** EFL will assess during tender evaluation**

Sub-Clause 13.15 Calculation of Payments in Foreign Currency

Delete Clause 13.15 and add the following:

"The Contract shall be paid in the currencies stated in the Appendix to Bid and shall be in accordance with Schedule of Prices and Conditions of Payment.

The foreign and local currency portions of the balance of the Contract Price shall be amended by agreement between the Employer and the Contractor to reflect any substantial changes in the expected foreign and local currency requirements of the Contractor during the execution of the Works, provided:

(a) the Contractor shall inform the Employer and the Employer's Representative whenever any such substantial change may occur;

(b) the Employer's Representative may recommend a review of such expected requirements if in its judgment there is evidence of a change in the country of origin of equipment, materials, plants, or services to be provided under the Contract which should result in any substantial change of such expected requirements.

Any such amendment shall be affected by comparing the amounts quoted in the bid with the amounts already used in the Works and the Contractor's future needs for imported items."

Sub-Clause 13.15 Calculation of Payments in Foreign Currency

To sub-clause 13.15 add the following paragraph:

The local (Fijian) component of the Contract Price shall not be subjected to any currency exchange rate variation.

Sub-Clause 13.17 Taxation

"(i) The prices bid by the Contractor shall include all taxes, duties and other changes imposed outside the Employer's country on the production, manufacture, sale and transport of the Contractor's equipment, Plant, materials and supplies to be used on or furnished under the Contract, and on the services performance under the Contract.

Sub-Clause 15.5 Corrupt or Fraudulent Practices

Delete the existing Sub-Clause 15.5 and substitute the following:

"If in the judgment of the Employer the Contractor has engaged in corrupt or fraudulent practices, in competing for or in executing the Contract, then the Employer may, after having given 14 days' notice to the Contractor, terminate the Contractor's employment under the Contract and expel the Contractor from the Site, and the provisions of Clause 15 shall apply as if such expulsion had been made under Sub-Clause 15.2."

Sub-Clause 17.3 Employer's Risks

This sub-clause is amended to read as follows:

"The Employer's risks are:

(a) insofar as they directly affect the execution of the Works in the country where the Permanent Works are to be executed:

(i) war and hostilities (whether war be declared or not), invasion, act of foreign enemies in the Country;

(ii) rebellion, revolution, insurrection, or military or usurped power, or civil war in the Country;

(iii) ionizing radiations, or contamination by radioactivity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radioactive toxic explosive or hazardous properties of any explosive nuclear assembly or nuclear component thereof in the Country;

(iv) pressure waves caused by aircraft or other aerial devised travelling at sonic or supersonic speeds in the Country;

(v) riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of its Subcontractors and arising from the conduct of the Works in the Country;

(b) loss or damage due to the use or occupation by the Employer of any Section or part of the Permanent Works, except as may be provided for in the Contract;

(c) any operation of the forces of nature (insofar as it occurs on the Site) which an experienced Contractor:

(i) could not have reasonably foreseen, or

(ii) could reasonably have foreseen, but against which he could not reasonably have taken appropriate measures to prevent loss or damage to physical property occurring."

Sub-Clause 18.2 Insurance for Works and Contractor's Equipment

(i) Amend the second sentence of the first and second paragraphs to read:

"This insurance shall cover loss or damage from any cause other than the Employer's risks listed in amended Sub-Clause 17.3 paras. (a)(i) to (iv) in Part II of the Conditions of Contracts".

(ii) Amend the fourth sentence of the first paragraph to read:

"Such insurance shall cover the Employer and the Contractor from the first working day after the Commencement Date until the date of issue of the Taking-Over Certificate for the Works."

Section 4

Employer's Requirements – Part I
Scope of Works

PART 1 - SCOPE OF WORKS

1.1 GENERAL DESCRIPTION

The scope of works for this contract for **Turnkey Development of Kalabu Tax Free Zone 33kV/11kV Substation Project** is for complete design, manufacture, supply, installation and commissioning of new 36kV SF6 indoor switchgears with SF6 insulated Bus Bars, complete with local & remote control, 2 x 12/15 MVA 33/11kV Dyn1 Power Transformers with on-load tap-changers, 12kV indoor VCB/SF6 switchgears, controls and relay panels, and carry out any other necessary works required inside the substation building in preparation for the installation of new switchgears. The above includes clearing the equipment from Suva Port and safe transportation to the substation project site and storage responsibility.

Kalabu Tax Free Zone Substation is a Greenfield Substation. The main items for supply and installation under the scope includes:

1. 36 kV Indoor fixed switchgears comprising

   4 No. Line feeder bay
   2 No. Transformer bays
   1 No. Bus section bay (and riser panel if applicable)
   SF6 insulated Busbar with single busbar arrangement with sectionalizer

2 Two (2) only 33/11 kV Transformer, 12/15 MVA ONAN/ONAF Dyn1, including On-load tap changer

3 12 kV Indoor switchgear comprising

   6 No. Line feeder bays
   2 No. Transformer bays
   1 No. Auxiliary Transformer Bay (Pad Mount Transformer)
   1 No. Bus section bay (and riser panel if applicable)
   Busbar with single busbar arrangement with sectionalizer

4 Construction of pad for 11/0.415 kV, 300 kVA, Dyn11 Auxiliary Station Pad Mount Transformer (Transformer to be supplied by Employer with plinth details)

5 Construction of Control Building and all associated civil works, electrical, plumbing works, firefighting system and alarm installation, yard crush metal works, etc

6 Construction of Pad for 2 x 33kV/11kV Power Transformer with bund wall, firewall with Galvanized or Aluminum Louver at one end and Oil Separator pit with alarm

7 Control, Metering, Monitoring and Protection equipment (SEL), etc.

8 Substation and Protection equipment supply comprising 2 set of 110 V Maintenance free battery banks and Battery charger equipment with Selector switch, etc.

9 1 x 110V DC Distribution Board with 2 x incomers, metering, Dual Chassis and Bus Tie Isolators.

10 1 No. LVAC changeover Switchboard with two incomers, metering provision and distribution board with at least 54 pole chassis

11 SCADA and Communications equipment (SEL) complete with dedicated panel.

12 Power and Control cables including terminations.

13 Control wiring and interfacing of various equipment according to protection schemes.

14 Concrete cable trench from the control building to the boundary for incoming and outgoing feeders.

15 Substation grounding system and lightning Protection system.

16 Electrical, Civil and Mechanical works required for substation including control and other building, landscaping, boundary works, concrete drainage way, concrete retaining wall (for slope protection) or short creating works, yard lighting Power Transformer AVR (REGDA or MR Tapcon Relay) complete with dedicated panel

17 Spare parts.

1.2 TERMINAL POINTS

The following shall be the Contract Terminal points:

a) 36 kV interface

The Contractor shall be responsible for installing and commissioning all 36 kV Switchgear and associated cables for the power transformers. The contractor is responsible for carrying out the outdoor cable termination including mounting for the 33kV/11kV power transformers. The contractor shall be responsible to construct concrete cable trench with removable lids from the control building to the boundary of the substation compound for the Employer to lay 36 kV 630mm^2 single core XLPE cables for the two (2) 33kV underground cables from proposed 33kV sub-transmission line extension to the identified termination points at Kalabu Tax Free Zone Substation.

b) 12 kV Indoor Switchgear interface

12 kV indoor switchgear shall be installed in the Control Building. The Contractor shall carry out termination of cables on all switchgears. The contractor shall be responsible to construct concrete cable trench with removable covers/lids from the control building to the boundary of the substation compound for the Employer to lay the 11kV feeder cables. The Contractor shall lay and terminate 240mm^2 three core XLPE cable between the switchgear and the Pad Mount Transformer.

c) LVAC Supply

The Contractor shall connect LV cable to the 1st incomer of change-over switch. The Contractor is responsible for laying the LV cables between the change-over panel and the terminal of the Pad Mount transformer. The Employer shall supply and install the Pad Mount transformer at the Kalabu Tax Free Zone Substation once the plinth is constructed. Terminate a second LV cable to the 2nd incomer of the change–over switch. The Employer shall lay 2nd LV cable from existing transformer within the vicinity.

d) Environmental Conditions

	Value	***Unit***
Altitude of site above sea level not exceeding	50	m
Maximum ambient air temperature	40	^oC
Minimum ambient air temperature	18	^oC
Average ambient air temperature over 24 hours	29	^oC
Average yearly temperature	29	^oC
Relative humidity (24 Hours)	90	%
Average annual rainfall	2200	mm
Maximum recorded rainfall for 24 hours	390	mm
Maximum Wind Speed	85	m/s
Average isokeraunic level	50	

e) Electricity, Water, Gas and other Services

The Contractor shall provide all electricity, water, gas and other services necessary to execute and complete the Works on site. Prevailing tariff and service connection procedure shall be applicable.

The contract also covers the maintenance for the defect liability period and all other works incidental thereto, whether specified in detail or not, necessary for securing efficient operation of the 33kV &11kV switchgear, 33/11 kV transformer and SCADA system, and associated control and relay equipment for a period of 12 months.

1.3 MAJOR PLANT & MATERIAL INCLUDING SPARE PARTS

1.3.1 Indoor 36kV Switchgear

1.3.1.1 4 No. 36 kV Line Feeder Bay comprising

1 No.	1250A, 36 kV, 31.5 kA/3sec, 3 phase SF6 circuit breaker fixed type complete with housing panel
1 No.	Three phase voltage transformers, ratio 33,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection.
	36 kV Current Transformers with following cores
1 Nos	Class 0.1PX, ratio 2000/1200:1 A for Busbar protection
1 Nos	Class 5P20, ratio 800/600:1 A for Protection (Over current &earth fault)
1 Nos	Class 0.1PX, ratio 800/600:1 A for Line differential protection
1 Nos	Class M, ratio 800/1A for metering

1.3.1.2 2 Nos. 36 kV Transformer Bay comprising

1 No.	1250A, 36 kV, 31.5kA/3sec, 3 phase SF6 circuit breaker fixed type complete with housing panel
	36 kV Current Transformers with following cores
1 Nos	Class 0.1PX, ratio 600/400:1 A for Transformer differential protection
1 Nos	Class 5P20, ratio 600/400:1 A for Protection (Over current &earth fault)
1 Nos	Class 0.1PX, ratio 2000/1200:1 A for Bus protection
1 Nos	Class M, ratio 800/1A for metering

1.3.1.3 1 No. 36 kV Bus Section Bay comprising

1 No.	2500A, 36 kV, 31.5kA/3sec, 3 phase SF6 circuit breaker complete with housing panel
2 Nos.	Three phase voltage transformers, ratio 33,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection.
	36 kV Current Transformers with following cores
1 Nos	Class 5P20, ratio 2000/1200:1 A for Protection (Over current & earth fault)
2 Nos	Class 0.1PX, ratio 2000/1200:1 A for bus protection
2 Nos	Class M, ratio 800/1A for metering

1.3.2 Indoor 12kV Switchgear

1.3.2.1 6 Nos. 12 kV Line feeder Bays comprising:-

1 No.	1250A, 12 kV, 25kA/3sec, 3 phase fixed-type circuit breaker complete with housing panel
	12 kV Current Transformers with following cores:
1 No.	Class 5P20, ratio 800/400:1 A for Over current and earth fault protection

1.3.2.2 2 Nos. 12 kV Transformer Bays comprising:-

1 No.	1250A, 12 kV, 25kA/3sec, 3 phase circuit breaker complete with housing panel
1 Nos.	Three phase voltage transformers, ratio 11,000/√3:110/√3:110/√3 Class 0.2 for Metering and Protection

12 kV Current Transformers with following cores:

1 Nos. Class 0.1PX, ratio 1600/1200:1 A for transformer differential Protection

1 Nos. Class 5P20, ratio 1600/1200:1 A for Over current and earth fault protection

1 Nos. Class 0.1PX, ratio 300/1500:1 A for transformer differential Protection

1.3.2.3 1 No. 12 kV Auxiliary Transformer comprising:-

1 No. 1250A, 12 kV, 25kA/3sec, 3 phase circuit breaker complete with housing panel

12 kV Current Transformers with following cores:

1 Nos. Class 5P20, ratio 800/400:1 A for Over current and earth fault protection

1.3.2.4 1 No 12 kV Bus Section Bay comprising:

1 No 2000A, 12 kV, 25kA/3sec, 3 phase circuit breaker with housing panel

12 kV Current transformers with following cores:

1 Nos. Class 5P20, ratio 2000/1600/1 A for Overcurrent and Earth fault protection

2 No Three phase voltage transformer, ratio 11,000/√3:110/√3:110/√3 Class 0.2 for Metering and Protection

1.3.3 LVAC Switchboards

1 Lot The two incoming supplies to switchboard are to be interlocked to automatically establish supply to the busbar in the event of failure of the selected supply (Incomer No.1 & 2) and not to parallel two of the incoming supplies at any time. Shall include at least 54 pole single chassis and 4 x MCCB (2 x 100A and 2 x 250A). Shall have provision for incoming energy metering.

1.3.4 Batteries, Chargers & Distribution Boards

2 Set 110 V Maintenance free battery banks with the capacity of 600Ah. (2.2V cell x 54 cells)

2 Set 30A Single phase charger with surge protection/filter capacitors and voltage stabilizer/regulator.

1 Set DC distribution board with 2 incomers, dual chassis with bus tie and with incoming metering. (Note: DC board shall be separate, not part of the charger panel)

1.3.5 Protection, Metering & Control

1.3.5.1 33 kV Protection Relays

4 Nos. SEL 311L with extended IO board

7 Nos. SEL 351S-7 with extended IO board

2 Nos. SEL 387E with extended IO board

2 Nos. AREVA - MVAJ13

1No. SEL 587Z

2 Nos. VAMP Arc Flash Protection

2 Nos. Partial Discharge Monitoring System

1.3.5.2 11 KV Relays

10 Nos. SEL 351S-7 with extended IO board

2 Nos. VAMP Arch Flash Protection

2 Nos. Partial Discharge Monitoring System

1.3.5.3 Scada Equipment

2 Nos.	SEL 2488 GPS Clocks for time synchronization of protection relays
2 Nos.	SEL 2730M switch for substation automation system
2 Nos.	SEL 3350 for substation automation system
1 No.	SEL3555 for Station HMI, 32inch Screen, key board and mouse.
2 Nos.	Switch with dual power supply (AC & DC) – Cisco CGS2520
4Nos.	Fibre Transceiver – GLC – Ex (40km)
5Nos.	SEL RTAC 3530 – 3530, 33 ports with both link ports to be Ethernet
20Nos.	20 x SEL RS232 cable – 9 pin male, (4 x 14ft, 4 x 20ft, 4 x 10ft, 4 x 5ft, 4 x 2ft)
1No.	Patch for RTU – 1 drum Cat 6 cable (red)
1No.	Fibre patch for Switch - LC – SC duplex cable, single mode (4 x 3m length)
1No.	Equipment Rack (cabinet) – Rital 790mm x 600mm x 2100mm, glass front door with build in fan and light.

1.3.6 Communications Equipment

2 Nos.	SEL 3530 RTU
2 Nos.	IP Telephone (Mitel 5312) – blue tooth wireless handset
1 No.	Radio Telephone (Tait 9355 VHF DMR mobile radio 136 – 174 Mhz)
1 No.	VHF Radio TM8250
1No.	48 core Cisco Layer 3 PPoE switch
1No.	Cisco SFP Transceiver Module for single mode fibre
1No.	3kVA APC UPS
1 No.	Fibre Distribution Panel (Warren & Brown Rack 1200mm x 300mm x 2200mm)
1No.	Fiber patch cords on both sides of the substations – SC – SC (20 x 3m duplex)
1No.	Fiber accessories on both sides of the substations – SC pigtails (144)
1 No.	4RF Data Radio and Antenna
1 No.	CARDAX Access System
1 Set	CCTV System for indoor and outdoor monitoring capable of integrating with EFL system

1.3.7 Substation Earthing

1 Lot	The earthing installation rates shall include excavation, backfilling and reinstatement of the ground, Soil Resistivity testing, Earthing Study and Design, supply and laying of copper cables, driving the earth rods, earth bars making of the connections and providing test access.

1.3.8 Lightning Protection System

1 Lot	Design and erection of lightning protection system with earth wires as specified.

1.3.9 Grounding System

1 Lot	Grounding system including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes using brass bolts.

1.3.10 Power & Control Cables

1 Lot	All low voltage AC power cables and terminations
1 Lot	All DC power and control cables and terminations
1 Lot	Power and lighting cable for all works, including indoor and outdoor lighting and auxiliary supply

1.3.11 Transformers

2 Nos.	33/11 kV Transformer, 12/15 MVA ONAN/ONAF Dyn1, including On-load tap changer, REGDA or TAPCON voltage regulator and Transformer Monitor

2 Nos. Digital Temperature monitoring Equipment for power transformers (Qualitrol).
1 No. 11/0.415 kV 300 kVA, Auxiliary Pad Mount Transformer Dyn11 (Supplied by Employer)
1 No. Class 0.1PX, ratio 600/350: 1 for SBEF and REF

1.4 CIVIL WORKS, INSTALLATION & OTHER SERVICES

1.4.1 Civil Works

1.4.1.1 Preliminary Works

a) Environmental Impact assessment (EIA)
b) Site Survey
- As per chapter 13 of Technical Specification.
c) Sub Soil Investigations
- As per chapter 13 of Technical Specification.

1.4.1.2 Site Clearing

a) Cutting and removing trees & shrubs.
- Big trees, shrubs and boulders.

1.4.1.3 Site formation and up keeping

a) Cutting and filling earth.
- Formation levels shall be approved by Employer's Representative. Total area required including future bays to be formed.

b) Earth retaining structures
- Earth retaining walls
- Rubble pitching work
- Slope protection works

c) Landscaping & tree planting
- As required for the layout.
- Weed control mat

d) Surface Chipping
- Area covered by the earth mat.

1.4.1.4 Cable Trenches & Ducts

- As per chapter 8 and 13 of Technical Specification.
- Provision shall be made for all future cables.

1.4.1.5 Foundations

Concrete Bund wall and blast wall for transformers complete with excavation, backfilling, form works, concrete works and reinforcement bars

2 Nos. 33/11 kV Power transformer (12/15 MVA ONAN/ONAF)
1 No. 11/0.415 kV Dyn11 Pad Mount Transformer (300 kVA)
1 No. Triple interceptor pit and oil containment. Outlet to be as per Environmental Management Plan.

1.4.1.6 Lightning protection system

- As per chapter 13 of Technical Specification.

1.4.1.7 Water supply & drainage system

a) Water supply system

-. Plumbing system to be connected to public water supply system. Including, necessary lodgement of request and acquiring of approvals from WAF.

b) Waste water sewerage system

- Waster water sewerage to be connected to public sewerage system. Including, necessary lodgement of request and acquiring of approvals from WAF.

c) Surface water drainage system

- Internal surface water drainage system shall be directed as per the Environmental Management Plan.

1.4.1.8 Construction & Maintenance of Roads

a) Approach Road
b) Structures for approach road.
c) Access road and structures

1.4.1.9 Fence & Gates

a) 3.15mm tough galvanized Chain link fence, barbed wire and 1 x 8m sliding gates and 1 x small swing gate.

1.4.1.10 Internal Lightning

- Shall include back up DC lights besides the AC lighting system (LED), trench lightning

1.4.1.11 External Lighting

- Shall include all Galvanized Pole Mounted Switchyard lighting and Transformer Bay Lightning (LED)

1.4.1.12 Miscellaneous Works

- Any work other than listed above.

1.4.1.13 Construction of Control Building

a) Control Building at Kalabu Tax Free Zone

- As indicated in concept building layout and as per chapter 13 of Technical Specification.

b) Steel Doors and Sliding glass windows (Cyclone rated Cat 5 with Debri impact grills)
c) False ceiling with Safety Net
d) Heat insulation and water-proofing
e) Painting (Fire retardant) & Glazing

1.4.1.14 Construction of Building Services

a) Ventilation system
- Refer chapter 13 of Technical Specification.
b) Fire protection minimum of 2 hours
- Refer chapter 13 of Technical Specification.
c) Internal Lighting & small power supply services.
- Refer chapter 13 of Technical Specification.

1.4.1.15 Laying of Cable

a) 630mm^2 36 kV Single Core XLPE Cables

The contractor shall lay according to the specifications, 2 set (both HV & LV side) of 630 mm^2 36kV single core XLPE cable for the 2 Nos. 33/11kV power transformers.

b) 240mm^2 12 kV Three Core XLPE Cables

The contractor shall lay according to the specifications, 1 set of 240 mm^2 12kV three core XLPE cable for the Auxiliary Pad Mount Transformer.

c) The contractor is responsible for laying 1 set of LV cable from Auxiliary Pad Mount Transformer to LV Supply Change Over panel.

d) Control Cabling

The contractor shall prepare schematics, lay all control cables and carry out wiring between various equipment.

1.4.1.16 Cable Termination

All 33kV &11kV cable terminations to the switchgear are the scope of the contractor. Termination box or covers should be covered with removable covers to allow access for Testing.

The Contractor is also responsible for terminating LV cable at Auxiliary Transformer and 1st incomer LV change over panel. The Employer will terminate HV cable at Auxiliary Transformer.

1.4.2 Other Services

1.4.2.1 Training

Training shall be provided before commencing the installation and commissioning of the relevant equipment at site. The Contractor shall therefore submit the training program for each category along with the installation/erection and commissioning program.

1.4.2.1.1 Objective of Training Modules

The training authority shall have a well-equipped training facility to provide hands-on training for the full range of offered High Voltage switchgears, Protection & Controls system. The program shall cover the installation, commissioning and maintenance aspects of the above categories as the trainee personnel will be responsible for commissioning witness by approving the tests & practices from the client's side during the project implementation period and they also will be responsible for maintenance of such equipment after the expiry of defect liability period of the project. The training shall be held at the same time as the witness testing and shall be conducted by an authority approved by the Manufacturer, if not the Manufacturer itself. The Manufacturer can provide the training at the manufacturer's facility for the number of participants listed below or at EFL premises in Central Division with at least 20 participant and in Western Division with at least 20 participants

Training Module No 1: Power Transformers and AVR
Number of Participants: 3 Engineers
Basic Contents:

- Erection and installation of power transformers
- Various Testing on Power Transformers with typical results (Type Test and Routine Test) & commissioning of power transformers
- Maintenance practices for the supplied power transformer as recommended by the Manufacturer
- Hands on training on test equipment, which are required for maintenance of installed equipment.
- Procedures for oil filling and vacuuming the transformers.
- Transformer Monitoring equipment and AVR programing.

Training Module No. 2: Indoor 33 kV and 11 kV Switchgears
Number of Participants: 3 Engineers
Basic Contents:

- Installation of switchgears.
- VariousTesting (Type Test and Routine Tests) & commissioning of switchgears including CT and VT.
- Testing of electrical and mechanical interlocking schemes.
- Maintenance practices for the supplied equipment as recommended by the Manufacturer
- Hands on training on test equipment, which are required for maintenance of installed equipment
- Hands on training on periodic adjustment required, and parts replacement procedure in Circuit breaker mechanism.
- Inspection and parts replacement procedure in the arcing chamber of the SF_6 Circuit breaker if supplied.
- Programing and testing of Arch Flash Protection and Partial Discharge monitoring equipment.

Training Module No. 3: Protection Equipment, SCADA and Communication Equipment and Substation Automation.

Number of Participants: 3 Engineers

Basic Contents:

- All Protection schemes for Feeder, Transformer and Bus.
- Programing and testing of all Protection Relays, RTU and HMI System.

1.4.2.2 Design Reviews

The Contractor shall allow for two (2) EFL personnel to attend Design Review meetings for the 11kV and 33kV switchgear and 33/11kV transformer at the Manufacturer's premises or factory to review and approve designs prior to manufacture of major equipment.

Any Steel Structures which are procured out of Fiji will be required Factory Acceptance Testing before shipment. Contractor will be required to arrange for 2 x EFL Engineers Factory visit including all associated cost.

Section 4

Employer's Requirements – Part II
Technical Specifications

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CHAPTER 1 - GENERAL INFORMATION

1.1 EXTENT OF CONTRACT

(i) Definite Work

This Contract is on a turnkey basis & includes the site survey, design, manufacture, inspecting and testing, insurance, packing for export, shipment, clearing from port, delivery to site, unloading, complete erection, finishing, painting, site testing, training and commissioning of the Plant described herein.

The Contractor shall be responsible for making good for any defective material design or workmanship for a period of 48 months after taking over. The Contractor is to co-operate with other contractors and EFL operating staff as may be necessary.

The Contractor is responsible for design, supplying and erecting all plant such that the complete function is guaranteed, without necessity for any additional works to be initiated by the Engineer, unless specifically excluded in these Bidding Documents or agreed upon in writing. That includes among others e.g.: protection and other studies, manufacture, type tests, testing at factory and at site, insurance, packing, transportation and delivery to site, erection and commissioning.

Works must fully interact with each other in every respect. Additionally, they must properly interact with any other Contractor's work as far as an interfacing is specified or mentioned herein.
In case the Contractor finds any parts of these Specifications incomplete, contradictory or defective, he shall be responsible to immediately bring this to the notice of the Employer and make a proposal for the Employer's approval, for making good such incompleteness or defect at the stage of bidding. No additional cost to the Employer shall arise out of such rectification.

Main design data given in these Specifications and general layouts of the substations are available in the Drawings.

1.2 ASSOCIATED PLANT DETAILS

The given particulars elsewhere in this document are those anticipated for plant being provided under other Contracts or already existing and should be used in the preparation of the Bid. They are, however, subject to confirmation and where they are considered to have an effect on the final design of equipment being provided under this Contract, the Contractor is to obtain figures from the Engineer before proceeding with designs.

1.5 ELECTRICAL DESIGN CRITERIA

1.5.1 System Conditions

System Particulars for 33kV & 11kV system applicable in Fiji Islands are stated below:

	33 kV	***11 kV***
Normal system voltage	33 kV	11 kV
System Highest voltage	36 kV	12 kV
Frequency	50 Hz	50 Hz
Earthing of Neutral point	Solidly earthed	Directly earthed with or without resistor
Design Symmetrical fault level	1125 MVA	250 MVA
	31.5 kA	25kA

1.3.2 Service Conditions

The Service Conditions applicable in Fiji Islands, at the location of substation site are given below:

Daily average ambient temperature 32^0C

Max ambient temperature	40^0C
Annual average ambient temperature	30^0C
Minimum ambient temperature	18^0C
Relative Humidity	90%
Altitude	50m
Maximum Wind Speed (under cyclonic conditions)	85m/sec - gusting (under cyclonic conditions)
Isokeraunic Level	50
Seismic Level	7 on the open ended Richter scale
Average Rainfall per year	2200mm

Note: Fiji is situated in a region where cyclones are experienced frequently. All plant and equipment shall be designed and constructed to withstand these extreme conditions. All plant and equipment shall be rust proof, vermin proof and weather proof and designed to be suitable for a damp, tropical climate, which may be experienced simultaneously.

1.3.3 Power supply for electrical operation

1.0 Control /alarm /emergency	DC Voltage	110 V
2.0 Supply voltage of auxiliary equipment	AC Voltage	415/240V
3.0 Supply voltage for auxiliary equipment	DC Voltage	110V

1.3.4 Minimum Substation Clearances

Air insulated outdoor and indoor busbars and connections shall have electrical clearances as listed in the following table: -

Highest system voltages between phases	**36 kV**	**12 kV**
Minimum clearance between live metal and earth	325 mm	200 mm
Minimum clearance between live metal of different phases	325 mm	250 mm
Minimum safety clearance between the nearest point not at earth potential of an insulator to ground(Pedestrian Access)	2300 mm	250 mm
Minimum safety clearance between live metal and positions to which access is permissible with other conductive equipment	2625 mm	2590 mm

1.3.5 Pollution levels of Insulators and Bushings

For 11kV systems - 31mm/kV
For 33kV systems - 51.7mm/kV

1.3.6 Insulation Co-ordination

The design of plant and equipment shall be such that insulation co-ordination is provided not only between different items of plant such as transmission line, surge arrestors, transformers, circuit breakers, but also between different components of items within a particular item of equipment.

1.3.7 Inter-Changeability

Corresponding items or parts shall be interchangeable as far as possible.

1.3.8 Maintainability

All plant and equipment supplied under this contract shall be maintainable. The contractor in adequate number of copies shall provide all necessary tools and equipment and operations and maintenance manuals required for this purpose. All special tools shall be supplied by the Contractor in 2 sets.

1.3.9 Ventilation

Kiosks, cubicles and similar enclosed compartments shall be adequately ventilated to restrict condensation. All panels shall be equipped with anti-condensation heaters. All contactors, relay coils, etc. shall be suitably protected against corrosion and fully tropicalized.

1.3.9 Risk of Fire

All apparatus, connections and cabling shall be designed and arranged to minimize the risk of fire and any damage, which might be caused in the event of fire.

1.4 QUALITY OF MATERIALS AND WORKMANSHIP

All materials used under this contract shall be new and of the quality and class most suitable for working under the conditions specified and shall withstand the variations of temperature, 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 of the work which they have to perform.

All work shall be carried out and completed in a neat and professional manner to the approval of the Employer's Representative.

1.5 STANDARDS

IEC Standards are to be adopted in general. British or Australian standards too may be applied wherever necessary. Any other national or international standard may be used if such standards are not less exacting than corresponding IEC Standard. In all instances a copy of the relevant standard adopted should be forwarded to the Engineer. All civil works should be carried out in conformity with Fiji Building Code.

The Works shall be constructed in accordance with the laws of Fiji and associated Acts and Regulations. These include:

The Electricity Act 2017
The Electricity Regulations 2019
Health and Safety at Work Act – 1996
Environment Management Act

In order to achieve Regulatory compliance under the Fiji Electricity Act, the Works shall comply with the Electricity Regulations and AS/NZS 3000:2018 "Wiring Rules". Regulatory compliance shall be sought by EFL prior to the commissioning of the Station.

In the absence of specific standards being nominated in the specifications, the following standards shall apply:

Australian/New Zealand Standards

AS	1154	Insulator and conductor fittings for overhead power lines
AS/NZS	1170	Structural Design Actions
AS/NZS	1768	Lightning Protection
AS	1824	Insulation coordination – Definitions, principles and rules
AS	1940	The storage and handling of flammable and combustible liquids
AS	2067	Switchgear Assemblies and Ancillary Equipment for Alternating Voltages above 1kV
AS/NZS	2312	
AS/NZS	2373	Electric cables – Twisted pair for control and protection circuits
AS/NZS	2650	Common specifications for high-voltage switchgear and controlgear standards
AS/NZS	3000	Wiring Rules
AS/NZS	3008.1.1	Electrical installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1 (1.2) kV.
AS/NZS	3010	Electrical Installations – Generating Sets
AS	3011.2	Electrical installations – Secondary batteries installed in buildings, Part 2: Sealed cells
AS/NZS	3080	Telecommunications installations - Generic cabling for commercial premises

AS/NZS	3155	Approval and test specification - Electric cables - Neutral screened - For working voltages up to and including 0.6/1 kV
AS/NZS	3191	Electric flexible cords
AS/NZS	3439.1	Low voltage switchgear and control gear assemblies
AS/NZS	3439.2	Low-voltage switchgear and controlgear assemblies - Particular requirements for busbar trunking systems (busways)
AS	3607	Conductors-Bare overhead, aluminium and aluminium alloy – steel reinforced
AS/NZS	3835	Earth potential rise - Protection of telecommunications network users, personnel and plant
AS/NZS	3947	Low voltage switchgear and control gear, (all relevant parts)
AS	4024.1	Safety of machinery, (all relevant parts)
AS/NZS	4026	Electric cables - For underground residential distribution systems
AS/NZS	60265.1	High-voltage switches - Switches for rated voltages above 1 kV and less than 52 kV
AS	60265.2	High-voltage switches - High-voltage switches for rated voltages of 52 kV and above
AS	60529	Degrees of protection provided by enclosures (IP Code)
AS	60870	Telecontrol equipment and systems (All parts)
AS/NZS	60898	Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Circuit-breakers for a.c. operation
AS	HB101	Coordination of power and telecommunications - Low Frequency Induction (LFI): Code of practice for the mitigation of hazardous voltages induced into telecommunications lines.

International Electrotechnical Commission (IEC)

IEC	11801	Information technology – Generic cabling for customer premises
IEC	14763	Information technology – Implementation and operation of customer premises cabling
IEC	24702	Information technology – Generic cabling – Industrial premises
IEC	60034	Rotating Electrical Machines – all relevant parts
IEC	60038	IEC Standard Voltages
IEC	60041	Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines
IEC	60044	Instrument Transformers
IEC	60051	Direct acting indicating analogue electrical measuring instruments and their accessories
IEC	60060	High Voltage Test Techniques
IEC	60076	Power Transformers
IEC	60085	Thermal Evaluation And Classification of Electrical Insulation.
IEC	60086	Primary Batteries
IEC	60099	Surge Arrestors
IEC	60137	Bushings For Alternating Voltages Above 1,000 V
IEC	60228	Conductors of Insulated Cables
IEC	60255	Electrical relays
IEC	60269	Low-voltage fuses
IEC	60304	Standard colours for insulation for low frequency cables and wires
IEC	60354	Loading Guide For Oil Immersed Transformers
IEC	60364	Electrical installations of buildings
IEC	60372	Locking devices for ball and socket couplings of string insulator
IEC	60383	Insulators for overhead lines with a nominal voltage above 1000 V
IEC	60437	Radio interference test on high-voltage insulators (RFI)
IEC	60551	Determination Of Transformer And Reactor Sound Levels
IEC	60664	Insulation coordination for equipment within low-voltage systems (All Parts)
IEC	60694	Common Specifications for high-voltage switchgear and controlgear standards
IEC	60715	Dimensions of low voltage switchgear and control gear
IEC	60895 Ed. 2.0 b:2002	Live working - Conductive clothing for use at nominal voltage up to 800 kV a.c. and +/- 600 kV d.c.
IEC	60896	Stationary Lead-Acid Batteries
IEC	60898	Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations
IEC	60909	Short-circuit current calculation in three-phase AC systems
IEC	60934	Circuit breakers for equipment

IEC	61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
IEC	61089	Round wire concentric lay overhead electrical stranded conductors
IEC	61232	20SA/A Aluminium clad wires for electrical purposes
IEC	61477 Ed. 1.2 b:2005	"Live working - Minimum requirements for the utilization of tools, devices and equipment"
IEC	61634	High-voltage switchgear and control gear - Use and handling of sulphur hexafluoride (SF6) in high voltage switchgear and control gear
IEC	61660	Short-circuit currents in DC auxiliary installations in power plants and substations
IEC	62063	High-voltage switchgear and control gear - The use of electronic and associated technologies in auxiliary equipment of switchgear and control gear
IEC	62271	High Voltage Switchgear and Control gear (All parts)
IEC	62285	Application guide for non-linear coefficient measuring methods
IEC	62305	Protection against Lightning

Institute of Electrical and Electronic Engineers (IEEE)

IEEE	C37.110	Guide for the Application of Current Transformers Used for Protective Relaying Purposes
IEEE	C57.13	Standard Requirements for Instrument Transformers
ANSI/IEEE	C62.1	IEEE Standard for Surge Arresters for Alternating-Current Power Circuits
ANSI/IEEE	Std 100	Standard Dictionary of Electrical and Electronic Terms
ANSI/IEEE	Std 100	Standard Dictionary of Electrical and Electronic Terms
ANSI/IEEE	Std 1050	Guide for Instrumentation and Control Equipment Grounding in Generating Stations
ANSI/IEEE	Std 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
ANSI/IEEE	Std 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
ANSI/IEEE	Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
ANSI/IEEE	Std 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
ANSI/IEEE	Std 367	Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault
ANSI/IEEE	Std 399	Recommended Practice for Industrial and Commercial Power Systems Analysis
ANSI/IEEE	Std 446	Recommended Practice for Emergency and Standby Power Systems
ANSI/IEEE	Std 450	Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
ANSI/IEEE	Std 665	Guide for Generating Station Grounding
ANSI/IEEE	Std 80	Guide for Safety in AC Substation Grounding
ANSI/IEEE	Std 81	Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System
ANSI/IEEE	Std C37.101	Guide for Generator Ground Protection

British Standards (BS)

BS	148	Unused Mineral Insulating Oils For Transformers And Switchgear
BS	EN ISO	1461 Hot dip galvanized coatings on fabricated iron and steel articles
BS	6231	Specification for PVC-insulated cables for switchgear and control gear wiring
BS	6651	Protection of structures against lightning.
BS	7354	Code of Practice for Design of high-voltage open-terminals stations, Section 7: Earthing.
BS	7430	Code of Practice for Earthing.

1.6 DETAILED DESIGN OF PLANT AND EQUIPMENT

The detailed design of plant and equipment including plant layout, protection, control, supervisory interface equipment, earthing, civil works designs etc. shall be carried out by the contractor in accordance with acceptable standards and codes of practice.

Notwithstanding the specifications, technical schedules or plant requirements specified by the tender document, the successful contractor shall be fully responsible for ensuring that the design, manufacture or construction of all

items of plant and equipment under this contract to be fully functional, compatible with each other technically and otherwise, complying with IEC and/or other relevant standards, and other safety regulations applicable, and to have the installation complete in all respects including finishing, painting, labelling etc.
The successful contractor shall from the commencement of his contract submit to the Employer's Representative, his conceptual design, detailed designs, technical submissions, design, manufacture and construction drawings, etc. for approval at each stage until the completion of the project.

The Employer's Representative will ensure that any revisions required, or in the absence of any such revisions the approval for such drawings technical submissions, designs or proposals shall be notified to the contractor within a reasonable time period.

1.7 PLANT AND EQUIPMENT TO BE SUPPLIED

All items of plant and equipment supplied under this contract shall be of proven design, manufacture and construction, and shall have been in commercial operation for at least five (5) years. Tenderer should furnish a list of past orders, indicating the type of equipment, location, country etc. in support of this. Type test certificates, or other certificates from independent international organizations may also be furnished. Where specific manufacturers are specified, bidders shall only use these – alternatives will not be accepted and result in automatic disqualification of bid.

The Contractor shall guarantee the availability of spare parts for all items of plant and equipment for a period of at least 15 years.

1.8 DESIGN REVIEW, INSPECTION AND TESTING

Type test certificates shall be furnished for all items of plant and equipment with the tender. The Contractor at his cost shall carry out all routine tests as per relevant IEC or other standards. Type tests specified for the 33/11kV Transformer namely, temperature rise test, shall also be carried out by the Contractor at his cost.

The Contractor shall make allowance for two (2) Employer's personnel to undertake the design review at the Manufacturer's premises prior to manufacture of the major equipment.

The Employer will require their representative to inspect the plant/equipment offered by the successful tenderer, before shipment, under this contract and to witness some of the type tests and routine tests. The associated cost must be included in the tender price.

All commissioning tests shall be carried out in accordance with the relevant IEC or other standards. All tools and equipment and instruments for carrying out such tests shall be made available by the Contractor.

The preparation of a list of commissioning tests for each item of plant and equipment will be agreed upon with the Employer's Representative at a later stage of the project. All costs of carrying out commissioning tests shall be borne by the Contractor.

The Contractor shall provide all facilities for such tests or inspections to be carried out by the EFL's representatives, and the Contractor shall meet all such costs.

1.9 TRAINING OF EFL PERSONNEL

The Authority requires 2 EFL personnel to be attached to be trained on installation, operation, maintenance of primary & secondary equipment to be supplied under this contract.

1.10 TOOLS AND EQUIPMENT

The tenderer shall forward a list of tools and equipment required for operation and maintenance of the installation and include the cost of supplying such tools and equipment in the price Schedules.

1.11 SPARES

The tenderer shall forward a list of manufacturer's mandatory spare parts required for operation and maintenance of the plant and equipment supplied under this contract for a period of 5 years. The cost of supply of these spare

parts shall form part of the contract. The tenderer shall also forward a list of optional spare parts which shall not form part of the contract but should be shown in a separate price schedule.
The successful contractor shall ensure the availability of spare parts for operation and maintenance of all the items of equipment for a period of at least 15 years.

1.12 TECHNICAL LITERATURE – OPERATIONS AND MAINTENANCE MANUALS

Tenderers shall furnish all technical literature, including catalogues, test certificates etc. in support of plant and equipment offered by him with the tender. The successful tenderer is to interface existing and new equipment drawings and a set of original drawings.

Successful contractor shall forward 6 copies of all operations and maintenance manuals, spare parts catalogues, detailed schematic and wiring diagrams and all other documents required for satisfactory operation and maintenance of plant. The originals of the drawings in AutoCAD format are required to be handed over. As built drawings are required to be furnished in 6 copies before the works are taken over as per Clause 5.6 & 5.7 of FIDIC Document (Conditions of Contract for Design – Build And Turnkey) edition 1.

During the design and manufacture stage the contractor shall submit all design calculations, design drawings, technical submissions at each stage of design or manufacture for the approval of the Employer's Representative.

The manuals shall include the following sections:

Plant Specification and Description

The Plant Specification and Description Section shall include the specification and description of each plant item and system.

Installation and Commissioning

The Installation and Commissioning Section shall include step-by-step procedures for the unloading, unpacking, transport, handling, assembly, erection, adjustment, alignment, preparation for service and testing of the plant.

Operation

The Operation Section shall describe in detail the procedures for the preparation into service, setting, adjusting, checking before and during operation, routine testing and operating of the plant to be supplied. It shall provide complete information on operating limitations, allowable rates of temperature change, allowable temperature differentials and any other information required by operating staff to ensure the safe and efficient operation of the plant.

Maintenance

The Maintenance Section shall contain sufficient detail to enable maintenance personnel to maintain the plant in good working condition and overhaul the plant from time to time. It shall describe and include pictorial representation of step-by-step procedures for dismantling, reassembly, alignment, replacement and adjustment of all components of the plant. This Section shall also include standards of workmanship, tolerances, air gaps, electrical resistance values, limits of wear, periodic adjustments, material specifications including special procedures (e.g. heat treatment), weights of large items, details and uses of special tools, test equipment, jigs, gauges and tightening torque values for bolts.

The Tenderer shall set down recommendations for preventive or condition based maintenance, including frequency of inspection and guidance in locating and rectifying faults and condition monitoring or diagnostic testing which may be performed on a regular basis.

Similarly lubrication routines shall be specified including locations, recommended frequency and recommended type of lubricants.

1.13 TYPE TEST CERTIFICATES

Copies of Type Test certificates for all plant and equipment shall be furnished as evidence in support of compliance with the specification.

The Contractor shall furnish copies of certificates of all routine tests, inspection tests and any other type tests, which would have to be performed at a later stage.

1.14 SITE CONDITIONS

The tenderer is required to ascertain for himself the Site Conditions, including limitations of space, geographical, climatic or other considerations. The tenderer shall satisfy himself of the suitability of the Sites for the erection of the plant and equipment to be supplied.

1.15 SITE OFFICE

The contractor shall setup a site office as the work commences.

1.16 PACKING

Equipment shall be carefully packed for transport and shipment in such a manner that it is protected from all dust and climatic conditions during loading, transport, unloading and subsequent storage in the open.

Equipment shall be suitably packed and protected against vibration, movement and shock which may occur during loading and transport. Particular care in packing shall be taken when the apparatus is transported by road.

Instruments and fragile items shall be packed separately. All items, which include delicate equipment, shall be sealed in polythene sheeting and silica gel desiccant or vapour corrosion preventive shall be inserted within the polythene packing. Straw shall not be used as packing material. The packaging should be neatly labelled to allow customs clearance if EFL has to clear the equipment. The signage on the packaging will be discussed at the time of award.

1.17 PROGRAMME AND PROGRESS OF WORK

Programme

Within 14 days of acceptance of the Tender the Contractor shall provide the Employer's Representative with (2) copies of the Programme of work covering design, manufacture, delivery and erection.

The programme shall conform to the general requirements of Schedule IX unless otherwise approved by the Employer's Representative.

The programme shall separately detail each item of equipment that is to be transported and delivered separately.

Progress Reports

The programme of work shall be reviewed monthly and a comprehensive progress report shall be submitted monthly to reach the Employer's Representative by the 25th day of each calendar month or as mutually agreed If in the judgement of the Employer's Representative the situation demands, the Contractor shall report at more frequent intervals.

These reports shall include for each item of plant manufacture, delivery and erection;

(i) The status at the last reporting date
(ii) The activities completed during the period
(iii) The current status of activities and progress
(iv) The start and completion date

The Employer's Representative shall be afforded such reasonable means of access to the Contractor or his Sub Contractors as may be required to confirm progress and delivery information.

CHAPTER 2 - SWITCHGEAR

2.1 SWITCHGEAR

2.1.1 General

This part of the Specification covers the design, ratings, testing, shipping, and installation and commissioning of factory assembled, type tested switchgear for voltages 36 kV & 12 kV. The preferred make/models are as follows:

- 11kV – Hawker Siddley Switchgear, Eclipse model, made in Australia or Siemens NX Plus made in Germany
  (Mandatory - Motorized Disconnector and Earth Switch)
- 33kV – ABB ZX2.0 series or Siemens 8DA10, made in Germany (Mandatory - Motorized Disconnector and Earth Switch)

Switchgears manufactured by other reputable manufacturers that fully comply with all requirements of the technical specification provided in the tender document shall also be accepted. Bidders must substantiate reliability of switchgear offered by other reputable manufacturers by providing evidence of long term field operation of such switchgears. Spare parts, if required by the Bidder for operation & maintenance, shall be quoted, separately as required by the Schedules of Rates & Prices.

The complete documentation, drawings, manuals, etc. shall be included in the Supply and will be subject to the approval of the Employer's Representative according to the requirements of these Specifications. Standard designs and models from the Bidder's manufacturing program are preferred, provided they meet the requirements of these Specifications, serve the intended purpose, and can be shown to have at least five years of successful service in the field.

All the equipment described in these Specifications is intended for continuous duty at the specified ratings under the specified ambient conditions. Unless otherwise noted, the switchgear shall be for front access only during operation and maintenance.

Data and documentation submitted with the Tender Proposal shall enable the Employer's Representative to evaluate the quotation against the requirements of the Specifications. Full descriptive information and filled-in data sheets are required as a minimum.

2.1.2 Switchgear Particulars

Feeder cable terminations, cable plugs, stress cones etc. are part of the Scope of Supply for outgoing feeder cables. The feeder bays or panels shall be delivered completely, including all necessary material for fixing them on suitable plinths or rails.

The switchgear equipment shall be dust-proof (explosion vents of the rear end if possible and top part to be sealed or covered with canopy) and vermin-proof and provision shall be made against condensation, particularly if the load is switched off. The infeed transformer bay or panel shall be placed in such a way that the current stress of the busbars is minimized. In the case of the heavily loaded transformer feeders, requiring an ancillary bay or panel next to the transformer infeed may be provided to accommodate multiple cable sealing ends and auxiliary equipment. In this respect, the cable ducts for the cables running from the infeed transformers to the MV switchgear should be arranged to end exactly under the relevant transformer bay or panel.

Protection relays and their associated instrument transformers are part of Scope of Supply. The relays shall be installed in the low voltage compartments associated with each individual switchgear bay or panel and its circuit breaker. The relays should be installed at a height so that a person can easily access & read the relay.

The functions of the protection relays are indicated in the typical single line diagrams in Drawings and their required performance shall be in accordance with Chapter 5 of Technical Specification. If the Bidder is of the opinion that

the indicated protection scheme is not optimal, he shall indicate this fact in his proposal along with suggested improvements.

2.1.3 Performance, Standards and Codes

The switchgear shall operate satisfactorily within its rated values in the environment specified in Chapter 1 of this specification.
The switchgear is planned to be installed indoors (inside substation building) with a service temperature of +40°C. However, the maximum ambient shade temperature at Site shall be the basic design data for the switchgear.

Routine maintenance to any of its external components, including the protective relays and instrument transformers, shall not be required in less than five year intervals; internal components shall be maintenance-free for at least ten years, including the refilling of SF_6 gas (if any).

Performance, testing and rating of the switchgear shall conform to the latest edition of all relevant IEC Publications. Bidder's proposing other than the above standards must specifically indicate the standards to which his switchgear conforms, and indicate all deviations (if any) from the above codes that affect performance and rating.

Compliance of the switchgear manufacturer and the Contractor with the provisions of this Specification does not relieve the Contractor of the responsibility of furnishing switchgear and accessories of proper design, electrically and mechanically suited to meet the operating guarantees at the specified service conditions.

2.1.4 Design and Construction

2.1.4.1 Electrical Data and General Requirements

a) Electrical key data as required by this Specification are stated herein, under Scope of Supply and in the enclosed single line diagram.
b) The switchboard, when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations under full rated fault conditions shall not lead to diminished performance or significantly shortened useful life of the switchgear. Arc faults caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear.
c) Temperature rise of current carrying parts shall be limited to the values stipulated in IEC 60694, i.e. +105°C for silver-plated contacts, +115°C for silver-plated connections, and +90°C for all other exposed parts, under rated current and the environmental conditions.
d) Lightning Impulse withstand capability and power frequency withstand capability for the entire switchboard shall be in accordance with IEC 60694, Table I and values required in schedule D.
e) Bracing of all mechanical components against the effects of short circuit current shall be a minimum of 2.5 times the rated symmetrical short circuit current.
f) Thermal rating for all current carrying parts shall be a minimum of one second for the rated symmetrical short circuit current. If the maximum short circuit time must be extended, the $I^2 X\ t$ value shall remain constant.
g) The auxiliary voltages as per Chapter 1 are to be considered for the design, in particular for the Motor control voltage, the Alarm voltage, the Close and trip voltage and the Space heater voltage. Note 2 trips coils are required for each circuit breaker.
h) The switchgear shall be of the free-standing, self-supporting, dead front design with all high voltage equipment installed inside metallic and earthed enclosures, suitably divided into individual compartments, at least for the
    - busbar system(s)
    - circuit breaker
    - cable connections
    - low voltage compartment

    All the above sections should be properly labelled in order to differentiate each sections.
i) Partitions between feeder bays or panels are required to avoid fault spreading from one feeder bay or panel to the other one and to the outside.
j) The row(s) of bays or panels shall be earthed through a suitable copper bar, which is to run along the full length of the switchgear, and to be connected to the station earthing, at least at two points.

k) The erection of the switchgear shall not require any cutting, welding or drilling of material on site. Each line-up of switchgear shall be prepared for future extension on either end without any drilling, cutting or welding on the existing equipment.

l) The design shall provide for maximum levels of reliability, ease of operation and maintenance, and maximum flexibility. The possibility of field repairs and exchange of enclosure parts shall be taken into account. The panels shall be constructed identically to ensure that equivalent switchgear parts can be interchanged. Design of the switchgear must allow for the removal of individual breaker bays, or parts thereof, without disturbing the remaining bays. It shall be possible to exchange an entire feeder, with or without its busbar section, without dismantling neighbouring bays.

m) Busbars and their enclosures shall take thermal expansion of the entire switchboard into account. Suitable mounting facilities, bellows and compensators shall be provided where necessary.

2.1.4.2 Safety Requirements

a) The switchgear shall offer a maximum degree of safety for the operators and by-standers under all normal operating and fault conditions. In particular, it must be impossible to unwillingly, i.e. without the use of tools, touch live parts of the switchgear, or perform operations that lead to arcing faults. For mechanical protection of the switchgear elements, panels with a minimum of Protection Class IP 41 is required, i.e. enclosed and inaccessible for granular foreign bodies during normal operation and protection against vertically falling water droplets. All high voltage carrying parts shall be totally protected against contact with live parts.

b) Should internal arcing occur, the release of pressurised air or gas by suitable pressure relieve devices into the atmosphere must occur in such a way that personnel standing at the operating position of the switchgear will not be injured. Furthermore, no part of the enclosure or any loose parts may fly off the switchgear in such an event, and no holes may burn through enclosures. All earthing connections must remain operational during and after an arc fault.

c) All interlocks which prevent potentially dangerous fail-operations must be constructed such, that they cannot be by-passed easily, i.e. the operator must use tools or force to bypass them.

d) Energy storing mechanism of breakers must be totally enclosed with the switchgear in the operating condition.

e) All low voltage terminals remaining "live" after the main feeder has been disconnected shall be wired to particularly marked terminal blocks and shall carry suitable warning tags (in red background and white lettering).

f) For each outgoing cable feeder an inductive or capacitive voltage detector with cable live indication shall be provided, indicating any reverse voltage, i.e. at least by means of voltage transformers plus lamps (including lamp test facilities).

2.1.5 Isolator and Earthing Switches

a) Means to safely isolate and ground any feeder in the switchgear shall be provided. Isolation shall be provided through operation of the dicsonnector after operation of the circuit breaker. Earth switch shall be suitably interlocked with the breaker. In case of double busbar systems, the busbar selection isolators shall be provided with motor drive facilities, however, manual operation shall also be available for both single and double busbar system.

b) Disconnector shall be designed to withstand the rated and fault current of the largest breaker interrupter element that can be fitted into the switchgear.

c) View-ports or mechanical indicators connected directly and permanently to the operating shaft are required to positively display the actual switch position. Indirect position indicators are not acceptable for Disconnectors and Earth Switch.

d) Mechanical locking for the circuit earth switches using a key switch for earthing each busbar

e) Busbar mechanical locking all CBs using the key switch

f) Earth switch shall be electrically interlocked or mechanically if possible where voltage transformers are present on the panels.

2.1.6 Circuit Breakers

a) Vacuum circuit breakers or SF_6 with totally enclosed and maintenance-free contact system are acceptable.

b) Circuit breakers shall conform to Publication IEC 60056 in terms of rating, testing and performance, but they may conform to the standards of the country of manufacture for construction requirements, provided these standards do not conflict with the corresponding IEC 60056 rules and are acceptable to the Employer's Representative**.**

c) Each breaker shall be capable of having the following positions:
   (i) Normal Service (connected)
   (ii) Disconnected (Isolated)
   (iv) Circuit Earth
   (v) Bus Earthed

d) Breaker operating mechanisms shall be of the electric 110V DC motor operated, stored energy type, with provisions for manual operation in case of control power failure. All breakers must be electrically trip-free and have anti pumping circuits. After loss of control power, the springs of the operating mechanism shall be capable of performing a sequence of OFF-ON-OFF operations with rated data. The circuit breaker shall have manual spring charge provision unless an actuator type circuit breaker.

e) A manually operable local trip push-button (mechanically working onto the trip shaft) shall be available, and all breakers shall be suitable for remote control. Manual, mechanical ON-switching shall be prevented if interlocking condition exists. Mechanical indicators shall be provided to shown the ON/OFF position of the breaker contacts. Visible Operation counters shall be provided without opening the front compartments.

f) Maintenance intervals of circuit breakers shall not be less than 25 full rated short circuit interruptions, 10,000 rated current interruptions, or 10 years, whichever comes first. Replacement of the breaker interrupter must be possible (at gas-insulated switchgear, the remaining part of the switchgear may be kept "live" and must not involve the use of special tools or delicate alignments).

g) Spare auxiliary contacts, 4 N/O, 4 N/C, 1 Impulse, rated at least as specified in schedule D shall be provided in addition to those required for breaker operation. These contacts shall be wired to the terminal blocks for use at the LDC terminal cubicles. Additional contacts as required, e.g. for interlocking, shall be provided and incorporated in the control system.

h) Rated nominal current of circuit breakers shall be selected to the rated values listed in Schedule B and schedule D in order to reach the required rating, once the breaker is installed inside its enclosure. The feeder nameplate shall indicate the actual site rating of the feeder at maximum ambient temperature in addition to the nominal rating of the breaker. CT nameplate data should be made available in front of the cubicle.

2.1.7 Interlocking System

Electrical and mechanical interlocking, which shall at least fulfil the conditions as listed below, shall be provided. The final interlocking scheme shall be proposed by the Contractor and shall be subject to the approval of the Employer's Representative.

a) The interlock system must positively prevent an operator from reaching or creating unintentionally a dangerous or potentially dangerous condition. Systems that can be by-passed without the use of tools and/or force are not acceptable.

b) All necessary electrical interlocks shall be provided as specified. Reference is made to the related sections of the High-Voltage switchgear of this Specification.

c) All breakers for remote control shall have a key-operated switch, allowing the selection of LOCAL - REMOTE operation modes mounted on the CB control cubical

d) The interlocking of the circuit breakers of the SF_6 gas insulated switchgear type shall prevent the following in addition:

-
- operation of the grounding switch whilst the breaker is closed.
- operation of disconnector whilst breaker is closed
- operating the circuit breaker while earth switch is closed and voltage is present on the circuit

Additionally the following has to be included for safe operation:

- Mechanical interlocks preventing operation of earth switch if the corresponding circuit breaker and disconnector is in closed position.
- Mechanical interlocks preventing operation of Disconnector while breaker or earth switch is closed or both are closed.
- Electrical interlock to allow closing of bus earth switch only if all circuit breakers and disconnector in respective bus section are open and earth switch closed..
- Electrical interlock preventing the closing of transformer circuit breakers if circuit is energised from other end.
- Interlock to prevent closing of any breaker if bus earth switch is closed.

The following position displays shall be provided for each circuit breaker;

CB in Closed Position – 'ON' to be marked in white lettering on a red background
CB in Open Position – 'OFF' to be marked in white lettering on a green background
Disconnector in Closed Position – 'ON' to be marked in white lettering on a red background
Disconnector in Open Position – 'OFF' to be marked in white lettering on a green background
Earth Switch In Open Position – 'E/S OPEN' in black lettering in yellow background
Earth Switch In Closed Position – 'E/S CLOSED' in white lettering in green background

2.1.8 Enclosures and Busbars

a) Metal enclosures shall be made from steel or aluminium, offering mechanical and thermal properties suitable for this application. Enclosures shall withstand the full rated fault current during arcing faults without puncturing for at least 1 second or means have to be provided to trip any such fault current prior to puncturing (e.g. busbar protection).

b) In no case shall arcing cause holes in the outer freely accessible sides of the enclosed feeder compartment. Gases and vapours escaping under pressure shall be deflected by rear and side covers in a direction such as to minimize the danger to an operator performing his normal operation duty.

c) Assembled enclosures must withstand at least twice their rated internal operating pressure. This fact must be proven on each individual section of the switchgear.

d) Each breaker bay shall consist of at least the following gas-tight high voltage compartments:
   - Busbars
   - Breakers
   - Cable termination compartment
   - LV compartment

   Each of the above should be clearly marked to differentiate the different compartments.

e) Design of the switchgear must allow for the removal of individual breaker bays, or parts thereof, without disturbing the remaining bays.

f) All operating elements and indicators of the switchgear must be located on, or be visible from the front side of the equipment.

g) The fully enclosed busbars shall be made from electrolytic drawn copper. They shall be rated for the continuous current of the switchgear under the site conditions and shall be braced for the maximum peak short circuit current or the minimum of 2.5 times the rated symmetrical short circuit current whichever is higher. Busbars and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and cast-resin shrouds for all joints and tap-offs shall be provided with insulated plastic screws for easy removals.

h) The busbars shall preferably be gas insulated and completely enclosed in an earthed metal chamber. If removable panels are fitted to give access to the busbar chamber, the removal of these panels shall not give access to any incoming or outgoing circuits, which may be electrically energised from their remote ends.

i) The busbars shall be so constructed that it shall be provision to extend the switchboard at either end by adding further panels.

j) Partitions shall be provided to divide the switchboard busbars into panel compartments to prevent the passage of fault producing ionised gasses. It must also be fully arc protected to the IEC standard and also have an arc protection system.

k) Bus bar chamber and the switchgear panels shall be vermin and rodent proof adequately to prevent against ingress of moisture.

2.1.9 Instrument Transformers and Protective Relays

a) All instrument transformers must be suitable for continuous operation for 20 % overload when installed in the switchgear under the ambient site conditions and for service under all rated and fault conditions.

b) Accuracy classes and burdens shall be in accordance with IEC 60044, IEC 60186 and schedule B of the tender document for current- and voltage-transformers.

c) Cores for measuring instruments shall have accuracy classes of not less than 0.2 % and saturation factors below 5, cores for relaying shall have accuracies better than 5 % and saturation factors of more than 10.

d) Current transformer ratios (secondary side) shall be as indicated in the Schedule B of this Tender.

e) Current transformers must have shorting type secondary terminals. The current transformer rating plate and the terminals must be accessible after power cables have been installed.

f) Current transformers of the epoxy type, mounted inside the high voltage enclosure on ground potential are preferred; other designs require the approval of Employer's Representative.

g) Potential transformers must be able to withstand the full rated power frequency withstand and lightning impulse capability.

h) Potential transformers for busbar metering shall be of the inductive type, mounted in a separate compartment of the bus coupler/sectionalizer switchgear bay panel or at the end of the busbars. The ratio shall be as per single line diagram, the rated burden suitable for the measuring and metering equipment connected, however, with a minimum of 100 VA.

i) The potential transformer shall be of the metal-enclosed, gas-insulated type or approved equal.

j) Potential transformers on the line side of incoming feeders or the load side of outgoing feeders shall be of the inductive type, suitable for the measuring and metering equipment connected to it. They may be mounted at or within the cable connection compartment.

k) CVT should be used for voltage indication purposes.

l) All voltage transformers to be provided with an identification label giving Manufacturer, Address, type, ratio, class, output, burden serial number, EFL contract number, frequency, rated IL, rated voltage factor, and the IEC/AS/BS standard number.

m) All current transformers to be provided with an identification label giving Manufacturer, Address, type, ratio, class, Winding Resistance, burden, serial number, EFL contract number, frequency, rated IL, rated voltage factor, and the IEC/AS/BS standard number. Magnetisation curves for all current transformers to be supplied with the equipment.

2.1.10 Auxiliary Switches

a) Auxiliary switches in addition to those required for the control of the circuit breaker shall be supplied to control circuits with spare contacts. Four of these spare circuits shall close when the circuit breaker closes and the other four shall close when the circuit breaker opens.

b) The drum type of switch with wiping contacts is preferred but the type offered shall be capable of adjustment relative to the operating position of the circuit breaker. Contacts shall be rated to withstand 120V 10A D.C. continuously.

2.1.11 Operation Counters

a) Each circuit breaker shall be fitted with a visible operation counter actuated from the mechanism.

2.1.12 Isolating Contact for Auxiliary Circuits

a) The connections in the auxiliary circuits between the fixed and moving portions of the equipment shall be by means of either self-aligning plugs and sockets or a flexible interconnecting harness.

2.1.13 Interchangeability

a) Circuit breakers of a particular current rating shall be completely interchangeable with others of the same and different rating.

2.2 CONTROL AND INDICATION

2.2.1 Circuit Breaker Control

a) Circuit Breaker shall be electrically controlled from the following control points.
   i. Local Control - Located adjacent to the item of plant to facilitate maintenance, test operation and emergency operation on feeder panels only.
   ii. Remote/Supervisory Control - Located at National Control Centre where principal items of the systems are monitored and remotely controlled by SCADA system.

b) Note: All external interlocks and remote indications are deflated in the "test" operation.

2.2.2 Control Switches and Pushbuttons

a) Control switches shall be of discrepancy type and arranged to operate clockwise when closing the circuit breakers and anti-clockwise when opening them. They shall be designed to prevent accidental operation. Two independent movements shall affect operation of switches of the discrepancy type. Control switches for circuit breakers shall be of the non-locking type with spring return to the "neutral" position. The contacts of switches shall be strong and have a positive wiping action when operated. Control switches shall be provided with labels to give clear indication as to the direction of each operation, for example, "Open" "Close" etc.
b) Pushbuttons shall be oil tight, and with the exception of emergency stop-buttons shall be the shrouded type. Pushbuttons shall provide weatherproof seal where they pass through panels and enclosures. Contacts shall be of the double air-break, self-cleaning and aligning type with silver surfaces and a minimum rating of 10 amps at 110V D.C. It shall be possible to modify the contact arrangements by changing contact blocks.
c) 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.

2.2.3 Switchgear Indication and Alarm

a) Healthy trip lamp (white) and push button with normally open contacts shall be provided connected across trip supply to enable the tripping circuit to be tested while the tripping supply is maintained and the circuit breaker is closed. A resistance shall be included in the circuit to prevent inadvertent tripping of the breaker should the healthy trip lamp become short circuited. Automatic tripping of a circuit breaker shall energise a remote alarm circuit and illuminate the auto trip lamp on the tripped panel. The auto trip lamp shall remain energised until the protection relay has been manually reset.
b) Alarm indications, when initiated by a maintained contact, shall continue until automatically cancelled by the opening of the initiating contact. When initiated by a fleeting contact the indication shall continue until cancelled by hand.
c) Clear and reliable indication shall be provided of the position of the contacts/switches of the primary circuit in case of non-visible contacts. It shall be possible to easily check the state of the position indicating device when operating locally.
d) Permission to close or synch check permission lamp (blue) shall be provided on all switchgear panels.

2.2.4 Indicating Lamps (LEDs) and Fittings

a) Indicating lamps fitted into the facial of switch and instrument cubicles or panels shall be adequately ventilated.
b) All Indicating lamps should be of LIGHT EMITTING DIODE with low wattage

c) Lamps shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors. The bezel of metal or other approved materials holding the lamp glass shall be easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.

d) The lamps shall be clear and must fit into an accepted standard form of lamp holder. The rated lamp voltages should be 25 percent in excess of the auxiliary supply voltage.

e) The lamp glasses shall be in standard colours, red, green, white and amber. The colour shall be in the glass and the different coloured glasses shall be interchangeable. Transparent synthetic materials may be used instead of glass, provided such materials have fast colours and are completely suitable for use in tropical climate.

2.3 Earthing

a) The switchboard shall be fitted with a copper earth bar of not less than 150mm² section, running the whole length of the switchboard, to which shall be effectively connected all metal parts not intended to be alive.

b) The Contractor shall provide 60mm x 4mm copper bar connection between the main earth bar of the switchboard and an earthing terminal at the bottom of each cable box.

c) Facilities shall be provided for earthing either the circuit or busbars through the earthing switch for withdrawable type circuit breaker without the use of any loose earthing device, and with the use of a three position switch with integral earthing for fixed type circuit breaker.

d) The secondary circuit of each current transformer shall be earthed at one point only. The yellow phase of the three phase voltage transformer secondary winding shall be earthed. Means shall be provided for these earth connections to be disconnected at a readily accessible position(s).

2.4 Low Voltage Equipment and Control Circuits

a) The feeder bay or panels LV compartment shall be completely enclosed by steel sheets of 2 mm minimum thickness and shall be separated from the other sections. It shall provide a protection degree IP 54, to accommodate protection relays and auxiliary devices. It shall have a separate access door with key-locks provided.

b) In each LV compartment a main terminal board shall be provided to which all incoming auxiliary cables are connected.

c) Mimic diagram, all instruments, protection relays, 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.

d) Voltage indication LEDs should be provided to indicate the presence of voltage.

e) Indicating instruments shall be included for the functions as specified in the Chapter 3.

f) All control circuits shall be according to the specified standards and designed for the application as required and shall be subjected to the approval of the Employer's Representative.

g) All necessary auxiliary contacts shall be provided to enable remote control, remote alarm, and indication of the position/state of any circuit breaker, isolator and earthing device. In addition, two potential-free NO and NC contacts shall be provided for the above purposes each and the contacts shall be connected to the terminal board and to the control room where specified.

h) 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.

i) Each control circuit shall be protected by a two-pole miniature circuit breaker with auxiliary NC contact. The auxiliary contacts of all MCB's 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.

j) Control wiring shall be executed with finely stranded copper wires of at least 2.5mm^2 cross-section, insulated with flame-retardant PVC or TEFLON. Wherever 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.

Identification of control wires and terminals must conform to the symbols used in the circuit diagrams. All control wiring shall be installed such that the likelihood of damage during normal operation, maintenance and fault conditions is minimized.

k) Terminal strips of the line-up type are preferred for all control wiring requiring external connections. Terminals must be corrosion-proof, and use indirect pressure, captive screw type mechanisms. Internal wiring terminations of the push-on type, e.g. AMP plugs, are acceptable, and wire-wrap connections are preferred for matrix-connections on electronic sub-assemblies.

l) Terminal strips for different voltage levels must be physically separated from each other and suitably identified. Terminals carrying dangerous voltages even when the main breakers are off, must be marked with a particular colour and carry suitable warning labels (red background and white letters).Further terminals shall be provided for the current transformers, which shall permit instruments to be connected without interrupting the secondary current transformer circuits.

m) 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.

n) 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.

o) 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 NC contact wired to a group alarm terminal.

2.5 Cable Terminations

a) All high voltage cables will be connected from below through cut-outs in the floor. To maintain the totally insulated design concept of the switchgear, only fully insulated terminations shall be used. The cut-out in the floor shall be filled out with fire proof material after the cable termination work.

b) A cable termination with direct solid insulation transition shall be used. Suitable plug type connection facilities shall be provided; the actual cable terminators shall be supplied fitting to the cables for the outgoing feeders.

c) Sufficient space must be provided in the switchgear to terminate and connect up to at least two XLPE or cables per phase. Suitable cable support and grounding facilities must be provided in this area.

d) Low voltage control and signal cables are fed into the switchgear from above or below. Exposed runs of control cable through the switchgear structure shall be protected by suitable covers.

e) Bidder's documentation shall clearly show all termination facilities and their dimensions.

2.6 Wiring & Schematic Tables and Diagrams

a) Wiring diagrams or tables shall be provided and shall show exactly how the equipment is wired and must show both wiring and terminal numbers. Wires carrying main supplies must be indicated and show whether the supply is for protection or control etc. All diagrams shall be drawn as viewed from the back of the panel.

b) Schematic diagrams shall be provided and shall include all the wiring in all the plant supplied. Layouts shall be schematic and not geographical. Terminal numbers must be clearly shown and the equipment to which they belong clearly identified and the location of the equipment able to be determined. Where a relay coil is shown all contacts must be indicated adjacent to it. All contacts illustrated on other parts of the diagrams must be cross referenced and a brief description of their purpose given. The use of dotted lines to associate a contact with its coil is acceptable.

2.7 Bushing and Insulators

a) Self-contained bushings within the scope of IEC 137 shall be separately rated and tested in accordance with that standard. The Tenderer shall also show by partial discharge dissipation factor

measurements (maximum of 1%) or by other means that the bushing, when mounted in a complete circuit breaker, have a satisfactory electrical stress distribution pattern.

b) The Tenderer shall supply drawings showing the construction and mounting of all terminals and bushings or equivalent insulation in sufficient detail to indicate the mechanical strength characteristics of the solid insulation characteristics of the solid insulation material used. Bushing construction shall be such as to allow free expansion of the central conductor.

2.8 Auxiliary Supplies

Single phase, 240V, 50Hz AC supply to be used for panel heating and indication via step down transformer of adequate rating The electricity supplies for auxiliaries will be:

i) 240V AC Single Phase for panel heaters.

ii) Auxiliary supplies for essential indication

iii) 110V DC control supply for controls, protection, alarms and circuit breaker closing 110V DC shall be obtained from 110V DC station battery bank. All DC supply to the panels should be wired to the terminal block.

The circuit breaker shall be capable of operating reliably at voltages down to 50% for circuit breaker tripping and 80% for other circuits.

2.9 Anti-Condensation Heaters

Any major items of the breaker panel which are liable to suffer from internal condensation due to atmospheric or load variations shall be fitted with heating devices controlled by thermostats suitable for electrical operation at 240 Volts A.C 50Hz single phase of sufficient capacity to raise the internal ambient temperature by 5ºC. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energised while the apparatus is in operation. Where fitted, a suitable terminal box and control switch shall be provided and mounted in an accessible position.

All bus bar chambers should have heaters with provision to switch On when required and possibility of being maintained when Circuit is livened.

2.10 Nameplates

Each breaker bay shall be identified with its feeder designation engraved on laminated plastic tags of at least 40 x 100mm size. Tag information will be supplied by the Employer's Representative at site. If a second language will be required, a second tag of identical size shall be mounted adjacent to, or underneath the first one, but left blank for customer inscriptions. The tags must be bolted or riveted onto a non-removable part of the cubicle. Stick-on or glued labels are not acceptable for this purpose.

Each cubicle shall have a rating plate with the information required by IEC 60298, i.e. at least the following:

- manufacturer's name
- type number
- serial number
- rated voltage
- rated frequency
- rated current
- rated interrupt power
- actual rating at site conditions.

Each device installed in the breaker bay, each terminal strip, and each indicating and operating element shall be identified with permanently attached plastic tags or labels of approved design. Inscriptions on these tags must coincide with those used on the drawings.

Each circuit breaker must have its own rating plate with information according to IEC 60056, i.e. at least the following:

- manufacturer's name
- type and serial number
- rated voltage
- rated insulation level
- rated frequency
- rated normal current
- rated short circuit breaking current
- weight
- rated duration of short circuit, if different from 1second
- rated supply voltage of closing and opening devices
- rated supply voltage and frequency of auxiliary circuits
- actual rating at site conditions.

2.11 Corrosion Protection

The switchgear shall be treated and protected to withstand at least five years of operation after final taking over, under the site conditions without sustaining significant corrosion or attacks from fungus or rodents, provided the surfaces remain mechanically undamaged.

Reference is made to Technical Specification – Grid Substation 'Protective Treatment for structural steel works' of this Specifications and requirements specified there shall be fulfilled provided they are not contradictory to those below.

As a minimum painting standard for all steel surfaces, the following is applicable:

- cleaning to the bare metal by mechanical and/or chemical means
- phosphatizing, or priming with at least one coat of zinc or lead-based primer
- finish painting shall preferably consist of electro-statically applied and oven-dried epoxy-powder to a thickness of at least 80 microns. Alternatively, at least two coats of epoxy-based compound lacquer may be spray-applied.

If approved by the Employer's Representative, manufacturers standard paint colour may be used, but a light grey finish with high scratch resistance is preferred.

All hardware used in the assembly of the switchgear must be either of corrosion proof material, or be hot dip galvanized.

2.12 Inspection and Testing

The switchgear is subject to inspection during manufacture. The Employer's Representative or its nominated personnel shall be allowed access to all those areas in the manufacturer's factory where the equipment covered by the contract is produced at all reasonable times for the purpose of inspection or obtaining progress of works. Routine testing of each switchgear bay shall be performed according to IEC 60694. The Contractor shall submit proposals for special tests, subject to the approval of the Employer's Representative.

Tests shall be performed generally at independent institutes, at the Contractor's premises if approved by the Employer's Representative, and at site (if applicable) in the presence of the Employer's Representative and further in strict accordance with:

- IEC 60298 for all the switchgear and control gear
  (Note: For internal arc tests to be regarded as type test, performance shall be according to the IEC 60298 Appendix AA)
- IEC 60056, IEC 60267, IEC 60427 and IEC 60694 for the circuit breakers
- IEC 60265 for MV switches
- IEC 60044- and IEC 60186 for current and voltage transformers
- IEC 60060, and others, as applicable.

Hereby, all test results and calculations evidencing the ratings under site conditions have to be submitted for approval to the satisfaction of the Employer's Representative.

The following table lists the acceptable values for certain tests performed on the switchgear.

Test Description	*Minimum Acceptance Criteria*
Partial Discharge Measurements	< 250pC
Dissipation Factor Measurement	< 0.02
Contact resistance of main circuit	< 50μΩ
Dielectric Apsorption test	ratio > 1.6
Insulation Resistance tests at 5kV	> 20GΩ

2.12.1 Routine Tests (Minimum requirements, at Factory):

Routine tests of each switchgear bay have to be successfully carried out in accordance with the IEC recommendations. Special tests may be agreed between the Employer's Representatives and the Contractor prior to award of contract.

2.12.2 Type tests

Type tests shall be performed on switchgear bays and circuit breakers of each different type if type test certificates are not made available with the Tender Proposal.

Type tests may be waived if satisfactory type test certificates are submitted with the tender.
All defects detected as a result of testing shall be repaired by the manufacturer at their expense and shall be documented and corrected prior to shipment. If, in the opinion of the Employer's Representative, re-testing is required after such repairs, this shall also be at the expense of the Contractor.

Acceptance by the Employer's Representative of any equipment shall not relieve the manufacturer and the Contractor from any of his performance guarantees, or from any of his other obligations resulting from this contract.

2.12.2.1 Test at Manufacture's Work

Circuit Breakers

a) Type Tests:

Circuit Breakers shall be covered by type test reports issued by a recognised short-circuit testing station certifying the operation of the circuit -breaker at duties corresponding to the operation of the rated breaking capacities of the circuit breakers. The test duties shall not be less than the requirements of IEC 60056. Test certificates shall be submitted with the Bid. Repetition of type tests may be waived at the Employer's Representative's discretion if adequate type tests have already been performed on the circuit breaker type to be supplied at an independent test laboratory and copies of the type test reports are supplied giving detailed test information, including results. Otherwise one circuit breaker of each type ordered under the Contract shall be fully type tested in accordance with IEC.60056. For SF_6 circuit breakers the gas pressures, gas supply conditions, test conditions, and the measuring and recording of the result are to be approved.

b) Routine tests:

Each circuit breaker ordered under the Contract shall be fully assembled at the manufacturer's works and subjected to routine tests in accordance with IEC 60056.
Circuit breakers, Disconnecting and Earth switches shall have functional tests carried out as described in relevant clauses in this specification including checks in the interlocking.

2.12.2.2 Disconnecting and Earthing Switches

Type and routine tests to IEC.62271-102.

Routine high voltage and mechanical test of insulators.
Sample and type tests of insulators.

2.12.2.3 Bushings

Routine, sample and type tests to IEC.60137.

2.12.2.4 Insulators

Routine and type test to IEC. 60233.

2.12.2.5 Structures

Sample assembly tests and galvanizing tests.

2.12.2.6 Current and Voltage Transformers

Type and Routine tests to IEC.60044/BS.3938 and IEC.60186.
Type tests shall include switching and impulse tests. Current transformers installed for differential protection shall be routine tested as sets.

2.12.2.7 Auxiliary Transformers, Motors, rectifiers, Contactors and control gears

As appropriate IEC or British Standard as required by this specification.

2.12.2.8 36 kV and 12 kV Switchgear

Type tests shall have been successfully carried out and been suitably documented for the switchgear type proposed by the bidder. Test certificates shall be submitted with the bid. Routine tests of each switchgear bay have to be successfully carried out in accordance with the IEC recommendations. Special tests may be agreed upon between and the Employer's Representative prior to order placement.

Routine factory tests, minimum:

- Pressure test on each enclosure. The test pressure for all cast housings shall be twice and for all welded housing 1.5 times the design pressure. Gastight bushings between the gas compartments must be able to withstand twice the service gas pressure at one side against 0 bar (absolute) on the other.
- At least 10% of welds must be subjected to non-destructive X-ray or ultra-sonic methods (random checks, according to pressure vessels regulations).
- Partial discharge test on each insulator before insulation in the switchgear. No measurable partial discharge (less than 10pC) shall occur on the insulator when 110% of rated voltage is applied. This test must be carried out on each post type insulator and bushing used in the switchgear.
- Gas leakage test on each transport unit. A Helium gas leakage test with a suitable accuracy must be carried out on each transport unit before dispatch.

The following tests shall also be performed as part of routine tests, as per the relevant IEC standards:

- power frequency voltage dry test on each shipping assembly
- rated voltage test on all auxiliary circuits
- insulation test with 2 kV on all auxiliary circuits
- Insulation resistance test with 5kV on all primary circuits including CB, CT, VT
- Dielectric absorption test
- Dissipation factor test
- Timing/speed test
- Contact timing test
- Contact resistance test
- Pressure test
- Primary and secondary injection test
- complete mechanical operation test

- function tests of all auxiliary devices, including all protective relays, alarm and trip circuits
- verification of wiring against drawings and specifications
- leakage test for insulating gas.

These tests shall be witnessed by the two of the Employer's personnel according to Chapter 11 of this Specification.

Acceptance by the Employer's Representative or his representatives of any equipment shall not relieve the manufacturer of his performance guarantees or from any of his other obligations resulting from the order.

2.12.3 Acceptance Test (Commissioning)

The following tests to be carried out as a minimum after installation of the switchgear at the site for commissioning purposes:

- rated voltage test on all auxiliary circuits
- Insulation resistance test with 2 kV on all auxiliary circuits
- Insulation resistance test with 5kV on all primary circuits including CB, CT, VT
- Dielectric Absorption Test
- Dissipation factor test
- Contact Resistance Test at 100A test current
- High Pressure test
- Primary and secondary injection tests
- Circuit breaker timing test
- Complete mechanical operation test
- Current transformer ratio, polarity, magnetisation curve, voltage withstand of secondary wiring
- Voltage transformer ratio, polarity, voltage withstand of secondary wiring
- Function tests of all auxiliary devices, including all protective relays, alarm and trip circuits
- Testing of SCADA IO points
- Control locally using HMI computers

CHAPTER 3 - SMALL WIRING AND ANCILLARY ELECTRICAL APPARATUS

3.1 SMALL WIRING

All control panel wiring, secondary control wiring in circuit-breakers, motor starters, control gear and the like shall be carried out in a neat and systematic manner with cable supported clear of the panels and other surfaces at all points to obtain free circulation of air. In all cases, the sequence of the wiring terminals shall be such that the junction between multi-core and terminals is affected without crossover. Except where terminals are approved by the Employer's Representative for use with bare conductors, claw washers or crimped connectors of approved type shall be used to terminate all small wiring. Insulating bushes shall be provided where necessary to prevent the chafing of wiring. All panel wiring shall comply with the requirements of BS.6231, Type A or B, as appropriate. Conductors shall be copper and have a minimum cross section equivalent to 50/0.25 mm (2.5 sq. mm), 7/0.67 mm (2.5sq. mm) or 1/1.78 mm (2.5 sq. mm) but single stranded conductors should only be employed for rigid connections which are not subject to movement or vibration during shipment, operating or maintenance. Flexible conductors equivalent to 30/0.25 mm (1.5 sq. mm) or smaller sizes generally shall only be employed with written approval.

For low voltage cabling and wiring, separate cables shall be used for each of the following groups:

- auxiliary power supply
- control and check back
- measuring
- communication

All control and power cables shall be armoured and all cables except those for auxiliary power supply must be shielded with annealed copper tape. Cables shall conform to IEC 60228, IEC 60228A, IEC 60287, IEC 60811 & IEC 60885.

The minimum cross-section of each copper wire shall be at least as given below:

- 4.0 mm^2 for current transformer circuits and heavy power consumers up to 20 A
- 2.5 mm^2 for all power consumers such as motors, heaters, lighting, etc. up to 10A
- 1.5 mm^2 for all instrument and control wiring, however, the maximum permissible voltage drop is < 5 % for the furthest point at full load.
- 0.6 mm^2 for all telephones wiring.

Wire colours are preferably to comply with British Standard 158, viz.:

Colour of wire	Circuit particulars
Red	Red-phase connections in current and voltage transformer circuits only.
Yellow	Yellow-phase connections in current and voltage transformer circuits only.
Blue	Blue-phase connections in current and voltage transformer circuits only.
Green/Yellow	Connections to earth.
Black	AC neutral connections, earthed or unearthed, connected to the secondary circuit of current and voltage transformers. AC connections other than those above and connections in AC/DC circuits.
Brown	DC indication circuits.
Grey	All other DC circuits.

Alternatively, where equipment is wired in accordance with a manufacturer's standard diagram, wiring may be carried out in a single colour except that all connections to earth shall be green.

Wiring diagrams must indicate wire colours; numbers designated to all equipment/ instruments and shall be drawn as viewed from the back of the panel. All wires shall be fitted with numbered ferrules (hand written numbers are not accepted) of approved type at each termination. At points of inter-connection between wiring, where a change of

numbering cannot be avoided, double ferrules shall be provided. Such points shall be clearly indicated on the wiring diagram. All secondary wiring to be performed at Site shall enter the terminal block at one side only. The panel wiring shall terminate in one or more terminal blocks accommodated at the side or bottom of each panel or compartment.

Internal wiring between instruments or other devices not using the terminal block shall be permitted within the same compartment only. The markers on all wiring directly connected to circuit breaker trip coils, tripping switches, etc., shall be of a colour, preferably red, different from that of the remainder and marked "trip". No wires may be teed or jointed between terminal points. Electrical wiring and instruments shall be so located that leakage of oil or water cannot affect them. Bus wiring between control panels, etc., shall be fully insulated and to be completely segregated from the main panel wiring. Generally, all signal, monitoring and protection circuits as well as shunt trips of circuit breakers shall be fed by DC. All other circuits may be controlled by AC. Also, contactor operating circuits shall be controlled by AC with the contactor solenoids preferably designed for DC with a pre-connected rectifier bridge. All metallic cases of instruments, control switches, relays, etc., mounted on control panels or in cubicles, steel or otherwise, shall be connected by means of copper conductors of not less than 2.5 sq. mm cross section to the nearest earth bar. These conductors may be bare or have insulation coloured green.

3.2 TERMINAL BOARDS

All terminal boards shall be mounted in accessible positions and, when in enclosed cubicles, are preferably to be inclined towards the door. Spacing of adjacent terminal boards shall be not less than 100 mm and the bottom of each board shall be not less than 200 mm above the incoming cable gland plate. Separate terminations shall be provided on terminal boards for the cores of incoming and outgoing cables including all spare cores. Where cores of multicore cables and internal cubicle wires have crimped ends, not more than two may be connected to any one terminal. When left bare, they shall have individual terminals and where bridging connections are necessary, these shall be incorporated in the terminal boards.

Acceptable types of terminals are:

(i) Screw or stud type used with crimped ring type termination. Screws and studs shall be not less than of size M6, but stainless steel and bronze down to size M5 may be used, provided that the current carrying capacity is adequate. All studs shall be provided with nuts, washers and lock washers.

(ii) Inspection clamp type whereby the standard conductor or crimped termination is clamped between plates by a screw having a suitable locking device. Terminal entries shall be shrouded such that not less than three full threads. Screws shall be of plated steel, stainless steel or phosphor bronze and size M3 or M4.

Terminal assemblies shall be to be of the unit form suitable for mounting collectively on a standard assembly rail, secured from the front and giving the required number of ways plus ten percent spare.

LV AC and DC power circuit terminals shall be segregated from other terminals and shall be fitted with non-flammable plastic covers to prevent contact with any live parts. They shall have warning labels, with red lettering, mounted thereon in a conspicuous position.

All connections shall be made at the front of the terminal boards and no live metal shall be exposed at the back. Insulating barriers shall be provided between each group of power circuit terminals and between the terminal categories, the height and the spacing being such as to give adequate protection to the terminals.

3.3 CONTROL SWITCHES AND PUSHBUTTONS

Control switches and pushbuttons shall comply with BS EN 60947-5-1 OF 1992 or the relevant IEC standards.

3.3.1 General

Control switches for electrically operated circuit-breakers and motor operated disconnectors shall be of pistol grip or other approved discrepancy type and arranged to operate clockwise when closing the circuit-breakers and anti-clockwise when opening them. They shall be designed to prevent accidental operation. When switches of the discrepancy type are approved, operation is to be effected by two independent movements.

Switches for other apparatus shall be operated by shrouded pushbuttons or to have handles of the spade type, the pistol grip type being reserved for circuit-breaker operation only. Control, reversing, selector and test switches shall be mounted, constructed and wired so as to facilitate the maintenance of contacts without the necessity for disconnecting wiring.

Where necessary, control switches shall be capable of being locked in appropriate positions but control switches for circuit breakers and for motor operated setting devices shall be of the non-locking type with spring return to the "neutral" position. Such switches shall be controlled by independent springs, the use of contact springs alone for restoring not being acceptable.

All pushbuttons shall be of non-retaining type made of non-hygroscopic, materials, non-swelling and fitted to avoid any possibility of sticking.

The contacts of all switches and pushbuttons shall be strong and to have a positive wiping action when operated.
Control switches for use in direct control schemes shall be rated for substation battery voltage.
All control switches shall be provided with labels in addition to clear indication as to the direction of each operation, for example, "open", "close", "raise", "lower", etc.

3.3.2 Electrical Control Locations

Equipment may be electrically controlled from a number of different control points as specified in the appropriate chapters of this Specification. The control positions shall be designated as follows:

Local Control:	Located adjacent to the item of plant to facilitate maintenance, inspection and emergency operation.
Remote Control:	Located at a substation control room where specified items of Plant are monitored and controlled by direct wire connection.
Supervisory Control:	located at a System Control Centre or where principal items of plant at a number of substations are remotely controlled via a SCADA (Supervisory Control And Data Acquisition) system.

3.4 ELECTRICAL MOTORS

All AC motors shall be of the induction type in accordance with BS 5000: PART 99 OF 1973 and BS.5000, Part II, or IEC.60034 and, unless otherwise specified shall have cooling type ICOI suitable for continuous operation and direct on-line starting. They shall be suitable in all respects for service under the conditions at site. Main conductor and slot insulation shall be non-hygroscopic and in accordance with Class B of BS 2757.If any motors supplied under this Contract shall be located outdoors, such motors shall be weatherproof and, where necessary, protected from overheating by the sun with a canopy of approved design. Motors shall be capable of operating continuously at rated output at any frequency between 48 and 51 cycles per second and at any voltage within 10% of nominal value. Motors shall be designed to operate for a period of not less than five minutes at a voltage of 25% below the nominal value and at normal frequency without injurious overheating. If required by the Employer's Representative, the Contractor shall demonstrate that the motors comply with this requirement.

Each motor shall be protected by a motor protective unit with adjustable thermal overcurrent and short circuit device. The starting current at full voltage is not to exceed six times the rated full load current. Motor bearings shall be of the rolling type and the cage locating the balls or rollers is not to be in contact with the racers. Vertical shaft motors shall have approved thrust bearings. The ends of motor windings shall be brought out to terminal boxes and the arrangement is such as to permit easy changing over of any two-phase leads. All terminals shall be fitted with an approved sealing chamber, conduit entry or adapter plate, as required, together with the necessary fittings to suit the type of cable supplied.

3.5 STARTERS AND CONTACTORS

Where starters shall be provided under this Contract, each motor is to be equipped with two or three pole control gear as appropriate and suitable, unless otherwise specified, for direct starting. Contactors shall be mounted in

ventilated metal cubicles. Where two or more contactors are contained in the same cubicle, barriers shall separate them. The cubicles shall be complete with all locks, cable-sealing arrangements for boards and accessories. All secondary wiring shall be so arranged and protected as to prevent its being damaged by arcing.
Starters shall be of the electrically held-in type with integral "start" and "stop" pushbuttons mounted externally on the door, with integral interlocked disconnectors. Where required, auxiliary switches should be included for the operation of "red" and "green" indicating lights on remote instrument panels. All AC contactor coils shall be connected between phases for 415V working.

All motor contactors and their associated apparatus must be designed to operate for a period of not less than five minutes at a voltage of 25% below the nominal value and at normal frequency without injurious overheating.
Contacts of level switches, pressure switches, temperature switches, limit switches, etc. shall be of the snap action type, the creeping action type and mercury contacts not being acceptable.

Contact devices transforming thermal variables into binary signals for the interlocking system shall be separate, i.e. contact devices serving in common for interlocking and other purposes shall not be accepted.

3.6 INSTRUMENTS AND METERS

3.6.1 Indicating Instruments

All indicating instruments shall be of the flush mounted pattern with dust, venom and moisture proof cases complying with BS.2011, Classification 00/50/04 and shall comply with BS.89 or IEC 60051.Unless otherwise specified, all indicating instruments shall have 72 mm square case to standards. Instrument dials in general should be white with black markings and should preferably be reversible where double scale instruments are specified. Scales shall be of such material that no peeling or discoloration will take place with age under humid tropical conditions. The movements of all instruments shall be of the deadbeat type. The meters and instruments shall be similar and aesthetically compatible with the existing equipment and to the satisfaction of the Employer's Representative. Wherever possible, instrument shall be provided with a readily accessible zero adjustment. Where required, isolating transformers should be used to protect the indicating instruments.

3.6.2 Electrical meters

All electrical meters shall comply with BS. 5685 part 1-4 or IEC 60051 and shall be of industrial grade accuracy. Three-phase power measuring instruments shall be of the three-phase unbalanced load pattern wherever the current and voltage reference permit. Where precision grade metering is specified meters shall be calibrated to precision grade accuracy to BS. 5685: or IEC 60051. Due allowance shall be made for the errors of current and voltage transformers with which they shall work and whose accuracy class shall be Class 0.2.Meters shall be fitted with suitable devices for the transmission of impulse to a summator. Var-hour meters shall be complete with phase shifting transformers as necessary. (The angular deflection of all the meter indicating current, voltage, power, Vars shall be 270 degrees).

Meter dials should be white with black markings and should preferably be reversible where double scale instruments are specified. Centre Zero meters shall be used for Active Power, Reactive Power and Current meters. Where required, isolating transformers should be used to protect the electrical meters.

3.7 INDICATING LAMPS AND FITTINGS

Indicating lamps shall be of LED type and fitted into the fascias of switch and instrument cubicles or panels shall be adequately ventilated. LED lamps shall be easily removed and replaced from the front of the panel by manual means preferably not requiring the use of extractors, The bezel of metal or other approved material holding the lamp glass shall be of an approved finish so as to permit access to the lamp and lamp glass.

The lamps shall be clear and shall fit into a standard form of lamp holder. The rated lamp voltage should be ten percent in excess of the auxiliary supply voltage, whether AC or DC. Alternatively, low voltage lamps with series resistors will be acceptable.

The lamp glasses shall comply with BS 1376 and BS. 4039 and shall be in standard colours, red, green, blue, white and amber. The colour is to be in the glass and not to be interchangeable. Transparent synthetic materials may be used instead of glass, provided such materials have fast colours and are completely suitable for use in tropical climates.

Lamps and relays incorporated in alarm fascia equipment may be arranged for normal operation from the station battery, subject to the approval of the Employer's Representative.

Lamp test facilities shall be provided so that all lamps on one panel can be tested simultaneously by operation of a common push-button. Where alarm fascias are specified, all alarm and monitoring indications (apart from circuit breaker and disconnector position indications) shall be incorporated in the fascia.

3.8 415 V SWITCHGEAR

The 415 V Switchgear shall be switchboard type. Switchboards for supplies to "Substation Service" are of the single busbar, air insulated multi-cubicle or multi-box factory built assembly type, incorporating air break, manually operated miniature circuit breaker units and disconnector units, suitable for installation in the substation building on a 415 V, three-phase, four-wire, 50 Hz system, having the neutral solidly earthed.

3.9 LVAC SWITCHBOARD SPECIFICATION

LVAC Switchboard shall be in accordance with IEC 60439. Shall include at least 54 pole single chassis and 4 x MCCB (2 x 100A and 2 x 250A). Shall have provision for incoming energy metering.

3.9.1 Rating

Incoming supplies to all switchboards will be protected at the point of supply by circuit breakers. All switchboards should be suitably rated for a prospective short circuit breaking capacity of not less than 40 kA at 415V.

3.9.2 Temperature Rise

Switchboards shall be capable of carrying continuously the currents specified in the Employer's Requirements without exceeding the maximum temperature given in the appropriate IEC Standards.

3.9.3 Busbars

Switchboards shall include three-phase busbars and one neutral busbar of high conductivity copper supported to withstand all normal and fault condition stresses. The neutral busbars shall have a rating not less than that of the associated phase busbars. The main circuit equipment shall have a busbar rating of not less than 800 amperes for 3-phase use and feeder circuit equipment a busbar rating of not less than 100 amperes for 3-phase use.

3.9.4 Construction

Each switchboard shall consist with a fabricated steel busbar chamber running horizontally at a height convenient for the operation of switches. The switchboard shall be of a type, which is readily extensible and suitable for use in a tropical climate. Each circuit shall be clearly labelled to show the destination of the associated cable, the "ON" and "OFF" positions of the switches being clearly indicated.

Distribution boards shall be of the metal enclosed free standing type with protective insulating barriers between the phases and between phase and neutral. Neutral connections for each circuit shall be made direct to the neutral busbar in each distribution board via removable links. The metal casing of the distribution boards be provided with knock-out or other approved cable entries for accommodation of the cables and cable glands the number and size of such knock-outs being such that the breakers can be used in any combination of single-phase and three-phase circuits.

Cubicles type switchboards, where specified, shall be so arranged that the cubicles housing the respective control units are grouped to form a multi-tier arrangement and a further part shall where possible constitute a cabling and wiring chamber of ample dimensions in which terminal boards, cable boxes and gland plates shall be located.

3.10 MAIN CIRCUIT BREAKERS

The Moulded case circuit breakers or air circuit breakers shall be provided for protection and disconnection of the main circuit of AC power supply system. The circuit breakers shall be of 4 poles, high speed fault limiting, thermal/magnetic type to IEC 60947 or equivalent standard with quick make and quick break trip free mechanisms which prevent the breaker being held in against overloads or faults. Tripping arrangements shall be such as to ensure simultaneous opening of all phases. Arc extinction shall be by de-ionising arc chutes.

The dolly shall have three positions, “on”, “off” and “tripped”. To reset from the “tripped” position the dolly shall first pass into the “off” position. Circuit Breakers on the main switchboard shall have facilities for locking in the “off: position. The rupturing capacity of the ACB shall not be less than that of the switchboard itself, or if this is not the case back up fuses must be included

3.11 MOULDED CASE CIRCUIT BREAKERS (MCCB)

Moulded case circuit breakers shall be provided for each feeder circuit protection and disconnection and mounted in the switchboards. The MCCBs shall be designed to comply with the requirements of IEC 60947. The MCCBs shall be equipped with a padlocking device to lock the MCCB toggle in the “OFF” position. Trip ratings and frame sizes of all MCCBs shall be suitably rated for loads and the available short circuit currents.

3.12 MINIATURE CIRCUIT BREAKERS

Facilities shall be provided for protection and isolation of circuits associated with protection, control and instruments. They shall be of approved type and grouped, as far as possible, both on the panels and the associated wiring diagrams. Facilities for protection and isolation of control and tripping circuits are preferably to be mounted on the outside of control panels. Miniature circuit breakers shall comply with BS EN 60898 of 1991 or IEC 60947.Where miniature circuit breakers are used on control, protection and alarm supplies, tripping shall cause an alarm to be displayed locally as well as in the remote and supervisory control locations. MCBs shall be positioned at the bottom of the face of relay and control boards.

3.13 SWITCHFUSES AND DISCONNECTORS

Each switch-fuse or disconnector switch unit shall be housed in a separate metal compartment and provided with a hinged metal door interlocked with the switch mechanism so that:

(1) The door cannot be opened whilst the switch is closed.

(2) The door, on opening, automatically locks the switch in the “off” position. Facilities shall be incorporated to allow for the deliberate release of this interlock for maintenance purposes, should it be desired to observe the switch in operation. An insulating barrier shall be fitted to segregate the fuses and neutral link from the switch and the connections of the latter shall be effectively shielded by an inner metal screen when the compartment door has been opened to obtain access to the fuses. The switch-fuses may be either of the combination fuse-switch type or of the type with the switch and fuse in separate units. In either case, interlocking shall be provided to prevent access to the fuses until the associated switch is opened and provision shall be made for padlocking the switch in the “on” and “off” positions. The switch shall have a quick make and quick break action independent of the speed at which handle is operated and shall be entirely suitable for switching the inductive loads associated with motor circuits.

3.14 FUSES

Fuses shall be of the HRC cartridge type for operation at a prospective fault level of not less than 40 kA and conforming to BS 88 or IEC 60269. The mountings of the fuses shall be such that they can be readily withdrawn and replaced whilst the associated busbars and circuits are live.

3.15 INTERLOCKS ON SWITCHBOARD & FUSEBOARDS

Incoming circuits at switchboards and fuse boards are not provided with fuses or circuit breakers, the circuits being protected on each case at the point of supply. Interconnector circuits with other 415 V boards shall be provided with fuses or circuit breakers at both boards. Switchboards shall be provided with electrical or mechanical key type interlocks of the “Castell” type in order to prevent the two normal incoming supplies being paralleled. The

Switchboard is to come with an automatic change over switch which will automatically switch between the two incomers in case of fault on one of the incomers (using phase failure relays). The contractor shall provide schematic drawings of the changeover switch and list the relevant spares required in the appropriate schedule.

3.16 ACCESSORIES

Following accessories shall be provided for the switchboards.

3.16.1 Termination of cables

Terminations for control cables shall be made in accordance with IEC 60439.
Special attention is drawn to Chapter 10.9, which details the general requirements for cable boxes and glands.

3.16.2 Earthing

Earth metal of switchboards, fuse boards and distribution board shall be bonded together and earthed to the main station earthing system. Earthing connections shall be carried out in covered copper strip (green & yellow) with cross sectional area of 185 sq.mm.

3.17 JUNCTION BOXES, TERMINAL BOXES AND MARSHALLING KIOSKS

3.17.1 General

All junction boxes, terminal boxes and marshalling kiosks shall be constructed of steel or cast iron. Each shall be provided with an earth stud. All main equipment shall be arranged so that it is accessible from the front of the box or kiosk. All junction boxes, terminal boxes and marshalling kiosks shall be properly labelled as per the wiring diagrams.
Enclosures for electrical apparatus are to afford the following degrees of protection classified in IEC.60529 of 1992 (BS.5490).

(i) Outdoor marshalling boxes or kiosks - IP54- also provision of a thermostatically controlled 240 VAC anti-condensation heater and having screened drainage holes.
(ii) Auxiliary switches and associated terminals - IP54 - as (I) but with heater control switch common to other apparatus on the same circuit.
(iii) Outdoor junction boxes - IP54.
(iv) Outdoor instruments - IP65.
(v) Outdoor motors - IP54.
(vi) Indoor control relay and low voltage AC & DC cubicles - IP41 - also provision of a thermostatically controlled 240V AC anti-condensation heater and indicating light common to a group of cubicles.

3.18 MARSHALLING KIOSKS

3.18.1 Switchgear Marshalling Kiosks

For each circuit bay an outdoor marshalling cubicles or kiosk shall be provided for the marshalling of all ancillary equipment cabling associated with the circuit, e.g. busbar selector and line isolating switches, current and voltage transformers, etc., to be routed via trunk multicore cables to remote control and relay panels. Kiosks shall be provided with the necessary terminal blocks, cable gland plates, etc., for termination of multicore cables.

The kiosks shall be free-standing and of weatherproof and vermin proof sheet steel construction. All fastenings shall be integral the doors and provision made for locking. Doors shall be rigid, and fitted with weatherproof sealing-material suitable for the climatic conditions specified. The kiosks shall be well ventilated through vermin-proof louvers comprising a brass gauze screen attached to a frame and secured to the inside of the cubicle.

Any divisions between compartments within the cubicles shall be perforated to assist air circulation. In addition, an anti-condensation heater of an approved type shall be provided and controlled by a single pole switch mounted within the cubicle.

3.18.2 Transformer Marshalling Kiosks

The transformer ancillary apparatus shall be mounted in an approved heated and ventilated cubicle, attached to the transformer for the accommodation of the following equipment: -

- Temperature indicators, (if not separately mounted) cooler control "Auto-Hand" selector switch and test links and ammeter for the winding temperature indicator circuits as specified in Chapter 10.
- Control and protection equipment for the tap change gear including an isolating switch in the incoming circuit capable of carrying and braking the full load current of the motor and of being locked in the open position. Provision shall also be made for termination of secondary wiring of current transformers.
- Control and protection equipment for the cooling plant including isolating switches in the incoming circuit each capable of carrying and breaking the full current of all cooling plant motor of one radiator bank and of being locked in the open position.
  The control facilities shall include a cooler selector switch, which can be padlocked in either position to select either cooler for remote control. Local control of the selected cooler shall be provided.
- Terminal boards and gland plates including glands where specified for incoming and outgoing cables.
  All doors shall be fastened by integral handle with provision for locking each door.

The temperature indicators shall be so mounted that the dials are not more than 1700mm from ground level and the door(s) of the compartment shall be provided with glazed windows of adequate size or otherwise, where separately mounted, their enclosure shall have a degree of protection not less than IP66. Facilities shall be provided to permit the temperature indicators with capillary tubing and bulbs to be removed from the cubicle. Mechanical protection shall be provided and sharp bends avoided where the capillary tubes enter the cubicle.

To prevent internal condensation an approved type of metal clad heater shall be provided, controlled by a watertight rotary switch mounted on the outside of the cubicle and a 5 A fuse inside the cubicle. All internal wiring shall be so placed as not to obstruct access. All wiring, connections, terminals, boards, and links shall be in accordance with Chapters 3.1 and 3.2.Labels in addition to those specified in General Technical Specification shall be provided on the outside of the kiosks to identify the compartments. All three-phase relays, contactors, isolating switches and thermal devices shall be marked with appropriate phase colour. Apparatus in which the phase elements are mounted vertically they shall be coloured red, white (yellow), and blue from top to bottom.

3.19 GAUGE CUBICLES AND PANELS

Gauge and instruments shall be grouped whenever possible and housed in suitable cubicles. Where circumstances do not justify cubicle accommodation, they may be secured to flat back panels but in such cases the approval of the Employer's Representative is first to be obtained. Cubicles shall be sheet metal having a minimum thickness of 2 mm (14SWG). The construction shall employ folding techniques with the use of standard rolled sections or other reinforcement where necessary. The stiffness shall be such as to prevent mal-operation of relays or other apparatus by impact. The front of the panel shall have a smooth well-finished surface.

3.20 KEYS AND KEY CABINETS

If key-locked switches are specified, they shall be provided with approved lock for locking in the respective position. A similar lock shall be provided for each selector switch for locking the switch in any of its positions.
Approved means shall be provided for locking the cubicle doors, live terminal shutters, etc. In general, each lock or padlock used shall be different from the others and shall be supplied with three keys. All keys shall fit to a master key system and six master keys to open any lock or padlock shall be supplied. The cabinet door keys shall be identical and shall be twelve in number. All locks and padlocks shall be of brass and where they are fitted to switchboards or similar cubicles they shall have the visible parts chromium plated. The Contractor shall submit for approval a key list and plan/ schedule for the intended system to be provided for securing the electrical operations and interlocking by keys.

Where a group of locks is supplied under any part of the Contract, a cabinet of approved design shall be supplied at the Station Control Room for the accommodation of all padlocks and/or keys while not in use. The padlocks and keys shall be engraved with an agreed identifying code or inscription and this shall be repeated in the cabinets on engraved labels.

3.21 LABELS

Labels shall be provided inside each junction box or kiosk to describe the functions of the various items of equipment. Where the kiosk is divided into compartments each door shall have an external label to identify the compartment.

3.21.1 Labels and Instruction Plates on Instruments

Labels written in the language(s) indicated by the Employer's Representative shall be provided for all instruments, relays, control switches, push buttons, indication lights, breakers, etc. In the case of instruments, switches and control switches where the function is indicated on the dial plate or on the switch escutcheon plate, no label is required. Relays shall be clearly labelled according to their function in the circuits, and to their related equipment, which shall be identical to the designations as used in the circuit manuals. This includes the test blocks as well.
Instruction plates in English language showing the sequence diagrams or cautions for maintenance shall be fitted inside of the front door of the electrical switchboards.

Sample of writings shall be submitted beforehand for approval to the Employer's Representative.

3.21.2 Circuit Labels

Circuit labels shall be made of synthetic resin with black letters on a white background, engraved in the English language. The sizes of the circuit labels shall be subjected to the approval of the Employer's Representative at site. In the case of indoor circuit breakers, starters, etc., transparent plastic material with suitably contrasting colours and engraved lettering may be acceptable. However, samples shall be submitted to the Employer's Representative at site for approval.

MV switchboards and transformers shall have red labels with 7.5cm high white letters reading:

DANGER..... VOLTS

in the approved language(s).LV switchboards and switch room doors shall have suitable labels (in colours as given below) with 5 cm letters reading:

MAINS 415 VOLTS

Busbar risers and sub switchboards shall have similar labels, but with letters 3 cm high.
The colours of labels shall be as follows:

- AC Mains — Yellow label with black letters
- Protection System — White label with red letters
- Emergency System — Red label with white letters
- DC Battery Supply — White label with black letters

All fixing facilities of labels shall be made of stainless steel.

3.21.3 Labels and Identification for Conduits, Boxes, etc.

Labels for conduits shall be of aluminium tape with 6mm minimum height, embossed ciphers. Other types of labels may be accepted subject to the approval of the Employer's Representative. The interior of each piece of equipment shall be clearly marked to show the phases and, for this purpose, either coloured plastic discs screwed to fixed

components, or identification by means of plastic sleeving, or tape shall be used. All conductors shall have their outer covering coloured to the phase colour or, alternatively, appropriately coloured plastic sleeves may be utilized at all cable terminations in fuse-boards, switchgear, etc.

3.21.4 Labels and Identification for Cables

When completely erected, each cable shall have permanently attached to it at each end and at intermediate positions as considered necessary by the Employer's Representative, non-corrosive metal plates upon which the identification number of the cable, voltage rating, conductor size and make shall be engraved or stamped.
Cable identification numbers shall comply with the cable schedules, which shall be prepared by the Contractor according to the cables actually laid. These cable schedules shall indicate the cable numbers, cable sizes, approximate lengths, voltage, number of conductors, conductor size, termination and connections at each end, and along the cable route.

All cables in cable pits and at entries to building blocks shall be labelled, utilizing the aforementioned type of label.

CHAPTER 4 - STORAGE BATTERIES, CHARGERS AND DC SWITCHBOARD

4.1 GENERAL

All batteries, chargers and distribution equipment shall be suitable for switchgear tripping and closing duties, alarm and indications, emergency lighting, and all other items of equipment covered by this specification.

The charger supply may be either three-phase 415V or single phase 240V 50Hz and the Contractors requirement shall be declared in Technical Particulars & Guarantees. The complete equipment shall preferably be a manufacture's standard, but any departure from this Specification shall be subjected to the approval of the Employer's Representative.

A durable instruction card shall be included in each set. Means shall be provided using diodes to prevent excess voltage causing damage to connected apparatus when a battery is being charged. All batteries shall be numbered.

4.2 TYPE OF BATTERIES

The batteries shall be of the high performance maintenance free pocket plate type complying with IEC.60623 and shall be designed for a life expectancy of at least 20 years under the conditions of service likely to be encountered by the equipment detailed in this Specification. A complete set of test and manufacture accessories suitably boxed, shall be provided for each battery. A durable instruction card shall be included in each set. The batteries must have provision for carrying out partial discharge test. There should be provisions to take voltage measurement on the cell without opening the covers to expose the terminals. Battery cases are of high impact translucent plastic. Cells shall be permanently marked with the following information.

Manufacture's reference number and code
Year and month of manufacture
Voltage and nominal capacity at the 20 hour discharge rate

4.3 STORAGE BATTERY

The Contract includes maintenance free type storage battery banks with battery charger and one DC (Direct Current) switchboard as requested in the Scope of Works. The rated capacity of each battery bank shall be 200Ah and the rating of the batteries shall be as specified in Technical Particulars & Guarantees. The following criteria shall be adopted and the calculations shall observe fully the requirements of BS 5486, BS 5227 & BS 7354.
The rating of battery shall be such that when charged to 80% of its rated capacity at the start of the duties, it shall be sufficient to supply the demands set out as follows with the charger disconnected.
The standby duty requested is as follows

(1) Supply all standing DC loads for control, protection alarms etc.
(2) Supply all transformer circuits standing loads.
(3) DC Emergency lighting via contactors

After supplying the above coincidental loads for a period of 6 hours, the battery shall be capable of two sequential closing and tripping operations of each HV & MV circuit breaker. Following this duty the battery terminal voltage shall not be less than 90% of the nominal voltage. All quantities derived in this manner shall be quoted in the Tender, but shall not be used for ordering materials until specifically approved by the Employer's Representative.
The electrolyte capacity and general design of the batteries shall be such that inspection and maintenance, including topping up of the electrolyte, shall be at the intervals of not less than twelve months. A visible window to indicate this would be preferable.

4.4 COMMUNICATIONS BATTERIES

Not applicable – communications equipment will be powered from one DC supply.

4.5 LOCATION

The batteries shall be installed in the battery room without any windows (sunlight). This room shall be properly ventilated by an extract fan with fan failure alarm/indication to SCADA. An eye wash unit is to be installed in the battery room as well. These batteries shall not be housed in the same room as any acid battery whether supplied under this Contract or not. The charging equipment and distribution switchboards are to be housed in a separate room. The batteries shall be numbered and are to be mounted in double tiers on timber stands and arranged in a manner such that each cell is readily accessible for inspection, test and maintenance including topping up of the electrolyte. There shall be a minimum clearance of 40mm between earthed metal and any conductor. Connections between the battery and the distribution cubicle shall be made in PVC insulated cable. A ambient temperature probe if provided with the battery charger should be located in the battery room as close to the cells as possible. Each battery cells should be labelled.

4.6 BATTERY FUSES

Cartridge fuses shall be provided in both positive and negative leads and positioned as close to the battery as possible and shall be rated for at least three times the maximum battery discharge current at the highest operating voltage. The fuses shall be mounted on the end of the battery stand or rack. Fuses shall be inside a transparent box and cables must be insulated. These fuse links shall comply with BS.88 Class DC.40 and shall be bolted in position without carriers. A warning label shall be fitted to warn personnel of the dangers of removing a fuse whilst the load is connected.

4.7 BATTERY CHARGERS

A battery chargers shall be provided for each storage battery. Each battery charging equipment shall comply with the requirements of BS.EN 60146-1-1, BS EN 60146-1-3 (IEC. 60146). And it shall be of the thyristor controlled automatic constant voltage type with current limit facilities and shall be suitable for supplying the normal constant load and at the same time maintaining the battery to which it is connected in a fully charged condition while floating across the load and charger. Arrangements shall be made such that in the event of the battery becoming discharged during AC supply failure, the rate at which recharging commences is as high as possible consistent with maintaining the automatic charging constant voltage feature and with the connections remaining undisturbed as for normal service.

Each charger shall also incorporate a boost charge feature which shall, after having been started, provide an automatically controlled high charge rate sufficient to restore a fully discharge battery to the fully charged state within twelve hours without excessive gassing or any form of damage to the battery. The boost charge shall be initiated manually.

Each charger shall operate satisfactorily within the permitted tolerances for AC supply voltage and frequency variations as specified in chapter 1. The design of the charger shall be such that it will operate satisfactorily from this supply without harm to itself, the battery or any equipment connected to D.C. auxiliary supply system.
A suitable voltage dropper shall be provided to control the system within the continuously allowable limits during boost charging and other high charging conditions.

Each charger shall be capable of automatically and continuously supplying the constant load with the battery disconnected. Under such conditions, the charger shall still maintain the nominal system voltage as previously specified without any damage to itself and the ripple shall not exceed 10% r.m.s of the no load output voltage.

Each charger shall also be capable of sustaining without damage to itself, a continuous permanent short circuit across its output terminals. The use of fuses, MCBs or other similar devices will not be acceptable in meeting this requirement. Earth leakages devices should also be used to detect DC earth faults. Should the AC supply fail while a battery is on boost charge the switching arrangements shall automatically revert the charger to the float charge status and then reconnect the battery supplies in parallel.

4.8 BATTERY CHARGER ALARM DEVICES

The following shall be provided:

- Over voltage detection equipment to give local indication and remote alarm when the charger voltage rises more than five volts above its normal automatic float voltage. This alarm shall be disconnected whenever the charger is operating on boost charge.
- Under voltage detection equipment to give local indication and remote alarm when the system voltage falls below 80% of its normal automatic float charge. A time delay shall be incorporated to prevent initiation during temporary voltage drops caused by transient conditions including circuit-breaker closing operations.
- Charger fails detection equipment to give local indication and remote alarm if the voltage from the charger falls below the nominal floating charge voltage. Suitable blocking diodes shall be provided to prevent the battery voltage being supplied to the equipment so that only the charger voltage is effective in causing the alarm. The device shall not operate on switching surges or transient loss of voltage due to faults on the AC system. The voltage at which the alarm operates shall be adjustable for operation over a range to be approved by the Employer's Representative.
- Rectifier: fuse operation detection equipment to give local indication and remote alarm of diode/thyristor and surge circuit protection fuse operation.
- Earth leakage detection equipment to give local indication and remote alarm of the occurrence of an earth fault and to give discrimination between positive and negative earth faults. Test circuits shall incorporated to simulate positive and negative faults by operation of test pushbuttons.

Provision of "local Indication" by lamps on the front of the charger cubicle and provision for "Remote Alarm" by changeover contacts (rated at 5A for voltages between 30 and 250V AC or DC) on the devices to energise a group alarm relay.

4.9 BATTERY CHARGER INSTRUMENTATION AND CONTROLS

In addition to the necessary controls for float and boost charging, the following are to be provided on the front of the cubicle:

- Charger Output/ battery Digital Voltmeter.
- Charger D.C. Load Digital Ammeter.
- Centre Zero Battery Ammeter with Retroactive Switch.
- AC Supply MCB. A link shall be provided in the supply neutral.
- Charger operating on Boost Charge indicating lamp (Amber).
- Isolating switches for each battery bank.

4.10 DC SWITCHBOARD

The distribution switchboard shall be of the cubicle type or otherwise incorporated in the cubicles for battery chargers. Two-pole miniature circuit breakers shall be fitted to the DC Switchboard required by substation services but as a minimum requirement that set out in Scope of Works. Each circuit shall be adequately labelled with its requirement function. The switchboard shall comply with the requirements of BS.EN 60439-1 (IEC. 60439).DC bus-bar voltage shall be monitored continuously and shall give an alarm (operated by AC) in the event of DC failure.

4.11 TEST AT MANUFACTURE'S WORK

Battery	-	Type test in accordance with IEC 60623.
	-	In addition the Contractor shall demonstrate that the battery will perform the duties specified.
Battery Charger	-	Type and Routine Tests according IEC 60146
DC Switchboard	-	Type and Routine Tests according to IEC.60439

CHAPTER 5 – PROTECTION, METERING AND CONTROL

5.1 ARRANGEMENT OF FACILITIES

Protection and control equipment shall be mounted on panels and boards as specified and shall be erected in permanent buildings on the substation sites. Panels provided as extensions or for erection in the same room as existing panels shall be of similar design and appearance to the existing panels. If existing protection is required to be modified for any reason, e.g. in order to operate with newly installed equipment, the Contractor shall supply all the necessary relays, panels, wiring terminals, wiring, etc. in order to ensure satisfactory performance.

This shall include the modification of the "remote end" (other station and/or other switchgear part) of any protected circuit. The Contractor shall also modify / improve the corresponding drawings, erect all necessary equipment and perform the commissioning in accordance with the requirements shown in these Tender Documents. Where additional relay equipment is to be installed in an existing station, it is the responsibility of the Contractor to ensure that the existing batteries and chargers have sufficient capacity to meet the additional load requirements of the new equipment. The characteristics and the appearance of all such equipment shall be to the approval of the Employer's Representative. Control panels shall incorporate all necessary control and indication facilities for the operation of equipment at the associated substation.

A design concept shall be applied using decentralized modules for alarm (monitoring) and tripping functions operating independently of each other. All components shall be suitable for the local climate and the control and protection panels shall be dust, venom and moisture proof to withstand all prevailing climatic conditions. The specified maximum ambient temperature shall be taken into consideration in closed rooms. The Contractor shall design the systems and select equipment accordingly. Open-air installed parts shall be protected against sun radiation by means of adequate and almost totally corrosion free steel covers, and shall be able to withstand all other prevailing climatic conditions. All instrumentation and control equipment shall be capable of continuous satisfactory operation, within the specified accuracy ranges, during a change of the supply voltage within the specified limits.

All equipment as well as the terminals of the panels shall be easily accessible. Space for at least one panel at each row of panels on either side in addition to the final extension stage shall also be provided. The instruments, relays, switches etc. on the front of the panels shall be arranged in such a way that a good overview, reading and maintenance will be guaranteed. Furthermore all instruments, relays, etc. shall be clearly labelled in relation to their functions and to the equipment to be protected or supervised, or to the location of any measuring point. Labelling shall be identical in panels and on drawings. The front panel shall also contain a test block(MMLG01) for testing purposes. Where appropriate, each item of the plant is to be equipped with all necessary auxiliary switches, contactors and mechanisms for indication, protection, metering, control, and interlocking, supervisory and other services. All auxiliary switches are to be wired up to a terminal board on the fixed portion of the plant, whether they are in use or not in the first instance. For maintenance purposes, it must be possible to individually isolate the protection and control circuits.

5.2 CONSTRUCTION OF CUBICLES

The interior of each cubicle shall be finished with a mat light coloured surface and an interior lamp suitable for the local LVAC supply and controlled by a door operating switch, shall be fitted at the top of each cubicle. Anti-condensation heaters shall also be fitted in each cubicle and each cubicle shall be well ventilated top and bottom through vermin proof louvers fitted with brass gauze screens. Each protection cubicle shall also be equipped with a built in AC supply socket out let of single phase, three wire rated 10 A at 240 V, 50 Hz.

The cubicles shall be of the self-standing, floor-mounted type and shall be provided with ways and means for floor fixing and anchoring devices. They shall be supplied completely with their fixing and lifting racks and eye bolts.

Equipment and terminals shall be readily accessible and shall require a minimum of disturbance of associated adjacent equipment for access. The arrangement of panel wiring and multicore cable terminal boards shall be in accordance with the relevant Clauses of Chapter 3 of this Specification.

Enclosures shall be provided for bottom entry of power and multi core cables via gland plates. Removable gland plates shall be located within the cubicles so as to provide adequate working clearance for terminating the cables. Where relay movements and other sensitive equipment are mounted on hinged front panels, these shall be designed to minimize shock sand wiring shall be so arranged as to impose no strain on terminations. No equipment whatsoever shall be mounted on rear access doors and there should be sufficient clearance for working from the back.

All sections of a composite cubicle shall be suitably labelled in accordance with the Specification and labels at the rear shall also readily identify each section or panel with the access doors either opens or close.

Each protection relay panel shall be of the swing rack type including 19" swing frame and a front cover door equipped with a glass window and each control panel shall be of the enclosed type.

Indoor cubicles and panels shall be of at least IP 41 protection class, and all outdoor local control cubicles shall be of IP64 with sun/rain shades of adequate size. Each door shall be fitted with suitable earth straps of at least 16mm ^{2} highly flexible stranded copper wire with insulation in green yellow colour. Doors are to be arranged so that every individual door or frame can be opened without moving doors of adjacent cubicles. Doors shall be of 2 mm thick sheet steel, equipped with 120° concealed hinges, with foamed in seal and shall be provided with a stable, bolted, rectangular tube frame, with pre-punched holes at 25 mm pitch for fixing channels, covers, cable harnesses, wiring plan pockets and etc. In each outdoor cubicle at least one door shall be equipped with sheet steel wiring plan pocket. If required, cross rails shall be fixed additionally. The doorstopper at the end of the throw shall be provided. All cubicles shall have rear doors, for easy maintenance and repair of the main- and auxiliary equipment accommodated in the interior. The Contractor shall perform a calculation for the heat dissipation for enclosures with the maximum installed heat losses and shall propose a suitable temperature control method. However the method has to be approved by the Employer's Representative. All enclosures and accessories, such as swing frames shall be corrosion protected by electrophoresis dip coat primers and final coats by an approved procedure as to suit the surrounding conditions at Site. The arrangement and mounting of all indicating devices, control switches, relays and other apparatus shall be to the approval of the Employer's Representative. The exterior and interior finish and colour of all cubicles shall be to the approval of the Employer's Representative.

5.3 CABLING AND WIRING

In selecting cable and wire sizes, due regard shall be paid to the appropriate de-rating factors in relation to the climatic conditions at site. All cables and wires shall continuously carry their rated currents under the worst temperature conditions, and shall also withstand maximum fault currents without damage or deterioration.

All secondary copper wiring within panels, racks, boards, etc. shall be in accordance with the pertaining IEC, it shall be carried out for the fully rated distribution voltage (2 kV AC/ 1 min. test voltage), and shall consist of copper wires. The bare ends of stranded wires shall be provided with squeezed sleeves.
The minimum cross-section of each copper wire shall be at least as given below:

- 4.0 mm^2 for current transformer circuits and heavy power consumers up to 20 A
- 2.5 $mm^2$for all power consumers such as motors, heaters, lighting, etc. up to 10A
- 1.5 mm^2 for all instrument and control wiring, however, the maximum permissible voltage drop is< 5 % for the furthest point at full load, with prior written approval.
- 0.6 mm^2 for all telephones wiring.

Wiring shall be neatly run in PVC rigid plastic wire ways clear of any metal panels and filled not more than 70 %, or bundles with no bunch containing more than 12 wires. Both ends of every wire core and all secondary panel wiring (at the screwed terminal side for external connection as well as at the screwed device sides in the panel) shall be fitted with numbered slip-on ferrules of moisture and oil resisting insulation material having a glossy finish, and with their identification numbers clearly engraved, each being the same as for the relevant terminal.

Ferrules, of white colour with black letters, shall be fitted in such a way that they cannot become detached when the wire is removed from the terminal (i.e. end crimps shall be provided).All secondary wiring to be performed at Site shall enter the terminal block at one side only. The panel wiring shall terminate in one or more terminal blocks

accommodated on the front of each panel. Internal wiring between instruments or other devices not using the terminal block shall be permitted within the same cubicle only. Whenever, required and necessary, armoured and shielded cables and/or groups of cores shall be provided for control, protection and supervisory equipment.

Cables carrying analogue signals shall be suitably twisted in pairs and the pairs shall be screened. Generally for wiring, the cable tails shall be so bound that each wire may be traced back to its associated cable without difficulty. Cores in pairs or groups shall be terminated together. All incoming control cables shall contain minimum 20% spare cores and be connected to terminal blocks, with 20% spare terminals of each type. Any further spare cores shall be numbered, and shall be sealed in further spare terminals. Terminal blocks shall be numbered consecutively in both sides, preferably beginning with TB1, from left to right or top to bottom.

Terminal blocks shall consist of single "insertion" type terminals of non-tracking, inflammable synthetic plastic, or ceramic of an approved type, lined up in one row. Polyamide terminal blocks are not acceptable.

All terminals shall have two separate pressure clamping plates suitable for connection of incoming or outgoing stranded or solid conductors, respectively. However, only one wire per terminal will be accepted. Terminals with clamping screws in direct contact with the conductor are not acceptable.

The following minimum categories of terminals shall be used:

- Terminals for power circuits of 10 mm^2, 6 mm^2 and 2.5 mm^2 size.
- Terminals with short circuit facilities for current transformer circuits of 4 mm^2size, and earthing link terminals of current transformer and voltage transformer circuits, all provided with insulated testing sockets.
- Terminals for wiring of 1.5 mm^2 and 0.6 mm^2 size with bridging facilities to the neighbouring terminals.

Insulating barriers shall be provided between each group of power circuit terminals and between the terminal categories, the height and the spacing being such as to give adequate protection to the terminals.

Control and relay circuits, current and voltage transformer secondary circuits, battery and auxiliary power supply wiring, supervisory, alarm and communication circuits shall be protected against conductive, electrostatic and electromagnetic influences.

5.4 LABELS ON INSTRUMENTS AND RELAYS

Labels written in English shall be provided for all instruments, relays, control switches, push-buttons, indication lights, breakers, etc. In the case of instruments, switches and control switches where the function is indicated on the dial plate or on the switch escutcheon plate, no label is required. Relays shall be clearly labelled according to their function in the circuits, and to their related equipment, which shall be identical to the designations as used in the circuit manuals. Each label shall be fitted both on relay front and on relay assembly. Instruction plates in English language showing the sequence diagrams or cautions for maintenance shall be fitted inside of the front door of the electrical switchboards. Sample of writings shall be submitted for approval to the Employer's Representative.

5.5 TEST AND EARTHING FACILITIES

5.5.1 Earthing Facilities

Each control or relay panel shall be provided with a copper earth bar of not less than 80 mm^2 cross-section and arranged so that the bars of adjacent panels can be joined together to form a common bus. The common earthing bus bar of control and relay panels shall be connected to the main station earthing system via a copper earthing connection of not less than 80 mm^2.Each current transformer secondary circuit shall be earthed through a removable link at one point only.

5.5.2 Test Facilities

All tests shall be carried out through a test block with a use of a test plug. The test block shall be mounted on the front of the panels for easy access.

5.6 PROTECTION DEVICES

Only approved protection devices shall be used, as specified in these specifications. Protection equipment shall be designed and applied to provide maximum discrimination between faulty and healthy circuits. All equipment's are to remain inoperative during transient phenomena which may arise during switching or other disturbances to the system except power system faults. The performance of the protection system and the performed coordination with the current transformer design shall be ensured. The Contractor shall submit a comprehensive technical report, which shall ensure that current transformer's and relays are designed saturation free under both transient and steady state fault conditions. The ratio of current transformers given in the SLD is a general guideline only. Proper calculations should be used to verify these ratios. Current transformers, where possible, are to be located so as to include the associated circuit breaker within the protected zone and shall be located generally as indicated on schematic drawings.

5.7 RELAYS

Relays shall be of approved types complying with latest version of the IEC 60255, and shall have approved characteristics. Only protective relays from well established manufacturers with a minimum of ten years successful experience in manufacturing protective relays and relays designed to identical relays with a minimum of three years field experience will only be accepted. The preferred relay is SEL. The protection relays, shall be located in specified panels and shall be flush-mounted in dust and moisture proof cases with protection class IP54 and of the draw out type with rear connections. The protection class of the cover for all relays, or protection systems, in which the modules are mounted in 19" racks shall be IP40 or better. Relays shall be of approved construction and shall be arranged so that adjustments, testing and replacement can be effected with the minimum of time and labour. Relays of the hand reset type shall be capable of being reset without opening the case. Electrical protective relays shall be only of numerical type. Numerical protection shall be designed in such a way that in case of a failure of DC auxiliary in feed, the full information needs to be maintained for at least 24 hrs. After a recovery of DC auxiliary in feed the last information and alarms will be displayed and the alarm "failure of DC auxiliary in feed" released. The relay reset shall not erase the relay memory. The protection functions shall be in the form of software such that additional or different functions, application specific logic etc. can be readily implemented without changes to the existing hardware.

All the numerical type protective relays shall be possible to program / parameterise directly (locally) and remotely by a portable computer (PC). All accessories equipment needed to communicate with the relays shall be provided. The relays shall be connected to the substation LAN which could be remotely accessed for required interrogation/download. The relay internal clock should have the provision to be updated by the EFL SCADA master clock. A GPS clock should be utilised to update the relay internal clock in case this provision is not available. The relay event log, disturbance records should be time tagged and these should be able to retrieve both locally and remotely by the substation LAN. The accuracy of time tagging shall be within $\pm$1 ms.

All the main protection relays shall have disturbance recorder and an event recorder in-built to them. Events shall be time tagged in the order of millisecond accuracy and the capacity shall be at least 100 events. The disturbance recorder shall include at least 6 analogue channels and 10 binary channels and the recording duration shall be at least 3 seconds. Relay contacts shall be suitable for making and breaking the maximum currents which they may be required to control in normal service but where contacts of the protective relays are unable to deal directly with the tripping currents, approved auxiliary contacts, relays or auxiliary switches shall be provided. In such cases the number of auxiliary contacts or tripping relays operating in tandem shall be kept to the minimum in order to achieve fast fault clearance times. Separate contacts shall be provided for alarm and tripping functions. Relay contacts shall make firmly without bounce and the whole of the relay mechanisms shall be as far as possible unaffected by vibration, shock and bump or external magnetic fields. Relays which rely for their operation on an external DC supply shall utilise for this purpose the same DC supply as the trip supply of the associated circuit-breaker trip coil.

This supply shall be monitored and an alarm provided in event of failure. Any auxiliary supplies needed shall be drawn from the main station batteries and not from separate internal batteries in the protection equipment.

Relays shall utilise a DC-DC converter type regulated power supply to provide transient surge isolation between the station battery and protection equipment. Each DC supply shall be designed to protect it from high voltage and surge and provide electrically isolated contacts for annunciation. Relays with provision for manual operation from outside the case, other than for resetting, will not be accepted. Relays shall be provided with clearly inscribed labels describing their application, version, type, serial number and rating etc. in addition to the general purpose labels. The protection schemes shall incorporate interface facilities to transform any offered low rated input/output signals of required equipment, to the necessary rated input/output signal. Unless otherwise specified, tripping shall always be directly from the relevant measuring relay. Any tripping relay, which completes the protection relays' initiated tripping of a circuit breaker, shall have an operations indicator. The tripping-contactors' operation must be guaranteed also with 50 % of the rated DC voltage (pick-up at 80 % of DC, self-holding down to 50 % of DC).

All protection relays shall be equipped with dedicated DC supply via MCB. The DC supply of all the protection relays shall be maintained by means of an auxiliary contact of the related MCB, which provide alarm in case of loss of supply. Any interruption of the DC supply to relays (internal and external) shall initiate an alarm. Converters and inverters used for feeding relays shall have their outputs monitored and shall initiate an alarm in the event they fail. These devices shall be of short circuit proof design. All relays shall be adequately protected against damage from incoming surge and shall meet relevant IEC standards.

All SEL protection and communication devices shall be ordered with and DNP3 and IEC61850 capability, with conformal coated boards and extended I/O boards. Fiber optic port connections on relays shall be of SC type. All protection relay communications to station RTU shall be over fiber optic communications cables provided by the Contractor. The fiber optic cables shall be vermin proof and of SEL make.

5.8 OVERHEAD & UNDERGROUND CABLE PROTECTION

5.8.1 36 kV Lines

Main Protection

For sub-transmission lines, main protection scheme of numerical type line distance protection is required this shall be provided using a SEL 311L relay. The relay shall be capable of single-pole differential, trip and auto-reclose functions.

CB Management & Backup Protection

CB Fail protection, Backup over current and Earth fault functions shall be provided through the SEL 351S-7 relays. Further all close commands to the CB (auto-reclose & close command) shall be routed through this relay and sync-check be performed for all operations.

5.8.2 12 kV Cable Protection

For distribution line protection, over current and earth fault protection shall be implemented using SEL 351S-7 relays. CB Fail protection, auto-reclosing and sync-check (where applicable) shall also be incorporated within the same relay.

5.9 AUTO-RECLOSING

5.9.1 36kV & 12 kV Line Auto-reclosing

Not applicable.

5.9.2 Check Synchronising Relay

Sync-check function shall be incorporated into the CB management relay SEL 351S-7 for all installations.

A voltage check function for checking, energizing conditions shall be provided. All energising options (dead-line/live-bus etc.) shall be selectable for each circuit breaker. The sync-check relay shall only release a closing command to the related circuit breaker, if the voltage amplitudes present at the two sides of the open circuit breaker and the phase angle between them, as well as the frequency difference are within acceptable limits. The required conditions for closing must be present for an adjustable time prior to passing a closing command to the circuit breaker under supervision. Continuous self-supervision of both hardware and software shall be incorporated.

5.10 TRANSFORMER PROTECTION

5.10.1 General

Power transformers shall be protected by the usually applied gas- and oil surge and pressure detectors, oil- and winding temperature monitoring devices, including the monitoring and protection of the tap changer and/or the cable connection chambers in the similar manner, all as specified below of this Specification.

Beside these protection systems as built into or mounted on the power transformers, at least the following electrical protection relays shall be provided, but shall not be limited to:

- differential protection, which internally facilitate the ratio and vector group compensation.
- restricted earth fault (REF) protection, which also facilitate internal current transformer ratio compensation.
- earth fault protection (stand by earth fault for low voltage winding, Neutral earth fault for high voltage winding etc.)
- back-up over current protection for all voltage levels.
- Over Voltage, Under Voltage and over fluxing protection for each winding

The protection relays shall be of numerical type with extensive self-monitoring and analog/digital conversion of all input quantities. All the electrical protection relays shall have sufficient number of contacts for signalling, alarms and the disturbance recorder. Tripping interface shall be provided such that any protection relay's tripping on the higher voltage side shall trip the lower voltage side's circuit breaker and vice versa for transformer faults. Back-up protection for other than transformer faults (external faults), installed at the low voltage side of the transformer shall only trip the low voltage side's circuit breaker and keep the transformer energized from the primary network side. A lockout relay shall be installed to avoid reclosing when a unit protection device has operated. The closing of breaker after a tripping due to a unit protection element shall only be done after a visual inspection has been carried out. An Areva MVAJ13 (master trip) relay shall be used to provide this functionality.

5.10.2 Transformer Main Protection

Overall numerical transformer differential protection & restricted earth fault protection shall be provided through a SEL 387E relay.

5.10.3 Transformer back up protection

Over Current Protection

Separately mounted three phase overcurrent IDMT elements of numerical type shall be provided for back up protection on each and every transformer winding of the transformer. These IDMT elements shall comply with IEC 60255-3 and they shall incorporate a range of standard characteristics. The “Normal Inverse” characteristic (i.e. curve Type A) will be applied in service. This function shall be provided by SEL351S-7 protection relays on each side of the transformer.

Earth Fault Protection

Earth fault elements shall be provided for each and every power transformer winding having its neutral earthed. The earth fault element shall be connected to the power transformer’s neutral current transformer and shall have the same curve specification like the over current elements. For Delta winding the neutral current transformer shall be the neutral current transformer of the earthing transformer. The IDMT elements provided for earth fault protection shall also have separate trip and alarm contacts and separate trip indicators.

5.10.5 Buchholz Protection

Power transformers shall be fitted with Buchholz devices of the two element type giving operation under gassing and under surge conditions.

All necessary flag indications, tripping relays and alarm relays associated with this protection shall be provided, mounted and connected under this Contract. The operation of such protection functions should be monitored using digital inputs of the numerical transformer main protection relay.

The Buchholz relay shall be equipped with gas sampling and testing devices to be operated from the ground level at a convenient height.

5.10.6 Oil and Winding Temperature

Transformers will be provided with oil and winding temperature protection. These will be of the two stage type with adjustable settings giving alarm and trip facilities. All necessary flag indication, tripping relays and alarm relays associated with this protection shall be supplied and connected up under this Contract.

5.10.7 Blocking of Automatic Voltage Regulator

The Automatic Voltage Regulator shall block on conditions of over current or under voltage of 70% of nominal operating voltage.

5.10.8 Tap Changer Blocking

A tap changer blocking scheme to prevent operating of the tap changer during system fault conditions, which result in fault current passing through the transformer, shall be incorporated in the tap changer control system.

5.11 BUS BAR, BUS COUPLER AND BUS SECTION PROTECTION SCHEMES

5.11.1 36kV Bus Bar Protection

Busbar protection shall be provided by SEL587Z bus protection relay. A supervision scheme to check buswire CT connections shall also be provided.

5.11.2 12kV Bus Bar Protection

Busbar protection shall be provided by SEL587Z bus protection relay. A supervision scheme to check buswire CT connections shall also be provided.

5.11.3 12kV Arc flash protection

Arc flash protection shall be provided by arc detection and tripping relays for any exposed busbar or cable compartments. Preference will be given to fiber optic arc flash sensors. Either SEL751 relays of VAMP321 relays shall be used for this function.

5.12 TRIP CIRCUIT SUPERVISION

Trip circuit supervision relays shall be provided to monitor each trip circuit (2 for trip & 1 for close) of 36kV and 12kV circuit-breakers and each relay shall have sufficient contacts for visual/audible alarm and indication purposes.

The trip circuit supervision scheme shall provide continuous supervision of the trip coils and trip circuits with the circuit breaker in either the open or closed position. Relay elements shall be delayed on drop-off to prevent false alarms during faults on D.C. wiring on adjacent circuits, or due to operation of a trip relay contact. Series resistance shall be provided in trip circuit supervision circuits to prevent mal-tripping a circuit-breaker if a relay element is short circuited. The trip circuit supervision design shall be such that in the event of a fault in any one component it shall not be possible to inadvertently trip the circuit breaker. The continuous trip circuit supervision relays shall initiate a delayed alarm after several seconds. This alarm shall operate for loss of DC voltage and for any interruption in the trip circuit wiring. Relay alarm elements should be equipped with well resetting flag indicators.

5.13 TRIPPING RELAYS

All tripping relays, where specified shall be of the heavy duty type suitable for panel mounting.

Trip relay contacts shall be suitably rated to satisfactorily perform their required duty and relay operating time shall not exceed 10 ms from initiation of trip relay operating coil to contact close. Where specified latching type relays shall have hand or electrically reset contacts and hand reset flag indicators. Resetting of the flag indicator and the contacts shall be possible without having to open the relay case. No time delay for the tripping contacts will be accepted. Where a master trip relay is shown in the specifications, it shall have a maximum tripping time equal to or less than 10 ms. The tripping-contactor operation must be guaranteed also with 50 % of the rated DC voltage (pick up at 80 % of DC, self holding down to 50 % of DC)

Trip circuits of the protection will not be sensible to mal-operate due to any conductive, electrostatic or electromagnetic influences on their AC or DC created from external current or voltages, high harmonic noise produced by the switching of HV sets together with the capacitance of the DC circuit or due to spikes during connection of DC current. The tripping contacts of a protection relay shall reset automatically if no further fault conditions are present. The signalling and blocking close order of the circuit breaker shall remain uninterrupted in case of operation of bus bar, breaker failure, transformer differential, buchholz and cable protection until operator resets the relay manually.

5.14 PROTECTION SETTINGS

Relay settings with calculations for all unit type protective schemes, over head line and cable protection relays shall be submitted to the Employer's Representative three month prior to commissioning of any plant / substation for approval. All system data required for calculating the settings shall be obtained from the Employer's Representative within 3 months of the contract award. The settings of 36kV and 12kV protection equipment shall be properly coordinated with the existing protection schemes. The settings shall also be provided for breaker failure, auto-recloser and other equipment. The complete trip matrix shall be subjected to Employer's Representative's approval prior to design.

5.15 AUTOMATIC VOLTAGE REGULATION, SYNCHROCHECK AND SYNCHRONISING

5.15.1 Transformer Automatic Voltage Regulation

5.15.1.1 General Requirements for Voltage Regulation

On-load tap-change control shall be performed with devices automatically controlling the voltages at the transformers secondary sides to pre-determined values. In the case of a voltage drop or rise in the network, voltage regulation devices connected to measure voltage and current at the MV level shall control automatically the on load tap changer as provided at the HV level, or as otherwise specified. The Specifications for transformers refer to requirements to the on load tap changer equipment and the supervision and monitoring facilities to be provided and installed at the transformer and its control cubicles/marshalling boxes. This section shall define the required functions of the voltage regulation, supervisory and auxiliary functions and the control of parallel operation of transformers.

Micro-processor based voltage regulator device (REG DA) shall be provided, which perform the automatic control of the motor driven on load tap changer(s) of each transformer. The voltage regulation system shall be mounted into transformer control cubicle(s) to be located at the substation control room or as otherwise specified in these Specifications. The continuous self-supervision of both hardware and software shall be incorporated.

All voltage regulation instruments to be provided shall be made by first class reputable manufacturer with well proven supply records. The submission of reference lists and the readiness to prove the supplied quantities must be confirmed by the Tenderer. The Contractor shall be responsible for the design interface and the supply coordinated equipment of the voltage regulator system to suit the requirements of the on load tap-changer and the substation control and interlocking system. The equipment shall be fully tropicalized to ensure long life and stability at the climate and surrounding conditions. All devices for voltage regulation shall have flush mounting cases and/or are built into standard 19" racks into panels. The wiring must be complete in every respect from the regulating devices to suitable terminal blocks in the cubicles or panels for external connections.

Equipment and devices shall provide automatic, electronic and/or thermal cut-out protection to avoid jeopardizing of the equipment in case of any defect.

Interface relays providing potential free contacts of sufficient rating for the RAISE/LOWER commands, signalling out-of-range voltage(s) and current(s) and automatic/manual operation are required in minimum. The control shall follow the step-by-step principle, i.e. a single control pulse shall operate the tap changer from one service position to the next. A RAISE or LOWER control signal shall be generated by the voltage regulator and issued to the motor drive whenever the measured voltage deviates from pre-set conditions.

Both the sensitivity limits and time of response must be adjustable to avoid a multiple of tap changer operations in the case of short time voltage fluctuations. Voltage sensitivity must be adjustable in very small steps.

The front panel(s) of the voltage regulating devices shall contain all necessary information of the operational data on a display and a series of push buttons or a keyboard shall allow the setting and the data information reading.

The voltage regulator system shall be prepared with facilities and be extendible by interface equipment for control of parallel operation of transformers for future extensions.

The manufacturer shall supply the necessary manuals and provide information to the Contractor to enable the engineers to be trained at site for setting, operating and maintaining the voltage regulator system.

5.15.1.2 Methods of Parallel Operation of Transformers

The controller shall be capable of operating paralleled transformers on Master-Slave and minimum circulating current mode. Each of the transformers to be operated in parallel shall be equipped with its voltage regulator as specified below and for up to six transformers one parallel control unit shall be provided. Interlocking with transformer/busbar circuit breakers to verify the actual number of parallel operating units shall be accomplished by means of auxiliary contacts from the circuit breakers and the busbar isolators, wired to the parallel control unit. The parallel control unit shall automatically adapt the actual configuration of busbars and transformers relative to the bus coupler circuit breaker position ON or OFF.

5.15.1.3 Requirements for the Interface of the Voltage Regulator Devices

The voltage regulation system shall be supplied with interface facilities to the substation LAN.

5.15.2 Voltage Regulator

Additional to the general requirements as per the Clause above, the basic voltage regulator system units shall provide the following functions:

- Both options of line drop compensation and load dependent regulation shall be selectable at the regulator.
- The time response for operating the on load tap changer shall be selectable to be a linear function of the voltage difference or to be an inverse function. The delay time shall be adjustable between 0.00 to 180 sec for linear function and in the inverse function shall be inversely proportional to the ratio of deviation

voltage to the band-width down to a delay of 1.0sec.A second adjustable time step from 0.00 to 10sec shall be available for overriding the delay time as above, if more than one tap change operation is necessary to bring back the deviation within bandwidth limits. The tap changer operation shall be blocked by adjustable settings of:

Under voltage below 95% down to 70%

Overcurrent above 100 % up to 210%

For each of these functions related signalling contacts for remote indication and alarming shall be provided

5.15.2.1 Voltage regulator (modular designed units)

The voltage regulator shall be built into 19" module frames and shall consist of a series of modules plugged into committed locations in the frame. If operational requirements change the modules shall be exchanged subsequently. The modular designed voltage regulator shall be housed in cubicles, the details of which are as specified under Clause 5.2.

5.15.2.2 Voltage Regulator (Programmable Unit)

This type of voltage regulator system shall be built also into 19" rack(s) and shall consist of a programmable solid state unit. The voltage regulator shall be housed in cubicle(s).The unit shall suit the custom made software, special requirements on the field of voltage regulation, control of parallel operation of transformers and the supervisory thereof, as specified. The independent supervisory of the total voltage regulation system shall be provided in a separate 19"-rack together with the regulation unit if so specified in Scope of Work/Scope of Supply. The details of the supervisory module shall be as follows:

5.15.3 Synchro-check and Synchronizing

5.15.3.1 Synchro-check relay

Any manual control command "CLOSE" to a circuit breaker shall be given through a synchro-check relay.
A dedicated Synchro check function for each circuit breaker shall be provided. The system provided under the Contract is to be to the approval of the Employer's Representative and is to be such that the synchronism must be verified before the circuit breaker can be closed. Synchro check systems and equipment provided as extensions to existing systems are to provide identical facilities and be of similar style and design to the existing equipment. The voltage check function for checking energizing conditions shall be provided. Four energizing directions shall be selectable for each circuit breaker. Continuous self-supervision of both hardware and software shall be incorporated. The type and setting ranges of the synchro-check relay shall be proposed by the Contractor and are subject to the approval of the Employer's Representative. The relay shall be possible to parameterize by a portable computer. Provision shall also be made for overriding the check synchronising facility, from an SA system workstation and also from the NCC.

5.16 SUBSTATION AUTOMATION SYSTEM

A substation LAN shall be used to transmit signals between relays for inter-relay communication and data sharing. This may include alarms or trip signals, or metering data. SEL switches shall be used in the design.

The Bidder shall arrange a training for the Employer's staff for one day on the design, operation and troubleshooting of the substation automation system.

5.17 FACTORY / SITE TESTS AND STANDARDS

The Contractor shall submit the applicable type test certificates in accordance with latest IEC standard for all relays before they are approved. Separate schedules for protection equipment factory- and site tests shall be submitted for approval at least one month before the start of tests. The Employer's Representative/Employer inspection of control and protection panels shall be arranged at least two weeks prior to packing for shipment when the contractor is ready for panel inspection. Customer's inspector shall have the authority to reject any items which are found

defective or not in conformity with the requirements of the specification. If the inspector rejects any item, the contractor either replaces or makes alterations necessary to meet specification requirements free of charge. Protection schemes mounted in cubicles shall be completely wired, tested and inspected at the manufacturer's factory. The only work to be performed at site shall be the connection to the external devices and the commissioning tests.

All types of test equipment and tools required by the Contractor for tests at Site and commissioning tests shall be provided and included in the quoted Scope of Work / Scope of Supply, whether specifically mentioned or not. Where work permits are required, the Contractor shall give sufficient notice to the Employer's Representative to allow the necessary outage to be arranged. The results of all tests shall be submitted, in handwritten form immediately following completion of the tests, and within ten days typewritten copies shall be supplied according to the requirements of these Tender Documents. The Contractor shall submit the results (as requested) of any test he may carry out on his own, following manufacture, installation or Site testing, as well as those required herewith. The equipment shall meet the requirement of IEC 60255-11 and their performance shall not be affected under the following conditions:

Interruption to the DC auxiliary supply of duration up to 10 ms
AC. component (ripple) in the DC auxiliary supply up to 5% of rated value

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CHAPTER 6 - SCADA EQUIPMENT

6.1 SCADA System

The existing SCADA system includes the Master Station hardware at the National Control Centre of the Employer and remote Terminal Units at Power Stations and Grid Substations. The Master Station equipment is supplied by DigitaLogic and uses iFix system. EFL uses DNP3 protocol from substation to Master Station for communications.

Configuration of the new equipment to the existing SCADA system and providing data, information and pictures displayed on the existing monitors at the System Control Centre is a responsibility of the contractor.

6.2 Scope of Facilities

6.2.1 Communication Equipment

The contractor shall be responsible for providing the following network end equipment at the substation:

1) 24 Port Industrial base Cisco switch with IP base image and supports PPoE. The switch shall be installed with dual power supply card that supports both 240VAC and 110DC. A spare power supply card shall also be supplied to support DC power in the range of 18VDC to 75VDC.
2) Genuine Cisco SFP Transceiver Module for single mode fibre to support communication over a distance of 50km
3) IP phone which can be integrated with the existing EFL VOIP system. Currently, EFL is using the 3300 ICP Mitel PABX, running version 7.2.
4) Fibre Termination rack that support 36 core splicing with complete fibre accessories. Fibre rack interface shall support SC/UPC
5) Industrial Based Smart On-Line 6kVA/3kW Single Phase (240V AC and 48V DC Output) UPS System with an uptime of 8 hours. The UPS shall support SNTP to report UPS activities to the Ops Manager software.
6) 12 V Battery Charger for RT (TAIT radio: model No.TM935) communication with the following parameters.
    a) Input: 240Vac 50Hz
    b) Output:27.6Vdc 11A
    c) Alarms (relays contacts) - DC Fail & Battery Low
    d) Front Panel (Illuminated ON/OFF switch, DC OK LED indicator, 15A circuit breaker, 15A battery breaker
    e) Rear Panel (3 pin IEC input socket, Load terminals (30A compression screw terminals), Battery terminals. (30A compression screw terminals), Alarm terminations.
    f) Operating Ambient Temperature: 0ºC to 40ºC
7) 1 x 42RU Floor Standing Rital Cabinet (Width: EIA standard 19" rack, External Width: 23.6"-600mm, Depth: 23.6" - 600mm, Height: 78.74" – 2000mm) Rital 790mm x 600mm x 2100mm, glass front door with build in fan and light.

The SFP module with LC fibre optic interface shall be used to connect to our fibre optic link and the range is such that the loss (dB) is acceptable for optimal communication. 4 X Fibre transceiver – GLC – EX (40km)

6.2.2 Teleprotection Equipment

6.2.2.1 General

Optic Fiber teleprotection equipment will be used to provide, with maximum security, the rapid, two-way transmission of a trip command between adjacent substations connected by an overhead fiber optic cable. All line protection relays to be supplied, are specified in Chapter 5. The teleprotection equipment supplied under this contract shall guarantee the smooth operation of the protection scheme specified in Chapter 5. In this case, necessary interfacing equipment such as interposing relays shall also be supplied. The equipment shall employ full solid state circuitry except for output tripping, alarm and flagging auxiliaries. The teleprotection equipment shall be of modular construction and shall be mounted in the Communications room inside the substation building.

6.2.2.2 Signalling Conditions

Each teleprotection unit shall allow the independent of at least four separate trip signals. They shall comprise of two permissive/blocking commands and two direct tripping commands. The equipment shall provide full duplex operation.

6.2.2.3 Alarms

An alarm shall be issued on failure of guard signal for a continuous period of 2 seconds. However there shall not be any fleeting operational output prior to the alarm conditions being given.
The alarm output shall persist for a minimum period of 100 milliseconds and the operational output shall be prevented until the alarm output condition is removed.
A separate low level alarm shall be given but not prevent operation when the input signal level drops by 6 dB from normal. Bidders shall state the level at which the receiver will cease to function. This level shall be at least 10 dB below normal. Voltage free contacts shall be provided for remote alarm purposes suitable for operation at voltage of the Substation general Battery Bank.

6.2.2.4 Protection Interface

The input/output interface to the protection equipment shall be by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/panel wiring. The make contacts of the output relays shall be capable of making and breaking at least one ampere at voltage of the Substation General Battery Bank. The input relays shall be operated by voltage free contacts of the HV protection equipment.
The isolation requirements of the protection interface shall be 2 kV r.m.s.

6.3 SCADA SYSTEM EQUIPMENT AND DEVICES

6.3.1 General Description

The contractor shall be responsible for the design and supply of all equipment such that the complete functioning with the rest of the SCADA system is guaranteed. All equipment must correctly interface with one another and also with the existing plant.

6.3.2 The Existing SCADA System at Load Dispatch Centre - Vuda

The EFL SCADA Master Station uses GE iFIX software and communicates with Remote Terminal Units using DNP 3.0 and Modbus protocol.

6.3.3 Remote Terminal Units (RTU)

6.3.3.1 General

The contractor shall be responsible for the design and supply of all equipment such that the complete functioning with the rest of the SCADA system is guaranteed. The plant connectivity to the RTU shall be designed in such way that 11kV and 33kV plants shall not be connected together on the same RTU.

All equipment must correctly interface with one another and also with the existing plant. SEL 3530 shall be used as the main RTU and SEL 2515 units shall be utilized to connect additional I/O as required.

The new RTU shall be connected to the main SCADA system using the EFL's fibre optic communication network provided through single mode OPGW and ADSS fibre. The communication protocol between the RTU and the SCADA master station shall use DNP 3.0 TCP/IP for stations which has fibre connectivity while stations which rely on serial communication as a means to connect to the SCADA master station shall use DNP serial.

6.3.3.2 Detailed Specifications of RTU

The RTU shall be a SEL 3530 and shall be of a modular design capable of being readily expanded by adding more input/output modules. The equipment shall be reliable and shall communicate with main SCADA system using DNP 3.0 protocol.

The number of inputs/outputs required will be given under the scope of work.

Digital input: As given in the scope of works
Analogue input: As given in the scope of works
Power Supply Input voltage 110V DC.

6.3.3.3 Environmental

Operating temperature 0 .. +55 °C
Relative humidity 5..95(non-condensing) according to DIN 40040 Class F

6.3.4 Alarms and Indications

Alarms and indications shall be installed on all relevant equipment. The major alarms shall be so wired that they are visible with the cabinet door closed. Voltage free contacts shall be provided to relay these indications to a remote point. The contractor shall provide a list of alarms available, with the offer.

6.3.5 SCADA I/O Points

All I/O points shall be wired to the RTU and brought back to the Employer's Master station. The Employer will then decide on the points that will be used on the iFix SCADA system for control and monitoring. The Standard I/O points are given below. A final list will be provided once the contract is finalised.

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6.3.5.1 36 kV I/O Points

ITEM	33 kV TRF		33kV TRF. CB CONTROL		33kV FEEDER CB CONTROL		33kV ISOLATOR		33kV EARTH SWITCH		33kV BUS SECTION CB CONTROL		TAP CHANGER CONTROL	
CONTROL	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
Open/Close	√	√	√	√	√	√	√	√			√	√		
Dead Bar Close	√	√	√	√	√	√					√	√		
AutoSync	√	√	√	√	√	√					√	√		
Generator Start/Stop														
Generator Speed Raise/Lower														
Generator Volts Raise/Lower														
Protection On											√	√		
Protection Off											√	√		
Reset Protection Relay	√	√	√	√	√	√								
OLTC Auto/Manual	√	√											√	√
OLTC Raise/Lower	√	√											√	√
OLTC Master/Follower	√	√											√	√
INDICATIONS	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
Open/Close	√	√	√	√	√	√	√	√	√	√	√	√		
Dead Bar Close	√	√	√	√	√	√					√	√		
Synchronising in Progress	√	√	√	√	√	√					√	√		
Synchronise Fail	√	√	√	√	√	√					√	√		
Distance to Fault Location					√	√								
TX Intertrip			√	√										
Station Local/Remote Control	√	√	√	√	√	√			√	√	√	√	√	√
Auto Reclose In														
Auto Reclose Out														
Auto Reclose in progress														
Protection On					√	√					√	√		
Protection Off														
Protection Fault														
OLTC Auto/Manual	√	√											√	√

Tap Position	√	√											√	√
Battery Charger DC fail														
Station A/C Supply fail														
Spring Charged			√	√	√	√					√	√		
MEASUREMENT	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
MW	√	√			√	√								
MVar	√	√			√	√								
Import/Export MW														
Import/Export Mvar														
Import/Export MWh														
Import/Export Mvarh														
Frequency											√	√		
Incomimg/Existing Frequency											√	√		
Delta Frequency											√	√		
R-ph Amps			√	√	√	√								
Y-ph Amps			√	√	√	√								
B-ph Amps			√	√	√	√								
Kilovolts			√	√							√	√		
ALARMS	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
R-ph Overcurrent Trip			√	√	√	√					√	√		
Y-ph Overcurrent Trip			√	√	√	√					√	√		
B-Ph Overcurrent Trip			√	√	√	√					√	√		
Earth Fault Trip			√	√	√	√					√	√		
Pilot Cable Translay Protection Trip														
Distance Protection Phase Trip			√	√	√	√								
Distance Protection Zone 1 Trip					√	√								
Distance Protection Zone 2 Trip					√	√								
Distance Protection Zone 3 Trip					√	√								
Distance Protection Faulty														
AutoRecloser -Operated														
Auto Reclose Lockout														
AutoRecloser RelayFailed														
SBEF Trip			√	√										

LV Earth Fault Trip	√	√												
LV REF Trip	√	√												
HV REF Trip	√	√												
REF Trip														
R-ph Differential Protection Trip	√	√	√	√										
Y-ph Differential Protection Trip	√	√	√	√										
B-ph Differential Protection Trip	√	√	√	√										
Buchholz Gas Alarm	√	√	√	√										
Main TX Buchholz Surge Trip	√	√	√	√										
Main TX Winding Temp High Warning	√	√	√	√										
Main TX Winding Temp Trip	√	√	√	√										
Generator Warning Alarms														
Generator Shutdown Alarms														
Zone Protection Trip											√	√		
Zone Protection Fail														
Overvoltage Trip														
Recloser Trip/Reclose														
Recloser Lockout														
Spring Charge Fail			√	√	√	√					√	√		
CB Fail			√	√	√	√					√	√		
Local/Remote			√	√	√	√					√	√		
Protection Fail			√	√	√	√					√	√		
Remote Control Blocked			√	√	√	√					√	√		
Battery Volts Low														
Battery Volts High														
Boost/Float Charge														
DC Load Amps														
Charger Fail														
Battery Earth Fault														
Station AC Supply Fail		.												

6.3.5.2 12 kV & Station I/O Points

ITEM	11kV TRANSF CB CONTROL		11kV FDR CB CONTROL		INTERCONNECTOR CB CONTROL		11kV BUS SECTION CB CONTROL		STATION		BATTERY CHARGER DC PANEL		AUXILIARY AC SUPPLY	
CONTROL	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
Open/Close	√	√	√	√	√	√	√	√						
Dead Bar Close	√	√			√	√	√	√						
AutoSync	√	√			√	√								
Generator Start/Stop														
Generator Speed Raise/Lower														
Generator Volts Raise/Lower														
Protection On							√	√						
Protection Off							√	√						
Reset Protection Relay	√	√	√	√	√	√								
OLTC Auto/Manual														
OLTC Raise/Lower														
OLTC Master/Follower														
INDICATIONS	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
Open/Close	√	√	√	√	√	√	√	√						
Dead Bar Close	√	√	√	√	√	√	√	√						
Synchronising in Progress	√	√	√	√	√	√	√	√						
Synchronise Fail	√	√	√	√	√	√	√	√						
Distance to Fault Location					√	√								
TX Intertrip														
Station Local/Remote Control	√	√	√	√	√	√	√	√	√	√				
Auto Reclose In														
Auto Reclose Out														
Auto Reclose in progress														
Protection On	√	√	√	√	√	√	√	√						
Protection Off			√	√										
Protection Fault														
OLTC Auto/Manual														

Tap Position														
Battery Charger DC fail											√	√		
Station A/C Supply fail													√	√
Spring Charged	√	√	√	√	√	√	√	√						
MEASUREMENT	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
MW	√	√												
MVar	√	√												
Import/Export MW					√	√			√	√				
Import/Export Mvar					√	√			√	√				
Import/Export MWh					√	√			√	√				
Import/Export Mvarh					√	√			√	√				
Frequency					√	√	√	√	√	√				
Incomimg/Existing Frequency					√	√	√	√						
Delta Frequency					√	√	√	√						
R-ph Amps	√	√	√	√	√	√								
Y-ph Amps	√	√	√	√	√	√								
B-ph Amps	√	√	√	√	√	√								
Kilovolts	√	√	√	√	√	√	√	√	√	√				
ALARMS	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA	LOCAL	SCADA
R-ph Overcurrent Trip	√	√	√	√	√	√	√	√						
Y-ph Overcurrent Trip	√	√	√	√	√	√	√	√						
B-Ph Overcurrent Trip	√	√	√	√	√	√	√	√						
Earth Fault Trip	√	√	√	√	√	√	√	√						
Pilot Cable Translay Protection Trip					√	√								
Distance Protection Phase Trip					√	√								
Distance Protection Zone 1 Trip														
Distance Protection Zone 2 Trip														
Distance Protection Zone 3 Trip														
Distance Protection Faulty														
AutoRecloser -Operated	√	√												
Auto Reclose Lockout	√	√												
AutoRecloser RelayFailed	√	√												
SBEF Trip														
LV Earth Fault Trip														

LV REF Trip														
HV REF Trip														
REF Trip														
R-ph Differential Protection Trip														
Y-ph Diifferential Protection Trip														
B-ph Diifferential Protection Trip														
Bucholz Gas Alarm														
Main TX Bucholz Surge Trip														
Main TX Winding Temp High Warning														
Main TX Winding Temp Trip														
Generator Warning Alarms														
Generator Shutdown Alarms														
Zone Protection Trip					√	√	√	√						
Zone Protection Fail					√	√								
Overvoltage Trip														
Recloser Trip/Reclose														
Recloser Lockout														
Spring Charge Fail	√	√	√	√	√	√	√	√						
CB Fail	√	√	√	√	√	√	√	√						
LocalRemote	√	√	√	√	√	√	√	√						
Protection Fail	√	√	√	√	√	√	√	√						
Remote Control Blocked	√	√	√	√	√	√	√	√						
Battery Volts Low											√	√		
Battery Volts High											√	√		
Boost/Float Charge											√	√		
DC Load Amps											√	√		
Charger Fail											√	√		
Battery Earth Fault											√	√		
Station AC Supply Fail											√	√		

6.3.6 External Wiring

All control and instrument panel will be wired with cable having flame retardant insulation and outer sheaths.
The wiring of all indications and controls will be done using multi-stranded, 1.5 mm^2 copper. However for Current Transformer Secondary wiring side, since transducers will have to be wired in series, the wiring will be of 2.5 mm^2 or 4.0 mm^2 copper (where the distances are long) in order to reduce burden. The multi-core cables supplied shall be made up of fine strands of plain copper wire with PVC based insulation and an outer sheath of PVC. Any fillers used to make a circular compact cable shall be non-hygroscopic. The armoured cable shall be similar in construction, but with a galvanized wire armour and outer PVC sheath.

The nominal operating voltage of cables shall be 300 V between core and earth 500 V between cores. This rating shall be stamped on the outer sheath of cable. The cores of control cables shall be identified by means of numerals printed at regular intervals throughout the length of the core. Armoured cable will be used between marshalling kiosk and outdoor equipment. All control and power cables shall include a green/yellow protective core in addition to the specified number of cores. All material required for installation work such as, cable glands, numbering systems, cable ties, terminals etc. should be provided with 10% extra.

6.4 VHF Radio Network

The Contractor is to install VHF half duplex radio for backup communications in case of failure of the LAN. The mobile radio and base are to be TAIT radios: model No.TM935.

6.5 System Requirements

The offered equipment shall be in compliance with all facilities existing and or provided by others and their capabilities, also future demands beyond the actual capacity shall be considered within the scope of this project.
It is required that the Bidder submits, together with the technical description of the equipment, proposals for:

- expansion/conversion of transmission equipment for higher multiplexer levels and combined use for public services on telephone and facsimile
- incorporation of the supplied equipment into the existing telecommunication network.

CHAPTER 7 - EARTHING SYSTEMS, ELECTRODES AND CONNECTIONS

7.1 GENERAL

The earthing of all equipment and the provision of earthing systems, electrodes and connections shall be in accordance with the recommendations in the "Guide for safety in Substation Grounding" IEEE No. 80 and the requirements of this Chapter. Steelworks and supporting structures shall be bonded and earthed to the substation earthing system. Earth connections shall be made approximately 250 mm above the top of the finished foundation level. Connections shall be made also to the earth terminals of operating mechanisms, control cubicles and marshalling kiosks. Except where the earth connection is bonded to the steelwork, insulated clamps shall be provided for supporting the earthing connection to high level equipment and the earth screen.
There shall be an extension of the earth bar system into the substation buildings for connecting to indoor switchgear, control, relay and ancillary equipment. All necessary studs, connectors and earth bars shall be provided to permit the connection of each switchboard, motor or other electrical equipment supplies under the Contract to the substation general earthing system. The provision for earthing shall be such that no reliance is to be placed on the conductivity of metal to metal joints without the use of special connectors however lightning arresters must be directly connected to the earthing grid. Brass nuts should be used to connect to studs to earth connections connected to the fence.

7.2 EXTENT OF WORK

The Contract includes the Complete design of the substation earthing system including, connections of Plant supplied under this Contract to the main earthing system and all Site Tests as specified in this specification.
The main earth system shall be installed prior to the construction of the building, transformer and equipment foundations. The Contractor will be required to prepare installation drawings and schedules of material to be provided. These drawings and schedules shall be submitted to the Employer's Representative for approval together with calculations of step, touch and mesh potentials. The contractor shall connect the new earthing grid to the existing earthing grids if available. The Employer's Representative shall approve the position at which the connections are made and the number of connections.

7.3 DESIGN OF EARTHING SYSTEMS

The grounding system shall be designed according to the guideline given in ANSI/IEEE Standard 80.
The site shall be provided with earth grid of buried conductors designed for an earth fault current specified in chapter 1 for duration of 3 second, keeping the step and touch voltages within the limits as recommended in the guide ANSI/IEEE std. 80. The design of earth grid over the area occupied by outdoor switchgear and associated apparatus shall be based on a maximum grid spacing of 10m x 5m.The Contractor shall carry out Site tests of the ground resistivity not later than one month after the award of the Contract and his final design of the earthing system shall be submitted and approved prior to foundation excavation works.

Earthing points shall be provided by the Contractor such that the combined resistance of the earth grid and earthing points does not exceed 1 ohm, however combined resistance shall be considered for acceptance provided that the conditions recommended above are satisfied. It is the Contractor's responsibility to provide design calculations.

7.4 CONSTRUCTION OF EARTH GRIDS

The earth grids shall be of hard drawn high conductivity copper conductor, and shall be installed at a depth approved by the Employer's Representative below the ground level. The size will of the copper conductor has to be calculated but a minimum of 70mm^2 has to be used. After the construction of footings and foundations the area shall be backfilled. Cadweld shall be used where two or more earth wires are to be joined. Connections for the transformer neutrals shall be provided

7.5 EARTHING POINTS

The number of earthing points shall be verified by Site earth resistivity tests after the letting of the Contract and handover of the site to the Contractor.

7.5.1 Earthing Points

Each will consist of at least 15mm diameter copper rod electrodes, driven into undisturbed soil. Each electrode will be complete with approved non-ferrous clamps for the connection of earthing conductors and with a hardened steel tip and cap driving by means of a power hammer. Test link chambers and covers for each earthing point are to be provided and the Contractor for the approval of the Employer's Representative shall submit a drawing showing the proposed arrangement.

7.6 CONNECTIONS OF EARTHING POINTS AND SYSTEM NEUTRALS

The electrodes of an earthing point shall be connected to the test link and there shall be duplicate conductors from each test link to the earth grid. Any neutral points for high voltage systems within the substation will have duplicate connections to earth grid. Conductors interconnecting the electrodes to a test link and between the test links and the earth grid will have a cross-sectional area of not less than 150 sq. mm. There will be at least two connections from each steel support etc. to the earth grid. Duplicate connections may be in the form of rings.
Earthing conductors will be of soft annealed high conductivity copper stranded in accordance with Table 4 in BS.6346. Earthing conductors will normally be buried directly in the ground but where necessary they may be cleated to walls, fixed to cable racks or laid in the cable trenches as convenient.

7.7 EARTHING OF EQUIPMENT

The frames of all electrical apparatus and the bases of all structural steelwork shall be connected by branches running to a group of equipment. All isolator bases, earth terminals and earthing switches, neutral current transformers shall be connected to the earth grid. An earth electrode, which may be part of the grid, shall be provided as near as practicable to each set of surge arresters. Earthing of 36 kV switchgear room shall be properly performed with copper strip, which enable connection to the equipment installed in and linked to main grid with more than two wires.

7.8 JOINTING AND BONDING

Connections to plant and equipment shall be made using the earthing terminals specified in the Contract. Where a strip has to be drilled to fit an earth terminal the hole shall not be greater than half the width of the strip.
Joints in earthing strip shall employ chemical welding or high compression joints.

CHAPTER 8 - POWER AND CONTROL CABLES

8.1 GENERAL

This Chapter of the Specification applies to single core and multicore solid dielectric insulated power cables and control cables. Polyvinyl Chloride (PVC) insulated cables shall generally be supplied for conductor cross-sections smaller or equal to 16 mm^2. Cross-linked polyethylene (XLPE) cables shall be generally supplied for larger cross-section than 16 mm^2.

8.2 L.V. 1000V SOLID DIELECTRIC POWER CABLES

8.2.1 Conductors

Conductors smaller or equal to 16 mm^2 shall consist of solid annealed copper or solid aluminium. They shall comply with IEC 60228,60229,60287 and 60811. Non-circular stranded conductors shall be pre-spiralled and compacted. Conductors of cross-section area larger than 16mm^2 shall be of stranded copper.

8.2.2 Insulation

Insulation shall be in accordance with IEC 60502 Clause 4.

8.2.3 Laying-Up

Laying-up of multi-core cables shall be in accordance with BS 5467 Clause 9.

8.2.4 Fillers

Where fillers are necessary to make a circular compact cable, for PVC insulated cable they shall be of PVC, for XLPE cable they shall be of PVC or cross-linked polyethylene. Textile and other hygroscopic materials are not permitted.

8.2.5 Core Identification

The cores shall be colour identified in accordance with Clause 7 of BS 6346, or Clause 8 of BS 5467.

8.2.6 Voltage Identification

The PVC outer sheath shall be embossed' "ELECTRIC CABLES" followed by the voltage, in accordance with Clause 15.2 of BS. 5467.

8.2.7 Screening

Conductor and insulation screening shall comply with IEC 60502 Clauses 5.2 and 5.3 and copper screens to Clause 8 of the same publication.

8.2.8 Armour

Armour bedding on multi-core cables shall comply with IEC 60502 Clause 6.6 and steel wire armour with Clause 11.

8.2.9 Oversheath

PVC outer covering type 9 (BS. 6746) shall be in accordance with IEC 60502 Clause 12.

8.2.10 Jointing

Jointing of LV cable is not permitted.

8.2.11 Sealing And Drumming

Immediately after the cable laying and testing, both end of the cable shall be sealed against the ingress of moisture, dirt and insects. The end projecting from the drum shall be similarly sealed and adequately protected against mechanical damage during handling.

8.2.12 Jointing Accessories

Jointing accessories for stranded copper conductor cables shall be designed for indentation ferrules. Solid aluminium conductors may be jointed with soldered ferrule. Conductor temperature during the soldering process shall be carefully monitored as not to exceed the maximum insulation temperature stated in the Technical particulars and Guarantees.

8.3 PVC INSULATED CONTROL CABLES

8.3.1 Scope

This part of the Chapter is for control cables with stranded copper conductors, PVC insulated, shielded if required and PVC sheathed overall. The cable design shall generally be in accordance with IEC 60228 & IEC 60287.

8.3.2 Conductors

Conductors shall be of plain copper and have a cross sectional area of 2.5 mm^2 made up of 50/0.25mm strands or 4mm^2 made up of 56/0.30mm strands. Copper conductors shall meet the requirements of IEC 60028.

8.3.3 Laying Up

Multicore control cables shall contain one of the following standard numbers of cores - 4, 7, 12, 27, 37 & 48. For control cables having more than seven cores, the direction of lay shall alternate for each successive layer. A PTP binder tape 0.013mm thick applied over the laid up cores may be used at the discretion of the manufacturer.

8.3.4 Fillers

Where fillers are necessary to make circular compact PVC insulated cable, they shall be of PVC. Textile and other hygroscopic materials are not permitted.

8.3.5 Core Identification

The cores of control cables shall be identified in accordance with Employer's Standards for control wiring. These standards shall be provided to the Contractor upon request. When numerals are used, they shall be printed in black on the white core insulation at intervals not greater than 75mm throughout the length of the core. The print shall be permanent and not easily removed.

8.3.6 Voltage Identification

The PVC outer sheath of control cables shall be embossed with the legend "ELECTRIC LV CONTROL CABLE". The letter shall be raised and consist of upright block characters in accordance with the requirements of BS 6346.

8.3.7 Jointing Accessories

Details of the jointing method shall be given by the Contractor with the jointing accessory designs.
Jointing of control cables is normally not permitted but in exceptional circumstances may be allowed subject to the Employer's Representative's approval. In this case stranded copper conductors may be jointed together by crimped type ferrules and the single wires to be insulated by heat shrinkable tubes, which shall also be applied as an overall sheath for the jointed cable.

8.3.8 Armour

Armour bedding on multi-core cables shall comply with IEC 60502 Clause 6.6 and steel wire armour with Clause 11.

8.3.9 Oversheath

PVC outer covering shall be in accordance with IEC 60502.

8.4 POLYETHYLENE INSULATED TELEPHONE TYPE CABLES

8.4.1 Design

Telephone type multi pair underground type and catenary type cables shall be of the filled type and shall have plain copper conductors insulated with polyethylene, armoured (underground type) and shall be sheathed overall with PVC. They shall be suitable for internal and external use in a tropical climate. Catenary type cables shall be suitable for an induced voltage up to 15kV.

8.4.2 Conductors

Each conductor shall consist of a single annealed copper wire, to BS. 6360 or IEC 60228 in so far as applicable for plain annealed copper wires and shall have a standard diameter of.

Underground type cable	-	0.9mm
Catenary type cable	-	1.38mm

The DC resistance per km of each conductor in the finished cable at 20^0 C shall not exceed 29.67 ohms and 13.61 ohms respectively.

8.4.3 Insulation

The conductor insulation shall be of extruded polyethylene type 03 in accordance with BS. 6234. The radial thickness of insulation shall be:

0.80mm +/- 0.14 for both catenary type cables.

The insulation thickness shall be determined in accordance with Clause 18 of BS 6346.

8.4.4 Identification of Cores

The cable shall be made with twin twisted pairs. Cores shall be clearly colour identified as per attached Table 1.

8.4.5 Twinning and Laying Up

The insulated conductors shall be uniformly twisted together in pairs with a right hand lay. The length of lay shall not exceed 150mm and the lays of pairs which are adjacent within the finished cable shall differ in length and shall be so chosen that cross talk is as small as possible. In the case of two pair cables, the cores shall be laid in quad formation.

8.4.6 Fillers

Where Fillers are necessary for the satisfactory laying up of the cable pairs. They shall be of Polyethylene. Textile fillers are prohibited.

8.4.7 Binders

A polyethylene terephthalate (PTP) tape having a thickness of not less than 0.013mm shall be applied as an open helix over the centre cores if more than one pair and over each successive layer except the out layer over which the tape shall be applied with a 50 per cent overlap.

8.4.8 Bedding

Cables shall be provided with a bedding of extruded polyethylene type 03C in accordance with BS 6234. The armour bedding of underground type cables shall have a radial thickness in accordance with Table. 2. The bedding thickness of catenary type cables shall be 1.8mm.

8.4.9 Armour (Underground Type Cables Only)

The armour shall consist of one layer of galvanised steel or aluminium wires complying with the requirements of BS EN 10257 Part 1 and BS 2627 (condition H68) where appropriate. The size of armour wires shall be in accordance with Table 2.

8.4.10 Screening (Catenary Type Cables Only)

A screen consisting of a helical lapping of aluminium tape, which shall be, electrically continuous, shall be applied with a thirty percent overlap over the polyethylene bedding. The aluminium tape shall be 0.08mm thick and for cables of five pairs or more, of a width not exceeding the diameter of the laid up pairs plus 6mm tolerance. Alternatively, two tapes each applied with a gap not exceeding 3mm and breaking joint, or a polyethylene/aluminium laminate tape applied longitudinally may be used.

8.4.11 Oversheath (Underground Type Cables Only)

The outer protective covering shall consist of an extruded PVC compound shall be type TM 1 and coloured black in accordance with BS 6746. The sheath radial thickness shall comply with Table 2 and shall be determined in accordance with Clause 19 of BS 6346.

8.4.12 Integral Suspension String (Catenary Type Cables Only)

Catenary type cables shall incorporate an integral suspension strand which shall be of galvanised wire to BS 183 (Grade 1150), 7./1.25mm for cables with a diameter not exceeding 20mm and 7/1.60mm for cables having a greater diameter. The oversheath shall be PVC type TM1, coloured over the cable cores and the suspension wire to form a dumbbell cross section with a suitable dimensioned web for each size of cable. Dimensions to be supplied in Technical Particulars and Guarantees.

8.4.13 Identification of Manufacturer

The PVC oversheath shall be embossed with the name of the manufacturer and year of manufacture followed by

ELECTRIC CABLE - TELE

Embossing shall comply with Clause 14.2 of BS 5346.

8.4.14 Cable Lengths

The cables shall be supplied in drum lengths of not less than 500m unless shorter lengths are specified or are required to complete a specific order.

8.4.15 Jointing And Terminating Accessories

Straight through jointing accessories for telephone type control cables shall be designed or the accommodation of crimped ferrules. Straight through jointing of short cable lengths is normally not permitted but, in exceptional circumstances, may be allowed subject to the Employer's Representative's approval.

8.5 36 kV POWER CABLES AND TERMINATIONS

8.5.1 General Requirements

36 kV power cables are required as follows:
For all 36 kV single core XLPE insulated aluminium conductor cable shall be used. The conductor size shall be 630 mm^2 rated for approximately 650A.

The cables will comprise aluminium conductor, semi conducting conductor screen, XLPE insulation, semi conducting insulation screen, copper tape shielding, PVC sheath. The current capacity shall be for the following operating conditions:

-	Ground temperature at 1 m depth of cover	30^0	C
-	Maximum conductor temperature XLPE	90^0	C
-	Maximum conductor temperature XLPE (Short circuit)	250^0	C
-	Average Thermal resistivity of soil	1.20	Km/W

8.5.2 Construction of Cross-Linked Polyethylene Insulated Cables

(i) Conductors shall consist of stranded circular or compressed hard aluminium wires. Aluminium wires shall comply with IEC 61089. Non-circular conductors shall be pre spiralled and completed. The conductors shall comply with IEC 60228.

*(ii) Conductor screening shall be extruded semi-conductor 1mm thick.

*(iii) The insulation shall consist of unfilled cross linked thermosetting polyethylene (XLPE) as defined in IPCEA S-66-524 NEMA WC 7 and shall be extruded in accordance with Clause 4 of IEC 60502-1. It shall be nominally 9.0mm thick for 36kV cables.

*(iv) The insulation screen shall consist of an extruded semi-conductor of minimum thickness 0.8 mm in intimate contact with the insulation in combination with double layer copper tape of minimum thickness 0.075mm and 20% interposed.

(v) The sheath shall consist of an extruded black PE compound applied directly over the cable shielding. The sheath shall be of minimum thickness 3.2mm for 36kV cables.

(vi) 36kV cables are to be provided preferably with baked-on graphite coating

(vii) The PVC oversheath shall be embossed with the name of the manufacturer followed by:
ELECTRIC CABLES 36,000 Volts

* - These three layers shall be triple-extruded. (in one process)

Cables shall be supplied in maximum drum lengths, bearing in mind any transportation that may be involved. No drum shall contain more than one length of cable. Immediately after cable laying and testing, both ends of every cable length shall be sealed by a heat-shrinkable end-cap. The ends of the factory lengths shall be marked “A” and “Z” in accordance with BS 6480.The cable and projecting from the drum shall be adequately protected to prevent damage during handling and in transit.

8.5.3 Cable terminations

Terminations and joints shall be either of a heat shrinkable polymeric or pre-moulded type. They shall be factory assembled kits of the cable manufacture containing all the necessary components to reinstate the cable insulation, metallic shielding of each core, together with the reinstatement of the outer sheath, equivalent for size of cable. Each terminating or jointing kit shall be in a separate package and a list of materials indicating quantities and weights in the kit, and an instruction sheet shall be included in the package. Kits shall contain sufficient cleaning solvents and cleaning clothes for the proper making of the joint or termination. Voltage stress relief shall be provided and this may be inherent in the heat recoverable polymeric material or alternatively incorporated in the pre-moulded termination. The termination or joint shall be capable of tolerating any variances in the manufacture dimensions of the cable such as oval, out of round, sectored or oversize cable cores. The termination shall be capable of immediate energisation once all components have been installed. The terminating or jointing materials shall not be subject to storage limitations such as controlled temperature or humidity restrictions, nor have shelf life limitations.

The termination kits shall have the following features (one or more of which may be included in one item):

- bimetallic compression lugs
- weatherproof seal between lugs and termination
- non-tracking weather resistant exterior complete with weather skirts for outdoor terminations
- built-in stress control equipment
- copper braid for earthing onto screen
- all other items necessary to complete the kit.

Heat shrinkable polymeric materials and terminations shall comply with requirements of IEC 60502, IEC 60466 appendix C, IEC 60060 sub clause 3.3, IEC 60071, IEC 60507 Chapter 3.The materials, completed terminations and joints shall be for the appropriate type of service, size and voltage. They shall include ferrules, lugs and other materials necessary for the terminating and jointing of the conductor and clamps, braid, etc. necessary for the terminating, jointing of screen and sheath for earth continuity. All heat shrinkable polymeric tubing and premoulded materials shall be ultra violet stable, non-tracking (per ASTM D2302) and suitable for operation in the presence of severe external contamination and environmental pollution. The entire termination or joint shall be environmentally sealed and capable of preventing the ingress of external moisture and contamination.
Terminations for auxiliary transformer shall be withdrawable plug and socket type (elastomeric or similar), which shall provide a fully insulated assembly of the cable and transformer bushing. The Contractor shall submit for the approval of the Employer's Representative, before jointing commences, copies of all the jointing instructions to be issued to the cable jointers for each type of jointing accessories included in this Chapter. Further copies shall be supplied at the completion of the Contract in the operation & maintenance manual.

8.6 CABLE END BOXES AND GLANDS

8.6.1 Cable End Boxes

Electrical equipment supplied under this Contract is to be fitted where specified with approved cable end boxes or glands, which are to be completed with all necessary fittings. Cable boxes are to be adequate proportions and designed in such a manner that they can be opened for inspection without disturbing the gland plate or incoming cable. Air filled cable boxes are acceptable where the terminations of solid dielectric or oil impregnated non draining cables and the connections to the Plant or cable disconnecting chamber are entirely sealed in heat shrinking plastic or elastomeric sheaths. Glands insulated from the body of the cable box are to be supplied where detailed in the appropriate Chapter of this Specification. Provision shall be made for earthing the metal body of each cable box. Where cable boxes are provided for three-core cables the seating sockets on the outer phases shall be inclined towards the centre to minimise bending of the cable cores.

8.6.2 Compression Glands

Compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be designed to secure the armour wires to provide electrical continuity between the armour and the threaded. Fixing component of the gland and to provide watertight seals between the cable outer sheath and gland and between the inner sheath and threaded fixing component. The glands shall preferably project above the gland plate to avoid entry of moisture.

8.7 CONCRETE CABLE TRENCHES – OUTSIDE CONTROL BUILDING

8.7.1 Concrete Cable Trench

The Contractor is required to construct 1 No. concrete cable trench outside the control building up to the lot boundary as specified in Clause 1.1.2 for 33kV & 11kV power cabling works. The Contractor will be required to submit proposed design to Employer's Representative to seek approval before design is finalized. The exact location of concrete trench shall be agreed at the site with the Employer's Representative before the installation work begins. Permits for excavation shall be obtained from the Employer's Representative.

The concrete cable trench shall be designed as straight as possible and shall be constructed to approved formations and dimensions. The concrete cable trench could be either made up of block walls or pre-cast slabs. The width and depth of the trench shall be 1800 mm and 1600mm respectively. A four (4) lane of fabricated mild steel structures

shall be fixed (dyna bolted) onto the inner sides of the concrete cable trench to form 4 Nos. cable hangers (L-shaped). The required width and height of the cable hanger shall be 350mm and 220mm respectively. The cable hangers will be required at every 1m and a gothic mesh will be required over these cable hangers. The concrete trench shall be 150mm above finish ground level. The concrete trench shall have removable trench covers/lids.

The Contractor will be required to make cable entry and exit provisions onto the concrete cable during its construction. The Contractor shall use no power excavation tools for excavation with in outdoor switchgear. The contractor shall take all precautions to avoid damaging any other power cables along the cable route. The Contractor will be required to invite Employer's Representative to carry out progressive inspection of the concrete trench.

8.7.2 Cable Laying

The power cable laying inside control building shall be carried out only under the direct supervision of a responsible officer and only in the presence of a representative of the Employer's Representative.

8.8 TESTS AT MANUFACTURER'S WORK

8.8.1 Cables 36 kV and above

8.8.1.1 Routine Tests

Solid dielectric cables drum lengths shall be subjected to the following tests:

(a) Conductor and Copper screen resistance as per IEC 60502 clause 16.2.
(b) High voltage test as per IEC 60502.
(c) Insulation resistance test.
(d) Partial discharge test. The partial discharge test shall be carried out during the H.V test. The detectable discharge pulse shall not be greater than 10pC at 1.3Uo and 30pC at 2.5Uo.The partial discharge extinction voltage shall be recorded.
(e) Voltage test on PE outer covering (30/36kV cables only):8 kV d.c./mm thickness for one minute - 25kV maximum or 4kV a.c./mm thickness for one minute - 21.5kV maximum. If backed-on graphite coating is not provided, cable drum length shall be completely immersed in water for execution of test.
(f) Measurement checks as per IEC.60502.

8.8.1.2 Sample Tests

The sample lengths shall be tested in accordance with IEC 60502 Clause 16.During the H.V. test, the discharge inception and extinction voltages shall be recorded

8.8.1.3 Type Tests

The sample length to be type tested shall contain all jointing accessories required on the Contract and Tests shall be carried out in accordance with IEC.60502

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CHAPTER 9 - ENERGY METERING

9.1 General

All metering on 33kV busbar, feeders and transformers shall be done using the NEMO meters. All metering on 11kV busbar and 11kV feeders shall be done using SEL relays.

9.2 Installation

Contractor shall perform visual inspection to ensure that there is no damage resulting from shipment. The relay shall provide the following minimum readings:

- Ampere
- kV
- MW
- MWh
- MVAR
- Power Factor

The Contractor shall ensure that these readings are able to be monitored locally and remotely. The relay shall be capable of storing the data for downloading.

CHAPTER 10 - TRANSFORMERS

10.1 TYPE OF TRANSFORMER AND OPERATING CONDITIONS

10.1.1 General

The Employer's will accept main power transformer manufactured by either Wilson Transformers in Australia or Tyree Transformers in Australia. Transformers manufactured by other reputable manufacturers that fully comply with all requirements of the technical specification provided in the tender document shall also be accepted. Bidders must substantiate reliability of transformer offered by other reputable manufacturers by providing evidence of long term field operation of such transformer. All transformers shall be oil immersed and suitable for outdoor installation and shall comply with IEC 60076, IEC 60137, 60214 & 60289. Each item or function which is obviously necessary for the proper completion of the work, it's full functionality and safety as well as complete interfacing with other work, whether especially specified in the tender documents or not, shall be included in the tender price. The transformers shall be fitted with a MR Reinhausen vacuum on-load divertor switch tap-changer (OLTC) with 33kV and 11kV cable end box. The transformers shall be delivered to site without oil, under dry pressurised Nitrogen air with gauges.

The new 12/15MVA 33/11kV power transformer for Kalabu Tax Free Zone Substation shall consist of as specifications outlined below:

Rating	12/15 MVA
High voltage winding	33kV + 8*1.5% kV, - 10*1.5%kV
Low voltage winding	11kV
Frequency	50 Hz
Vector group	Dyn 1
Cooling	ONAN/ ONAF
Tap Changer	M R ON-load vacuum Divertor Switch
Impedance volts	7 %
HV bushings	Enclosed in cable end box
NV Neutral bushing	Enclosed in cable end box
LV bushings	Enclosed in cable end box

10.1.2 Cooling

The types of cooling shall be as stated in the Employer's Requirements and the letters relating to the method of oil circulating and cooling used in this Specification and Employer's Requirements shall be in accordance with IEC 60076.Where a combination of two methods of cooling is applied to one transformer as for ONAN/ONAF units, the transformer shall be capable of operating under the ONAN condition as stated in the Employer's Requirements, after which the cooling equipment is to come into operation and the Transformer will operate as an ONAF unit. Transformers shall be fitted with tank mounted radiators. They shall be capable of remaining at the operation of full load for 20 minutes in the event of failure of blowers associated with both coolers without the calculated winding hot spot temperature exceeding 130^0C.Failure of one fan in each group of blowers shall not reduce the continuous maximum rating of the transformer.

10.1.3 Parallel Operation

Transformers supplied against each item shall be designed to operate satisfactorily with the others when operating on the same tap position.

10.2 CONTINUOUS MAXIMUM RATING

Transformers shall have the continuous maximum rating as stated in the Employer's Requirements and shall comply with the requirements as regards temperature rise and overloads on all tapings irrespective of the direction of power flow and with the voltage of the lower voltage winding at the normal voltage stated in the Employer's

Requirements. To allow for high atmospheric temperatures, the allowable temperature rise shall be reduced as stated in this Specification. The overload capability shall be in accordance with IEC 60354.

10.2.1 Electrical Connections

Transformer windings shall be connected in accordance with the IEC 60076 group symbol specified in the Employer's Requirements. The neutral point shall be brought out of the tank and earthed outside of the tank.
All electrical connections within windings shall be brazed but subject to approval, mechanically crimped joints may be used for round stranded conductors on tapping, bushing or earthing connections and on bundle conductors when design has been proved by the type test and application is subject to rigorous quality control.

10.3 ABILITY TO WITHSTAND SHORT CIRCUIT

10.3.1 General

All transformers shall be capable of withstanding on any tapping and without damage the thermal and dynamic effects of external short circuits under the conditions stated in IEC 60076 Part 5. For at least 3 seconds at rated conditions and after all loading conditions as specified in IEC 60354.

10.3.2 Calculations and Tests

Evidence shall be submitted with the Tender as to the extent to which the manufacturer has proved or is able to prove either by calculation or test the ability of the specified Transformers to withstand short circuit. The Tenderer shall submit a reference list of two or more transformers of same or similar design and rating manufactured and supplied by the manufacturer for orders from outside the country of the manufacture. Offered transformer will only be accepted if transformers identical/similar in design have a minimum of five years field experience.

10.4 LOSSES AND EVALUATION OF LOSSES

The Tenderer shall state in the Technical Particulars and Guarantees, guaranteed values for component losses of the total loss which shall be as low as is consistent with transport restrictions, reliability and economic use of materials. Tenders will be assessed on the basis of the least 'Present Worth' of capital cost plus guaranteed losses, being the sum of the installed Tender Price of the transformers plus:

No load losses	-	6700 Fijian Dollars/kW
Copper losses	-	970 Fijian Dollars/kW

The acceptance of transformers yielding component losses higher than the guaranteed values shall be governed by either of the following: -

(A) Component losses in excess of guaranteed values but within the tolerance permitted under IEC 60076 Part 1.Transformers shall be accepted subject to full compliance with all technical particulars including temperature rises at CMR and subject to the Tenderer accepting deduction from the Contract Price of charges for each kW on part thereof of component losses in excess of the guaranteed values, at the above evaluation rates.

(B) Component losses in excess of guaranteed values and exceeding the tolerance permitted under IEC 60076 Part 1.The acceptance of transformers shall be entirely at the discretion of the Employer's Representative/Employer and subject to the Tenderer accepting the deduction from the Contract Price of charges for each kW on part thereof of component losses in excess of the guaranteed values, at the above loss evaluation rates. In the event of transformers, which are, either equal to or below the guaranteed losses values, the Tenderer will not be entitled to any premium in respect of reduction in losses below the guaranteed values.

10.5 IMPEDANCE

The value of impedance measured on principal and extreme tappings shall be as stated in the Schedule and minimum and maximum values where stated in the Employer's Requirements shall not be subject to tolerance.

Where transformers are required to operate in parallel with existing units the appropriate data will be stated in the Employer's Requirements.

10.6 NOISE

The transformer noise levels shall be measured as a type test and in accordance with IEC 60551. The noise level of the transformers shall be as stated in the Employer's Requirements. When the bottom plate of the transformer tank will be in direct contact with the surface of the foundation anti-vibration pads shall be provided for insertion between the transformer and its foundation.

a) Measurement and calculation of sound power levels shall comply IEC 60076-10
b) The permissible maximum sound pressure level for the transformer operating at 15MVA measured 5 metres from the transformer shall not exceed 40 dB(A) with the transformer energised to 100% voltage on the principal tap and rated frequency with ONAN.
c) The permissible maximum sound power level for the transformer operating at maximum rating of 15MVA measured 5 metres from the transformer shall not exceed 40 dB(A) with the transformer energised to 100% voltage on the principal tap and supplied auxiliaries operating (i.e. fans, etc.).

10.6.1 CORONA INCEPTION FIELDS

Under Induced and Impulse test voltage conditions, there shall be at any particular stress point a minimum 35% safety margin between the corona inception field strength and the actual figure determined from the field plots supplied by the Contractor for all oil ducts in both axial and radial dimensions. The corona inception field strength shall be referenced to the published curves A 41-5 (2) and A 41-6 (2) in Weidmann Book Band 1, Volume 1.

10.7 HARMONIC SUPPRESSION

Transformers shall be designed with particular attention to the suppression of harmonic voltages, especially the third, fifth and seventh harmonics and to minimize the detrimental effects resulting therefrom.

10.8 MAGNETIC CIRCUIT AND WINDINGS

10.8.1 Magnetic Circuit

The design of the magnetic circuit shall be such as to avoid static discharges development of short circuit paths internally or to the earthed clamping structure, and the production of flux components normal to the plane of the laminations. Each lamination shall be insulated with a material stable under the action of pressure and hot oil.
The winding structure and major insulation shall be designed to permit an unobstructed flow of cooling oil through core cooling ducts to ensure efficient core cooling. The magnetic circuit shall be insulated from all structural parts, and shall be capable of withstanding a test voltage to core bolts and to the frame of 2,500 volts RMS for one minute. In order to allow testing, 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.

10.8.2 Flux Density

Core shall be constructed from cold rolled grain oriented steel sheets. Design shall be such that there will be no adverse effects due to core or stray flux heating with the quality of steel employed, and that when operating under the most onerous conditions envisaged in IEC 60076 and IEC. 60354, flux density in any part of the magnetic circuit does not exceed 15,000 lines per square centimetre (i.e. 1.5 Tesla).The maximum flux density in the legs and yokes of the core shall not exceed 1.5 Tesla at rated voltage and frequency.

10.8.3 Windings

All windings shall have copper conductors from SAM DONG KOREA or better alternative. Transformer 33kV delta connected windings may have graded insulation as defined in IEC 60076 and 11 kV winding shall have uniform

insulation as defined in IEC 60076. All neutral points shall be insulated to withstand an applied voltage test specified in the Employer's Requirements.

The windings shall also be thoroughly seasoned during manufacture by the application of axial pressure at a high temperature for such length of time as will ensure that further shrinkage is unlikely to occur in service. The windings and leads of all transformers shall be braced to withstand the shocks, which may occur through rough handling and vibration during transport, switching and other transient service conditions including external short circuit.

If the winding is built up of sections or of disc coils splitted by spacers, the clamping arrangements shall ensure that equal pressures are applied to all columns of spacers.

Regardless of the mode of cooling specified in accordance with IEC 60076-2 Clause 3, the transformer windings shall have fully directed oil flow consisting of the following:

1. Oil from the radiators directed into the bottom of each winding.
2. Directed oil flow within each winding by means of zig zag cooling directed flow washers. Klakbands shall not be used.
3. The transformer winding conductors and conductor connections shall be constructed from high conductivity copper and shall be burr free and profiled.
4. All electrical connections within windings shall be brazed or welded to withstand shocks of the type that might occur through handling, vibration during transport, switching, earthquakes and other transient fault service conditions. Soft soldered connections are not acceptable.
5. All connections from windings shall be mechanically sound, supported and fastened to prevent movement and damage under transport, site erection, and normal and abnormal operating conditions.
6. If a brazed crimp or crimp joint is used to connect the winding lead-out and the lead connection, the Contractor shall state the type of joint to be used and the method of stress relieving; both of which shall be subject to the approval of the Employer.
7. All cylinders/wraps shall be made of pre-compressed transformer board. Machined wrapped paper cylinders/wraps are not acceptable.
8. Scarfed overlap shall be used for forming cylinders and angle collars. Overlaps shall be formed on duct strips
9. Only moulded angle collars/caps shall be used from high density pre-compressed boards with contoured edges. Petalled collars/caps are not acceptable.
10. Metal backed paper shall not be used in the stress relieving of winding to lead connections.
11. Metal backed paper shall not be used in the manufacture of the stress shields without the express approval of the Employer.
12. Enamel covered wires shall only be used when approved by the Employer and shall also meet the following additional criteria:
    (a) The particular enamel and method of use has a proven history.
    (b) For continuously transposed cable the radial thickness of the enamel shall be 0.1 mm.
    (c) For helical windings that are transposed by hand, the cross-over/transposition shall be mechanically and electrically protected.
13. There shall not be any electrical out of balance of turns between the phase windings.
14. Duct strips shall be of a solid construction one piece and have contoured edges– duct strips made of multiple strips tied together are not acceptable. All duct strips and spacers shall have contoured edges.
15. All paper covered conductors shall use thermally upgraded paper.
16. Continuously transposed cable shall:
17. Be epoxy bonded to withstand free buckling short-circuit forces unless it can be proved otherwise in accordance with Clause 6.2.
18. Utilise a spacer between strand stacks to keep the stacks separate.
19. All crossovers and transpositions are to be under bent so that after compression, the crossover/transposition does not protrude into the adjacent radial duct.
20. All crossovers, transpositions and winding lead outs are to be effected by a pre-set bender to ensure that they are correctly bent and are uniformly identical.
21. Winding conductors shall use butt lapped insulation papers for all layers except for the final outer layer which shall be overlapped.

22. All internal winding and bushing lead support structures shall use fibreglass nuts and bolts. Wooden or cellulose based nuts and bolts shall not be used. The winding and lead support structures shall not rely on the shear strength of the fibreglass nuts and bolts.
23. All winding coils shall be sized for correct height in a vapour phase oven.
24. Paperless LV windings are not acceptable.
25. Winding Assembles shall be prepared as follows:
    a. The individual cylinders/wraps and their associated duct strips shall be pre-dried to minimize shrinkage.
    b. Each winding shall be clamped under the design load (kN) as determined from the short circuit loadings and the design pressures as used in compressing the complete active part.
    c. A single ring shall be used to compress all windings for each limb
    d. Any blocking required shall be distributed such that the HV, FR and LV windings retain their design force balance
    e. Each winding shall be clamped complete with the entire end blocking in place.

10.8.4 Internal Earthing

(i) General - All metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at some fixed potential.

(ii) Earthing of Core Clamping Structure - The top main core clamping structure shall be connected to the tank body by a copper strap. The bottom main core clamping structure shall be earthed by one or more of the following methods.
    (a) by connection through vertically tie rods to the top structure;
    (b) by direct metal to metal contact with the tank base maintained by the weight of the core and windings;
    (c) by connection to the top structure of the same side of the core as the main earth connection to the Tank.

(iii) Earthing of Magnetic Circuits - The magnetic circuit shall be earthed to the clamping structure at one point only through a removable link placed in an accessible position just beneath an inspection opening in the tank cover and which, by disconnection, will enable the insulation between the core and clamping plates, etc., to be tested at voltages up to 2.5 kV. The link shall have no detachable components and the connection to the link shall be on the same side of the core and the main earth connection. These requirements are compulsory. Magnetic circuits having insulated sectional construction shall be provided with a separate link for each individual section. The arrangement of the connections shall be subjected to the plane of the laminations divide the magnetic circuit into two or more electrically separate parts, the ducts and insulating barriers which have a thickness greater than 0.25 mm are to be bridged with tinned copper strips so inserted as to maintain electrical continuity.

(iv) Earthing of Coil Clamping Rings - Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of the Transformer as the main earth connection.

(v) Size of Earthing Connections - Main earthing connections shall have a cross-sectional area of not less than 200 sq. mm. but connections inserted between laminations may have cross-sectional areas reduced to 150 Sq. mm. when in close thermal contact with the core.

10.9 TANKS AND ANCILLARY EQUIPMENT

10.9.1 Transformer Tanks

Each transformer shall be enclosed in a suitable stiffened welded steel tanks such that the transformer can be lifted and transported without permanent deformation or oil leakage. The construction shall employ weldable mild steel and shall be of sufficient strength and rigidity to withstand moving, shipping and handling without deformation.
Lifting lugs shall be provided, suitable for the weight of the transformer, including core and windings, fittings, and with the tank filled with oil. Each tank shall be provided with jacking lugs suitably positioned for transport. The transformer tank shall be capable of withstanding full vacuum without deflection exceeding the value stated in the

Schedule of Tests. Where the design of the tank is such that the bottom plate will be in direct contact with the surface of the foundations, the plates shall have the following minimum thickness: -

Length of Transformer	Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500 mm	6 mm	19 mm
Greater than 2500 mm	12 mm	25 mm
Greater than 7500 mm	32 mm	40 mm

Where skid type bases are provided, the plates shall have the following minimum thickness: -

Length of Transformer	Minimum Thickness	
	Side Plates	Bottom Plates
Less than 2500 mm	6 mm	9 mm
Greater than 2500 mm	9 mm	12 mm

In case of a self-supporting tank bottom of the power transformer without steel crossbeams, the bottom plate shall have a minimum thickness of 40 mm. The base of each tank shall be so designed that it is possible to move the complete transformer unit in any direction without injury when using rollers, plates, or rails. Transformers may have flat, skid or wheel bases subject to the approval of Employer's Representative, but, detachable under bases must not be used unless specifically approved by the Employer's Representative. All joints other than those, which may have to be opened, shall be welded. Caulking of defective welded joints may be re-welded subject to the written approval of the Employer's Representative. The tank and cover shall be designed in such a manner as to leave no external pockets in which water can lodge, no internal pockets in which oil can remain when draining the tank or in which air can be trapped when filling the tank, and to provide easy access to all external surfaces for painting.

When built-on radiators are used, each radiator bank shall be connected to the main tank through flanged valves mounted on the tank at top and bottom and each bank shall be fitted with drain valve and air release plug.
Each tank cover shall be of adequate strength, must not distort when lifted and shall be provided with suitable flanges having sufficient and properly spaced bolts. Inspection openings shall be provided to give access to the internal connections of bushings, winding connections and earthing links. Each opening shall be correctly located and must be of ample size for the purpose of which it is intended. All inspection covers shall be provided with lifting handles. Tank covers with low level welded flanged joints are preferred, but contractors may offer alternative designs with high level covers. It must be possible to remove any bushing without removing the tank cover. Pockets shall be provided for a stem type thermometer and for the bulbs of temperature indicators where specified. These pockets shall be located in the position of maximum oil temperature and it must be possible to remove any bulb without lowering the oil level in the tank. Captive screwed caps shall be provided to prevent the ingress of water to the thermometer pockets when they are not in use.

10.9.2 Construction

Weldable structural steel of an approved grade to BS 7668, BS EN 10029, BS EN 10025 and BS EN 10210 or equivalent shall be used in construction. Each transformer shall be enclosed in a suitably stiffened welded steel tank suitable for outdoor service and designed so the transformer can be transported. When fully oil filled, the transformer shall be able to be jacked, lifted, and hauled into place without permanent deformation or leakage.

Tank wall stiffeners shall be of the vertical type to minimise corrosion of the surfaces and to allow for the option of sand filling inside the stiffeners for noise control. Sand filling inside the tank wall stiffeners for additional noise control shall be agreed during the Design Review at the manufacturers' works.

The design of the tank and cover shall not have any external pockets or dips in which water can lodge or pond, or internal pockets in which oil can remain when draining the tank or in which air can be trapped when filling the tank. The same applies to spaces under access covers.

The tank design shall provide for easy access to all external surfaces for painting. Joints around access openings, bushings and any other removable accessories shall be bolted, and an electrical bond provided across the bolted joint.

All external edges shall have a minimum 3 mm radius to ensure adequate paint thickness.

10.9.3 Cover

Each tank cover shall be of adequate strength, must not distort when lifted and shall be provided with suitable flanges having sufficient and properly spaced bolts. Inspection openings shall be provided to give access to the internal connections of bushings, winding connections and earthing links. Each opening shall be correctly located and must be of ample size for the purpose of which it is intended. All inspection covers shall be provided with lifting handles. **Tank covers with low level welded flanged joints are preferred, but contractors may offer alternative designs with high level covers. It must be possible to remove any bushing without removing the tank cover and adequate access chambers shall be provided for this purpose.**

A bolted or welded cover may be used for the main tank cover. If a welded cover is used 'MIG' welding shall be used to weld the cover to the main tank. The core and windings shall not be suspended from the main tank cover.

The top of the tank cover shall be fitted with two Uni-Anchor Plates with Tie-Off Anchors, manufactured by Unique Concepts Ltd (Part No. 17415 - stainless steel version), for safety harness attachments.

10.9.4 Thermometer Pockets

Pockets shall be provided for a stem type thermometer and for the bulbs of temperature indicators where specified. These pockets shall be located in the position of maximum oil temperature and it must be possible to remove any bulb without lowering the oil level in the tank. Captive screwed caps shall be provided to prevent the ingress of water to the thermometer pockets when they are not in use. Thermometer pockets shall comply with the requirements of BS 2765 and be located according to IEC 60076-2.

10.9.5 Access Openings

Openings shall be provided in the main tank to give access for in-situ tightening of the core and windings without removing the main tank or the main tank cover. Openings shall be provided in the tank to give access to the internal connections of all bushings, earthing connections, CT secondaries, and tap-changers. The opening shall give unimpeded internal access and shall be of ample size for the purpose intended.

All access openings shall have flanges welded to them by means of continuous welds both on the inside and the outside of the flange. To make it easy to fit covers to the openings, the flanges shall have drilled and tapped blind holes to accommodate the studs.

All access covers shall be provided with lifting handles.

10.9.6 Lifting, Jacking and Haulage

The transformer tank shall be provided with attachments (front, rear, and both sides) for lifting, jacking, and haulage. Lifting lugs shall be strong enough to lift, without distortion, the complete transformer when full of oil.

Jacking pads shall be provided, two on each side of the tank, extending perpendicularly from the tank, with a minimum effective size of 200 mm length and 150 mm width. The jacking pads shall have a minimum clearance from the tank base of 300 mm.

Haulage eyes shall be provided on each side and each end of the transformer tank. They shall be located symmetrically about the tank centre line, 200 mm to 300 mm above the base of the tank and perpendicular to the tank. A hole, at least 50 mm in diameter, shall be provided for the eye, and at least 100 mm of free working space shall be provided above and below each haulage eye.

10.9.7 Pressure and Vacuum Withstand

The complete tank with all fittings and pipework shall withstand full vacuum (-1014 millibars gauge), and an internal pressure of 50 kPa without permanent deformation or leaks. The Contractor shall test the tank in accordance with Clauses 6.5.7and 6.5.8 to prove compliance with the above.

10.9.8 Mounting of Busings

a. Each bushing shall be mounted on an annular steel ring equipped with studs and designed to the following specifications:
b. Outside diameter = flange diameter of the bushing.
c. Inside diameter = lower portion bushing diameter plus 12 mm
d. Minimum thickness = 1.5 x diameter of fixing studs
e. Each ring shall be fixed to the outside surface of the cover or tank by means of continuous welding around both the internal and external circumferences.
f. Stainless steel studs shall be fitted to the mounting ring.

10.9.10 Bushing Turret Bleeds

Air bleed pipework for trapped air and combustible gases shall be provided for all bushing turrets. The air bleed and trapped gas pipework shall be connected to the main tank Buchholz relay.

10.9.11 Gun Studs

Stainless steel gun studs shall be used for all stud fittings on the external surfaces of the main tank.
Subject to the approval of the Employer, the following alternative method of stud installation may be used: Stainless steel threaded rods inserted into tapped blind holes - provided a suitable method for preventing moisture ingress into the tapped blind holes is used.

10.9.12 Conservator Tank

Each transformer shall be provided with an overhead conservator tank formed of substantial steel plates and arranged above the highest point of the oil circulating system. Connections into the main tank shall be at the highest point to prevent the trapping of air or gas under the main tank cover. Main tank conservator vessels shall be equipped with elastic diaphragms of the air-bag type. The capacity of each conservator tank shall be adequate for the expansion and contraction of oil in the whole system under the specified operating conditions. Conservator tanks shall also be provided with a cleaning door, filling cap, filter and drain valve with captive cap and a prismatic type oil level indicator of MR Reinhausen MESSKO brand or equivalent in each compartment. Each oil level indicator shall have the minimum and maximum levels indication and alarm contacts.

The main conservator tank shall be provided with a partitioned chamber, with the same diameter as the main tank conservator, for the tap change conservator. The tap change conservator shall also be fitted with a MESSKO maintenance free dehydrating breather MESSKO® MTraB® DB 200 and an oil level gauge with alarm contacts.

All bolted connection plates of the conservator tank supports shall be a non-corrosive material that does not require painting. The material may be either a non-magnetic black steel or stainless steel. The conservator tank supports that are bolted to the side wall of the main tank shall have bottom stops welded on the tank side wall to hold the supports in place when bolted into position during site assembly. Access for inspection, cleaning and painting of the main tank and tap change conservator chambers shall be provided via one of the following two options:

1. Removable end plates, or

2. Sealed end plates but with an opening at the top of the main tank chamber of a sufficient size to allow entry and for the tap changer chamber removal of the oil level gauge to allow entry.

The second of the above two options is preferred.

Conservator tanks shall be provided with a filling cap, drain valve with captive cap, and oil level gauge. The conservator shall have the same pressure and vacuum withstand, and be tested in the same manner as the transformer tank specified.

Gusset plates or other reinforcing members shall be so arranged as to ensure the free passage of oil along the bottom of the conservator. The location of the conservator tank shall not obstruct the removal from the tank of equipment such as the tap-changer.

The conservator for the main tank shall be of the fully sealed type to prevent oxygen, moisture, and particles from entering into the transformer oil. It shall consist of:

i. An impermeable synthetic cell type rubber membrane that separates the oil from the air.
ii. A breather connected to the airside of the rubber membrane at 1400mm above the transformer base.
iii. A sump.
iv. An oil level gauge with alarm contacts.
v. An air release valve to permit bleeding off air during filling of the transformer or when in service.
vi. An oil handling facility.

Inspection covers shall be provided to permit inspection of the rubber membrane without dismantling the conservator. The internal surfaces of the conservator shall be varnished to resist corrosion. The design of the conservator shall be such that internal re-treatment (of the conservator) and replacement of the rubber membrane can be easily carried out. The conservators shall have sufficient capacity to accommodate expansion and contraction of the oil due to temperature changes from -5°C to 120°C.

10.9.13 MR Reinhausen Breathers MESSKO® MTraB® DB 200 and Air Dryers

The location of the conservator tank shall be so arranged that it does comply with the requirements and a valve shall be provided at the conservator to cut off the oil supply to the tank. Each conservator shall be fitted with or equivalent. Due to the climatic conditions at site, this breather shall be larger than what would be fitted for use in a temperate climate. All (two units) breathers MESSKO® MTraB® DB 200 shall be mounted at a height of approximately 1400 mm above ground level. Breathers for the power transformer main tank conservator shall have a minimum filling capacity of 3 kg. The pipe work between the conservator and the transformer tank shall comply with the requirements and a valve shall be provided at the conservator to cut off the oil supply to the tank.

10.9.14 Valves and Location

All valves up to and including 75 mm bore shall be made of gunmetal. Each Transformer shall be fitted with the following valves as required for:-

a) Draining the case (flanged-gate valve)
b) Sampling oil from the extreme bottom and top of the case.
c) Lower filter press connection and complete drain.
d) Upper filter press connection.
e) Isolating each radiator.
f) Air relief or venting from each radiator.
g) Draining oil from each radiator.
h) Nitrogen.
i) Conservator oil removal and filling.
j) Tap Changer.
k) Isolation of Buchholz relay for main tank.
l) Transformer conservator main valve.
m) Vacuum line connection.
n) Gas analysis sampling.

The omission of any, or the provision of alternative arrangements to the above requirements, will not be accepted unless approved in writing by the Employer's Representative before manufacture.

Valves shall be arranged so that the hand wheel moves in a clockwise direction to close the valve. The face of each hand wheel shall be clearly marked with the words "open" and "shut" and be provided with an arrow to indicate direction for opening and shutting. Valves shall not be fitted in an inverted position. Unless the valve is one that can only be either fully open or fully closed, valves of 50 mm nominal bore or larger shall have position indicators. These show the amount by which the valve is open or closed in relation to its full travel.

All valve hand wheels shall be fitted with nameplates. Suitable means shall be provided to protect the operating mechanisms of all valves against mechanical damage and dust or dirt. Adequate provision shall be made for the lubrication of the mechanism and guides and this shall be of the pressure type.

All valves that are part of the oil flow circuit, either via the radiators or to and from the conservator, shall be of the indicating lockable type.

Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing. Isolating valves for the radiators shall be the Butterfly type with lockable positions.

Radiator isolating valves, oil inlet valves, oil outlet valves, oil sampling valves and any on-line monitoring valves fitted to the main tank, conservators and radiators shall use bolted flange connections and be easily removable for maintenance purposes.

Isolating valves shall be Gate type valves with lockable positions.

10.9.15 Oil Handling Facilities

Each transformer shall be provided with the following female gate valves and fittings that, with the exception of sampling outlets, shall where necessary be brought down to a height of 1.5 m or less from ground level, with 40 mm galvanised C Grade pipe complying with ISO 65.

All threads in valves, fittings, and on pipes shall comply with ISO7/1. The valve and fitting sizes shall be the metric equivalent of the sizes given in the table below:

Item	Description	Requirements	Size
1	Main Tank:		
1.1	Inlet filter connection valve		Rc 1½
1.2	Outlet filter connection valve	Drains the tank to within 15 mm of the tank bottom	Rc 1½
1.3	Drain plug		Rc 1½
1.4	Oil sampling valve	Samples from top & bottom of tank	Rc ½
2	Transformer Conservator Tank:		
2.1	Inlet filter connection valve		Rc 1½
2.2	Outlet filter connection valve		Rc 1½
2.3	Drain valve		Rc 1½
3	On-load Tap-changer Conservator Tank:		
3.1	Inlet filter connection valve		Rc 1½
3.2	Outlet filter connection valve		Rc 1½
3.3	Drain valve		Rc ½
4	Radiators:		
4.1	Drain plug		Rc 1½
4.2	Bleeder Valve		Rc 1½
5	Radiator Bank:		

Item	Description	Requirements	Size
5.1	Inlet filter connection valve	Drains tank to within 40 mm of its bottom	Rc 1½
5.2	Outlet filter valve		Rc 1½
5.3	Drain plug		Rc 1½
6	Tap-changer Switch Chamber:		
6.1	Drain valve		Rc 1½
6.2	Oil sampling valve		Rc ½

10.9.16 Pressure Relief Device

An approved pressure relief device of sufficient size for the rapid release of any pressure that may be generated in the tank and designed to operate at a static pressure lower than the hydraulic test pressure called for in Schedule of Works Tests, shall be provided. In the event that the device is a spring operated valve type, it shall be provided with one set of normally open signalling contacts to trip the transformer. The relief device is to be mounted on the tank cover and is to be provided with a skirt to project at least 25 mm into the tank to prevent gas accumulation.

10.9.17 Earthing Terminals

External earthing terminals shall be provided as follows:

a) Two earthing terminals located on the transformer tank, each one on opposite sides of the tank wall and located near to ground level for connection to the substation earth grid.

b) One earthing terminal located on any separate associated radiator bank and located near to ground level.

c) One earthing terminal for the neutral current transformer mounting bracket. The earthing terminal shall be located near the top of the tank wall, underneath the neutral current transformer mounting bracket.

d) The external earthing terminals shall be a flat vertical lug, 100 mm x 50 mm, and drilled with two 14 mm diameter holes for M12 bolts, at 45 mm vertical centres. The terminals shall be stainless steel, suitable for use with copper earthing connections, rated for 3 s of at least 31.5 kA. The earth terminals shall be located so they are readily accessible from both sides of the foundation pads. Dimension details of the arrangement offered shall be supplied with the tender.

e) Every part of the equipment intended to be earthed shall be electrically continuous with the earthing terminals without relying upon fortuitous contacts. The earth lug shall be marked with an 'earth' symbol. An adequately rated electrical bond shall be provided across all bolted joints of the tank.

10.9.6.1 Rating, Diagram and Valve Plates

The following plates, or an approved combined plate, shall be fixed to each Transformer tank at an average height of 1500 mm above the ground level:-

(a) A rating plate with the data specified in IEC 60076 Part 1. This plate shall also include a space for the Purchaser's serial number and in addition include the short-circuit current rating and time-factor for each winding.

(b) A diagram plate showing in an approved manner, the internal connections and the voltage relationship of the several windings, in accordance with IEC 60076 Part 1 with the Transformer voltage ratio for each tap and, in addition, a plan view of the Transformer giving the correct physical relationship of the terminals.

(c) A plate showing the location and function of all valves and air release cocks or plugs. This plate shall also if necessary warn operators to refer to the Maintenance instructions before applying vacuum.

Plates are to be of stainless steel or other approved material capable for continuous outdoor service and withstanding the climatic conditions of at site.

10.10 COOLING PLANT

10.10.1 Cooling Plant - General

Radiators and cooling fans shall be hot dip galvanized accordance with ISO1459. The design shall also avoid pockets in which water can collect and shall be capable of withstanding the pressure tests specified in Schedule of Works Tests for the transformer main tank. The clearance between any oil or other pipe work and live parts shall be not less than the minimum clearances as specified in the specification.

10.10.2 Radiators Connected Directly To Tank

Honeycomb-tube type radiators are not acceptable to the Employer. The radiators shall have the same pressure and vacuum withstand, and be tested in the same manner as the transformer tank. Radiators shall have the following features:

a. Oil handling facilities.
b. Two lifting lugs per radiator.
c. Isolating gate valves to permit uncoupling of the radiator from the transformer or the separate radiator bank, without draining the oil from the transformer or the separate radiator bank. These valves shall withstand full vacuum.
d. Braced to withstand the seismic forces detailed in this specification.
e. If a separate radiator bank is supplied there shall be two bolted earth bonds to the support structure, one on each diagonally opposite corner of the radiator.
f. If the radiators are attached to a manifold welded to the tank then this manifold shall have:

- Removable end plates.
- Drain Plug and an air admission vent.

If the manifold is detachable it shall have all the fittings with the gate valves attached to the tank indicating and lockable. Any radiator shall be able to be removed from a bank without first removing any other item such as conservator or other radiators.

10.10.3 Cooler Banks

Each cooler bank shall be provided with:-

(a) A valve at each point of connection to the tank.
(b) A valve at each point of connection of radiators.
(c) Loose blanking plates to permit the blanking off of the main oil connection to the top.
(d) A 50 mm filter valve at the top of each cooler bank.
(e) A 50 mm drain valve at lowest point of interconnecting oil pipes.
(f) A thermometer pocket, fitted with captive screw cap, in the inlet and in the outlet oil pipes.
(g) Air release and drain plugs on each radiator.
(h) Visual oil flow indicators, on transformers having forced oil circulation fitted with electrical contacts to close when oil did not flowing. Contacts to be connected in the cooler fail alarm circuit.

The omission of any, or the provision of alternative arrangements to the above requirements, will not be accepted unless approved in writing by the Employer's Representative before manufacture. An approved expansion piece shall be provided in each oil pipe connection between the transformer and each oil cooler bank.

10.10.4 Forced Cooling

The type of forced cooling shall be as stated in the Employer's Requirements. Forced cooling equipment for transformers of similar rating and design shall be completely interchangeable one with the other without modification on Site.

10.10.5 Oil pipes and Flanges

All oil piping shall be of approved material with machined flagged joints. Copper pipe work is to comply with BS.61.Dimensions of steel pipes shall be in accordance with BS.3600 and the drilling of all pipe flanges shall comply

with BS.4504.It shall be possible to drain any section of pipe work independently of the rest and drain valves or plugs shall be provided as necessary to meet this requirement.

10.10.6 Air Blowers

Air blowers for forced air cooling shall be of approved make and design and be suitable for continuous operation out-of-doors. They shall also be capable of withstanding the stresses imposed when brought up to speed by the direct application of full line voltage to the motor. To reduce noise to the practical minimum, motors shall be mounted independently from the coolers or, alternatively, an approved form of anti-vibration mounting shall be provided. It shall be possible to remove the blower complete with motor without disturbing or dismantling the cooler structure framework. Blades shall be of galvanized steel unless otherwise approved. Blower casings shall be made of galvanized steel of thickness not less than 2.6 mm (14 S.W.G.) and shall be suitably stiffened by angles or tees. Galvanized wire mesh guards shall be provided to prevent accidental contact with the blades and to prevent access of birds and their nests. Guards shall also be provided over all moving parts. Guards shall be designed such that blades and other moving parts cannot be touched by test fingers to IEC.60529.

10.10.7 Pipe Supports

All pipe-work and accessories included in this contract shall be supported and mounted in a manner approved by the Employer The Contractor shall supply all necessary saddles, structural steelwork, foundation bolts, fixing bolts and all other attachments.

The number and positions of all intermediate flexible supports between anchor points shall be determined by the weights to be carried and by the steelwork available for the purpose. All this shall be subject to the Employer's approval.

10.10.8 Pressure Gauges

If required, all pressure gauges shall be fitted with stop-cocks immediately adjacent to each gauge, and all pressure gauge piping shall be fitted with an isolating valve at each point of connection to the main system. Where pressure gauges are mounted on panels, the stop-cocks shall be suitable for the connection of a test gauge.

Where a difference in level exists between the position of the gauge and the point at which pressure is measured, appropriate compensation shall be made in the dial reading (the dial shall be marked with the degree of compensation). However, dials only need marking if the degree of compensation is greater than 2%.

Pressure gauges shall be mounted on panels where practicable. The Employer shall approve the locations of the pressure gauges. All pressure gauges shall be clearly identified by means of separate labels of an approved type and lettering. All high pressure gauge piping shall be stainless steel 316 grade but other pressure gauge piping may be of copper tube or other material approved by the Employer.

10.10.9 Transformer Cooling Fan

Air blowers for forced air cooling shall be ZIEHL- ABEGG AG and be suitable for continuous operation out-of-doors. They shall also be capable of withstanding the stresses imposed when brought up to speed by the direct application of full line voltage to the motor.

To reduce noise to the practical minimum, motors shall be mounted independently from the coolers or, alternatively, an approved form of anti-vibration mounting shall be provided. It shall be possible to remove the blower complete with motor without disturbing or dismantling the cooler structure framework.

Blades shall be of galvanized steel unless otherwise approved. Blower casings shall be made of galvanized steel of thickness not less than 2.6 mm (14 S.W.G.) and shall be suitably stiffened by angles or tees.

Galvanized wire mesh guards shall be provided to prevent accidental contact with the blades and to prevent access of birds and their nests. Guards shall also be provided over all moving parts. Guards shall be designed such that blades and other moving parts cannot be touched by test fingers to IEC.60529.

The Transformer Cooling fans blowers shall be from ZIEHL- ABEGG AG

10.10.10 Cooler Control

Where multiple fan cooling using three-phase 415V 50HZ motors is from ZIEHL- ABEGG AG, the motors in each cooling bank shall be grouped so as to form a balance three-phase load. Each motor or group of motors shall be provided with a three-pole electrically operated contactor and with control gear of approved design for starting and stopping manually. The electrical supply for the control of the cooling units shall be provided by means of two independent feeders.

Where forced cooling is used on transformers provision shall be included under this Contract for automatic starting and stopping from the contacts on the oil / winding temperature indicating device as specified. Where small motors are operated in group, the group protection shall be arranged so that it will operate satisfactorily in the event of a fault occurring in a single motor.

The control arrangements are to be designed to prevent the starting of motors totalling more than 1.5 kW simultaneously either manually or automatically. All contacts and other parts, which may require periodic renewal, adjustment or inspection, shall be readily accessible. All wiring for the control gear accommodated in the marshalling kiosk IP55 together with all necessary cable boxes and terminations and all wiring between the marshalling kiosk and the motors shall be included in the Contract.

The first group of fans shall come into operation at lower temperature (i.e. at 50^0 C hot spot temperature) and the second group at a higher temperature.(i.e. at 65^0 C hot spot temperature). The winding temperature shall give the starting signal for the fans and the oil temperature shall give the stopping signals.

The cooling equipment shall be controlled by the control contacts on the electronic winding temperature monitor. The cooling fans shall be controlled separately with separate Off/Manual/Auto selector switches. Fan failure alarms shall be provided and wired back to the cooling control cubicle. Each fan shall have independent protection, i.e. failure of one fan shall not trip the remaining fans.

The control scheme shall not inhibit the action of the Buchholz relay at any time. Electrical isolation of the Buchholz relay during fan starts is not acceptable.

Manual reset, inverse time, ambient temperature compensated, overload and single-phase protection shall be provided in each phase of the supply to each motor. Arrangements shall be such that operation of a protective device in any phase automatically disconnects all supply from that motor and closes a cooling failure alarm contact. Disconnectors shall be provided to permit maintenance work to be carried out independently on each motor. All equipment shall be suitably housed for installation outdoors on the transformers.

The fan motors shall be of the 3-phase type and shall comply with IEC 60072. All bearings shall be self-lubricating and sealed for life.

10.11 VOLTAGE CONTROL

10.11.1 General

Transformers shall be provided with voltage control equipment of the on-load tap changing type for varying the effective transformation ratio. Winding taps as called for in the Employer's Requirements shall be provided on the high voltage winding. But, where stated in the Employer's Requirements, in the case of on-load tap selectors, the Tenderer is at liberty to submit transformers with tap selectors on the lower voltage winding if by so doing a more economical and robust design can be offered and provided the transformer complies in all respects with Clause 10.11.2. in this event, details of the tappings shall be given in the Employer's Requirements. All terminals shall be clearly and permanently marked with numbers corresponding to the cables connected thereto.

10.11.2 On Load Tap Changers

10.11.2.1 General

On-load tap changers shall comply with IEC.60214. and with IEC 60542 and shall be suitable for power flow in both directions. Only designs, which have been type tested in accordance with these standards, will be accepted.

On-load tap changers of Maschinenfabrik Reinhausen shall be accepted. Tap changers shall be mounted from the cover into the transformer tank. Current making and breaking switches shall be contained in a tank designed in a manner to make it impossible for the oil therein to mix with oil in the tap selector and main transformer. The head of oil in this tank may be maintained by a separate compartment of the main conservator or by a separately mounted tank.

An oil surge detector relay and an oil level indicator shall be provided. The same requirements shall apply also in respect of designs in which tap selection and current making and breaking are accomplished by the same contacts within a tank separate from the transformer.

10.11.2.2 Mechanisms

The tap change mechanism shall be designed such that when a tap change has been initiated, it will be completed independently of the operation of the control relays and switches. If a failure of the auxiliary supply during tap change or any other contingency would result in that movement not being completed an approved means shall be provided to safeguard the Transformer and its auxiliary equipment. Limit switches shall be provided to prevent over-running of the tap changing mechanism. These shall be directly connected in the operating motor circuit. In addition, mechanical stops shall be fitted to prevent over-running of the mechanism under any conditions. For on-load tap change equipment these stops shall withstand the full torque of the driving mechanism without damage to the tap change equipment. Thermal devices or other approved means shall be provided to protect the motor and control circuit.

A permanently legible lubrication chart shall be provided and fitted inside the tap change mechanism chamber.

10.11.2.3 Local and Remote Control

Equipment for local manual and electrical operation shall be provided in an outdoor cubicle mounted on the transformer. Electrical remote control equipment shall also be supplied where specified in the Employer's Requirements.
The following operating conditions are to apply to the on-load tap selector controls: -

(a) It must not be possible to operate the electric drive when the manual operating gear is in use.
(b) It must not be possible for two electric control points to be in operation at the same time. Operation from the local or remote control switch shall cause one tap movement only unless the control switch is returned to the off position between successive operations.
(c) It must not be possible for any transformer operating in parallel with one or more Transformers in a group to be more than one tap out of step, with the other Transformers. In such case "Transformer out of step" alarm shall be indicated. In the case of Transformers are more than one step out of step all the tap changers shall be blocked.
(e) All electrical control switches and local manual operating gear shall be clearly labelled in an approved manner to indicate the direction of tap changing.

10.11.2.4 Indications

Apparatus of an approved type shall be provided on each Transformer: -

(a) To give indication mechanically at the transformer and electrically at the remote control point of the number of the tapping in use.
(b) To give electrical indication, separate from that specified above, of tap position at the remote supervisory point.
(c) To give indication at the remote control point and at the supervisory control point that a tap change is in progress, this indication to continue until the tap change is completed.
(d) To give indication at the remote control point and at the supervisory control point when the transformers operating in parallel are operating at more than 1 tap apart.
(e) To indicate at the tap change mechanism the number of operations completed by the equipment.

10.11.3 Automatic Voltage Control

Automatic Control shall be suitable for control of all transformers in parallel. In addition to the methods of control covered by Clause 10.11.2, the following alternative methods shall be provided.

(a) Automatic independent Remote - It shall be possible to select non-automatic remote or local electrical control, or automatic remote control for each transformer irrespective of the method of independent control selected for any other of the associated transformers.

b) Automatic parallel control in one group or two independent groups. - It shall be possible to select any transformer for either group and also select any transformer in a group for master control.

It must not be possible to operate any tap changer by remote or local electrical hand control while the equipment is switched for automatic operation. In the event of reverse power flow occurring through the transformer, the automatic voltage control function shall be automatically switched out.

10.11.4 Voltage Regulating Relays

Automatic voltage control shall be initiated by a microprocessor based voltage regulating relay of an approved type and suitable for flush mounting. The relay shall operate from the nominal reference voltage stated in the Employer's Requirements derived from a circuit mounted LV voltage transformer having Class B accuracy to BS. 3941 and the relay voltage reference balance point shall be adjustable. TAPCON voltage regulating relay is the Employer's requirement. The relay bandwidth shall preferably be adjustable to any value between 1.5 times and 2.5 times the transformer tap step percentage, the nominal setting being twice the transformer tap step percentage. The relay shall be insensitive to frequency variation between the limits as specified in chapter 1. The relay shall be complete with a time delay element adjustable between 10 and 120 seconds. The relay shall also incorporate an under voltage blocking facility which renders the control inoperative if the reference voltage falls below 80 percent of the nominal value with automatic restoration of control when the reference voltage rises to 85 percent of nominal value. On each transformer the voltage transformer supply to the voltage regulating relay shall be monitored for partial or complete failure. The specified indicating lamp and alarm will be inoperative when the circuit-breaker automatic control controlling the lower voltage side of the Transformer is open and also that it is disconnected when the tap changer is on control other than automatic control.

10.12 SUPERVISORY CONTROL

10.12.1 Requirements

Transformer tap change control will be effected from the sub-station control room. All necessary connections, indicating auxiliary switches, relays and changeover switches to meet supervisory control requirements shall be provided and connected under this Contract to terminal blocks at the transformer marshalling kiosk or cubicle or at the Transformer control cubicle, as appropriate. The following supervisory facilities are required:
Control Selection : A multi-pole changeover selector, i.e., switch labelled "remote" and "supervisory".
Controls: Tap change raise/lower by direct operation of tap changer. AVR voltage reference adjustment.
Indications and Alarms:
Refer alarm scheme specified in Chapter 5.

10.12.2 Bushing Insulators and Terminals

10.12.2.1 General

Transformers are to be provided with bushing and terminals for phase and neutral terminals as required in the Technical Particulars & Guarantees. All bushings shall comply with IEC.60137 and the minimum creepage distance for outdoor bushings shall be as specified in the Employer's Requirements. Bushings shall be provided with adjustable arcing horns if not enclosed type.

Bushings shall be of sealed construction suitable for service under the very humid conditions at Site and, in addition, to the very rapid cooling of equipment exposed to direct sunlight when this is followed by sudden heavy rainstorms. Typical sections of bushing insulators showing the internal construction, method of securing the top cap and methods of sealing shall be included in the Tender. The 36 kV bushing insulators shall be oil impregnated paper type and have no communication with the oil in the transformer. An oil gauge shall preferably be provided in indicate that the correct level is maintained. The 11 kV bushing insulators shall be of the oil filled or solid type.

On all condenser bushings a tapping shall be brought out to a separate terminal for testing purposes on Site.

Special precautions shall be taken to exclude moisture from paper insulation during manufacture, assembly, transport and erection. The surfaces of all paper insulators shall be finished with approved non-hygroscopic varnish, which cannot easily be damaged.

10.12.2.2 Porcelain

Hollow porcelain shall meet the test requirements of IEC.60236 and shall be sound, free from defects thoroughly vitrified. The glaze must not be depended upon for insulation. The glaze shall be smooth, hard, of a uniform shade of brown and shall cover completely all exposed parts of the insulator. Outdoor insulators and fittings shall be unaffected by atmospheric conditions producing weathering, acids, alkalis, dust and rapid changes in temperature that may be experienced under working conditions.

The porcelain must not engage directly with hard metal and, where necessary, gaskets shall be interposed between the porcelain and the fittings. All porcelain clamping surfaces in contact with gaskets shall be accurately ground and free from glaze. All fixing material used shall be of suitable quality and properly applied and must not enter into chemical action with the metal parts or cause fracture by expansion in service. Cement thicknesses are to be as small and even as possible and proper care is to be taken to centaur and locate the individual parts correctly during cementing.
All porcelain insulators shall be designed to facilitate cleaning.

10.12.2.3 Marking

Each porcelain insulator shall have marked upon in the manufacturer's name or identification mark and year of manufacture. These marks shall be clearly legible and visible after assembly of fittings and not impressed but shall be imprinted before firing.
When a batch of insulators bearing a certain identification mark has been rejected, no further insulators bearing this mark shall be submitted and the Contractor shall satisfy the Employer's Representative that adequate steps will be taken to mark or segregate the insulators constituting the rejected batch in such a way that there can be no possibility of the insulators being re-submitted for the test or supplied for the use of the Purchaser.
Each bushing shall be marked with the manufacturer's name or identification mark, year of manufacture, serial number, electrical and mechanical characteristics in accordance with IEC 60137.

10.12.2.4 Mounting of Bushings

Bushing insulators shall be mounted on the tank in a manner such that the external connections can be taken away clear of all obstacles. Neutral bushings shall be mounted in a position from which a connection can be taken to a neutral current transformer mounted on a bracket secured to the transformer tank. Supply of the current transformer is part of the scope and provision shall be made on the tank for mounting to the Employer's Representative's requirements. The clearances from phase to earth and phase to phase must not be less than those stated in the specification. The line current transformers, where required, will be provided under this contract, the bushing is to be so arranged that it can be removed without disturbing the current transformers, secondary terminals and connections or pipe work. When bushings with an under-oil end of a re-entrant type are used the associated flexible pull-through lead is to be fitted with a suitably designed gas bubble deflector. The bushing flanges must not be of re-entrant shape, which may trap air. Clamps and fittings made of steel or malleable iron shall be galvanised in accordance with the specification and all bolt threads are to be greased before erection.

10.13 CABLES AND TERMINATIONS

10.13.1 Cable End Boxes

33kV and 11kV HV/LV cable box shall be air insulated. The box shall have connections for 4 x single core, 630 mm^2 XLPE-insulated, copper wire screened, PVC-sheathed cables per phase.

The 33 kV cable box shall be supplied with 7 split gland plates. The gland plates shall be marine grade 8 mm thick aluminium.

The 11 kV cable box shall be supplied with 6 split gland plates. The gland plates shall be marine grade 8 mm thick aluminium.

The arrangement shall allow cables to be connected to a separate terminal plate mounted on stand-off insulators on the back of the cable box. Each terminal plate shall be connected, by easily removable copper links, to the HV winding bushing.

The cable box shall have an open front design such that the cables can be slid into their final termination position. The top of the front opening in the cable box shall be equal to or greater than the height of the internal main busbars to allow easy access for bolting of the cable termination palms at site.

The front bolted cover of the cable box shall be marine grade 8 mm thick aluminium and fitted with two lifting handles. One lifting handle shall be positioned on the left hand side of the cover and one on the right hand side of the cover such that two people can lift the cover off for regular maintenance access inside the cable box.

The cable box design shall be such that with the cables supported at the gland plate (the support is part of this Contract), then with the cable box access cover removed and the gland plate unbolted, that the transformer and cable box can be removed.

The front of the cable box shall have *an infra-red window* to enable cable termination temperature checks to be performed while the transformer is in service.

The cable box shall have sufficient support structures between the main tank and the cable box such that the cable box can bear the additional weight of two 100 kg people standing on or in the cable box without the need for additional vertical supports installed under the bottom of the cable box.

Removable insulated barriers shall be provided between the phases.

The cable box internal air electrical clearances shall comply in accordance with the system highest voltage requirements.

Except for the internal electrical clearances, the cable boxes shall comply with the requirements of BS 6435: 1984, and also the following specific requirements:

a. They shall be suitable for through currents determined from this specification.

b. They shall be suitable for earth fault currents equivalent to the system MVA fault levels.

c. Electrical clearances with cables connected to the terminals shall be such as to provide the impulse withstand strength.

d. A pressure relief vent such as a square panel of at least 0.2 m^2. The sides shall be sufficiently strong such that the vent panel cannot become detached from the cable box. The panel shall open at a pressure of at least 50 kPa lower than the internal withstand pressure of the cable box.

e. The air filled cable box shall be fitted with one dehydrating breather to prevent internal condensation. The breather shall be from MR Reinhausen Germany and shall be accessible to a person standing at ground level and fitted with 2 kg of dehydrating material. **All cable box shall have a small window with IR views**

f. The bottom of the cable box shall be at least 1000 mm from the bottom of the transformer tank.

g. The bushing to cable connections (solid or flexible) shall be supplied by the Contractor and the Employers **mandatory** requires from **ABB Sweden MICAFIL.**

h. The positioning of the cable to bushing connections shall be mechanically restrained in such a manner as to meet the short circuit conditions as specified in this specification.

i. The cable box shall have the following earthing facilities:

i. An earth bar for the separate connection of each individual cable's screen. The earth bar shall be mounted on stand-off insulators with a removable connection from the earth bar to an earth stud on the cable box wall to facilitate testing. The earth bar shall be located outside the cable box no more than 300 mm from the cable entry to enable in service cable testing. Each cable screen shall be brought outside the cable box through an insulation gland to connect separately onto the earth bar.

ii. The cable box earthing points mentioned above shall be bonded together, and then connected to the transformer tank.

iii. The cable box shall be weatherproof to IP 55 classification in IEC 60529.

Where the cable box is bolted on to the main transformer tank, flange mountings for the gasket seal shall be provided.

10.13.2 Cables

The HV/MV Cables will be 36kV and 12kV single core XLPE insulation type respectively. Auxiliary power and multicore control cables between the integral parts of the transformer, its marshalling kiosk or tank mounted cubicle and ancillary equipment shall be installed, glanded and have individual cores identified and terminated under this contract. Cable from each transformer to its associated remote control and protective equipment to auxiliary supply switchboards and interconnections with other transformers will be supplied, glanded and have individual cores identified and terminated.

10.14 PROTECTION, TEMPERATURE AND ALARM DEVICES

10.14.1 Temperature Indicating Devices and Alarms

The transformers shall be provided with Qualitrol 509DW for indicating the oil and winding temperature. The device shall have a digital type indicator. The winding temperature device shall have three separate contacts fitted, which shall be used to control the cooling plant motors, give an alarm and to trip the associated circuit-breakers. The indicator should provide the following indications:

(a) Top tank temperature

(b) Bottom tank temperature

(c) Ambient temperature

(d) Winding temperature (HV and MV)

(e) Tap changer oil temperature

To simulate indication of the hottest spot temperature of the windings the device shall comprise a current transformer associated with one phase only. Heating device shall be designed to operate continuously at 130 percent of transformer CMR current and for 30 minutes at 150 percent of CMR current, associated with a sensing bulb installed in an oil tight pocket in the transformer top oil. One CT shall be installed in the HV winding termination and the second in the LV winding termination. The winding temperature indicators shall be housed in the marshalling cubicle. The tripping contacts of the winding temperature indicators shall be adjustable to close between 80 °C and 150 °C and to re-open when the temperature has fallen by not more than 10 °C.
The tripping contacts for oil temperature are to be adjustable to close between 60°C and 120 °C and re-open when the temperature has fallen by not more than 10°C. The alarm contacts shall be adjustable to close between 50°C and 100°C and to re-open when the temperature has fallen by not more than 10°C. The alarm contacts and the contacts used to control the cooling plant motors and initiate automatic start-up of the reserve cooler on the above devices shall be adjustable to close between 50°C and 100°C and to re-open when the temperature has fallen by a desired amount between 10°C and 15°C. All contacts shall be adjustable to a scale and must be easily accessible. Alarm and trip circuit contacts shall be suitable for making or breaking 150 VA for 250 volts AC and 245 V DC and for making 500 VA for 250 V AC and 245 V DC. Cooler motor control contacts shall be suitable for operating the

cooler contactors direct, or if necessary, through an auxiliary relay. Connections shall be brought from the device to terminal boards placed inside the marshalling cubicle.

10.14.2 Gas and Oil Actuated Relays

Each transformer shall be fitted with gas and oil-actuated relay equipment having alarm contacts, which close on collection of gas or low oil level, and tripping contacts which close following oil surge conditions. Each gas and oil-actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay. Each relay shall be fitted with a calibrated glass window for indication of gas volume. To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point approximately 1400 mm above ground level, where it shall be terminated by a cock which shall have provision for locking to prevent unauthorised operation. The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal operation of the relays will not take place under normal service conditions, including starting or stopping of oil circulating pumps whether by manual or automatic control under all operating temperatures.

The pipe work shall be so arranged that all gas arising from the transformer will pass into the gas and oil-actuated relay. The oil circuit through the relay must not form a delivery path in parallel with any circulating oil pipe, or is to be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.
When a transformer is provided with two conservators the gas and oil-actuated relays shall be arranged as follows: -

(a) If the two conservators are connected to the transformer by a common oil pipe one relay shall be installed in the common pipe.
(b) If the two conservators are piped separately to the transformer two relays shall be installed, one in each pipe connection.

The clearance between oil pipework and live metal is to comply with the specifications as specified.

10.14.3 Dissolve Gas Analysing Equipment

Where specified in the Scope of Supply, online dissolved gas in oil-analysing equipment for the performance and interpretation of gas chromatography test shall be supplied to analyse and record in detail dissolved atmospheric and characteristic fault gases in transformer oil (in ppm) as follows:

- Nitrogen (N2)
- Oxygen (O2)
- Carbon monoxide (CO)
- Carbon dioxide (CO2)
- Hydrogen (H2)
- Methane (CH4)
- Ethane (C2H6)
- Acetylene (C2H2)
- Propane (C3H8)
- Propylene (C3H6)

The equipment shall be functional and complete in every respect and the supplies shall include (but not be limited to) the following main equipment:

- Complete de-gassing equipment
- All necessary measuring and recording equipment
- A sufficient quantity of all necessary gases such as for calibration, operation, stand- by operation, heating-up etc. required for a period of at least 12 months.
- A sufficient number of sealed metal bottles for oil sampling.
- All necessary adapters, pipes and hoses for oil sampling.

The recording equipment shall be suitable to print out simultaneously test reports (gas chromatic analysis) for at least two oil samples. In addition to the concentration of the individual gases as listed above, sums of the values shall be recorded such as

- Total gas content
- Combustible gases (H2 + CxHy)
- Carbon-oxides (CO + CO2)

- Main atmospheric gases (O2 + N2)

The solution pressure shall be recorded as well. The supply shall also include all necessary standards (e.g. IEC 60296, IEC 60567, IEC 60599 etc.) as well as manuals for operation and maintenance and for interpretation of the concentration of the dissolved gases detected in transformer oil. All necessary tools for taking oil samples from transformer tank and diverter switch as well as gas samples from Buchholz relay shall be included in the supplies.

10.14.4 Buchholz Protection Devices

The transformers shall be fitted with Buchholz devices from MR Reinhausen Messko's Germany of type, Msafe with two element type giving operation under gassing and under surge conditions.

The Buchholz relay shall be equipped with gas sampling and testing devices to be operated from the ground level at a convenient height. Our preferred is CEDASPE RG3. All necessary flag indication, tripping relays and alarm relays associated with this protection shall be supplied and under this Contract. Each transformer shall be fitted with gas and oil-actuated Bucholz relay equipment having alarm contacts, which close on collection of gas or low oil level, and tripping contacts which close following oil surge conditions. The gas and oil actuated relay shall be connected on the piping connection from the main conservator to the tank. Each gas and oil-actuated relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay. Each relay shall be fitted with a calibrated glass window for indication of gas volume.

To allow gas to be collected at ground level, a small bore pipe shall be connected to the gas release cock of the gas and oil-actuated relay and brought down to a point approximately 1400 mm above ground level, where it shall be terminated by a cock which shall have provision for locking to prevent unauthorised operation.

The design of the relay mounting arrangements, the associated pipe work and the cooling plant shall be such that mal-operation of the buchholz relays will not take place under normal service conditions under all operating temperatures. The pipe work shall be so arranged that all gas arising from the transformer will pass into the gas and oil-actuated relay. The oil circuit through the relay must not form a delivery path in parallel with any circulating oil pipe, or is to be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided and not permissible. When a transformer is provided with two conservators the gas and oil-actuated relays shall be arranged as follows: -

(a) If the two conservators are connected to the transformer by a common oil pipe one relay shall be installed in the common pipe.
(b) If the two conservators are piped separately to the transformer two relays shall be installed, one in each pipe connection.

The clearance between oil pipe work and live metal is to comply with the specifications as specified. The connection pipe between the conservator tank and the transformer main tank shall be fitted with a gas operated (Buchholz) relay for the protection of the transformer. The connection pipe shall have the same bore as the relay. Buchholz relays shall not operate under any of the following conditions:

a) Due to the operation of the pumps.
b) Due to movement of the transformer by earthquakes.
c) Due to magnetic fields either on energising the transformer or due to the fault currents in conductors creating field intensities in air of up to 0.07 Tesla.

Stop valves shall be provided on both sides of the relay, and as near as possible to the Buchholz relay. The stop valves shall have clearly marked 'open' and 'closed' positions **visible from ground level**. A means of securing the valves in the 'open' position is required, preferably without needing to use key locking devices.

Transformer construction shall allow any rising gas to readily reach the Buchholz relay(s) and not be trapped. If necessary, piping shall be provided to lead away any gas that could be trapped in any part of the main tank. The relay shall be provided with both "Trip" and "Alarm" contacts wired to the cooling control cubicle.

Piping and petcocks shall be provided so that gas and air can be released from the Buchholz relay and air can be injected into the top and bottom of the relay (this tests the operation of the contacts). Petcock movement shall be prevented by securing them to the transformer tank. The gas bleed pipe shall be fitted with a readily accessible gas trap suitable for taking gas samples from a height of 1.4 m above ground level. The required pressure of the air injected through the bottom connection to test the trip contact shall not exceed 2,000 mbar. The piping shall be 10 mm diameter and all threads shall comply with ISO 7/1.

10.14.5 Pressure Relief Device

An approved pressure relief device of Qualitrol brand or MESSKO MPreC which shall be independent of electrical power, of sufficient size shall be provided for the rapid release of any pressure that may be generated in the tank and designed to operate at a static pressure lower than the hydraulic test pressure called for in Schedule of Works Tests. In the event that the device is a spring operated valve type, it shall be provided with at least two normally open signalling contacts to trip the transformer and remote alarm/indication purposes.

The relief device is to be mounted on the main walls above the level of the winding and is to be provided with a skirt to project at least 25 mm into the tank to prevent gas accumulation. The device shall be capable of maintaining oil tightness of the transformer under all conditions of normal service.

A cover or other arrangement shall be provided so that any oil discharges are in a downward direction avoiding adjacent or ancillary equipment. The design of the device shall be such that gas cannot accumulate around it inside the tank, nor moisture can enter it from the outside of the tank. This cover must not impair the function of the device and the openings shall be protected by suitable sized mesh to prevent birds nesting.

A resettable indicator **visible to a person on the ground** shall be provided to show that the relief valve has operated. Overpressure device shall not generate invalid trip signals by tank vibrations and by the magnetic fields generated during normal operation and during through-faults. Each device shall:

1. Maintain its oil tightness under a static oil pressure equal to the static operating head of oil plus 50kPa;
2. Attain its full opening in not more than 2.5 ms when subjected to an internal pressure impulse equal to the static operating head of oil plus 50kPa;
3. Be capable of withstanding full internal vacuum at sea level;
4. Be fitted with a visual operation indicator plainly visible and accessible from ground level, and arranged for manual resetting;

10.15 SHIPMENT AND DRYING OUT

10.15.1 Shipment

Each transformer when prepared for shipment shall be fitted with a shock indicator or recorder which shall remain in situ until the transformer is delivered to Site. In the event that the transformer is found to have been subjected to excessive shock in transit, such examination as is necessary shall be made in the presence of the Employer's Representative. Transformers shipped under pressure of gas shall be fitted for the duration of delivery to Site and for such time thereafter as is necessary with a gauge and gas cylinder adequate to maintain internal pressure above atmospheric.

10.15.2 Drying Out

All transformers shall be dried out by an approved method at the manufacturer's works and so arranged that they might be put into service without further drying out on Site. Clear instructions shall be included in the Maintenance instructions and any required material shall be provided with the transformers regarding any special precautionary measures (e.g. strutting of tap changer barriers or tank cover) which must be taken before the specified vacuum is applied to the transformers so that they can withstand the treatment.

10.15.3 Oil Storage

The Contractor shall supply the first filling of transformer oil, which in accordance with the Purchaser's current practice shall be to IEC 60296. It is envisaged that the oil will be supplied to site in 200 L drums and filtered by use of the plant described in the preceding paragraph into the Employer's mobile storage tank prior to transfer again via filter plant into the transformer.

10.15.4 Transformer Oil

Transformer and switchgear oil shall be compatible with that available in Fiji and should be new.

10.16 33/11 kV TRANSFORMERS

10.16.1 Continuous Maximum Rating

The transformer shall have the continuous maximum rating (CMR) stated in Employer's Requirements when operating as ONAF.

10.16.2 Impedance

The HV - LV impedance shall be 7% at principal voltage ratio 33 kV at tap position no.5 at reference temperature 750 C on a 15 MVA base.

The value of impedance measured on principal and extreme tapings shall be as stated in the Schedule and minimum and maximum values where stated in the Employer's Requirements shall not be subject to tolerance. Where transformers are required to operate in parallel with existing units the appropriate data will be stated in the Employer's Requirements. The impedance on other tappings shall be stated in Technical Particulars and Guarantees.

It is preferred that the equivalent zero sequence impedance of the transformer, when viewed from the 33 kV terminals is not less than the positive sequence impedance between 33 kV and 11 kV terminals at normal ratio normal rating. The value shall be stated in Technical Particulars and Guarantees on the basis of system short circuit levels stated in Employer's Requirements.

10.16.3 Winding Terminations

Terminations of delta connected windings and neutral ends of windings shall be as follows: -

(i) Neutral ends of the three phase windings shall be connected at points accessible from hand holes in the cover and brought out via one bushing insulator.

(ii) Delta windings shall be closed within the tank and the termination shall be brought into cable termination boxes.

10.16.4 Voltage Control

The nominal voltage ratio shall be 33/11 kV. On-load tap-changer tappings on the HV 33 kV winding shall be provided as follows:

33 kV + 8 X 1.5% to 33 kV -10 x 1.5% steps. The tapings shall be numbered from the highest ratio no. 1 to the lowest ratio no. 19.

The principal voltage ratio shall be 33 kV at tap position no. 9

The category of voltage variation shall be constant flux voltage variation in accordance with clause 3 of IEC 60076-1

10.17 EARTHING & AUXILIARY TRANSFORMERS

10.17.1 Earthing Transformer

Not applicable.

10.17.2 Auxiliary Transformer

To be supplied by Employer.

10.18 GALVANIZING

10.18.1 General

a. Galvanising shall be in accordance with BS 729 and shall consist of a thickness of zinc coating of between 100 to 120µm.

b. Hot dip galvanising of metal, including the threads of bolts and screwed rods shall be carried out after all machining, bending, cutting, drilling, punching, marking and welding operations have been carried out.

c. Nuts shall be tapped up to 0.4 mm oversize after galvanising and the threads shall be lubricated by water-resisting rust-inhibiting oil.

d. Where punching is used the draw shall be removed together with all burrs from drilling, punching etc prior to galvanising.

e. The zinc coating shall be smooth, clean and of uniform thickness and free from defect.

f. The preparation for galvanising and the galvanising itself shall not adversely affect the mechanical properties of the coated material. Surfaces in contact with oil shall not be galvanised.

g. Galvanising Damage and Shipping Corrosion - If the extent of damage found on site to a galvanised part appears capable of repair, the Manufacturer may, after receiving agreement from the Employer, attempt to effect such repair by approved methods.

h. This agreement shall not bind the Employer to accept the repaired part when it is reoffered for inspection.

i. In the event that it is found that galvanised parts are subject to the formation of white rust during shipment or storage on site, the Employer shall either :

    a. Approve a system of scrubbing and protective painting to be applied on site if, in his opinion, this is expedient, or
    b. Reject the affected parts. Replacement parts shall be given special dip or spray treatment without extra charge to the Employer. Replacement parts are subject to the Employer's inspection and approval.

10.18.3 Castings

a. All castings shall be true to pattern, of uniform quality and condition, and free from blowholes, flaws, and cracks. No welding, filling or plugging of defective parts is to be done under any circumstances.

b. The surfaces of castings, which do not undergo machining, shall be free from foundry irregularities and burrs.

10.18.4 Iron Castings

All cast iron is to be of close-grained quality approved by the Employer. Iron casting material shall be in accordance with ASTM A 126 Class B, and shall be subject to appropriate tests and inspection as detailed therein.

10.18.5 Steel Castings

Steel castings shall be manufactured in accordance with ASTM A27, and shall be subject to appropriate tests and inspection as detailed therein.

10.18.6 Non-ferrous Castings

Non-ferrous casting material and castings shall be manufactured in accordance with the appropriate ASTM standards for the material concerned.

10.18.7 Welding

a. Welds across oil tight joints shall be subject to the approval of the Employer. Such welds may be allowed providing the joining process is by automatic submerged arc welding with welding from both sides of the plate.
b. Where gussets are provided cut-outs shall be provided and of sufficient size to allow welding behind. All tanks, fittings and flanges shall be double welded.
c. No Space welding is allowed externally. No end-to-end jointing of steel sections shall be allowed. Joints between members connected by welding shall be completely sealed by a continuous weld.
d. The Manufacturer is to submit evidence, satisfactory to the Employer, that the welding operations are qualified in accordance with the requirements of the appropriate section of BS 4871, or such other standard approved by the Employer
e. In all cases where welds are liable to be highly stressed such as in the case of containing short-circuit forces; the Manufacturer shall supply to the Employer a general arrangement drawing of the proposed welding and the supporting evidence that the structure will contain the above mentioned forces.
f. Subsequently, and before fabrication commences, a detailed drawing of all proposed weld preparations on the fabrication shall be supplied to the Employer for approval.

10.19 ANTI CORROSION DESIGN

The design shall be based severe marine on worst atmospheric classification with a durability of minimum 20 years in accordance AS/NZS 2312.

In choosing materials and their finishes, due regard shall be given to the conditions under which equipment is to work, particularly since the corrosion of outdoor equipment is of continuing and serious concern to the Employer. The equipment offered shall be constructed of suitable high-grade materials to minimise corrosion.

I. Metals of iron or steel shall be painted or galvanised as appropriate in accordance with this specification. Alternatively, indoor parts may have chromium or copper-nickel plated or other approved protective finishes. Materials and combinations of materials used to construct the equipment shall be selected and arranged to prevent bimetallic corrosion. Aluminium alloys containing Cu or Mg shall not be used. Current carrying parts shall be made from non-ferrous metal. Where practicable, all surfaces shall be self-draining, and all air filled enclosures (e.g., terminal boxes) shall have an insect-proof drain hole. All surfaces, openings and flanges shall be designed and constructed to avoid the settling or accumulation of moisture, including condensation, and any other corrosive material.

II. Bolts, Screws, Nuts, Springs, Pivots, etc.

Any cover bolts, nuts, washers etc shall be galvanised, and all others shall be 316 stainless steel bolts mated with 308 stainless steel nuts together with an anti-seize compound.

When used, stainless steel screws shall be used when plating is not possible owing to tolerance limitations, be of corrosion-resisting steel. Instrument screws (except those forming part of a magnetic circuit) shall be brass or bronze. Springs shall be of non-rusting material, e.g., phosphor-bronze, or nickel silver.

III. Fabrics, Cork, Paper, etc.

These materials, which are not to be protected subsequently by impregnation, shall be adequately treated with an approved fungicide. Sleeving and fabrics treated with linseed oil or linseed varnishes shall not be used.

IV. Gaskets

All joint faces shall be arranged to prevent the ingress of water or leakage of oil with a minimum of gasket surface exposed to the action of oil or air. **Oil resisting synthetic rubber is not permissible except where metal inserts are provided to limit compression.**

Gaskets shall be as thin as is possible consistent with the provision of a good seal and full details of all gasket sealing arrangements shall be shown on the Plant drawings. ALL Gaskets shall single piece without joints. Where joints are inevitable then dovetail or other approved joints shall be used.

All "O" Ring gaskets shall be of the Green (or other nonblack colour) Viton high temperature type. Any alternative gasket type supplied shall be to the approval of the Employer.

All flat gaskets (including the LV Cable Box) shall be of the Klingerite type or the Green (or other nonblack colour) Viton high temperature type. NIBBER is also acceptable. Any alternative gasket type supplied shall be to the approval of the Employer.

Welded lid gaskets and all Control Cubicle gaskets may be of a suitable type at the discretion of the Contractor. Gaskets shall not deteriorate due to weathering or when exposed to transformer oil at operating temperature of 130◦C.

If sealing rings are used for the main oil retention control:

a. Machined flanges

The machined flanges shall be painted with the same external paint system as the main tank, excluding "O" ring seats and sealing surfaces. The method of effecting the above in relation to the sealing ring shall be to the Employer's approval.

It is required from the "O" ring outwards that a sealant be used to prevent ingress of moisture between faces after assembly of the flange. This can be in the form of a thin gasket or sealant to the approval of the Engineer and shall cover the surface from the "O" ring to the outside of the flange.

b. Non-machined flanges

Non-machined flanges shall be painted with the same external paint system as the main tank. The use of gaskets each side of the bolts in any flange is not acceptable. The flange shall have its mating surface fully covered by the gasket.

c. Main Flange

The joint shall be sealed by a restrained "O" ring, or full flange gasket that prevents moisture ingress.

10.19.1 Finishes

Special attention shall be given to ensure the integrity of all protective coatings during sea freight.

10.19.2 Tanks, Accessories, Pipe-work

Painting shall commence with the least possible delay after inspection of the cleaned surfaces by the Employer. No visible deterioration as compared to a freshly cleaned area shall be allowed. A blast-cleaned surface shall not stand overnight without being coated. The tank base underside shall have the same paint system applied as other tank surfaces.

10.19.3 Zinc Spraying of Main Tank Base

The outside of the main tank base and all sides of the main tank wall up to a level of 500 mm from the bottom of the tank base shall be zinc sprayed prior to painting. The zinc spray applied shall have a minimum dry coating thickness of 120 μm.

10.19.4 External Surface Preparation

1. Air Filled Cable Box shall have only external surfaces painted to the same standard as the main tank external surface requirements
2. Exterior surfaces to be painted shall be prepared by a dry method of blast-cleaning to one of the following standards :

    a) "First Quality" in accordance with BS 7079, with the metallic abrasive conforming to BS EN ISO 11124-3 & 4.
    b) "Class 2.5" in accordance with AS 1627.
    c) "Sa 2.5" in accordance with Swedish Standard SIS 05 59 00.

3. The external colour of outdoor equipment shall be Neutral to BS 4800, reference 00A05. Each coat of paint shall have a contrasting colour to all the adjacent coats of paint.

    A) First Coat
    Exterior surfaces shall have an inorganic zinc silicate primer applied, "Dulux ICI" Zincanode 304, or equivalent, with a dry film thickness between 65 to 75 microns, and with no porosity.

    B) Second Coat
    The second coat shall be "Dulux ICI" Ferreko No 3 Micaeous Iron Oxide Mid Grey, or equivalent, with a dry film thickness ranging between 80 to 100 microns.

    C) Third Coat
    The third coat shall be "Dulux ICI" Luxepoxy 4 White Primer, or equivalent, with a dry film thickness ranging between 30 to 40 microns.

    D) Fourth Coat
    The fourth coat shall be "Dulux ICI" Urethane or epoxy Enamel, or equivalent, with a dry film thickness ranging between 30 to 40 microns.

4. The total thickness shall range between 205 microns and 255 microns.

5. All corners, nuts, bolts, tap changer, fan and pump housings shall be covered to the above specified paint thickness.
6. Interior Surfaces

Interior voids and surfaces of all oil-filled chambers shall be free from all rust, scale and other detritus. Accessible interior surfaces shall be power brushed.

The interior of all oil filled chambers (except for radiators), shall be painted with an oil resistant white anti-tracking varnish or enamel.

7. Radiators

    a) Surface Preparation
    Internal surfaces of radiators shall be hot acid flushed and shall be free of all rust, scale and detritus. Alternatively, a nitrogen lance shall be used to purge the atmosphere of oxygen during welding and fitting. A non-return valve shall be used to prevent the entry of air into the radiator during galvanising.

    External radiator surfaces shall be hot-dip galvanised.

    b) Painting
        i. Clean galvanised surfaces of all grease, oil and fluxing residues using galvanising-preparation solution and hot water blast.
        ii. Phosphate and pre-treat all surfaces to ensure proper adhesion of primer and subsequent coats and allow sufficient time to dry.
        iii. Apply full immersion prime in ZP zinc phosphate to 50 um DFT.

iv. Apply intermediate coat to 100 um DFT using epoxy hi-build.
v. Apply top coat in acrylic urethane to 60 um DFT (Colour: 00A05 to BS5252).
vi. Provide Quality Control documentation.
vii. No damaged radiator shall be acceptable on site.
viii. The transformer manufacturer shall supply sufficient spare amounts of all four layers of transformer paint for the repair work at site of all damaged transformer surfaces - with the exception of the radiators.

8. Galvanising Damage and Shipping Corrosion

If the Employer considers that on-site damage to a galvanised part is repairable, then the contractor may attempt repair by using approved methods. Any agreement to attempt repair shall not bind the Employer to accept the repaired part when it is re-offered for inspection. If galvanised parts are found to be subject to the formation of white rust during shipment or storage on site, the Employer shall either:

i. Approve a system of scrubbing and protective painting to be applied on site if, the Employer considers this expedient, or,

ii. Reject the affected parts. Then, before any future shipments are dispatched from the works, replacement parts shall be given special dip or spray treatment at no extra cost to the Employer. Replacement parts are then to the Employer's inspection and approval.

10.19.5 Internal Fastings

Spring washers shall not be used. The preferred method of locking nuts is to use a full nut and a half nut. After tightening a nut and washer or nut and lock nut assembly, the steel thread shall be "popped" with a sharp pointed punch to prevent loosening of the nut. Non-steel bolts and nuts shall use a locking system together with glue or ties

10.20 UNLOADING EQUIPMENT

Special attention has to be given for unloading the transformers as the harbour in Fiji as today has limited facilities to handle such heavy equipment. Also the transport to site by trailers etc. has to be thoroughly planned by the Contractor, with regard to maximum permissible loads for roads and bridges or other obstacles and detailed information has to be included in the Bid. Inside the boundaries of the substations under this project, it is the Contractors responsibility to construct any means required for an easy moving of the transformers onto their foundations, as for example access roads, temporary crossings of culverts or drains, temporary dismantling of existing facilities etc. For movement and alignment of the main transformers on site, 8(eight) hydraulic jacks of 100t and 50t respectively, each with common hand operated oil pump and housing system and all accessories and spare parts as necessary are to be included in the scope of supply. Individual hand operation shall also be possible. The final capacity shall be matched to the heaviest transformers. Furthermore, twelve heavy duty tank type steel rollers, and ten numbers 1 cm high, 2m by 1m steel sheets for offloading of the transformers together with $10m^3$ heavy wood oil impregnated, rectangular sectioned timber logs of assorted length between 0.5m and 3m and assorted thickness between 5cm and 20cm shall be supplied.

10.21 TEST AT MANUFACTURE'S WORK

10.21.1 Main Transformers

Each of the transformers shall be subject to acceptance tests to be performed at the Contractor's premises (and at site) in order to verify their conformity with the guaranteed and other design data. The methods of testing shall be submitted for approval at least three months before testing. The transformers shall be completely assembled in every respect. All of the tests shall be performed with all original bushings installed. The tests shall be performed in accordance with the latest issues of the recommendations of the (International Electrotechnical Commission) IEC, in particular IEC 60076 and IEC 60060.The Contractor is obliged to submit a detailed test program (including detailed test connections for all dielectric tests) for approval in due time, prior to the tests (at least three months before testing). Detailed test schedules separately for each unit showing exactly when each of the tests will be carried out shall be submitted for approval at least six weeks prior to the tests.
The following test shall be performed in the presence of the Employer/Employer's Representative:

10.21.1.1 Routine Tests

Routine test shall be according to the IEC 60076, part 1, clause 10.1.1.

Clause 10.2	-	measurement of winding resistance
Clause 10.3	-	measurement of voltage ratio and check of phase displacement
Clause 10.4	-	measurement of short-circuit impedance and load loss
Clause 10.5	-	measurement of no-load loss and current.
Clause 10.8	-	Test on on-load tap changers
IEC 60076 , part 3	-	Dielectric routine tests
IEC 60076 , part 3	-	Insulation of Auxiliary wiring
IEC 60076 , part 3	-	Separate source AC withstand voltage
IEC 60076 , part 3	-	Induced AC voltage test
IEC 60076 , part 3	-	Partial discharge measurement
Over Pressure test of tank		

10.21.1.2 Type Tests (apply only for one transformer)

Type test shall be according to the IEC 60076, part 1, clause 10.1.2.

10.21.1.3 Special test (apply only for one transformer)

Special test shall be according to the IEC 60076, part 1, clause 10.1.3 -

a) Dielectric special tests (IEC 60076 , part 3)
b) Determination of capacitances windings–to-earth, and between windings.
c) Determination of transient voltage transfer characteristics.
d) Measurement of zero-sequence impedance(s) on three-phase transformers.
e) Determination of sound levels (IEC 60551).
f) Measurement of the harmonics of the on-load current (Clause 10.6).
g) Measurement of the power taken by the fan and oil pump motors.
h) Measurement of insulation resistance to earth of the windings, and/or measurement of dissipation factor (tan δ) of the insulation system capacitances
i) Insulation test of oil and Measurement of dielectric strength of oil
j) Dissolved gases analysis
k)

10.21.2 Earthing and Auxiliary Transformers

10.21.2.1 Routine Tests

Not applicable.

10.21.2.2 Type tests

Not applicable.

10.21.2.3 Special Tests

Not applicable.

10.22 TEST ON SITE

10.22.1 Transformers and Ancillary Equipment

The following site tests shall be performed:-

1. Measurement of the excitation current at any star-connected winding with low voltage (AC, 3 phase) when the transformer is completely de-magnetised.
2. Measurements of voltage ratio at all tap positions.
3. Check of vector group.
4. Measurement of winding resistance at all taps.

5. Measurement of insulation resistance between the core and core tank at 2500 V DC.
6. Measurement of insulation resistance and polarization index at 5kV or 10kV DC.
7. Determination of capacitances windings–to-earth, and between windings.
8. Measurement of dissipation factor (tan δ) of the insulation system capacitances
9. Dissolved gases analysis
10. Sweep frequency response analysis (to be compared with the initial test carried out at the factory prior to dispatch) for minimum, maximum and normal operating tap.
11. Measurement of the dielectric strength of the insulation oil.
12. Applied over-voltage test at 2000Von AC wiring, control and supervision equipment
13. Functional test on control & supervision test.
14. Functional test of tap changer
15. Functional test of alarm and trip signals from all auxiliary protection (bucholz gas relays, winding temperature, oil temperature, pressure relief device, oil level indicators)
16. Visual checks.

Prior to commencing installation at site, the data from the impact recorders is to be extracted and analysed to assess any major shock/vibration incurred by the transformer. If there is evidence of a substantial impact on the transformer, a sweep frequency analysis will be carried out immediately to determine the extent of damage, followed by transformer examination. If the impact recorders do not show any substantial shock experienced by the transformers during transport, then the SFRA will be carried out after installation of the transformer.

10.22.2 Paint and Galvanising Thickness Tests

The Contractor shall test and record the paint and galvanising thickness and may be required to demonstrate to the Employer's inspector that the thicknesses comply with the requirements of the specification.

CHAPTER 11 - INSPECTION AND TESTING

11.1 GENERAL REQUIREMENTS

The plant covered by this Contract will be subjected to inspection and test witnessed by the Employer/Employer's Representative during manufacture and on completion. The approval of the Employer/Employer's Representative or the passing of any such inspection or test will not, however, prejudice the right of the Purchaser to reject the Plant if it does not comply with the Specification when erected to give complete satisfaction in service. The costs of all tests and inspection shall be borne by the Contractor and shall be deemed to be included in the Contract Price.

Before any plant is packed or dispatched from the Main or Sub-Contractor's works, all tests called shall have been successfully carried out to the satisfaction of the Employer/Employer's Representative. Adequate notice shall be given when the plant is ready for inspection or test and every facility shall be provided by the Contractor and his Sub-Contractors to enable the Employer/Employer's Representative to participate at the necessary inspection and tests.

11.2 TESTS AT MANUFACTURER'S WORKS

Works tests shall include all routine electrical, mechanical and hydraulic tests in accordance with the relevant IEC Standard except where departures therefrom and modifications thereto embodied in this Specification. For plant not covered by any ISO or IEC or specially mentioned in this Specification, such tests as are relevant shall be agreed with the Employer/Employer's Representative. Should the Plant or any portion thereof fail under test to give the required performance, further tests, which are considered necessary by the Employer/Employer's Representative, shall be carried out by the Contractor and the whole costs of the repeated tests will be borne by the Contractor. This applies also to tests carried out at the Sub-Contractor's works. No item of Plant is to be dispatched to Site until the Employer's Representative has given his approval in writing.

11.2.1 Sub-Contractors

Within two months of acceptance of the Tender, the Contractor shall forward to the Employer's Representative, a list of all sub-orders placed or intended. The contractor shall submit three copies of all sub-orders as selected by the Employer's Representative for progress or inspection. One copy of all drawings referred to in the sub-orders is to be submitted, unless otherwise agreed by the Employer's Representative. The drawings and sub-orders submitted to the Employer's Representative shall cover all components, which are subjected to electrical & mechanical pressure or stress when the plant is in operation and also those items, which will be dispatched to Site direct from the sub-Contractor's works. For the purpose of this clause, inter works orders shall be treated as sub-orders. Sub-ordered shall include a statement advising the Sub-Contractor that the items being ordered will be subject to inspection and test by the Employer/Employer's Representative.

It is important that all copies of sub-orders are clearly marked with the name of the contractor and the following references:

Employer's Name:
Contract Number:

Sub-Contractors shall comply with all the applicable requirements of this Specification and, in particular, with this Chapter. Orders issued by the Sub-Contractor shall also include the Main Contractor's name and reference on their sub-order in addition to the above-mentioned heading.

11.2.2 Material Tests

The contractor shall provide test pieces as required by the Employer's Representative to enable him to determine the quality of the material supplied under this contract. Such test pieces shall be prepared and supplied free of charge and any cost of the tests shall be borne by the contractor. If any test piece fails to comply with the requirements of the appropriate specifications for the material in question, the Employer's Representative may

reject the whole of the material represented by that test piece: the Contractor's designers and metallurgists will be consulted before any material is so rejected.
In the event of the Employer's Representative being furnished with certified particulars of tests, which have been carried out for the Contractor by the suppliers of materials, they may, at their own discretion, dispense with the previously mentioned test entirely.

11.2.3 Test Certificates

Triplicate sets of all principal test records, test certificates and performance curves shall be supplied for all tests carried out in accordance with the provision of this Contract. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer/Employer's Representative. The information given in such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate.

11.2.4 Switchgear, Protective Relay Equipment, D.C. Batteries, Chargers and Distribution Switchboards

Refer relevant Chapters.

11.3 SITE TESTS AND COMMISSIONING TESTS

Tests on completion of erection shall be carried out by the Contractor in accordance with Clauses 28 of the General conditions of Contract (FIDIC). Test equipment shall be provided by the Contractor. The contractor shall state in the Schedule of "Special Tools and Appliances", any special testing equipment he thinks necessary.
The Contract Price shall include the hire of the equipment but the Schedule of Prices shall include the cost of the equipment so that the Employer's Representative may have option to buy the equipment on completion of the Contract.

11.3.1 General Test Requirements

11.3.1.1 Procedure

A program of tests shall be agreed between the Contractor and the Employer's Representative, and a test program for all Sites agreed in conjunction with the erection and commissioning program approved by the Employer's Representative. Testing shall be carried out during normal working hours as far as is practicable. Tests, which involve existing apparatus and outages, may be carried out outside normal working hours. The Contractor shall give sufficient notice to allow for the necessary outage arrangements to be made in conformity with the testing program. The Contractor shall advice the Employer/Employer's Representative in writing by the time of commencement of site erection of the supplies which will be required for the operation of the test equipment. This should be necessary, to enable the Employer/Employer's Representative to arrange accordingly or to agree alternative arrangements.

The Contractor shall provide the requisite experienced test personnel and all relevant test equipment, unless otherwise agreed by the Employer's Representative or stated in the Employers Requirements. The Employer's Representative shall approve the data of the test equipment provided. The Contractor shall record the results of the tests clearly, in an approved form and with clear reference to the equipment and items to which they refer, so that the record can be used as the basis for the maintenance tests during the working life of the equipment. The required number of site test result records shall be provided by the Contractor to the Employer's Representative as soon as possible after completion of the tests. The Contractor shall submit the necessary sets of test schedules and copies prior to the commencement of the tests. However, one legible copy of the test results as taken on site immediately after the tests are completed has to be handed over. No tests as agreed under the program of tests shall be waived except upon the instruction of agreement of the Employer's Representative in writing.

11.3.1.2 Standards and Methods

The method of testing, unless otherwise specified in the Employer's Requirements, shall be agreed with the Employer's Representative. Details of the test equipment and instruments used shall be noted in the test sheets in cases where the instrument or equipment characteristics can have influence on the test results.
The Contractor's test equipment shall be of satisfactory quality and condition and, where necessary, shall be appropriately calibrated by an approved authority or standard at the Contractor's expense.
The testing requirements detailed under this Specification may be verified only by instruction of the constructional techniques.

11.3.2 Protection, Control, Alarms, Measurements and Indication Equipment.

11.3.2.1 Wiring

Insulation resistance Tests at 2kV AC for one minute are to be carried out on all protection, control, alarm and indication circuits to ensure that wiring is in satisfactory condition. Visual inspection shall be made on cable glands, cable jointing, fuse or circuit breaker ratings and small panel items, such as indicating lamps.
Static equipment, which may be damaged by the application of test voltages, shall have the appropriate terminals short-circuited. Inter-relay, inter-unit and cubical wiring carried out at site is to be checked to the appropriate circuit and/or wiring diagram. This may be done by using bells or buzzers. DC supplied from the station battery may also be used. Where it is found necessary during pre-commissioning work to make modifications to the secondary wiring, then the diagrams shall be suitably marked as agreed with the Employer's Representative before the circuit is commissioned. Loop resistance measurements are to be made on all current transformer circuits. Separate values are required for current transformer and lead resistance and all measurements are to be recorded on lead resistance diagrams. When pilot cable is used to transmit protection measured values, its impedance and phase angle shall be compensated for properly in the protection settings.

11.3.1.3 Mechanical Inspection

All relays are to be examined to ensure that they are in proper working condition and correctly adjusted, correctly labelled and that the relay case, cover, glass and gaskets are in good order and properly fitting.

11.3.1.4 Secondary Injection

Secondary injection shall be carried out on all AC relays, using voltage and current of sinusoidal waveform and rated power frequency. For circulating current protection employing high impedance voltage operated relays, the points of injection for relay voltage setting tests shall be across the relay and stabilizing resistance. The fault setting for the type of protection is to be established by secondary injection, where it is impracticable to ascertain this value by primary injection. Injection is to be made across the appropriate relay bus wires with all associated relays, setting resistors, and CT's connected.

11.3.1.5 Current Transformer Magnetizing Tests

The magnetization characteristic of all current transformers shall be checked at the minimum of two points and up to a maximum of five points as necessary to identify the current transformers with reference to the manufacturer's estimated design curve, and to determine the suitability of the current transformer for its intended duty. Special measures may be taken to ensure that the core is fully demagnetized before commencing the test.

11.3.1.6 Primary Injection

Primary current injection tests are to be carried out by the Contractor. The primary injection methods employed for a particular installation are to be agreed with the Employer's Representative.
Tests are to be carried out as follows: -

a) Local primary injection to establish the ratio and polarity of current transformers as a group, care being taken to prove the identity of current transformers of similar ratio.
b) Overall primary injection to prove correct interconnection between current transformer groups and associated relays and the voltage transformers.
c) Fault setting tests to establish the value of current necessary to produce operation of the relays. If not possible these tests are to be carried out by secondary injection applied at the wiring close to the current transformers.

11.3.1.7 DC Operations

Tests are to be carried out to prove the correctness of all DC polarities, the operating levels of DC relays and the correct functioning of DC relay schemes, selection and control switching, indications and alarms.

11.3.1.8 On Load Tests

In view of the hazards inherent in these tests, they shall be carried out under the direct supervision of the Employer/Employer's Representative and/or the Purchaser. An operation and stability test shall be carried out for on load commissioning. Tests for restraint shall be carried out to prove the characteristic of protective systems with directional characteristics. On load check shall be made after the protective gear has been placed in service to ensure that all connections and test links have been replaced and test leads removed, as well as to confirm the integrity of the current transformer circuits. Where necessary voltage readings shall be taken at the terminals on each relay to ensure that loop connections between the relays are complete. Special attention shall be paid to broken delta voltages and residual current circuits where zero voltage or current respectively may not be proof of the completeness of the circuit.

11.3.3 Switchgear And Ancillary Equipment

Written programs for tests and checks according to points under this paragraph shall be set up and agreed between the parties.

11.3.3.1 General Checks

A general check of all the main switchgear and ancillary equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, labelling, arcing ring and horn gaps, painted surfaces, cables, wiring, pipe work, valves, blanking, plates and all other auxiliary and ancillary items. Checks shall be made for oil and gas leaks and those insulators are clean and free of external damage. A check shall be made that loose items, which are to be handed over to the Employer's Representative, e.g. blanking plates, tools, spares are in order and are correctly stored or handed over.

11.3.3.2 Circuit-Breaker Tests

Circuit breaker shall be given a visual inspection. Test shall be made also on mechanical and hydraulic operating systems. Contact resistance test shall be carried out. In the case of multi-interrupter circuit-breakers resistance tests will be required at each interrupter or pair of interrupters as well as through the series of interrupters on each pole. Operational tests will include local and remote trip/close, Circuit Breaker timing tests shall be carried out on all circuit breakers. In the case of gas type circuit breakers testing will be required on the gas type system to prove the gas quantity, its dryness and its dielectric strength. The gas leakage shall be measured at factory and checked at site.

11.3.3.3 LVAC Switchboards

General testing and inspection shall be carried out as referred to above so far as is applicable. Attention is drawn to the requirement for the functional testing and timing testing of interlocking between incoming and bus section circuit-breakers circuits where automatic operation is specified. Insulation tests carried out with 2 kV AC for one minute test set. Shutters, interlocking, earthing procedures and the inter-changeability of components shall be checked.

11.3.3.4 Voltage Transformers

The following tests shall be carried out on electromagnetic type voltage transformers: -

a) Insulation tests at 2 kV to earth and between windings.
b) Checks on gas/oil relays, if there are any.

All voltage transformers shall be checked for polarity phasing and for secondary output.

11.3.3.5 Earthing System

Tests shall be made on the effectiveness of the bonding and earthing which will include conductivity tests on selected joints, on the main earthing system, and at the connections to equipment and structures. Checks shall also be made on precautions taken to avoid corrosion attack on the earthing system.
The resistance of the earthing system to the general mass of earth shall be tested and recorded including the method, and equipment used to carry out the tests. Test probes at approximately 300 and 600 meters separation will normally be required to effectively test the earthing system.
Tests of the earthing resistivity shall be carried out as called in Clause 8.3.
The earth resistance shall be measured during the installation and on completion.

a) Each earth rod after driving.
b) The earth grid after completion and backfilling of the trenches.
c) Each group of earth rods or earth point after completion of the connection fromthe test link terminal.
d) The completed installation without any connections outside the substation.
e) The Contractor shall be called upon to provide assistance in the measurement of each resistance after earth connections to the system have been completed. The test shall be carried out by a method and with equipment approved by the Employer and all tests are to be witnessed.

11.3.3.6 Batteries and Battery Charging Equipment

The insulation to earth of the complete DC installation shall be tested. Tests shall be carried out on the batteries and chargers to confirm the charger ratings and adjustment, the battery and charger alarm systems and battery capacity. The discharge & voltage recovery test should be carried out. The specific gravity and cell voltages of the batteries when fully charged shall be recorded.

11.3.3.7 Instruments and Fault Recorders

Instruments and instrument transformer circuits shall be checked for polarity or direction and for calibration including any interposing transformer or transducers. These checks shall be made on all current transformer ratios where applicable. Fault and event recorders shall be tested for printing operation and paper transport. Operation shall be checked by secondary injection and initiating device operation as applicable. Stability and normal operation shall be checked after the main high voltage circuit has been commissioned.

11.3.3.8 Interlocking

All interlocking arrangements both electrical and mechanical shall be fully checked and tested.

11.3.4 Power Cables

11.3.4.1 High Voltage Test

For cables up to 3.3 kV:
Each completed circuit of cable shall be subjected to a direct current high voltage test as follows:-
For cables installed in a three-phase, 230/400V, 50 Hz system, the test may be applied with a 2000V Megger insulation tester. For other cases, the voltage test shall be in accordance with BS.6346, Appendix B.

For cables above 3.3 kV:
Each completed circuit of cable shall be subjected to a high voltage test in accordance with IEC 60060 & IEC 60840. Cables shall be submitted to a DC test voltage in accordance with IEC 60502. A line impedance test should also be included in the test.

11.3.5 Transformers, Reactors and Ancillary Equipment

11.3.5.1 Main Transformers

The following site tests shall be performed:-

1. Measurement of the excitation current at any star-connected winding with low voltage (AC, 3 phases) when the transformer is completely de-magnetised.
2. Measurements of voltage ratio at all tap positions.
3. Check of vector group.
4. Measurement of winding resistance at central tapping and the extremes.
5. Measurement of insulation resistance at 5000 V DC.
6. Measurement of insulation resistance between the core and core tank at 2500 V DC.
7. Measurement of the dielectric strength of the insulation oil.
8. Re-calibration and current injection test on winding temperature indicators.
9. Applied over-voltage test at 2000V, AC wiring, and control and supervision equipment. (on motors 1000V, AC plus 2X Un)
10. Functional test on cooling plant.
11. Functional test on control & supervision test.
12. Functional test on O.L.T.C.
13. Visual checks.
14. Polarisation Index Test on the Windings.

11.3.5.2 Earthing Transformer& Auxiliary Transformer

The following site tests shall be performed:-

1. Measurement of voltage ratio.
2. Check of vector group
3. Measurement of winding resistance.
4. Insulation Resistance test on HV & LV.
5. Dielectric strength of oil.
6. Functional test of supervisory equipment.
7. Visual checks.

Where applicable the above tests shall also be carried out on shunt Reactors.

11.3.6 Bushing Type Current Transformers

(i) **Magnetising Tests**

The magnetisation characteristic of all current transformers shall be checked at the minimum of two points and up to a maximum of five points as necessary to identify the current transformers with reference to the manufacturer's estimated design curve, and to determine the suitability of the current transformer for its intended duty. It may note that it is not normally necessary to check the characteristic up to the knee-point for this purpose. Special measures may have to be taken to ensure that the core is fully demagnetised before commencing the test.

(ii) **Primary Injection**

Primary current injection tests are to be carried out by the Contractor. The primary injection methods employed for a particular installation are to be agreed with the Employer's Representative.

Local primary injection tests are to be carried out to establish the ratio and polarity of current transformers as a group, care being taken to prove the identity of current transformers of similar ratio.

CHAPTER 12 - GENERAL REQUIREMENTS

12.1 GENERAL

12.1.1 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. Generally, all equipment and materials shall be in accordance with the International Electrotechnical Commission (IEC) standards, International Standardization Organization (ISO) standards or standards especially indicated in the respective Chapters. The issues of standards valid for the contract shall be the latest issues (including amendments) current at the Tender closing date.

Wherever in these specifications the requirements are stricter than those in the standards, these specifications represent an additional requirement above that of the standard. The essence of design should be simplicity and reliability in order to give long continuous service with high economy and low maintenance costs. Particular attention should be paid to internal and external access in order to facilitate inspection, cleaning and maintenance. The design, dimensions and materials of all parts are to 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 are to be submitted describing particularly the materials to be used. Works shown upon the drawings and not mentioned or described in the specification, and works described in the specification and not shown on the drawing will nevertheless be held to be included in this contract and their execution shall be covered by the contract price in the same manner as if they have been expressly shown upon the drawings and described in the specification. The materials used in the construction of the Plant shall be of the highest quality and selected particularly to meet the duties required to 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, shall be as minimal as possible. All apparatus shall be designed to prevent the risk of accidental short circuit, malfunction or damage due to vermin. 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 Contractor shall also abide by the Project Manual which documents the project organisation, details the form and handling of correspondence and documents including a numbering system, procedures for meetings and document approval, gives some guidelines on quality assurance, time scheduling and progress monitoring.

12.1.2 Quality Assurance

The quality of the design, manufacturing and erection processes shall be assured by the Contractor in accordance with the ISO 9000 series standards. The Contractor must prove his possession of the respective certificates.
The Tenderer shall prove that the quality of the design, manufacturing and erection is done in accordance with the ISO 9001. The Tenderer shall submit respective certificates issued by an International Organisation at least for the equivalent list below.

(a) Circuit breakers
(b) Transformers
(c) Current transformers
(d) Voltage transformers
(e) Disconnecting and earthing switches
(f) Power/Earthing/Auxiliary Transformers
(g) Surge arresters
(h) All outdoor post insulators and bushings for current and voltage transformers
(i) Metering, Protection & Control equipment
(j) Digital Radio, PLC & SCADA equipment
(k) Power and Control equipment
(l) Cables & Conductors
(m) Indoor switchgear

12.1.3 Units of Measurement

In all correspondence, in all technical schedules and on all drawings metric systems International Units (SI) units shall be used. On drawings where Imperial or other units have been used it will be in order if the equivalent SI units are suitably marked in addition.

12.1.4 Compliance with Specification

Notwithstanding any descriptions, drawings or illustrations which may have been submitted with the Tender, all details other than those shown on the Schedule of Departures will be deemed to be in accordance with the Specification and the standard specifications and codes referred to therein. No departures from the Specification except those shown on the Schedule of Departures and approved by the Employer are to be made without the written approval of the Employer's Representative.
All exceptions shall be clarified and separately itemised. It shall not be necessary for the Purchaser to examine the standard literature and documents of the manufacturer to determine the existence and extend of any exceptions or deviations from specification.

12.1.5 Drawings

Before the work is put in hand, three copies of general drawings and diagrams showing all details of the Plant and materials to be used shall be submitted to the Employer's Representative for approval. The wiring or connection diagrams shall be submitted for approval unless prior approval has been obtained for schematic diagrams, which shall include control and protection schematics, showing the facilities being provided and the working of the schemes. Detailed drawings shall be submitted in quadruplicate as soon as possible after the commencement date and in any case in sufficient time to permit modifications to be made, if such are deemed necessary by the Employer's Representative, without delaying the delivery of the Contract work. The drawings submitted shall be modified as requested by the Employer's Representative and re-submitted for approval. When requested by the Employer's Representative, the Contractor shall supply at his own expense a copy, of any standard pertaining to the material or equipment covered by the contract. Any documentation submitted by the Contractor for approval shall only be in sizes A1, A2, A3 or A4 (210 X 297 mm), preferably A3 and A4. A2 and A1 shall only be used if absolutely necessary. All drawings shall be prepared using AUTOCAD 2010 or better. All documents shall bear a drawing or document title in a form and with a numbering system, which will be explained to the Contractor by Employer's representative. This numbering system will be in a format that is compatible to the existing numbering system of the Employer. Following documentation shall definitely be included in the documents to be submitted by the Contractor for approval by the Employer's Representative before construction or erection of the respective part of the works may start:

- detailed layout of all areas and equipment
- arrangement drawings of all equipment
- foundation drawings and design calculations
- functional block diagrams for protection
- complete circuit diagrams
- Earthing grid calculation
- Current Transformer calculations
- dimensional drawings of all equipment and installation
- general structural design calculation & drawings of all equipment and all buildings
- detailed construction schedule in form of a bar chart
- cable laying diagram
- building structures
- bending schedules
- drawings of lighting and small power installation

The contractor shall submit a complete list of all drawings listing the drawing number and title, together with the date that the drawing is planned to be submitted for approval, and the date it is required on site. In the same list, the actual dates of submission of each revision as well as date and status of approvals. The Contractor shall update the list at monthly intervals.
If the Contractor requires urgent approval of some drawings to avoid delay in the delivery of the Contract Works, he shall advise the Employer's Representative to such effect when submitting the drawing.

It shall be understood, however, that approval of the drawings will not exonerate the Contractor from any responsibility in connection with the work. After all items of Plant have been manufactured and erected, data file on Auto CAD format or reproducible digitised drawing file, of each drawing previously approved shall be provided together with four prints on heavy gauge white paper from such drawings as may be required to show the detail and arrangement of the Plant as made and installed. All drawings submitted by the Contractor or by any Sub-Contractor shall have the following particulars in the lower right hand corner in addition to the Contractor's name, date, scale, number and title of the drawings:

(i) Site

(ii) Project Name

(iii) Name of Employer – Energy Fiji Limited

(iv) Description of Apparatus

(v) Contract Name

(vi) Contract No.

(vii) Revision No.

The Contractor shall when submitting drawings provide an indexing system for all the drawings divided into sections for each substation and sub-divided for each type of equipment, e.g., indoor switchgear, control and relay panels, wiring diagrams, schematics, ancillary equipment, foundation, steelwork, etc.
The index shall contain the following information for each drawing:

(1) Drawing number
(2) Revision
(3) Title
(4) Data submitted for approval
(5) Date returned for correction
(6) Data approved for construction
(7) Date final drawings submitted
(8) Number of copies
(9) Remarks/distribution column for use by the Employer's Representative.

12.1.5.1 Drawings and Records

The contractor shall keep on site accurate and up to date drawings and records, and shall provide the Employer's Representative with one set of copies each. At the end of every week the Contractor shall submit to the Employer's Representative schedules of labour, plant and materials employed on the site during that week.

12.1.5.2 As built documentation

All documentation approved by the Employer's Representative and any documents used during erection or commissioning shall be updated at the end of the commissioning period to show the as built status. This updating shall be done by hand, clearly marking any changes in red colour. Two sets of complete drawings at least shall be prepared under the responsibility of the contractor's chief commissioning engineer. One set shall remain with the Employer's Representative while the other set is sent to the contractor's office where all modifications will be included in new neat as built documents which shall be distributed to the Employer and to the Employer's Representative. Receipt and acceptance of this documentation shall be a prerequisite for the issuance of the final acceptance. Soft copies of all as-built drawings has to be provided.

12.1.6 Access To Site

The Contractor shall make his own arrangements for handling and transport, and off loading at site, so as no facilities being available for him, free of cost. Plant will generally be delivered to the sites by road. The Contractor is to make his own enquiry as to the suitability, availability and charges for railway cranes, suitability of available wagons for the transport of any loads and any restrictions imposed by clearance gauges. The highways, road and bridges have widely varying load limits and the Contractor shall be responsible for determining the load limits existing at the time and ensuring that his Plant does not exceed such limits.

The Contractor shall be deemed to have included in his costs any temporary measures necessary to allow the transport of the Plant over existing roads and bridges. Before moving any heavy traffic on to highways, road and bridges, the Contractor shall make suitable arrangements with the appropriate Government authorities and obtain their approval for the passage of such traffic. In the event that any permanent reinforcement of road and bridges may be considered necessary for transport of the Plant, the Tenderer shall obtain an estimate of the costs from the Government Department concerned and include this as a provisional sum in the Schedule of Prices. Within the site areas, the Employer will maintain existing roads and the Contractor will be given use of the roads essential to his operations free of charge for normal traffic. Any damage caused by the Contractor's abnormal traffic shall be repaired at his own expense. The contractor shall take into account the fact that the Grid Sub Stations are high security areas, where access is strictly controlled. The contractor shall follow all security procedures adapted at these installations.

12.1.7 Packing

Each item shall be packed properly and protected for shipment and transport from the place of manufacture to Site, and in addition for storage for a minimum of three months under the Site climate conditions. The recommendations of the BS 1133 Packaging Code or equivalent International Standard shall be observed with particular reference to:

Section 5	:	Protection against spoilage of packages and their contents by microorganisms, insects, mites and rodents.
Section 6	:	Temporary protection of metal surfaces against corrosion.
Section 8	:	Wooden containers

Tube ends and other similar open ends shall be protected from both, 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 blank flange secured by service bolts.
Precautions shall be taken to protect shafts and journals where they rest on wooden or other supports likely to contain moisture. At such points, wrappings impregnated with anti-rust composition or vapour phase inhibitors shall be used of sufficient strength to resist chafing and indentation due to movement, which is likely to occur in transit. Protective wrappings and impregnation shall be suitable for a period of three months. In the case of ball or roller bearings installed in any item of Plant, precautions shall be taken to avoid indentation of the bearing races.
Metal bindings of cases shall be of corrosion resistant material and shall be properly tightened and the ends crimped together by means of a purpose made tool.

Contents of cases shall be bolted securely or fastened in position with struts or cross battens preferably supported by cleats fixed to the case so that there shall be no movement. Where parts are required to be bolted to the sides of the case, large washers are to be used to distribute the pressure and the timber shall be strengthened by means of a pad. Where practicable, all indoor items such as electric motors, switch and control gear, instruments and panels, machine components, etc., shall be "cocooned" or covered polyethylene sheeting, sealed at the joints and the enclosure provided internally with desiccators. All delicate equipment e.g. relays and instrument shall be removed from panels and packed separately for transport in the same consignment as the associated panels. The packing shall contain all equipment destined for the same location. Where transformers or similar devices are shipped under oil, the oil level shall be above the core and the windings and a silica gel breather shall be fixed to the tank cover or pipe work for protection against moisture entry during transport.
Each crate or package shall contain a packing list in a waterproof envelope. All items of material are to be clearly marked for easy identification against the packing list. All cases, packages, etc., shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating to them to the appropriate shipping documents. Stencil marks on the outside of casings shall be indelible.

The Employer's Representative may require to inspect and approve the packing before the items are dispatched but the Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not exonerate the Contractor from a loss or damage due to faulty packing.

12.1.8 Installation, Operating and Maintenance Instructions

When the general arrangements and details of the Plant have been finalised and not later than the erection commences, the Contractor is to submit to the Employer's Representative for approval fully detailed installation instructions.

the equipment supplied and are free of extraneous matter. The information provided should include essential circuit diagrams, general arrangement and detailed drawings of the installation make mention of special materials, erection apparatus and tools where used and include schedules of lubricants and all ball and roller races employed on the Plant. The drawings and diagrams, which may be approved existing drawings reduced to a convenient size, should be bound into the volume and not inserted into cover pockets. List of contract record drawings shall be included. If the complete text is unduly bulky, then the manual is to be appropriately sub-divided and produced in multi-volume form. When approved, four copies of the complete text, diagrams and drawings as made up in draft form are to be handed to the Employer's Representative for distribution at Site and these are to be provided not later than the erection commences.

Handing over of originals of Operating and Maintenance Instructions shall be as per the Clause 6.6 of General Condition of FIDIC.A further four copies are to be reproduced as a book or books of approximately A4 size and bound into durable covers inscribed in permanent form 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 "Operating and Maintenance Instructions". The name of the main Contractor and that of any Sub-Contractor shall also be inscribed upon the cover after the description of the Plant. The name of the Employer and substation or other identification followed by a classification of the plant (e.g. 33 kV Switchgear), is to be inscribed upon the spine of the cover and, if the instructions are contained in several books, these are to be marked with the appropriate volume number.

12.1.9 Cleaning And Painting

12.1.9.1 General

All bright metal parts shall be covered, before shipment, with an approved protective compound and protected adequately during shipment to Site. After erection these parts shall be cleaned with a correct solvent and polished brightly where required. Before testing, all steel pipes shall be thoroughly cleaned by an approved process. Any protective coatings shall be applied after tests have been carried out. Pipes, valves and other similar parts of the Plant which are subject to hydraulic test and are not readily accessible for drying out are on completion of tests at the manufacturer's works to be drained out by washing with approved de-watering oil prior to protection for shipment.

All surfaces shall be prepared before coating in accordance with ISO 1456, ISO 1458 or others as applicable.
All iron and steel structures shall be protected against corrosion in accordance with Chapter 13.Where painting is carried out at the manufacturer's works and where erection at Site is the responsibility of the Contractor, any damage during delivery or erection at Site shall be made good to the requirements of the Employer's Representative including, where deemed necessary, application of a complete finishing coat of an approved colour and quality paint. Where painting is carried out entirely at Site after erection, the whole of the Plant, including bare pipe surfaces and hand railing, shall be well wire brushed down and cleaned after which all parts shall be given one coat of primer, one undercoat and at least one finishing coat of an approved colour and quality paint. All paint shall have appropriate standard finish, requiring at least two finishing coats on prepared surfaces properly filled in to provide a smooth finish. The insides of outdoor control cubicles, cabinets, etc., where condensation is liable to occur, shall receive the same number of coats.

12.1.9.2 Tanks and Accessories

Interiors of oil tanks shall be thoroughly cleaned by shot blasting or other approved methods and, where exposed to corrosion before use, shall be coated with an approved corrosion preventing compound. The internal surfaces of oil tanks that will be exposed to atmosphere in service shall be painted with an epoxy or other approved oil resisting compound. The exterior shall be thorough cleaned by shot blasting or other approved methods and given one coat of primer, two coats of contrasting colour of durable oil and weather resisting paint and a final coat of gloss paint.

12.1.9.3 Radiators

Radiators shall be thoroughly cleaned and treated externally by phosphating or other approved rust inhibiting process and given, preferably by flood painting, the same number and type of coats specified in Sub-Clause 11.1.9.2 of this Clause. Radiators, which are hot dip, galvanised, shall be artificially weathered and given one coat of zinc chromate primer followed by the same number and type of paint coatings specified in Sub-Clause 11.1.9.2 of this Clause.

12.1.10 Lubrication

The Contractor is to include for the supply of flushing oil for each lubrication system when the item of plant is ready for preliminary tests and the first filling of approved lubricants for the commercial operation of the plant.
A schedule of the oil and other lubricants recommended for all components of the Contract work is to be submitted to the Employer's Representative for approval. The number of different types of lubricants is to be kept to a minimum. Copies of this schedule shall be included in both the draft and final copies of the Operating and Maintenance instructions. In the case of grease lubricated roller type bearing for electrical motors, lithium based grease is preferred. Where lubrication is effected by means of grease, preference will be given to a pressure-gun system with a separate nipple to each point. Where necessary for accessibility, the nipple is to be placed at the end of extension piping, and when a number of such points can be grouped conveniently, the nipples are to be brought to a battery plate mounted in a convenient position. Nipples shall be of the hexagon headed type complying with BS 1486 Part1 table1 type 11B or equivalent IEC/ISO. Where special greases are to be used and where high temperatures are encounted, then 'button' nipples in accordance with BS 1486 or equivalent IEC/ISO are preferably to be used. The Contractor is to supply at least one grease gun equipment for each type of nipple provided. Where more than one special grease is required, a grease gun for each special type is to be supplied and permanently labelled.

12.1.11 Tropicalisation

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which equipment is to work, and the recommendations of British Standard Code of Practice 1014 or equivalent IEC/ISO should be observed unless otherwise approved. Some relaxation of the following provisions may be permitted where equipment is hermetically sealed but it is preferred that tropical grade materials should be used wherever possible.

12.1.11.1 Metals

Iron and steel are generally to be painted or galvanised as appropriate. Indoor parts may alternatively have chromium or copper-nickel plating or other approved protective finish. Small iron and steel parts (other than stainless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms are to be treated in an approved manner to prevent rusting.

12.1.11.2 Screws, Nuts, Springs, Etc.

The use of iron and steel is to be avoided in instruments and electrical relays wherever possible. Steel screws are to be zinc, cadmium or chromium plated, or when plating is not possible owing to tolerance limitations, are to be of corrosion-resisting steel. Instrument screws (except those forming part of a magnetic circuit) are to be brass or bronze. Springs are to be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible. Brass or bronze is preferred.

12.1.11.3 Rubbers

Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, and transformer vibrations pads etc.

12.1.12 Tools

Where specified, the Contractor shall supply in steel boxes, complete with keys, any normal tools that are required for making adjustments to equipment during normal operation or maintenance. Any special tools required for

erection, commissioning, operation and maintenance of the equipment should be indicated in the price schedule with individual quantities, minimum time for delivery, and prices including the cost of delivery to the Employer's store. These special tools shall be of alloy steel. All tools shall be stamped with an approved identification.

12.1.13 Spares

The Contractor shall state in the Schedule of Spares the spares that he recommends, with individual quantities and CIF prices, together with the cost of the delivery to the Employer's storage (Labasa).The Employer may order all or any of the spares so recommended at his discretion. Those ordered shall be delivered to the Employer's Representative at the Employer's store or on the Site no later than the date of issue of the Taking Over Certificate for the item of Plant or equipment in question. They shall also be delivered within the minimum period stated in Schedule E for the delivery of the spares from the date of receipt of the Employer's order.
These spares will be charged against the Provisional Sum included in the Schedule of Prices and shall be supplied at the prices listed in the Schedule of Spares subject to the qualification that, if any spares should be ordered after the date of the Taking Over Certificate in question, the price may be subject to adjustment.
All spares supplied shall be strictly interchangeable with the parts for which they are intended to be replacements of and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose and, when more than one spare is packed in a single case or other container a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed inside. All cases, containing and other packages must be suitably marked and numbered for purposes of identification.

12.1.14 Inventory Records For Plant & Material

The Contractor shall forward his inventory records for plant & material at the end of each month to the Employer.

12.1.15 Documents & Drawings To Be Submitted After The Contract Award

As a minimum, the following documents & drawings shall be submitted after the Contract award.

a) General arrangement drawing
b) Single line diagram
c) Bill of material in detail.
d) Description of system components
e) Technical brochures
f) Breaker control elementary diagram
g) Disconnect switch control elementary diagram
h) Schematic and Wiring diagrams
i) Terminal board locations and arrangements
j) Voltage transformer connection diagram
k) Current transformer connection diagram
l) Name plate drawing
m) Protection stability calculations to demonstrate the adequacy of the Current Transformer cores.
n) Detail protection schematic drawings and protection setting calculation
o) Construction Schedule.
p) All relevant civil design calculations and drawings.

Other technical documents

a) Current transformer excitation curves.
b) Routine test reports.
c) Factory test reports
d) Test reports for onsite tests
e) Operation & Maintenance Manuals
f) Documents as required by the Employer's Representative.

12.2 MECHANICAL

12.2.1 Nuts, Bolts, Studs And Washer

Nuts and bolts for incorporation in the plant are preferably to conform to ISO Metric Coarse to ISO 68,261,262,272,724, 885,888 and 4759 or BS 3643, 3692 and 4190. Other sizes or threads are permitted for threaded parts not to be disturbed in normal use or maintenance. Where the Contract includes nuts and bolts of different standards, then the tools to be provided in accordance with the Specification are to include spanners, taps, and dies for these nuts and bolts. Bolts shall fit in the reamed holes they occupy. They shall have the screwed portion of a diameter such that it will not be damaged in driving and are to be marked in a conspicuous position to ensure correct assembly at Site. On equipment all bolts, nuts and washers shall be non-rusting material where they are in contact with non-ferrous parts in conductor clamps and fittings and elsewhere where specifically required by the Employer's Representative. All washers are to be included under this Contract, including devices and anti-vibration arrangements, which are to be subject to the approval of the Employer's Representative. Taper washers are to be fitted where necessary. Where there is risk of corrosion, bolts and studs shall be finished flush with the surface of the nuts and electro-chemical corrosion shall be avoided by bimetallic plates.

12.2.2 Rivets

Rivets shall conform to the appropriate ISO and general use pan heads are preferred. Rivets on bearing surfaces are to be flat counter-sunk, driven flush. Whenever practicable, riveting is to be done by hydraulic tools and the rivets must completely fill the holes when closed. If loose, or if the heads are badly formed, cracked or eccentric to the shank or do not bear truly on the plate or bar, such rivets are to be cut out and replaced. All surfaces to be riveted must be in close contact throughout.

12.2.3 Forging

All important forgings are to be examined by the latest methods for the detection of defects.

12.2.4 Castings

All castings are to be free from blowholes, flaws and cracks as is practicable. No welding, filling or plugging of defective parts is to be done without the sanction of the Employer's Representative and then only with his approval in writing. All cast-iron is to be of close-grained quality and is to be corrosion-resistant for those parts in contact with seawater. Cast-iron is not to be used for any part of the equipment which is in tension or which is subject to impact stresses. This clause is not intended to prohibit the use of suitable grades of cast-iron for parts where service experience has shown it to be satisfactory.

12.2.5 Welding

Where fabrication welds are liable to be highly stressed, the Contractor is to satisfy the Employer's Representative before such welding commences, that the welders or welding operators are qualified in accordance with the requirements of the appropriate section of BS 4872, Part 1 or equivalent IEC/ISO Standard Specification. The Employer's Representative will inform the Contractor of the stages at which inspection will be required. It will be the Contractor's responsibility to notify the Employer's Representative when one or more of the inspection stages will be reached and no further work is to be carried out until the specified stage has passed the Employer's Representative's inspection. In addition to the above, the Employer's Representative reserves the right to visit the Contractor's Works at any reasonable time during fabrication of the items of Plant and to familiarise himself with the progress made and the quality of the work to date. All tests are to be carried out in accordance with the relevant ISO or other approved standards. Where required by the Employer's Representative, non-destructive examination of the finished weld is to be made. If the examinations be by radiograph means, then the recommendations of BS EN 1435 or equivalent IEC/ISO where applicable are to be followed and the resulting negatives are to be made available to the Employer's Representative.

12.2.6 Chromium Plating

The chromium plating of those components of the Plant where specified and where offered by the contractor is to comply with the requirements of ISO 1456 & 1458 or BS 1224.

CHAPTER 13 - CIVIL WORKS

13.1 PRELIMINARY WORKS

13.1.1 Site Survey

Contractor shall collect for himself site levels, sub-soil data and other information to enable him to estimate the bearing capacity, foundation requirements, etc., for use in the preparation of the tender. After the award of the contract and handover of the site, the Contractor must make his own site surveys to collect all the information to prepare layout drawings.

The Contractor shall be responsible for all setting-out, irrespective of any checking by the Employer's Representative.

The Contractor shall survey the site of the new substation to obtain the following.

(1) Location of datum of setting out and levelling.
(2) Establishment of site boundaries and reduced site datum level.
(3) Position and condition of any approaches, bridges and access roads to and over the site, including highest recorded flood level (from local knowledge).
(4) Existing site levels on a 5 meters grid; and resultant contours at a meter vertical interval.
(5) Drainage pattern of the area

The Contractor shall survey the sites of the substations to obtain details of above items. Site survey plan at a scale of 1: 500 shall be prepared, showing the survey results and the proposed layout of the new works. The plan shall be sent to the Employer's Representative for his approval. After completion of the work, the Contractor should do a complete detail survey of the substation including all the parts completed to the date of handing over. The Employer's Representative should be provided with 3 hard copies and a soft copy of the results.

13.1.2 Sub soil Investigations

After award of the contract and the handover of the site, the Contractor is to ascertain for himself the nature of the sub-soil conditions of the work sites by means of boreholes and trial excavations etc. Samples shall be taken as necessary and tested to determine the physical and chemical characteristics of various strata and of the ground water. The sub-soil investigation should include determination of the design bearing pressure recommendations for foundations type and material to be used for the foundations. The safe bearing capacity of the sub-strata may be modified at his final design stage when the full site survey and investigation have been completed and the final layout, structural details etc. agreed. No variation in contract price will be made due to any variation in the bearing capacity leading to modification of foundation design at the final design stage. Special attention shall be paid to the Ground water table and chemical composition of the ground water and soil in the substation area. The following should be considered as a minimum requirement, assuming uniform conditions over the Site, but should be extended if many inconsistencies are encountered.

1. Project Objectives

- Assess subsurface conditions for foundation design.
- Evaluate soil stability, bearing capacity, and settlement risks.
- Identify potential geotechnical hazards (liquefaction, slope instability, etc.).
- Provide recommendations for foundation type, earthworks, and drainage.

2. Desk Study & Site Reconnaissance

- Review existing geological, hydrological, and geotechnical data.
- Conduct a site walkover to identify surface conditions, drainage, and signs of instability.
- Check for nearby structures, utilities, and past land use (contamination risks).

3. Field Investigations

Borehole Drilling & Sampling

- Number & Depth: Minimum 3 boreholes (or as per AS 1726), drilled to 1.5 x foundation width or 6m (whichever is deeper).
- Sampling:

  - Undisturbed samples (for cohesive soils) using thin-walled tubes.
  - Disturbed samples (for granular soils).
  - Standard Penetration Tests (SPT) at 1.5m intervals (NZS 4402:1986).
  - Cone Penetration Tests (CPT) (if required for fine-grained soils).

In-Situ Testing
- Field Vane Shear Test (for soft clays).
- Permeability Tests (if groundwater is a concern).
- Dynamic Cone Penetrometer (DCP) for shallow compaction assessment.

Groundwater Monitoring
- Install standpipe piezometers to monitor water table levels.
- Assess seasonal variations and potential for buoyancy effects on foundations.

4. Laboratory Testing
- Atterberg Limits (AS 1289.3.1.1) – for clay classification.
- Particle Size Distribution (Sieve & Hydrometer analysis) (AS 1289.3.6.1).
- Moisture Content & Density (AS 1289.2.1.1).
- Unconfined Compressive Strength (UCS) (AS 1289.6.4.2).
- Consolidation Tests (for settlement analysis) (AS 1289.6.6.1).
- Direct Shear / Triaxial Tests (for shear strength parameters).
- pH & Sulfate Content (for concrete durability).

5. Analysis & Reporting

Foundation Design Parameters
- Allowable Bearing Capacity (AS 2870).
- Settlement Analysis (immediate & long-term).
- Liquefaction Potential (if in seismic zone, NZS 1170.5).
- Slope Stability (if on embankment or cut slope).

Recommendations
- Foundation Type:
  - Shallow (pad/strip footings) or deep (piles/piers) based on soil strength.
  - Consider raft foundation for high-load transformers (50 tons each).
- Earthworks & Compaction Requirements (AS 3798).
- Drainage & Erosion Control (to prevent waterlogging).
- Seismic Considerations (if applicable per NZS 1170.5).

Risk Assessment
- Expansive soils.
- Corrosive soil (affecting earthing systems).
- Groundwater ingress risk during excavation.

6. Deliverables
- Geotechnical Investigation Report including:
  - Site description & investigation methodology.
  - Laboratory & field test results.
  - Interpreted soil profiles & design parameters.
  - Foundation recommendations.
  - Construction considerations (excavation, shoring, dewatering).
- Logs of Boreholes & Test Pits.

7. Compliance & Standards
- AS 1726 (Geotechnical Site Investigations).
- AS 2870 (Residential Slabs & Footings – adapted for substations).
- NZS 4402 (Methods of Testing Soils for Civil Engineering Purposes).
- NZS 1170.5 (Seismic Actions).
- AS 3798 (Guidelines on Earthworks for Commercial & Residential Developments).
- Electrical resistivity of the soil shall be verified on four samples, in accordance with approved practice (e.g. IEEE 80).

8. Additional Considerations
- Vibration Impact (due to transformer operation).
- Thermal Effects (if underground cables are present).
- Corrosion Protection for buried steel structures.

Three copies or records and the report shall be sent to the Employer's Representative. The Sub-soil investigations shall be undertaken by a reputed Institution approved by the Employer's Representative. A qualified geologist or materials engineer shall be in attendance at all times when borings are being driven or samples extracted. Laboratory tests shall be carried out at an establishment approved by the Employer's Representative.

13.2 SITE CLEARANCE

13.2.1 Cutting and removing trees & shrubs

The Contractor shall clear all areas required for the work. All unwanted materials, debris, etc. shall be removed from the employer's premises. Bushes, undergrowth, trees and hedges which are not specifically noted on the drawings or in the Contract for preservation shall be uprooted and burnt or otherwise disposed of wisely. Holes left by uprooting shall be promptly filled with suitable material and compacted.

13.2.2 Removing/Shifting existing equipment, dismantling steel structures

Equipment and support steel structures, which are to be removed shall be remove carefully and handed over to the employer. Removing, dismantling, handling, transporting and handing over shall be done by the contractor as instructed by the Employer's Representative.

13.2.3 Demolishing & removing of existing Masonry/concrete structures

Unwanted foundations shall be demolished or up-rooted. The Contractor shall clear all areas required for the work. All unwanted materials, debris, etc. shall be removed from the employer's premises.

13.3 SITE FORMATION AND UPKEEPING

13.3.1 Cutting and filling earth

13.3.1 .1 Excavation

The whole of the excavations shall be carried out to the widths, lengths and depths shown on the approved drawings and in accordance with BS CP-8004 and BS 6031 or AS 3789. If top layer of soil is not suitable for the construction it shall be removed or stabilised. The Contractor is to provide all strutting and shoring necessary for the safe execution of the Works. Materials from the excavation may, if approved by the Employer's Representative, be used by the Contractor in the construction Works. Other excavated material shall be back filled where required or deposited where directed by the Employer. Surplus materials shall be removed from the Site by the Contractor. The Contractor shall at all times keep the site free from all surplus materials, rubbish and offensive matter.
The bottom of all excavated areas shall be trimmed, levelled and well rammed. Concrete shall not be deposited thereon until the bottom has been inspected and approved by the Employer's Representative.

13.3.1 .2 De-watering

All excavation works are to be kept dry and clean, in order that work is not affected or interfered with by water entering the excavations. The Bidder is to allow in his Tender for the costs of pumping, de-watering or other methods of dealing with the water during and after excavation. No concrete, masonry, brickwork or other materials shall be placed or built until the surfaces are properly drained.

13.3.1 .3 Filling and Reinstatement

If it is required to fill the land, the Contractor shall get approval for the filling material and method of construction before the commencement of work.

a. Relevant Standards & Guidelines
   - AS 3798 – Guidelines on Earthworks for Commercial and Residential Developments.
   - AS 2870 – Residential Slabs and Footings (for settlement considerations).
   - NZS 4431:1989 – Code of Practice for Earth Fill for Residential Development (NZ).
   - Local Council Regulations – Many councils have specific requirements for filling and reinstatement (e.g., compaction, material quality).

b. Key Steps in Filling & Reinstatement
   i. Site Preparation
   - Clear vegetation, debris, and unsuitable material (e.g., organic soils).
   - Ensure proper drainage to prevent waterlogging.
   - Test existing ground for bearing capacity (if required).

   ii. Fill Material Selection
   - Must be clean, inert, and free from contaminants (e.g., no organic matter, chemicals).
   - Common materials:
     - Granular fill (crushed rock, gravel) – High stability.
     - Clay or sandy soils – Must meet compaction requirements.
     - Engineered fill – For structural support (e.g., under foundations).
   - Avoid expansive or highly compressible soils unless treated.

   iii. Compaction Requirements
   - Fill must be placed in layers (lifts) typically 150–300 mm thick before compaction.
   - Compaction should achieve ≥95% Standard Proctor Density (AS 1289.5.1.1).
   - Use vibratory rollers, plate compactors, or sheepsfoot rollers depending on material.

   iv. Moisture Control
   - Optimal moisture content is critical for compaction (too dry or too wet reduces density).
   - Conduct Proctor tests (AS 1289.5.1.1) to determine ideal moisture.

   v. Slope Stability & Erosion Control
   - Batters (slopes) should be designed per AS 3798 (typically 3:1 or 2:1 gradient).
   - Use erosion control measures (geotextiles, vegetation, riprap) if needed.

   vi. Reinstatement After Excavation
   - Backfill trenches in layers with compacted select fill.
   - For utility trenches, follow AS/NZS 2566.1 (Buried Flexible Pipelines).
   - Ensure reinstated surface matches surrounding ground level and drainage.

c. Testing & Compliance
   - Field Density Tests (Nuclear Density Gauge or Sand Replacement Method – AS 1289.5.3.1/5.8.1).
   - Plate Load Tests (for high-load areas).
   - Laboratory Tests (sieve analysis, Atterberg limits – AS 1289 series).
   - Certification may be required by a geotechnical engineer.

d. Environmental & Safety Considerations
   - Contaminated Soil: Must be removed/disposed of per AS 4482.1 (Site Investigations).
   - Dust & Noise Control: Follow local EPA guidelines.
   - Groundwater Protection: Avoid contaminating aquifers with fill material.

e. Post-Reinstatement Monitoring
   - Monitor for settlement (especially if fill is deep).
   - Repair any depressions or cracks that develop over time.

13.3.1 .4 Stability of Fill and Embankment

The Contractor shall be responsible for the stability of embankments, which formed either by cutting or filling, and precautions taken to protect the earthworks from deterioration under adverse weather conditions. Wherever applicable the recommendations contained in the following codes of practice shall be followed in calculations, detailing and performance of the earthworks and drainage. The Earthworks standard that should be used is - BS 6031 or AS 3789.All top surfaces of earthwork shall be finished off level and regular and the sides of cuttings and embankments shall be properly trimmed to the detailed slopes. The soil stability of such slops etc. shall be ensured. The Contractor shall construct where necessary open ditches, bunds, culverts, etc., to divert and protect the site in both the short and long-term from flash floods. If any slips occur in the excavations, banks or filling during the

execution of the Works or during the period of maintenance from any cause whatsoever, the Contractor shall execute the necessary remedial work in such manner, and with such materials as approved by the Employer's Representative, at the Contractor's expense.

13.3.1 .5 Explosives

Explosives may only be used when specified or approved by the Employer's Representative. If approved, their use shall comply with the following:

(1) All local by-laws and regulations.
(2) Proper/safe storage in magazine provided for
(3) Explosives shall handled by qualified personal only
(4) Shall use controlled blasting techniques in all circumstances

13.3.2 Earth retaining structures

Retaining structures or turfing to be done to side slopes Where applicable as follows:
Relevant AS/NZS Standards:

a. AS 4678:2002 – Earth-retaining structures
    - Provides design requirements for earth-retaining structures, including gravity walls, reinforced soil walls, and anchored walls.
    - Covers load calculations, stability checks (sliding, overturning, bearing capacity), and material specifications.
b. NZS 9401:2009 (withdrawn but still referenced)
    - Previously provided guidelines for retaining wall design in New Zealand; some principles may still be applicable.
c. AS 1170.1 – Structural design actions (Permanent, imposed, and other actions)
    - Defines load combinations and design actions.
d. AS 1170.4 – Earthquake actions (for seismic design in NZ)
    - Critical for seismic zones in New Zealand.
e. AS 5100 (Bridge Design) – If applicable to large-scale retaining structures.

i. Key Design Considerations:

- Soil Parameters: Must be determined via geotechnical investigation (AS 1726).
- Drainage: Proper drainage behind the wall is essential (per AS 4678).
- Wall Types:
    - Gravity walls (concrete, masonry)
    - Cantilever walls (reinforced concrete)
    - Anchored/soldier pile walls (for deep excavations)
    - Reinforced soil walls (geosynthetic or metallic reinforcement)
- Factors of Safety:
    - Sliding: ≥ 1.5
    - Overturning: ≥ 2.0
    - Bearing capacity: ≥ 2.5 (AS 4678)

ii. Construction Compliance:

- AS 3798:2007 – Guidelines on earthworks for commercial and residential developments.
- AS 2870 – Residential slabs and footings (if near buildings).

13.3.3 Anti Termite Soil Treatment

Anti-termite treatment with more than 10 years guaranty shall be done for the control building area including 3m to either side of the building.

13.3.4 Land Scaping & Tree planting

Suitable trees shall be planted in available vacant areas where necessary and grassing to protect erosion.

13.3.5 Surface Chipping

Stone chipping used for substation surfacing are to be clean hard crushed stone graded from 16 - 40 mm. The formation in areas where stone chipping are to be used shall be well compacted to the approval of the Employer's Representative, and treated with an approved total weed killer, used in accordance with the manufacturer's instructions. Approved weed mats has to be installed in the entire yard before stones chips are installed. Geo mat and geo fabric may also be used in areas where water is present. Stone chipping shall be laid and lightly compacted to a minimum finished thickness of 100 mm.

13.4 CABLE TRENCHES & DUCTS

13.4.1 Control and Power Cable Trenches

The Contractor is responsible for all civil works required for cable runs between switchgear and building in concrete cable trenches. Main cable trenches shall be rack types with sufficient working space. Cable entries into buildings shall be through ducts or in concrete cable trenches. Trench covers outside buildings shall be of reinforced concrete designed for the maximum likely imposed loads appropriate to their location. Cable trenches shall be adequately sloped and drained to soak ways of adequate capacity. Cable trench in the substation building should house a submergible pump to remove excess water from the trench. A trench light should also be provided and a steel step to access the bottom of the trench should also be provided.
Power cable which passes under roads, car parking areas, hard standing areas or where they would otherwise be at risk shall be laid in approved ducts. A 100% additional capacity shall be installed for future use and the whole surrounded in a minimum of 150 mm C10 concrete. Conduits provided shall be sized to suite the cables provided. All other main cable trenches shall have additional capacity of 30% future use. Cable entries into buildings shall be sealed using suitable materials to prevent entry of any water, dust, vermin, etc. Cable entry to the control building shall be provided for future requirements.

13.4.2 Ducts

All cable ducts shall be laid in straight lines and regular gradients between cable pits, as directed. All ducts shall be kept clear from earth, debris and other obstructions during and after laying. Cable ducts may be PVC, plastic or other material approved by the Employer's Representative and obtained from an approved manufacturer.

13.4.3 Concrete Beds and Casings

Concrete beds and casings to cable ducts and under roads, buildings, floors and foundations shall be of lean concrete and of 150mm minimum thickness. Elsewhere the ducts shall be laid on and surrounded with approved granular material of 150mm minimum bed thickness and 300 mm minimum cover.

13.4.4 Cable Pits

Cable pits shall be provided at interval not exceeding 100 meters and also at the bends of all cable ducts.
Cable pits may be constructed in situ concrete or precast concrete. In each case, the material shall be in accordance with the relevant sections of this Specification. Cable pits shall be sized according to their depth, to provide sufficient working space and access for maintenance. Galvanised malleable iron steps are to be provided in all cable pits over one meter deep and built in as work proceeds. Rates shall include for all necessary crossings shifting any existing obstructions etc. Power cables shall be laid on and surrounded with sand fill in unlined trenches. Pre-cast concrete cable protection covers & PVC marker tape shall be provided over the full width and length of cables in sand filled trenches. Pre-cast concrete marker posts shall be provided along cable runs at 500 meters intervals. Rates shall include for all necessary crossings shifting existing any obstructions etc.

13.5 STEEL SUPPORT STRUCTURES

13.5.1 Galvanised Steel Support Structures

Where required, all galvanised steel structures shall be provided under this Contract for supporting the insulators, switchgear, overhead conductors, bus bars, earth wires. Building structures and other equipment and fittings generally as shown on drawings shall be minimum of 120µm for C5M environment The contractor will be required to provide certification to confirm on this requirement.

The structure shall include all necessary access ladders or step bolts to give access to the various levels of equipment and shall incorporate all necessary earthing. The design and arrangement of supporting structures shall be subject to approval of Employer's Representative; such structures shall be rigid and self-bracing against all dead, wind, pull off and other applied loads. At or near ground level, all uprights shall be provided with holding down bolts. Steel sections forming the framework shall be heavily galvanized in accordance with the BS EN ISO 1461 1999 or AS/NZS 2312. The bolts and nuts shall be complying with the ISO 898-1.Bolts and nuts shall be galvanized and fitted with spring washers. Taper washers are to be added where necessary. Threads of bolts shall be spun galvanized and the threads of nuts shall be oiled. All members shall be cut to jig and holes shall be drilled or punched to jig. Parts shall be carefully cut and holes accurately located so that when the members are in position the holes can be accurately aligned before being bolted up. Drifting of holes will not be permitted.

13.5.1.1 Load Combinations for Design Purposes

The design wind speed 85m/s shall be in accordance to AS 1170 for Building Importance Level 4.The design calculations shall include the computation of stresses in all structural components and shall show how all loads are transferred to the foundations. The structures shall be designed to meet the maximum of the total forces calculated from the following loading.

- Dead weight
- Wind loading
- Short circuit force
- Loads arising during assembly and erection.

Recommended factors of safety for steel structures 1.5
Recommended factor of safety for foundations 1.5

Consideration shall be made in sizing members to eliminate excessive deflection or vibration during service.
All structures shall be designed so that no failure or permanent distortion shall occur when tested with an applied force equal to 1.5 times the loading associated with the simultaneous applications of any of the load combinations.

13.5.1.2 General

The standards of workmanship, materials and design are to be equal to those laid down in the latest editions of BS 5950 or AS 4100. The Contractor shall make the following submittals to the Employer's Representative:

a. Production mill sheet and quality control tests sheets for each delivery of structural steel.
b. Full details of the results of material tests.
c. Full details of steel types and types of nuts and bolts to be used.
d. Full details of erection procedures.
e. Full details of proposals for all main welds, arrangement of welded assemblies and welding procedure.
f. Approval of welders including all tests for welders
g. Full details of protection system to be used for steelwork.
h. Test results for paint thickness.
i. Results for structural deflections under test loads.

The design of all structures shall be as specified and, in addition, is to ensure that in the event breakage of either one earth wire or one stay wire the factor of safety is not less than 1.5.

13.5.2 Supplying & Erecting of steel structures

13.5.2.1 Materials

Samples of all materials shall be tested and copies of the test reports giving physical and chemical properties issued to the Employer's Representative for approval. These tests shall prove the compliance of the material for the purpose intended in accordance with the approved standard. Where tests are carried out by an independent laboratory, the source of origin of the material shall be stated and if different sources of supply are contemplated additional tests shall be carried out.

13.5.2.2 Connections

Shop connections shall generally be electric arc welded or bolted. Site connections shall be bolted as shown on the drawings unless specifically approved by the Employer's Representative. Bracing connections shall develop forces not less than 50 percent of the effective capacity of the member. All connections shall have a minimum of 2 bolts per connections and the gusset plates shall have a minimum thickness of 10 mm. Fabrication and erection shall conform at all stages to the standard approved by the Employer's Representative and allowance should be made for the Employer's Representative to inspect the steelwork during fabrication and before shipment to site.
Bolted construction shall be tested for dimensional accuracy before dispatch to site by the complete assembly of a frame or truss in the shop. Bolted connections shall be fabricated with due attention to the calculated mode of action of the joint and where an eccentricity cannot be avoided members must be adequate to resist the bending stresses induced. All steelwork shall be fabricated to the following tolerances below:

a. On length 1.3 mm
b. Twist and deviation from the required profile shall not exceed 1 in 1000.

13.5.2.3 Welding

Welding of structural steelworks shall be by an electric arc process. The procedure to be followed, plant and equipment to be used and the testing and inspecting to be applied, shall all be to the satisfaction of the Employer's Representative and shall conform generally with BS 5135 or AS 1554 and with further details contained in the Specification. Electrodes for metal arc welding shall comply with BS EN 499 or AS/NZS 4857.Welded construction shall be carried out in workshops under approved conditions by experienced operators and where continuous supervision is exercised. Machine welding will be allowed where approved machines are in use, correctly controlled by qualified operators. Where the Employer's Representative approves site welding, this shall not adversely affect the efficiency of the welding and, where necessary, effective protection and other safeguards, as shall be agreed with the Employer's Representative.

13.5.2.4 Cleaning and Steelwork Protective Coating

The Contractor shall provide all hoists, slings, cradles, ladders , scaffolds, plant and machinery required for the carrying out of the painting and in particular, he should pay special attention to his requirements for painting the structural steelwork on site. The suitability and capacity of all plant and equipment used for the carrying out of the painting shall be to the satisfaction of the Employer's Representative. The Contractor shall select a system of steelwork protection, which shall conform to the recommendations of BS 5493 or AS/NZS 2312 Protective coating of iron and steel structures against corrosion or equivalent standard. The selected system shall have a life to first maintenance of 20 years under the environmental conditions at the site, which shall for purposes of classification by BS 5493 or AS/NZS 2312.

13.5.3 Galvanising

13.5.3.1 General Requirements

This article defines the minimum requirements for galvanizing as well as for surface cleaning and preparation for the protective coating of galvanized steel surfaces. All steel for outdoor and indoor use is to be galvanized and further painted if requested by the Employer's Representative. The galvanizing procedure shall be started only after having finished all chipping, trimming, fitting and bending. Also, all drilling punching, cutting and welding shall have been completed and all burns removed. All steel including bolts, nuts and washers, shall be galvanized at the manufacturer's premises by means of hot-dipping in accordance with internationally recognized standards such as:

a. Hot-Dip Galvanizing (HDG) – AS/NZS 4680
    - Minimum Coating Thickness:

- For steel thickness ≥6mm: 120 µm (microns) average
- For steel thickness <6mm: 100 µm (microns) average

- Surface Preparation:
  - Steel must be cleaned by abrasive blast cleaning (AS 1627.4) or pickling to remove mill scale, rust, and contaminants.
- Galvanizing Process:
  - Full immersion in molten zinc (AS/NZS 4680).
  - Post-galvanizing inspection for uniformity, adhesion, and absence of defects.

b. Additional Protection (AS/NZS 2312 Recommendations for C5-M)

- Duplex Coating (Galvanizing + Paint):
  - For enhanced corrosion resistance, a duplex system (HDG + suitable paint) is recommended.
  - Paint System: Epoxy or polyurethane-based coatings (AS/NZS 2312.2).
- Sealing of Cut Edges & Welds:
  - After fabrication, any cut edges or welded areas should be re-protected with zinc-rich paint.

c. Material Selection (AS/NZS 3678 / AS/NZS 3679.1)

- Steel should be suitable for galvanizing (avoid reactive steels like high-silicon content).

d. Inspection & Testing (AS/NZS 4680.1 Appendix D)

- Coating thickness tested with a magnetic gauge (min 5 readings per batch).
- Adhesion tested by knife or tape test.
- No bare spots, excessive ash, or uncoated areas allowed.

Summary for C5-M (Very High Marine) Environment:

Requirement	Specification
Galvanizing Standard	AS/NZS 4680 (Hot-dip galvanizing)
Minimum Coating Thickness	≥6mm: 120µm / <6mm: 100µm
Additional Protection	Duplex coating (HDG + paint) recommended
Surface Preparation	Blast cleaning (AS 1627.4) or pickling
Post-Galvanizing Protection	Seal welds & cut edges with zinc-rich paint

13.5.3.2 Painting of Galvanized Towers and Outdoor Steel Structures

Where installed, after erection/stringing, on all galvanized steel the pre-primer (if any) is to be cleaned by use of a rotating wire brush and washed with fresh water. All galvanized steel must be painted with one layer of primer, one layer of intermediate coat and one layer of final coat with the paints specified in the Technical Data Sheets.

13.5.3.3 Surfaces of Stub Angles and Caps

The stub angles shall be galvanized as described above. Prior to galvanizing, all stub angles shall be sandblasted. Painting should be applied in the zone 50 cm above and 50 cm below concrete level.

1) 1 coat of primer as described in the Technical Data Sheets to be applied.
2) 3 coats of 120 microns, each to be applied, 2-pack coal tar epoxy paint
3) After setting of the stub angles and concreting foundation caps the sealing of the joint shall be performed by an acrylic type sealer (approximately 1.5cm thickness around the stub angle).
4) 2 coats of 2 pack coal tar epoxy paint, 120 micro each covering approximately10 cm above the concrete level and coating the foundation cap in total (including approximately 5 cm of the vertical surface of the foundation) shall be applied

5) After erection the intermediate and final coat as for the galvanized steel painting shall be applied as described above up to the joint of the stub angle
6) Surfaces of steel piling cases:
Steel pilling cases shall be sandblasted and treated by bituminous fill etc. down to 50 cm below ground level
7) Bidder may propose other measures to protect the stub angles from corrosion, e.g. proposing special type of steel.

13.5.3.4 Transportation and Storage of Steelwork

All steelwork shall be transported, lifted and generally handled in a manner that does not affect the shape or surfaces of the section. Lifting slings shall be of nylon rope; chains and hooks shall not be used in contact with the steelwork. The position of lifting points used on sections shall be such that the stress induced in the sections does not exceed one half of the yield stress of the materials. Steelwork shall be stored in clean, dry conditions off the ground. Separate pieces of steelwork shall have spacer blocks between them.

13.5.3.5 Erection

The Contractor must provide all temporary works, of any kind whatsoever, he shall deem necessary to ensure the correctness f alignment, plumbing and stability of the various frames and members. During erection the work shall be securely bolted or otherwise fastened and, if necessary, temporarily braced to provide safety for all erection stresses and conditions, including those due to erection equipment and its operation. No permanent bolting of high strength friction grip bolts shall be done until proper alignment has been obtained.

13.5.3.6 Inspection and Tests

The Contractor shall supply to the Employer's Representative details of all steelwork and accessories in order that inspection can be effected. Details shall include dates, times and places of manufacturing, rolling, fabricating, painting, galvanising and all other processes. The details shall be given to the Employer's Representative at least 7 days prior to such inspections taking place. All the tests shall be carried out by the Contractor. The Contractor shall prepare test sample to suit the appropriate testing methods all tests and inspection results shall be submitted to the Employer's Representative within 24 hours of the test completion. Inspection and Testing of Welds to be inspected shall not be painted or otherwise obscured until they have been inspected.

13.5.3.7 Inspection and Testing of Paint

Tests shall be carried out to the appropriate sections of BS 3900 or AS 1580.Tests for final dry film thickness (DFT) shall be carried out over 10% of the painted area. Over such test areas, readings shall be taken on a grid 200-mm square and recorded. The contractor shall carry out tests, which are requested by the Employer's Representative as specified in relevant British Standards.

13.5.3.8 Testing of Welding Operators

Only welding operators who satisfy the appropriate tests shall be employed on welding. Should an operator fail in the first test, two further tests shall be undertaken immediately and to qualify the operator must satisfactorily pass both these tests.

13.5.3.9 Responsibility and Guarantees

The Employer's Representative shall have access at all times for inspection of the work and all pertinent materials during preparation and progress of the work. Should any work or material be found to be defective or not in compliance with the Employer's Representative's requirements, correction or replacement shall be done by the contractor at his own cost.

13.6 FOUNDATIONS

13.6.1 Main Transformer foundation & Fire Walls

In transformer foundations provision shall be made for the catchments of oil spillage from the transformers resulting from mechanical or electrical failure. Oil separators shall be provided to prevent pollution of streams, ground water, irrigation ditches and other watercourses by leaking or ejected oil. Each transformer shall be protected from the potentially damaging consequences of a catastrophic failure in any of the transformers by providing firewalls between adjacent transformers. Fire precautions shall be provided for the extinguishing of burning transformer oil. The oil pits shall be connected by oil pipes and discharge the oil or water in to an oil separator, which should be equipped with oil, and water removing pump. Oil resisting paint shall be applied inside the pit. The foundations supporting the transformers shall incorporate built-in haulage bollards, rails, slipways, etc., for the purpose of unloading and locating the transformers in their required positions.

Each transformer foundation shall be surrounded by a low wall enclosing a. The pit within the low wall shall be such that the entire oil content of the transformer can be accommodated. The stone chipping layer to be provided over the pit should be of 35 mm single sized. It shall be at least 200mm thick and lay over galvanised steel grating installed over the pit. Standards of design, materials and workmanship are to be equal to or better than those laid down in British Standard CP 8110 and 8004 or an equivalent international standard.

13.6.1 .1 Concrete

The Contractor shall submit not less than 3 weeks before the commencement of manufacture of preliminary trial design mix for 30Mpa Concrete strength. The following information to the Employer's Representative in respect of each grade of concrete that will be supplied by an established and reputable ready mix concrete supplier.

(1) Grade of concrete
(2) Title of particular trial mix.
(3) The grading of the aggregates.
(4) The ratio by weight of all the constituents of the concrete.
(5) The expected compacting factor and slump.
(6) Full details of the proposed site quality control.
(7) Full details of the proposed laboratory for testing.

The Contractor shall also confirm his proposed testing regime and acceptance criteria for the Preliminary Trial Mixes. If the proposals not be approved by the Employer's Representative, and then the Contractor shall comply with the paragraph on preliminary test cylinders and the two following paragraphs. At least four weeks before commencing any Concreting in the Works, the Contractor shall make trial mixes using samples of aggregates and cements typical of those to be used. If possible, the Concreting plant and the means of transport to be employed in the Works shall be used to make the trial mixes and to transport them a representative distance. A clean dry mixer shall be used to make the trial mixes and the first batch shall be discarded. Preliminary test Cylinders shall be taken from the proposed mixes as follows:

For each grade, a set of 6 cylinders shall be made from each of 3 consecutive batches. Three from each set of six shall be tested at an age of seven days and three at an age of 28 days. The cylinders shall be made, cured, stored, transported and tested in compression in accordance with AS/NZS 1012.8.1, AS/NZS 1012.9, AS/NZS 1012.14or AS 1012. The test shall be carried out in a laboratory shall be approved by the Employer's Representative. If it is proposed to use an admixture in the mix then for each grade of concrete a batch shall be made with a double dose of the additive. For each of these batches 3 cylinders shall be made and one tested at 7 days and 2 at 28 days to determine the likely effect of error in dispensing.
The trial design mix proportions shall be approved if the average strength of a set of 9 cylinders tested at 28 days exceeded the specified characteristic compressive strength by current margin less 3.5 N/mm^2. The results of the seven-day cylinder tests shall be used to give an indication for future use of the strengths likely to be achieved at 28 days. They shall not be used to satisfy the 28 days preliminary test cylinder strength requirements.

The Contractor shall inform the Employer's Representative of his intention to carry out such tests and the time and place of the tests at least 24 hours before they take place. Neither the mix proportions nor the source of supply of materials shall be altered without the prior approval of the Employer's Representative except that the Contractor shall adjust the proportions of the mix as required to take account of permitted variations in the materials. Such

approval shall be subject to the execution, to the Employer's Representative's satisfaction, of trial mix procedures set out herein.

Curing of Concrete, ready-mixed, shall comply to the requirements of AS/NZS 1012.8.1. Site mixing of concrete is not allowed.

For the 30Mpa Concrete the acceptable characteristic compressive strength is 36.5Mpa. Any Test result below 26Mpa will be automatic total rejection of works.

13.6.1 .2 Ready-Mixed Concrete

Ready-mixed concrete, which batched off the Site, may be used only with the agreement of the Employer's Representative and comply with all requirements of the Contract. All ready mix concrete shall be designed, batched and tested in accordance to the requirements of:

AS 1379:2022 – *Specification and Supply of Concrete*
- The primary standard governing ready-mix concrete production and supply.
- Defines requirements for:
    - Material selection (cement, aggregates, water, admixtures)
    - Batching tolerances (permissible variations in mix proportions)
    - Mix design compliance (strength, slump, durability)
    - Production records (batch tickets, delivery dockets)

AS/NZS 1478.1:2000 – *Chemical Admixtures for Concrete*
- Covers admixtures (plasticizers, retarders, accelerators) used in batching.

AS 2758.1:2014 – *Aggregates for Concrete*
- Specifies quality requirements for coarse and fine aggregates (grading, impurities, durability).

AS 3972:2010 – *Portland and Blended Cements*
- Defines cement types (GP, GB, HE, LH, etc.) allowed in batching.

AS/NZS 3582 Series – *Supplementary Cementitious Materials (SCMs)*
- Covers fly ash (AS 3582.1), slag (AS 3582.2), and silica fume (AS 3582.3) used in batching.

1. Batching Tolerances (AS 1379:2022)

Material	Permissible Variation
Cement	±1% of specified mass
Water	±1% of total mix water
Aggregates	±2% of specified mass
Admixtures	±3% of specified dosage

- Cumulative batch mass must be within ±1% of total design mass.
- Moisture content in aggregates must be adjusted in real-time (automated batching systems preferred).

2. Batching Process Requirements
    a. Weighing & Measurement
        - Batching plants must be calibrated (AS 1379 requires 6-monthly verification).
        - Load cells & moisture probes must meet AS 1379 accuracy standards.
    b. Mixing Time & Uniformity
        - Minimum mixing time:
            - Drum mixers: 70–100 revolutions at mixing speed.
            - Pan mixers: 1.5–2 minutes after all materials are loaded.
        - Uniformity test (AS 1379): Samples from the same batch must have:

- Slump variation ≤20mm
- Density variation ≤1%
- Compressive strength variation ≤5%

c. Temperature Control (AS 1379 & AS 1012.18)

- Maximum concrete temperature: 35°C (unless otherwise specified).
- Cold weather (<5°C): Aggregates may need heating.

3. Quality Control & Documentation

a. Batch Tickets (AS 1379 Requirement)

- Each delivery must include a batch ticket showing:
- Mix designation (e.g., N32, N40)
- Batch quantities (cement, water, aggregates, admixtures)
- Slump & strength class (e.g., SL80, 32MPa)
- Time of batching & dispatch

b. Compliance Testing (AS/NZS 1012 Series)

- Slump test (AS/NZS 1012.3.1) – Every truck before dispatch.
- Compressive strength (AS/NZS 1012.9) – 7-day & 28-day tests.
- Air content (AS/NZS 1012.4) – For freeze-thaw resistance.

Summary of Key Standards

Aspect	Standard
General RMC Supply	AS 1379
Cement	AS 3972
Aggregates	AS 2758.1
Admixtures	AS/NZS 1478.1
SCMs (Fly Ash, Slag)	AS/NZS 3582
Testing Fresh Concrete	AS/NZS 1012 Series

In order to control the quality of concrete to be placed, samples of concrete for testing shall be taken in cylinders. Three (3) test Cylinders are to be taken from each sample (In accordance with AS 102). One cylinder to be tested at 7 Days, the other 2 at 28 days. Each truck of (5m3) will constitute a batch in applying AS1012.

The mix and delivery of ready mix concrete or concrete mixed in central plant shall comply with:
1. AS 1012 Methods of testing concrete
2. AS 1411 Methods of sampling and testing aggregates
3. AS 1379 Specification and supply of concrete

The following Tests shall be done in accordance with this Specification or equivalent Standards approved by the Energy Fiji Limited Engineer for each Batch of Concrete:
a. Slump test
b. Compression test
c. Any other test which may be specified by Engineer as specified in the relevant concrete standards.

The cost of preparing, storing and transporting test specimens to the place of testing and testing shall be borne by the Contractor.

13.6.2 Auxiliary Transformer

Shall be Reinforced concrete.

13.7 LIGHTNING PROTECTION

Approved earthed screens, generally in accordance with the Tender Drawings, shall be provided to protect the equipment from direct lightning strikes. The screens shall be of stranded hard drawn copper wires of not less than 35sq.mm total cross section, or stranded galvanised steel wires of not less than 7/3.5mm cross section and connected to provide low impedance paths to earth. The layout of the earth wires shall be such that generally, equipment's to be protected lie within areas bounded by lines drawn from the earth wire at 300 to the vertical in a plane perpendicular to the axis of the earth wire. The earth screens shall be suitable for extension to protect the substation equipment's to be installed in future stages of development. Connections shall be made of copper strip of 30mm x 5mm cross-section between the overhead earthed screen wire and the main substation earthling system at each support. Earth wires shall be held in clamps with free, pin type joints between clamps and supports. Connections shall be provided for the terminations of the earth wires of the overhead lines including bimetal connectors where necessary. The necessary stays, fittings and anchors shall be provided under this Contract including, if required, flying stays and additional masts to ensure clearance of not less than 9144 mm (30 ft.) over roadways for breaker or transformer removal.

13.7.1 Lightning Protection for control building

A complete lightning protection system for the control building shall be constructed in compliance with BS 6651 or AS 1768.

An air termination network shall be installed on the surfaces of the roofs. No part of the roofs shall be further away than 10m from the nearest horizontal protective conductor. Salient points of the structure such as air conditioning installations, vent pipes railings, gutters, and steel constructions etc. shall be connected to the network. Down conductors shall be distributed around the outside walls of the building with a maximum distance of 20m and all main metal parts near the down conductors shall be connected there to. Each down conductor shall; be provided with test joints in such positions that periodic testing is easily possible.

All connections and joints shall be installed mechanically and electrically effective (clamped, screwed or welded) to suit the local climatic conditions.

For every building, at least, one ring of ground conductors shall be installed and interconnected.

Materials,

Air terminations:	Tinned copper 8mm diameter
Earth terminations:	Copper 8mm diameter with lead coating minimum 1.2mm thick as protection against corrosion
Ground rods:	Tinned copper weld or stainless steel 3000x30mm diameter
Potential equalizing bars:	tinned copper 500x50x5mm

All support and connections shall be made of best suitable materials.

13.7.2 Copper

Copper and copper alloys shall comply with the Australian Standards and approved standard relevant to the form and use for which the material is intended. Copper components shall be placed so that neither in no case shall they come in direct contact with aluminium nor shall it be possible for water or consideration to pass off copper on to aluminium.

13.8 WATER SUPPLY & DRAINAGE SYSTEM

13.8.1 Water supply system

The Contractor will be responsible for the provision and installation of a water supply, from a public water supply system, connected to serve the substation buildings. Every cistern, sink, basin etc., shall be provided with a stopcock in the supply pipe adjacent to the fittings. Each basin and sink is to be provided with water. Shaded from direct sunlight, supplying a 1.5 cubic meter header tank, situated within the building. Space and ladder should provide for maintenance of overhead tank.

Layout of the plumbing shall be to approved standards and of the highest workmanship, with all bends to easy sweeps and bores and thickness maintained throughout. Internal plumbing system shall be connected either to public water system or to a local water supply system via borehole pump and tank storage.

All plumbing and drainage design, materials and workmanship shall comply to the requirements under AS 3500.

13.8.1 .1 Water Pipes

PVC pipes shall generally be used throughout of an approved type. They shall be secured to the structure. Pipes to wash hand basins and WC cisterns shall be 15 mm bore and supply pipes to header tanks 25 mm bore.
Overflow pipes shall be taken from the tops of cisterns and set to discharge in a prominent position.

13.8.1 .2 Sanitary Fittings

Wash hand basins shall be supported on cantilever brackets cut and pinned to the walls or screwed to 30mm timber chambered backboards, which shall be plugged and screwed to the walls. They shall be provided with 35mm bottle traps with brass cleaning eye and lining soldered on, or alternatively, similar PVC fittings.
Cistern supporting brackets shall be screwed to 30mm timber chambered backboards, which, shall be plugged and screwed to the walls. Overflow pipes from WC cisterns shall be 20 mm bore. Glazed ware shall be of best quality type and manufacturer shall be approved by the Employer's Representative. Fittings shall be securely fixed in an approved manner. Taps and all visible metal fittings shall be chromium plated, heavy-duty quality. Drinking fountain outlets shall be clearly labelled. All fittings shall be individually isolated with a stopcock in the water supply pipe. On completion of the works, all sanitary fittings shall be left in a clean and proper condition.
After completion, drains shall be subjected to an air test, in which a pressure equal to 150 mm of water is to be applied for a period of five minutes without dropping below 125mm head. Any defects revealed shall be made good at the Contractor's expense.

13.8.2 Waste water sewerage system

13.8.2 .1 Drain Pipes

Drain pipes shall be PVC pipes and fittings of approved manufacture and shall be jointed with sleeves or sockets. PVC pipes provided should be black unplasticised PVC.
Concrete beds and casings to drain pipes under roads shall be of week concrete and of 150mm minimum thickness. Elsewhere the pipes and ducts shall be laid on and surrounded with approved granular material.

13.8.2 .2 Manholes

Manholes shall be generally in accordance with BS EN 752 or equivalent international standard. Galvanised malleable cast iron step irons are to be provided and built in as work proceeds. Manhole covers shall comply with BS EN 124 or equivalent international standard, and in roadways or heavily loaded areas shall be heavy duty, area with non-vehicular access to be medium duty.

13.8.2 .3 Septic Tank& soakage pit

The septic tank, where main drainage is not available, shall be constructed in an agreed position at least 20 meters from any building. The design and installation of the septic tank and soak pit shall comply to the requirements of the Fiji Building Code and shall be to the satisfaction of the local authority.

If the location of the septic tank is within the vehicle manoeuvring area, then the top of the tank shall have a reinforced concrete hard stand. If the location of the septic tank is away from the vehicle manoeuvring area, then steel bollards of 100mm dia and 1.2m above ground, shall be erected to demarcate the tank area.

The system shall be properly ventilated by continuing the soil pipe above the highest branch upwards above roof level.

All drains shall be laid in straight lines and regular gradients as described. Great care shall be exercised in setting out and determining the level of the drains. All drains shall be kept clear from earth, debris, superfluous cement and other obstructions during and after laying and shall be provided with eyes, inspection covers, etc. to ensure that every length can be rodded effectively in the event of a blockage.

13.8.3 Surface water drainage system

General

Embankments and cuttings shall have drainage facilities at their top or bottom. The formation level of switchyard area shall be formed with uniform cross-falls of about 1 in 300 in the same direction as the natural drainage path of the surrounding Area Provision shall be made for the disposal of surface water from roads.
A surface water drainage system covering the switchyard shall be installed. The system may be discharged to natural watercourses or to soak ways as approved. Surface water from roofs of buildings shall be drained to down pipes connected with the site drainage system. The number of runs and out falls and pipe sizing must be sufficient to cope with the severest precipitation, with a factor of safety of 1.2 within switchgear and other areas. It is to be ensured by the contractor that the surface water discharged from the substation does not cause any damage to the properties through which such water is discharge up to natural water courses as approved.

The Contractor shall ascertain whether main foul drainage is available locally, and if so, arrangements are to be made to connect the substation toilets into this system. Where main drainage is not available foul drainage shall terminate at suitably dimensioned septic tank and soakage pits. Drains shall be laid with regular gradients, such that full flow velocity exceeds 0.75 m/sec. Manholes shall be provided at each places where change in direction take place and at not greater than 80 m canters.

13.9 CONSTRUCTION & MAINTENANCE OF ROADS

13.9.1 General

The Contractor shall ensure that the roads are levelled graded, properly compacted with appropriate rollers, or surfaced with Bitumen or concrete to ensure that the finished road is suitable for the maximum foreseeable imposed loads expected from vehicles transporting the various items of plant and electrical equipment. In detailing the layout of the roads and parking areas, special attention must be given to the travelling of vehicles delivering plant, stores, spares and other materials and equipment. Material for the hard-core shall consist of natural stone broken to pass a 100-mm ring. It shall be free from dust, rubbish, wood, vegetable or other injurious matter.

Broken stones and aggregates shall consist of hard crushed natural stone or gravel of approved sizes.
Bituminous Wearing courses shall be suitable for the extreme soil condition in the area and shall comply with an authoritative and approved standard appropriate to the locality of the work. The details and grading of the aggregate and the binder contents shall be submitted to the Employer's Representative for approval. Sealing grit will be applied as required.

13.9.2 Road carriage way

The upper 300-mm of the formation shall be of suitable soil; otherwise the Contractor shall improve it to strength of greater than 156 CBR by blending it with granular materials such as gravel and sand and gap 65.The formation shall be rolled to an even and uniform surface, which shall be parallel to the finished surface of the road or path. Rolling shall be carried out with a 4 to 7 ton power driven roller unless otherwise ordered or permitted by the Employer's Representative.

13.9.3 Sub-Base

After the formation has been properly made, rolled and approved by the Employer's Representative, a sub-base consisting of well graded natural sand, gravel or rock or mixtures thereof shall be laid in accordance with standards to give a finished thickness of at least 200 mm or as described or directed.

13.9.4 Prime Coat

For the prime coat 0.5 to 1.5 lit/m^2 liquid bitumen shall be sprayed on in accordance with the best practice fitting to the locality of the work.

13.9.5 Bituminous Surface

Two layer of bituminous surfacing of 75 mm overall thickness shall be laid in accordance with the approved standard.

13.9.6 Roadsides

In-situ concrete kerbs or pre-cast concrete kerbs set on a concrete bed are to be laid on each side of the roads, to define the limits for vehicular access. All drains, sewers, cable ducts and other necessary work below road formation level shall be completed, inspected and passed by the Employer's Representative before any road work is started. Concrete paving slabs shall comply with a relevant approved standard. Trench covers shall be minimum of 50 mm thick and provided with handles or holes for lifting purposes. They shall be reinforced to the approval of the Employer's Representative. The reinforcement shall be in the middle of the covers with 25mm cover to the edges. Trench covers shall comply with the relevant standard as approved.

Where concrete covers are required for trenches crossing roads, these shall be designed for the heavy wheel loads expected on them and shall be reinforced with mesh fabric or mild steel bars as necessary.

13.9.7 Approach Road

The contractor shall construct or upgrade the approach to site that is road from main road to the gate of the substation to allow heavy vehicles to site. The minimum flat form width shall be 7m and road shall surface with bitumen or concrete.

13.9.8 Structures (Culverts, Bridges retaining walls) for approach road.

The contractor shall follow the guide lines and requirements of the Fiji Road Authority.

13.9.9 Access road and structures

Access roads are the roads within the switchyard area. Road shall properly graded, compacted and surfaced. Access roads shall be either concrete or bituminous wearing surface roads. The Contractor's proposed site layouts shall allow for 5 m wide vehicular access to the control building and electrical equipment, for installation and subsequent maintenance. Roads shall be surfaced with concrete or bitumen as approved by the Employer's Representative. All the cable trenches crossings canal crossings road side constructions shall be considered.

13.10 FENCE

13.10.1.1 Chain link fence and Gate

Chain link fences shall be constructed of galvanised steel wire, and shall be of such manufacture that when any one segment is cut, remaining segments within the pattern retain their rigidity. The bottom of the fence shall be fixed down with staples to a continuous concrete sill (in 2 layers of block work), in accordance with BS 1722, Part 10 or AS 1725. All mesh shall be of galvanised steel wire of 3.15 mm diameter, with a length of side not exceeding

50 mm. Line wires shall be of galvanised steel wire of the same gauge to adequately support the mesh rigidly. Line wire shall be provided at the top and bottom of the mesh and at two evenly spaced intermediate levels. The line wires shall be strained tightly by eyebolt strainers or winders at each straining post and secured to intermediate posts of stirrup wires passed through holes in the posts. The top wire shall be doubled, Mesh and line wires shall comply with BS 4102 or AS 2423. Chain link mesh shall be strained between straining posts by means of stretcher bars and tied to line wires. Straining posts and struts shall be of Galvanised steel to the same standard as above. The posts shall be set in concrete in the ground. The posts shall have cranked tops set at 45^0 to the posts, to which shall be attached three strands of galvanised barbed wire to BS 4102 or AS 2423. Barbed wires shall be strained between straining posts with eyebolts and fixed to intermediate posts with stirrup wires. Droppers shall be fitted at the centre of each Bay of the fence to prevent the wires being bunched together. Intermediate posts shall be provided at centres not exceeding 3 meters. Corner posts and struts shall be provided at all ends, corners, changes in direction, adjacent to gateposts and at intervals not exceeding 35 meters. All fence fittings shall be galvanised. All galvanised post shall have PVC caps installed.

13.10.1.2 Gates

Gates shall be accordance with the drawings. The gates shall be fitted with a vertical drop bolt on each leaf, a sliding bar lock with padlock eyes and a padlock to prevent movement of the sliding bar lock. The padlocks shall be included in the overall locking system. All these fittings shall be galvanised. The vertical drop bolts are to drop into galvanised steel tubes cast into the road, to secure the gates when in both closed and open positions.
Gateposts shall be made from galvanised steel RHS which shall be capped and set in concrete in the ground. Gate hinges (pivots) shall be heavily galvanised.

13.10.2 Galvanised Barbed Wire Fence & Gate

13.10.2.1Galvanised Barbed Wire Fencing

The straight spans are to be erected with intermediate posts which are spaced at 10ft**.** centre to centre where the number of intermediate posts in a straight span exceeds ten (10) a strutted post shall be placed. Two corner Posts, supported with 02 strutted posts on either side of the spans shall be used in every corners. Barbed wire shall comply with the requirements of BS 4102 or AS 2423.

13.10.2.2 Gate

A gate consisting of two sashes complete with gateposts & locks, bolts and other accessories as per Drawing shall be supplied and erected at the entrance to the land. The fence of the gate shall be terminated with two corner posts just adjacent to the gateposts, with suitable adjustments to the foundations of the two corner pots.
Both sashes of the gate and all other accessories of it including bolts, locks & hinges shall be fully galvanized, to the satisfaction of the Employer's Representative. It is preferable if the gate sashes could be galvanized after the fabrication. However, if it is not possible, welding, cuts and any other form of connections done after the galvanizing The gateposts shall be concreted at site, as. Concrete used for posts should be grade 25 while that for foundations shall be Grade 10. Gateposts shall be plastered to a semi rough finish with cement mortar not less than 15mm thick, and applied with two coats of weather sealed paint of which, make and colour to be approved by the Employer's Representative. Galvanised barbed wire shall conform to BS 4102 or similar approved material.

13.11 MISCELLANEOUS WORK

Shall be carried out according to the relevant clause of this specification.

13.12 CONSTRUCTION OF BUILDINGS

13.12.1 Control Building

The Contractor shall be required to produce full design calculations for the foundations, building structures, etc. and detailed working drawings and bending schedules, etc. He shall be responsible for the detailed design, strength and safety of the structures, to meet the structural, acoustic and environmental requirements of the buildings and other works. The Building to be designed for 85m/s wind speed and for importance level 4. He will be responsible

for ensuring that the design satisfies the requirements of all authorized local and national bodies. Design calculations and detailed drawings must be submitted to the Employer's Representative for approval before the relevant construction work is carried out and at least six weeks before the relevant drawing is required at site. All drawings have to be lodged with the local authority for approval before construction commences. Design calculations shall be in accordance with an approved method of computation and should take account of the design criteria set out in Clause 13.5.1.1.

Civil engineering works and services shall be designed and constructed in accordance with British or Australian Standards and shall comply to the Fiji Building Code.

The Tender shall include a schedule of standards and codes to be followed in design and construction of the works. Copies of these codes and standards shall be made available to the Employer's Representative and Employer during the design and construction period on site. The Standards and/or Codes of Practice employed throughout the Works, where they do not conflict with the local by-laws.

As far as practicable the standards or codes adopted shall be consistent throughout any section of the works except in meeting superior specified requirements. The Contractor shall investigate the existence of any regulations and local by-laws governing the proposed works and he shall be deemed to fully comply with such requirements, which are effective 30 days prior to the date of tender submission. The buildings are to be designed with ease of operation and maintenance as a major factor. Materials, workmanship and finishes must be of an appropriately high standard. In considering the various materials, details, construction methods, etc., The Bidder must investigate the availability, delivery and transportation to the sites of all materials, plant, labour, etc., to enable the program to be maintained. A New substation building shall have reinforced concrete frames. If the Bidder wishes to propose an alternative form of construction, any combination of reinforced concrete, structural steel works, etc. will be considered, provided that the buildings are completely weatherproof and satisfy all other requirements of this specification. All walls and roofs shall be fully insulated, to produce maximum thermal transmittance U. values of 1.14 (watts/m^2/^{0}c for walls and 0.57 for roofs. Architectural treatment of the new buildings shall be satisfied the requirement of relevant local authority or Rural Development Authority. Windows and roller shutter door have to comply with the cyclone ratings.

After the construction of the building has completed in all aspects, the Contractor shall provide a building completion certificate or an Engineers Certificate.

13.12.1 .1 Fire criteria

Non-combustible or fire-resistant components shall be used in the construction. To provide resistance to the collapse of the structure in the event of a fire, and also to avoid a fire occurring in one room to spread in to adjacent rooms all structural elements of the building shall have the following minimum fire resistance:

External walls and columns	2 hr
Internal walls and columns	2 hr
Roof	Non-combustible (1hr)
Ceiling	1 hr

Doors and windows shall have a minimum fire resistance of 1 hour that associated with the walls in which they are located or as set out by the Fiji Building Code.

13.12.1 .2 Super structure (Structural frame & walls)

Shall have reinforced concrete frames with walls of cement hollow block work. All work shall be carried out in accordance with BS 5628 & BS 8110 or equivalent international standard. Movement joints shall be provided where required. They shall incorporate a joint filling strip and sealant. Gaps in movement joints shall be left free from debris and shall not be pointed with mortar. Walls shall be constructed with an approved metal reinforcement every second course.
Where block work is built against steel columns, provision should be made to tie the block work to the columns every second course, by means of a rod welded to the steel columns and bedded into the block work.

13.12.1 .3 Cement

Cement quality shall be as described in the section for concrete. The clause in that section referring to cement storage shall also apply.

13.12.1 .4 Doors & windows

Shall be as specified in schedule of finishes. Particular attention must be given in the design of the buildings to fire prevention and safety of the personnel at all times. Access doors and escape doors shall be provided and fitted with panic bolts where necessary, so that operating and maintenance staff can always exit safely from the buildings in fire emergencies of any nature or location. Hydraulic door closures shall be fitted to all doors. Emergency exits should be clearly marked. Exit signs in the substation building should use illuminated lights on the top of the doors.

Aluminium windows and doors shall be obtained from an approved manufacturer and of a type, design, colour and finish to be approved by the Employer's Representative. All opening windows shall be provided with integral fly-screens, which shall be removable for cleaning, and maintenance. Also a gothic mesh cover should be provided over the window for security reasons. The construction of aluminium windows, including weather-stripping, hardware, etc., is to comply with the requirements of BS 4873 or other approved standard.
Allowance shall be made when fixing frames for expansion to aluminium members so as to prevent distortion of frames or cracking of glass. The perimeter of the frame shall be pointed with approved mastic.

13.12.1 .5 Fire resisting steel doors

Doors shall be fabricated from steel sheet covering a framework of angle sections. Steel doors shall be galvanised after fabrication. Doorframes shall also be galvanised steel all fire resistance doors shall be insulated and fitted with panic latches.
Steel doors shall be effectively sealed (including the bottom) to reduce the leakage of heat ingress of dust as far as practicable using heavy duty seals.

13.12.1 .6 Door Closures

Door closures shall be of the overhead hydraulic type. They shall be of an approved type and provided with fine-adjusting facilities. The size of the door closer shall be relative to the weight of the door leaf and shall be approved by the Employer's Representative.

13.12.1 .6 Door Fittings

All metal fittings such as hinges, locks, door handles, door bolts, etc. shall be made for heavy duty and mounted in adequate numbers.

13.12.1 .7 Roof and ceiling

All metals and metalwork components whether fabricated on or off site shall confirm to the requirements of the relevant British Standards or any other standards to the approved by the Employer's Representative. Metalwork articles shall have a good finish, and be free from scale, rust, damage or other defects. Components shall be properly assembled and jointed in a neat and functional manner. Welded connections shall be ground off as necessary to present a clean smooth finish without detriment to the strength of the connection. Particular attention shall be given to the protection of metalwork from degradation caused by the environment in which it is to be used. Galvanizing, surface coating or such other treatment suitable for the metalwork under consideration shall accomplish this.

13.12.1 .8 Floor and trenches

Control building basement and cable trenches shall be waterproofed. A minimum of 1m width openings shall be provided in the falls bottom/cable basement etc. where applicable. Indoor concrete lined cable trenches shall have reinforced concrete beams to support panels with openings to pass cables. Water proof lights have to be provided to illuminate all sides of the trench. A trench sump is to be provided along with stairs to access the bottom of the trench.

13.12.1 .9 Checker Plate

Mild steel chequer plate (raised pattern) shall be fabricated from first grade mild steel with a minimum thickness over the plain portion of 6 mm. Weight of individual panels shall not exceed 25 kg. All mild steel chequer plate shall be galvanised after cutting to the required size. Lifting handles to be provided for lifting the checker plate.

13.12.1 .10 General

All floor finishes shall be protected from damage by following trades and other causes and any damage, howsoever caused, shall be made good by the Contractor at his own expense to the satisfaction of the Employer's Representative.

13.12.1 .10 Damp Proof Course (DPC)

A damp proof course shall be laid in walls, above ground levels so as to exclude rising moisture.

13.12.1 .11 Tiling

The porcelain wall and floor tiles shall be of size approved by the Employer's Representative. Colour and manufacturer shall be approved by the Employer's Representative. The ceramic tile fixing and grouting materials shall be obtained from the same source. The Contractor shall ensure that the rendering is accurately formed and has a true, plumb surface, which is free from all high spots and depressions.

13.12.1 .12 Finishes and fittings

All internal plastering shall be carried out in accordance with BS 5492 and external rendering with BS 5262 or equivalent international standard.
All proprietary brands of plaster or rendering materials shall be selected and applied strictly in accordance with the manufacturer's instructions regarding the different purposes and backgrounds for which they are intended. Particular attention shall be paid to the manufacturer's instructions regarding the time allowed to elapse between mixing and using.

13.12.1 .13 External Rendering

Where walls are to be rendered externally, the concrete frame shall be proud of the block work panel walls.

13.12.1 .14 Paints and Other Materials

Paints for priming, undercoating and finishing shall be ready mixed paints of the best quality for the intended use and comply with BS 6150 or equivalent international standard. All paints shall be obtained from an approved manufacturer who shall certify that the paint is suitable for the intended purpose. Paint for use on concrete or block work shall be of a type specially prepared for this purpose.

Control Building Requirement of Finishes

Item	Description	Control, Protection, Auxiliary room	Store room	Battery room	Toilet
1	Floor	Raised modular	Cement rendered painted with floor paint.	Cement rendered painted with anti acidic/alkaline floor painted	Tiled
2	Walls	Emulsion painted	Emulsion painted	Emulsion painted	Tiled
3	Ceiling	False Ceiling	False Ceiling	False Ceiling	False Ceiling
4	Roof	Sheet metal covering	Sheet metal covering	Sheet metal covering	Sheet metal covering
5	Doors	Fire proof steel with panic latches	Aluminium	Fire proof steel with panic latches	Aluminium

6	Windows	Aluminium with 13mnm clear wired glass shutters with curtain solar lamination			Aluminium with glazed shutters
7	Furniture and fittings	Table & Chairs. File & drawing racks	Racks	Eye washer with shower tray Distilled water plant wash basing	Commode, cistern wash basin shower Mirror & all accessories
8				Exhaust fans	Exhaust fans

13.12.1 .15 Supplying and erecting a Crane

Capacity shall be adequate to lift switchgear provided.

13.12.2 Site office

Site office shall be either temporary as requested in scope of work. Contractor shall provide all, services, and shall maintain up to the date of handing over the project. This site office shall be erected immediately and shall be available at the time of mobilising in a position as directed by the Employer's Representative outside the chain link fence. If contractor is delayed to provide permanent site office at the time of mobilization he should provide temporary site office to the satisfaction of the Employer's Representative.
The permanent site office shall be as per the given drawing**.** The site office either permanent or temporary shall be provided all the services water, Electricity, Air conditioning and Telephone facilities to the satisfaction of the Employer's Representative. Service connections to be provided for all the facilities. Toilets shall be draining to a suitably sized septic tank with overflow to an enclosed soak away. The office building shall have a damp-proof floor and be provided a roof. It is to have opening windows fitted with sunblind. The office and toilet facilities and all services shall be provided and maintained to the Employer's Representative's satisfaction. The services and maintenance shall be provided until the taking over date of the work. Contractor shall provide two executive tables four chairs two cupboards for Employer's Representatives rooms, one conference table eight chairs, and all the equipment for pantry as requested by the Employer's Representative.

13.12. 3 Employer's Representatives living Accommodation

Not applicable

13.12.4 Temporary Works (Stores, access, contractors offices etc.)

The Contractor's site office stores for all the substations shall be temporary structure locate outside the chain link fence area. The contractor should demolish it and clear the site as directed by the Employer's Representative.
Any temporary approach or access roads, Drainages or any other temporary structure required by the contractor for the successful completion of the work shall include under this item.

13.13 VENTILATING SERVICES

Shall be designed by the Contractor and approved by the Employer's Representative. The following parameters shall be used for designing the ventilation system:

13.13.1 Battery Room

System Description	Wall extract fan. A heat pump unit cools the room.
Heating	None
Cooling	Cool to 24^{o}C
Outdoor Supply air	None
Extract Air	2 AC/hr minimum for fume removal

Control System	All systems run continuously. Local isolators to start/stop the systems. A thermostat controls the cooling. A (separate) room temperature sensor feeds into the Station PLC for remote monitoring.
Action in the Event of a Fire	No Action.

13.14 FIRE SAFETY FACILITIES

13.14. 1 General

Fire Safety Facilities shall be designed for maximum reliability and ease of maintenance. They shall be in accordance with the codes applicable for Fiji. The Tender shall be based upon the Standards named in this Specification. The Contractor may propose equipment in accordance with other relevant published standards, as optional alternatives. The Contractor shall submit copies of such alternative Standards with his proposal.

13.14.2 Project Requirements

All new substations are to be provided with fire safety facilities. For existing substations these facilities are to be provided as specified in the schedules. Portable fire extinguishers shall be provided under this contract. There shall be at least

5 – Portable wall mounted BCF extinguishers.
1– Trolley mounted BCF extinguishers.

Portable fire extinguishers shall be provided for control room, protection room, switchgear room, Battery room and at the entrance and guard room appropriately: Mobile trolley extinguishers shall be placed as directed by the Employer's Representative. Smoke detectors are to be strategically placed with the building (including toilet, store & battery room) and connected to a Wormald Fire System that is linked to the National Control Centre.

13.14.3 Design and Liaison of the Work

Design proposed for fire protections shall be in compliance to the applicable standards in Fiji.

13.14.4 Supplying and installation of services

All fire protection equipment shall be of types approved and listed by recognised approval authorities, or approved by the Employer's Representative. Acceptable approval authorities include national standard organisations, official testing laboratories, and testing laboratories of the fire insurers, licensed testing laboratories with specialised experience of fire protection, and recognised marine classification societies.

13.15 LIGHTING AND SMALL POWER SUPPLY WORK

13.15.1 General

The completed installations shall comply in all relevant respects with the Regulations issued by the Institution of Electrical and Electronic Engineers (IEEE) (or equivalent applicable in Fiji) with the Codes of Practice issued by the Chartered Institutions of Building Services, or International Electrical Committees Standards, or with such other.

13.15.2 Contractors Responsibilities

The Contractor shall submit to the Employer's Representative for approval copies of all his calculations forming the basis for the designs of the lighting and small power installation which shall be shown on the working drawings, also to be submitted for approval.
Any approval shall not, however, relieve the Contractor of his contractual responsibilities.
The Contractor shall enter into the schedules, a fixed sum for the complete design work and construction works under this section of the Specification and no price variation will be considered.

13.15.3 Project Requirement

This section of the Specification includes for the lighting and small power installations in new buildings and for extensions to the interior, exterior and emergency lighting and diesel generator small power installations where appropriate. All civil works associated with this section of the works shall be deemed to be included either as part of the main civil engineering works or as part of the works in this section. No additional payments will be made for such requirements. The requirements of this section of the works are subjected to the Conditions and Specifications laid down in other sections and volumes of the Tender Documents. The lighting installations shall be designed to give the standard service illuminations set out in the schedule appended to this section. Control and relay room and office room shall have the service illumination measured at 850 mm above finished floor level. All other areas shall have the service illumination measured at floor level.

The installations shall also meet the limiting glare index requirements as set out in the specified codes of practice. The schedule gives proposals for the types of lighting fittings to be used in the area, type of control to be employed, number of socket outlets and the types of mounting expected to be suitable for the respective areas. When 3 phase lighting installations are to be used, contactor switching controlled by pushbuttons located in the areas to be illuminated is preferred. In all rooms and corridors having two entrances the lighting installation shall have two way switching, the switches / push buttons being located in appropriate positions adjacent to the entrances. Emergency lighting shall be arranged to illuminate all stairways, exits and entrance and provide some illumination in operational areas. Where the DC is system is used, DC contactors are to be used for switching.

13.15.4 Design and liaison of work

Coding System

The Contractor shall when preparing drawings showing the respective designs use a code to identify each lighting fittings and socket outlet.
The code shall comprise letters and figures so compiled that the following information can be readily identified;

(1) The lighting distribution board to which the fitting or socket outlet is connected.
(2) If connected to the normal supplies or to the emergency DC supplies.
(3) The circuit numbers and phase of the distribution board to which the fitting is connected.
(4) The sequence of the fitting in a particular circuit.

13.15.5 Supplying and installation of service

13.15.5.1 AC Distribution boards

Distribution board for substation supplies shall be of the single busbar, air insulated multi-cubicle or multi-box factory built assembly type, incorporating air break, manually operated MCCB units, suitable for installation in the substation building on a 415-230 V, three-phase, four-wire, 50 Hz system, having the neutral earthed through earthing transformer. Unless otherwise specified, distribution boards shall be in accordance with IEC 439 IEC 408 or BS 5486 Part 1 and Part 2 and to BSEN 60947-8 and the degree of protection shall be not less than IP 41 to BSEN 60947-1 or better equivalent of the concerned standards. Incoming supplies to all distribution boards shall be protected at the point of supply by MCCB. All distribution boards should be suitably rated for a prospective short circuit breaking capacity of 25 kA at 600 V. Distribution boards shall each include three-phase busbars, one neutral busbar and an earth bar; all of high conductivity copper supported to withstand the normal and fault condition stresses.
The neutral busbars shall have a rating not less than 50% of that of the associated phase busbars. Distribution boards shall have a busbar rating not less than 100 Amperes.

Each distribution board shall consist of a fabricated steel busbar chamber having MCCB, in distribution boards and attached and mounted at a height convenient for the operator. The distribution board shall be of a type, which is readily extensible and suitable for use in a hot humid climate. Each circuit shall be clearly labelled to show the destination of the associated cable, the "ON" and "OFF" positions of the switches being clearly indicated. Cubicle type (metal-enclosed type) distribution boards shall be so arranged that the cubicles housing individual control units are grouped to form a multi-tier arrangement and a further part shall where possible constitute a cabling and wiring chamber of ample dimensions in which terminal boards, cable boxes and cable seal plates shall be located.

Fuses shall be of the HRC cartridge type for operation at a prospective fault level of 25 kA and conforming to BS 88, where applicable. The mountings of the fuses shall be such that they can be readily withdrawn and replaced whilst the associated busbars and circuits are live. Incoming circuits at distribution boards shall not be provided with fuses for prevention of lack of phase. MCCBs shall be of the high speed fault limiting, thermal/magnetic type to IEC, or BS 3871 or equivalent standard, with quick make and quick break trip free mechanisms, which prevent the breaker being held in against overloads or faults. Tripping arrangements shall be such as to ensure simultaneous opening of all phases. Arc extinction shall be by de-ionizing arc chutes. MCCBs on the incoming circuits shall have facilities for locking in the "off" position. The rupturing capacity of the MCCB shall not be less than that of the switchboard itself.

ACBs or MCCBs shall be provided on the incoming circuits at the respective Substation Services, main distribution boards. These circuit breakers shall be equipped with thermal device shall have an adjustable IDMT characteristic and the magnetic device an adjustable short time delay. Earth metal of distribution boards shall be bonded and earthed to the main station earthing system. Approved MCCB or title labels shall be fitted externally on the front cover of each switch or distribution board giving the function of each circuit. A non-fading printed list of circuits shall be provided on each sub distribution boards, stating the location of the equipment served, rating of the protective unit and the circuit loading. The lists shall be mounted on the inside of the cover door and shall be protected by an acrylic sheet slid into a frame over the circuit list, the list and cover to be easily removable to permit circuit modifications.

The distribution boards for building services shall be manufactured and tested in accordance with the latest standard and be capable of withstanding without injury the mechanical and electrical stresses set up by a fault equivalent to 25 kA at 600V for twice the period required to disconnect such on any circuit. Each distribution board shall have a dust proof metal case of sheet steel with either a galvanised or enamelled finish to IP 41.The colour of the enamel finish shall match the colour of other switchgear. The metal casing shall be provided with a number of knockouts or other approved form of cable entries corresponding to the circuit capacity of the distribution board and a suitable earth busbar. Distribution boards shall also meet the requirements of the appropriate sections of this clause. Distribution boards for exterior use shall be galvanized and weatherproof to IP 54.Distribution boards for use on direct current system shall be double pole types equipped with adequately rated fuses. Mixed capacity board shall be employed and all contactors and control switches associated with the respective outgoing circuits shall be accommodated within the distribution boards.

13.15.5.2 Cables

Cables designated PVC shall be polyvinyl insulated or polyvinyl insulated and sheathed types manufactured and tested to the requirements of BS 6004, 600/1000V grade or equivalent. Sheathed types shall be equipped with an earth continuity conductor. Cables designated XLPE shall be cross-linked polyethylene insulated filled and polyethylene sheathed or polyvinyl chloride sheathed overall and be manufactured and tested in accordance with the requirements of BS 6364, 600/1000 V grade or equivalent. The outer sheath to be coloured black. Jute fillings will not be permitted.
Flexible type cable for pendant cords and final connections to fixed apparatus shall be butyl or silicone rubber insulated and sheathed manufactured and tested in accordance with the requirements or BS 6500, 300/500V or 300/300 V grade as applicable. The conductor shall comprise multi-strand of 0.25 mm or more. The number of strands shall be not less than 30 and in all cases of a number suitable for the protection rating of the respective circuits.

All cables used for lighting and small power shall have copper conductors.

The Contractor shall select conductor sizes for the respective final circuits to meet the following conditions;

(1) That the minimum conductor size for lighting circuits shall be 1.5 sq. mm and for socket outlets 2.5mm.^{2}

(2) That the size shall be adequate for the current to be carried as set out in the cable manufacturers specification.

That the size is sufficient to keep the voltage drop in the phase and neutral conductors to the farthest lighting or power point, under normal full load conditions, to within the final circuit limit specified in the Australian Wiring Regulations. Diversity will not be allowed.

13.15.5.3 Cable termination

Termination's for XLPE cables shall comprise compression type clamps and bonding clamps to meet the requirements of BS 6121 or equivalent and shall be designed to secure and to provide electrical continuity between the conductor and the threaded fixing component of the clamps. Earth bond terminal attachments shall be provided. Termination for PVC insulated and rubber insulated cables shall comprise compression type clamps as specified for the terminations for XLPE cables mentioned above.

13.15.5.4 Sealing and drumming

Drums and sealing and drumming of XLPE and PVC cables shall generally meet the requirements of the relevant clauses in Section 8.

13.15.5.5 Cable trays

Cable trays where required as part of the Contract supply shall be the perforated galvanized sheet type.
Trays shall have upturned edges and be of a width suitable for the number of cables to be supported and shall be supplied with purpose-made galvanized steel brackets suitable for mounting from the building structure and in the trenches.

13.15.5.6 Cable jointing

The Contractor shall be responsible for the sealing and jointing of all cables supplied and installed as part of this Section of the Contract. All jointing and terminations shall comply with the relevant clauses of Section 8.

13.15.5.7 Contactors

Contactors shall comply with BS 5454, IEC 518/1, IEC 518/1A or equivalent and shall be of the electrically held-in types contained in heavy gauge sheet steel case suitable for panel mounting. Each contactor shall be continuously rated and suitable for thirty inductive switching operations per hour and a utilization category of AC2. This should be used in the Dc light system and in the daylight switches for external lighting.

13.15.5.8 Switches and Push buttons

Switches shall be rated for 15A (single phase) or 20 amps (3 phase) and shall be single pole types and be provided with an earth terminal. The oil filtration plant switch will be of 100A mounted near the transformer.
Switches for use in areas designated for surface installation shall be quick-make-quick-break fixed grid industrial types mounted in galvanized malleable iron boxes with protected dolly and arranged where necessary for multigang switching. Switches for use in areas designated for flush installation shall be micro-break types fixed to white plastic cover plates and mounted in galvanized steel flush type boxes. Two way and multigang variations shall be provided as appropriate.
Push-button switches shall either be flush or surface types contained in galvanized steel boxes and are single pole rated for 5 Amps. or more. Push buttons shall be made of non-hygroscopic material be non-swelling and so fitted as to avoid possibility of sticking. The terminals for all switches shall be adequate to accommodate 2 conductors each 1.5 sq. mm in area.

13.15.5.9 Lighting Fittings

Illustrations and/or samples of all lighting fittings, which the Contractor proposes to purchase, shall be submitted to the Employer's Representative for approval before issuing any sub-orders. Lighting fittings for interior and exterior use shall be manufactured and tested in accordance with the appropriate sections of BS 4533 or equivalent and together with all components shall be suitable for service and operation in the climate stated.
Each fitting shall be complete with all lamp holders, control gear, internal wiring, fused terminal block, earth terminal and reflectors or diffusers as specified. The design of each fitting shall be such as to minimize the effect of glare

and such that the ingress of dust, flies and insects is prevented. Where open type fittings are used it shall be impossible for insects to become lodged therein. The control gear for use with fluorescent lamps shall incorporate power factor and interference suppression capacitors. Chokes shall be impregnated and solidly filled with polyester resin or other approved high melting compound and shall be manufactured to restrict the third harmonic content to less than 25% of the uncorrected current value and shall be silent in operation.
Control gear for discharge lamps shall incorporate power factor correction and interference suppression capacitors. Internal connections shall comprise stranded conductors not less than 0.75 esq. covered with heat resistant insulation to the requirements of BS 6500 or equivalent. All internal wiring shall be adequately cleated to the fitting casing with an approved form of cleat. The finish of fittings for interior use shall be impervious to deterioration by atmospheric reaction. Fittings for exterior use shall have a vitreous enamel, natural aluminium or galvanized finish according to the manufacture's standard product. Fittings for housing tungsten lamps exceeding 150 watts rating shall be provided with an approved method of dissipating heat from the lamp cap and terminal housing. Lamp holders as applicable shall be suitable for the lamp specified.

Flood lighting fittings suitable for 250W high-pressure sodium lamps are preferred. Lighting fittings shall be of the type description as generally set out in the schedule appended to this Section of the Specification. The type references used shall be repeated in the Schedule and on the drawings.

13.15.5.10 Lamps

The Contract includes the supply and erection of all lamps and tubes necessary to complete the installation and these shall be included in the prices quoted for the supply and erection of fittings. Fluorescent lamps shall be manufactured and tested in accordance with British Standards 1853; IEC 81 or equivalent shall be bi-pin types and shall be warm white colour. Tungsten lamps shall be manufactured and tested in accordance with BSEN 60064 or equivalent and shall be bayonet cap for lamps up to and including 100 watts. Lamps rated for 150 watts and higher shall have Edison screw caps. Low wattage lamps used in exit signs and emergency lighting units may be small or miniature Edison screw. Discharge lamps shall be manufactured and tested in accordance with British Standard 3677 or equivalent. Mercury vapour lamps shall be fluorescent types having a 10% red ratio colour correction, whenever used.

13.15.5.11Socket Outlets and Fused Spur Outlets

The Contract shall include suitably located; heavy duty, weatherproof three phase and neutral interlocked switched socket outlets and plugs for supplying the transformer oil filtration units. Ample single phase outlets shall be located in convenient positions, and at least one three phase and neutral, light duty outlet with plug shall be located in each relay room.
Each socket outlet shall comply with the requirements of the British Standard 1363 or equivalent and shall be the interlocked shuttered and switched types arranged for surface or flush mounting in single or multi gang units as appropriate. Each fused spur outlet shall be equipped with double pole isolator, a fuse to British Standard 1362 or equivalent and where required front entry for flexible connection. Each socket outlet and fused spur outlet shall be equipped with a galvanized metal box with earth terminal. Each group of five socket outlets shall be provided with matching fused plug top. All socket outlets for exterior use shall be galvanized and weatherproof and be equipped with screwed dustproof cap attached to the socket by means of a chain.

13.15.5.12 Conduit and Fittings

Steel conduits shall be manufactured in accordance with BS 4568, Part 1 or equivalent, heavy gauge screwed and welded Class B and shall be galvanized, or an alternative price can be quoted for high impact heavy gauge PVC of similar dimensions.
Fittings for steel conduits shall be manufactured of good quality malleable cast iron and of small circular pattern to BS 4568, Part 2 or equivalent, with internally tapped spouts minimum length 21 mm threaded to the correct length at inter-sections tees, draw through and stop ends.
Conduit fittings of PVC shall be of the plain bore pattern suitable for a push-on compression type joint and shall be sealed with a hard setting vinyl cement to prevent ingress of vermin, water, dust, etc.

13.15.5.13 Poles

Lighting poles shall be of tubular or polygon shaped steel with a base of sufficient section to house an inspection trap, lockable door, cable entry and terminations suitable for the incoming cables and the secondary cables feeding

the light sources, all of which shall be supplied with the pole. All poles shall be suitable for burying to a depth of 1.5 m, shall be suitable for embedding in concrete and shall be adequate to withstand the local wind forces with a factor of safety of 2.5.Steel poles shall be galvanized and covered with a bituminous base preservative to cover both the inside and outside of the pole.

13.15.5.14 Interior Installations

Wiring for the lighting and socket outlet installations shall comprise PVC cables drawn into conduits attached to walls, structural or roof steelwork or ceilings as appropriate. All fixings shall be of a type approved by the Employer's Representative and all metal work used shall be galvanized. Fixings to structural steelwork shall be with purpose made brackets or clamps, the drilling of structural steelwork will not be permitted. Cleats with two screw fixings shall be used for supporting conduits at not greater than 2-m intervals. All switch boxes, socket outlet boxes and items of a similar type shall be fixed with two screws or bolts. Switches and push buttons for lighting circuits shall be mounted at 1,300 mm above finished floor level. Socket outlets shall be mounted 500 mm above finished floor level but those for use with workshop benches shall be mounted 150 mm clear of the bench working surface.

Lighting fittings shall be attached to ceilings, walls, trucking or roof steelwork or suspended therefrom as appropriate. Where fittings are to be suspended, rod type suspension units shall be employed.
Final connections to all suspended lighting fittings shall be with heat resistant flexible cable terminated in porcelain clad connectors in the ceiling or junction box which shall also terminate the main circuit cable. The cable length shall be such that the suspension unit supports the full weight of the lighting fittings.
Where recessed type lighting fittings are to be installed suspension units shall be used to prevent the weight of the fittings being applied to the suspended ceiling. It shall be possible to carry out maintenance from the underside of the fitting without disturbing the false ceiling. To facilitate this need the final connection to each fitting shall be with heat resistant flexible cable from a plug in type ceiling rose mounted above the false ceiling.
All cables not contained within conduit shall be terminated with a cable hole sealing to the requirements of Section 8.Where lighting fittings are mounted direct on walls or ceilings the main circuit cables may be connected into the fitting terminal block and where the fittings are mounted flush with the ceiling the final connection shall be taken through ceiling roses. Where terminal blocks do not exist within the lighting fitting flexible heat resistant cable shall be used connected to a separate junction box. Earth continuity shall be maintained throughout the entire wiring installation with separate insulated earth continuity conductors of adequate cross-section ultimately connected to a common earth terminal at the respective distribution board. Each and every trucking route shall be bonded across all joints with external copper bonding links supplied for the purpose.

13.15.5.15Exterior Installation

Switchyard floodlighting shall preferably be mounted on earth mast structures at a height of 11 meters above ground level and suitable access ladders shall be provided on the masts for maintenance of the lighting fittings. Where this is not feasible the floodlight fittings shall be mounted on poles also at a height of 11 meters above ground.
Roadway lighting shall comprise roadway lanterns mounted on poles at 5.5 meters above the finished road level. All exterior lighting shall be controlled by at least 2 photoelectric cell. A by-pass switch is to be install on each photocell to test the external light periodically.

Cables to exterior lighting shall be XLPE cables laid in concrete trenches or cleated to building structures or into steel conduits galvanized as appropriate to the route requirement. The cables shall be terminated at a cutout located at the base of each support. Wiring between the cut-out and the control gear or lantern shall be with PVC or PE multi-core cables run within poles or drawn into galvanized steel conduit attached to the supporting structure. This exterior lighting shall be with sodium vapour lamps and shall be supplied by a diesel generator set during emergency.

13.15.5.16 Earthing and Bonding

All equipment being supplied under this Section shall be effectively bonded to ensure earth continuity throughout the system. Continuity may be provided by means of steel conduits but a separate earth continuity conductor shall be included with all wiring in conduits. No reliance shall be placed on metal to metal joints in conduits for each continuity. The earth continuity conductors shall as far as possible be in one continuous length to the furthest part of the installation from the controlling switchboard. The earth conductor shall connect all metal cases housing

electrical equipment. The branches shall be connected to the main conductor by permanent exothermic fusion welded joints or crimped joints approved by the Employer's Representative.

13.15.5.16 Emergency Lighting

Emergency lighting shall be installed in the new substation buildings. The emergency lighting shall be divided into two parts. One part shall have fittings installed in strategic locations to ensure safe evacuation of the buildings, and shall switch on automatically following a power failure. This part shall not be connected to the substation DC system, but shall have dedicated batteries and chargers.

The other part shall be supplied from the substation DC system and the lighting in each room shall be controlled by a switch located in that room (connected to DC contactor). The illumination level shall be sufficient to enable an operator to undertake emergency inspection and switching duties. At least two rechargeable hand lamps shall be installed at each substation. They shall normally rest on wall mounted brackets incorporating the chargers. Each lamp shall incorporate a small red light to facilitate location following a lighting failure.

Lighting and Small Power Supply Works

Schedule of Requirements

Location	Service Illumination		Type of fittings		Type of fixing	Type of control & switch	Socket outlet	Type of installation
	Lux	Index	Main	Emer			Type, No.	
Switchgear Room	500	19	F6/F7	E4	C	L/A	S1,	F
Battery room	150	-	F5	E4	C	L	S1,	F
Office room All buildings	500	16	F6/F7	E4	C	L/A	S1	F
Auxiliary room	300	16	F8/F9	E4	C	L/A	S1	F
Control, Protection and relay room	300	16	F8/F9	E4	C	L/A	S1	F
Store all buildings	150	-	F1	-	C	L	S2,	S
Corridors all buildings	200	-	F6/F7	E4	C	L/A	S1	F
Exits	-	-	-	E2	W	A	-	F
Switchyard area	10	-	M1	-	P	PEC/ MAN	-	-
Road ways	10	-	J1	-	P	PEC/ MAN	-	-
Building's exterior	10	-	T1	-	W	PEC/ MAN	-	-
Rest room	300	16	F8/F9	-	C	L	S1, 2	F
Toilet all buildings	150	-	T2	-	C	L	-	F
Guard room	300		F6/F7	E4	C	L/A	S1	F
Watchtowers	150		F3		C	PEC/MAN	S1	
Security lighting	10		J1/M1		P	PEC/MAN		

Notes:
2) The above small power outlets are those required over and above the requirements for fans***, water heaters etc. specified here in.***

13.15.5.17 Clocks

Dry battery cell type clocks shall be installed in the control and protection room in new control building. The clock shall be 600 mm in diameter or digital type approved by the Employer's Representative.

13.15.5.18 Maintenance

The Contractor shall be responsible for maintenance of the installations comprising this section of the Specification for the agreed period as set out in this Specification

Section 5
Form of Proposals and Appendices

Form of Technical Proposal

To: Mr Jitendra Reddy
Manager Procurement, Inventory & Supply Chain
Energy Fiji Limited
2 Marlow St, Suva
Fiji

Contract No: _____

Gentlemen:

We have examined the Conditions of Contract, Employer's Requirements, Schedules, Addenda Nos _____ and the matters set out in the Appendix hereto. We have understood and checked these documents and have not found any errors in them. We accordingly offer to design, execute and complete the said Works and remedy any defects fit for purpose in conformity with these documents and the enclosed Proposal.

We further undertake, if invited to do so by you, and at our own cost, to attend a clarification meeting at a place of your choice, for the purpose of reviewing our Technical Proposal and duly noting all amendments and additions thereto, and noting omissions therefrom that you may require, and to submit a supplementary price proposal if the amendments, additions and omissions that you require would alter our price proposal as submitted with our bid.

We accept your suggestions for the appointment of the Dispute Adjudication Board, as set out in Schedule ____ *[We have completed the Schedule by adding our suggestions for the other member of this three-person Board, but these suggestions are not conditions of this Bid].*[*]

We are, Gentlemen
Yours faithfully

Signature _____ in the capacity of _____ duly authorized to sign bids for and on behalf of _____

Address
_____
_____

[*] If the Bidder does not accept, this paragraph may be deleted and replaced by:

We do not accept your suggestions for the appointment of the Dispute Adjudication Board, and propose that we jointly agree upon the appointment after the Effective Date (unless previously agreed) in accordance with Sub-Clause 20.3 of the Conditions of Contract. ***[OPTIONAL:*** *Our Proposal includes our suggestions for this appointment, but these suggestions are not conditions of this Bid.]*

Appendix to Technical Proposal

[Note: with the exception of the items for which the Employer's requirements have been inserted, the following information must be completed before the Bid is submitted]

	Sub-Clause	
Employer's name and address	1.1.2.1 & 1.8*	Energy Fiji Limited, Private Mail Bag, Suva, Fiji
Contractor's name and address	1.1.2.2 & 1.8	_____ _____
Name and address of the Employer's Representative	1.1.2.2 & 1.8	General Manager, System Planning & Control, EFL, Private Mail Bag, Suva, Fiji
Time for notice to commence	8.1	28 days
Time for Completion of the Works	1.1.3.4	12 months
Electronic transmission systems	1.8	Email & Facsimile
Confidential details	1.12	Nil
Time for access to the Site	2.2	5 days after the Commencement Date
Amount of performance security	4.2*	Ten (10%) of the Contract Price and in the proportions of currencies which the Contract Price is payable
Time for submission of programme	4.14	14 days after the issue of Letter of Acceptance
Normal working hours	6.5	7.30am to 4.30pm, Monday to Friday
Liquidated damages for delay	8.6*	0.25 % of the Contract Price per day, in the proportions of currencies in which the Contract Price is payable
Limit of liquidated damages for delay	8.6*	Ten (10) % of the Contract Price
Amount of insurance for design	18.1	Full value of the Contract Price
Amount of third party insurance	18.3	Contractor to Propose
Periods for submission of insurance:	18.5	
(a) evidence of insurance	*	Not later than Commencement Date.
(b) relevant policies	*	Fourteen (14) days after Commencement Date.

Number of members of Dispute Adjudication Board	20.3*	Three (3)
Arbitration rules	20.6*	International Chamber of Commerce, Rules of Arbitration
Number of Arbitrators	20.6*	Three (3)
Language of arbitration	20.6*	English
Place of arbitration	20.6	Fiji

Initials of signatory of Bid _____

Form of Price Proposal

To: Mr. Jitendra Reddy
Manager Procurement, Inventory & Supply Chain
Energy Fiji Limited
2 Marlow St, Suva
Fiji

Contract No: _____

Gentlemen:

We have examined the Conditions of Contract, Employer's Requirements, Schedules, Addenda Nos _____ and the matters set out in the Appendix hereto. We have understood and checked these documents and have not found any errors in them. We accordingly offer to design, execute and complete the said Works and remedy any defects, fit for purpose in conformity with these documents and the enclosed Proposal, for the fixed lump sum of (in currencies, of payment) _____ or other such sums as may be determined in accordance with the terms and conditions of the Contract. The above amounts are in accordance with the Price Schedules herewith and are made part of this bid.

We confirm our agreement with the appointment of *(name proposed in Bid Data Sheet or during the clarification meeting of the First Stage bid)* as the Adjudicator.

We agree to abide by this Bid until _____ and it shall remain binding upon us and maybe accepted at any time before that date. We acknowledge that the Appendix forms part of our Bid.

If our bid is accepted, we will provide the specified performance security, commence the Works as soon as reasonably possible after receiving the Employer's Representative's notice to commence, and complete the Works in accordance with the above-named documents within the time stated in the Appendix to Technical Proposal.

Unless and until a formal Agreement is prepared and executed this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.

We understand that you are not bound to accept the lowest or any bid you may receive.

Commissions or gratuities, if any, paid or to be paid by us to agents relating to this Bid, and to contract execution if we are awarded the contract, are listed below:

Name and Address of Agent	Amount and Currency	Purpose of Commission or Gratuity
_____	_____	_____
_____	_____	_____
_____	_____	_____

(if none, state “none”).

We are, Gentlemen
Yours faithfully

Signature _____ in the capacity of _____ duly authorized to sign bids for and on behalf of _____

Address
_____
_____

Date _____

Appendix to Price Proposal

[Note: with the exception of the items for which the Employer's requirements have been inserted, the following information must be completed before the Bid is submitted]

	Sub-Clause	
Employer's name and address	1.1.2.1 & 1.8*	Energy Fiji Limited, Suva, Fiji
Contractor's name and address	1.1.2.2 & 1.8	_____ _____
Name and address of the Employer's Representative	1.1.2.2 & 1.8	General Manager, System Planning & Control, EFL, Private Mail Bag, Suva, Fiji
Total amount of advance payments	13.2*	Ten (10)% of the Contract Price
Number of instalments	13.2	One (1)
Start repayment of advance payment	13.2(a)	when payments are Ten (10) % of the Contract Price
Repayment amortization of advance payment	13.2(b)	25%
Percentage of retention	13.3(c)*	Five (5)%
Limit of Retention Money	13.3(c)*	Five (5)% of the Contract Price
Minimum amount of Interim Payment Certificates	13.6*	Five (5)% of the Contract Price
If Sub-Clause 13.15 applies:		
Payments in Local and Foreign Currencies	1.1.5.3 & 13.15	

Currency Unit	Amount Payable in such Currency
Local: _____ [name] Foreign: _____ [name] _____ [name]	_____ _____ _____

Initials of signatory of Bid _____

Section 6
Sample Forms

Form of Contract Agreement

This Agreement made this _____ day of _____ 20 _____ between _____ _____ of Energy Fiji Limited (hereinafter called "the Employer") of the one part and_____ of _____ (hereinafter called "the Contractor") of the other part

Whereas the Employer desires that the Works known as Kalabu Tax Free Zone 33/11kV Substation Project should be designed and executed by the Contractor, and has accepted a Bid by the Contractor for the design, execution and completion of such Works and the remedying of any defects therein.

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement:

(a) The Letter of Acceptance dated _____
(b) The Employer's Requirements
(c) The Addenda nos. _____
(d) The Bid dated _____
(e) The Conditions of Contract (Parts I and II)
(f) The completed Schedules, and
(g) The Contractor's Proposal.

3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to design, execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor, in consideration of the design, execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

5. This Agreement shall come into effect on signing by both parties.

In Witness whereof the parties hereto have caused this Agreement to be executed the day and year first before written in accordance with their respective laws.

Authorized signature of Contractor SEAL (if any)	Authorized signature of Contractor SEAL (if any)
in the presence of:	in the presence of:
Name _____ Signature _____ Address _____	Name _____ Signature _____ Address _____

Form of Performance Security
(Bank Guarantee)

To: Energy Fiji Limited
2 Marlow St, Suva
Fiji

*WHEREAS*_____ *[name and address of Contractor]* (hereinafter called "the Contractor") has undertaken, in pursuance of Contract No. _____ dated _____ to execute _____ *[name of Contract and brief description of Works]* (hereinafter called "the Contract");

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for the sum specified therein as security for compliance with its obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee;

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible *to* you, on behalf of the Contractor, up to a total of _____ *[amount of Guarantee]* _____ *[in words],* such sum being payable in the types and proportions of currencies in which the Contract Price is payable, and we undertake to pay you, upon your first written demand and without cavil or argument, any sum or sums within the limits of _____ *[amount of Guarantee]* as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change or addition to or other modification of the terms of the Contract or of the Works to be performed thereunder or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

This guarantee shall be valid until the date of issue of the Performance Certificate.

Signature and Seal of the Guarantor _____
Name of Bank _____
Address _____
Date _____

Section 7

Schedules – Part I
Schedule of Prices

TABLE OF CONTENTS

1 NOTES ON SCHEDULES

The Schedules are intended to provide the Employer with essential supplementary information in an organized format. Examples of more commonly used Schedules are given herein. Others may be devised and added in accordance with the requirements of the Instructions to Bidders.

All the Schedules are essential for bid evaluation and some in contract execution; they should all be incorporated in the Contract, and appropriate changes introduced with the approval of the Employer or its representative.

The schedules are to be completed and submitted as part of the Technical Proposal and Price Proposal in accordance with the Instructions to Bidders Clause 13, Documents Comprising the Bid.

2 SCHEDULE OF PRICES & CONDITIONS OF PAYMENT

2.1 *CONTRACT PRICE*

The Contract Price is comprehensive in that, in consideration of the Contractor meeting all obligations, conditions and liabilities under the Contract, including the Contractor's allowance for the cost of supply of all labour, materials, plant, supervision required to complete the Contract Works, overheads and profit, subject only such adjustment as is provided for the Contract.

2.2 *BASIS OF SCHEDULES*

Descriptions of various items contained in the Schedule of Prices are intended to be a complete definition of the scope of the Contract Works, for which reference shall be made to the Specification, Drawings, Basis of Payments and other Contract Documents. The items descriptions on the Schedule of Prices shall be used only for the purpose of calculating progress payments and for valuing variations.

2.3 *BASIS OF PAYMENTS*

The rate or cost of the items shall represent the total cost of designing (where appropriate), checking, approving, purchasing, constructing, installing, commissioning, training the Employer's staff, testing and providing as-built drawings and O&M manuals for the works unless separate items have been included for some of these activities.

2.4 *PAYMENTS TERMS*

1. All payments shall be due and payable by the Employer in accordance with the payments terms detailed below.
2. The payments shall be made on completion of milestones as identified and agreed by both the Employer's Representative and the Contractor.
3. The payments will be made based on the following schedule:
    - ninety percent (90%) of the total DDU to Site amount shall be paid on submission of receipt of invoice and documents. Documentation shall include as a minimum a bill of landing, a sea way bill, an airway bill, a railway consignment note, a road consignment note, insurance certificate as appropriate for the method of transportation undertaken.

- five percent (5%) of the total DDU to Site amount shall be paid upon issue of Completion Certificate.
- five percent (5%) of the total DDU to Site amount shall be paid upon completion of retention period.

4. Payments to be made under this contract fall into two categories:

   i] payments for work carried out off-shore and hence not subject to GST or VAT.
   ii] payments for work carried out within Fiji (i.e. on-shore), and hence

shall be subject to Fiji tax, legislation including the VAT Decree 1991 and its subsequent amendments.

5. Off - Shore Work

All invoices issued for off-shore work pursuant to this Contract shall be expressed in the foreign currency stated in Appendix to Bid, and will be issued using Contractor's overseas office letterhead. No GST or VAT shall be included in the invoice.

The Employer shall pay the invoice amount in foreign currency to each overseas bank account nominated by Contractor within 30 days of acceptance of the invoice.

6. On - Shore Work

All invoices issued for on-shore work pursuant to this Contract shall be expressed in Fiji Dollar currency, obtained by converting any foreign currency amounts to Fiji dollars using the corresponding foreign exchange rate prevailing on the date of the invoice. Any Value added Tax (VAT) amount component at the prevailing VAT rate shall be added to indicate the VAT inclusive price (VIP). The invoice shall be issued using Contractor's Fijian registered entity letterhead.

7. The Contractor shall advise the Employer the details of its Fijian registered entity including the Tax Identification Number given by the Fiji Islands Revenue and Customs Authority (FIRCA) as soon as possible after the execution of this Agreement.
8. The Employer shall not be responsible to pay invoices issued by the Contractor or its Fijian registered entity if such invoices are not in conformance with the above stated requirements.
9. If the Employer disputes any portion of the amount claimed in an invoice submitted by the Contractor or by its Fijian registered entity, the Employer shall notify the Contractor in writing of the reasons for disputing the amount and the Employer shall pay that portion of the amount in the invoice that is not in dispute.
10. If any payment due to the Contractor or its Fijian registered entity through a valid invoice submitted to the Employer is not received by the Contractor within 30 working days from the date of receipt by the Employer of any undisputed invoice, the Employer shall pay interest as from the due date at the Reserve Bank of Fiji Lending Rate per annum accruing daily.
11. The Contractor hereby agrees that payments made by the Employer in accordance with this Agreement to the Contractor's Fijian registered entity shall be proper consideration deemed to be received by the Contractor.
12. All matters relating to taxation such as income tax, withholding tax, PAYE and other tax issues shall be the responsibility of the Contractor and its Fijian registered entity. Similarly any superannuation

related issues such as FNPF liabilities (where applicable) shall be the responsibility of the Contractor and its Fijian registered entity.

3 SCHEDULES OF RATES & PRICES

3.1 *NOTES ON SCHEDULES OF RATES AND PRICES*

1. The Schedules are divided into six separate sections as follows:
   - 3.2 Price Schedule of Main Items
   - 3.3 Alternative Offers
   - 3.4 Recommended Tools & Spare Parts
   - 3.5 Summary of Prices
   - 3.6 Bidders Tools & Equipment
   - 3.7 Rate of Variations
2. The quantities shown in these schedules are estimates only.
3. The Schedules do not generally give a full description of the plant and equipment to be supplied and the services to be performed under each item. Bidders shall be deemed to have read the Employer's Requirements and other section of the bidding documents and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling in the rates and prices. The entered rate and prices shall be deemed to include for the full scope as aforesaid including overheads and profit.
4. Bid prices shall be quoted in the manner indicated and in the currencies specified in the Instructions to Bidders in the bidding documents.

   For each item, bidder shall complete each appropriate column in the respective Schedules, giving the price breakdown as indicated in the Schedules.

   Prices given in the Schedules against each item shall be for the scope covered by that item as detailed in the Employer's Requirements, Drawings or elsewhere in the bidding documents.
5. Items left blank with be deemed to have been included in other items.
6. These schedules are intended primarily to provide information for bid evaluation but not intended to be used for the evaluation of work done for the purpose of interim payment. They may however, be used as a reference for the adjustment of the Schedule of Payment should the need arise.
7. These schedules can also be used as a basis to value variations of work done under the Proposal Sum.

3.2 *DRAWINGS, DESIGN AND DOCUMENTATION*

F/C – Foreign Currency
FJD – Fijian Dollars

Item No.	Description	Estimated		Rate		Total Price	
		Qty	Unit	F/C	FJD	F/C	FJD
1	***KALABU TAX FREE ZONE SUBSTATION***						
1.1	**ELECTRICAL WORKS**						
1.1.1	Design and Liaison of Works	1	LS				
1.1.2	Drawings and Documentation required for Electrical works	1	LS				
1.2	**MECHANICAL WORKS**						
1.2.1	Design and Liaison of Works	1	LS				
1.2.2	Drawings and Documentation required for Mechanical works	1	LS				
1.3	**CIVIL WORKS**						
1.3.1	Design and Liaison of Works	1	LS				
1.3.2	Drawings and Documentation required for Civil works	1	LS				
TOTAL (Transfer to Grand Summary)							

3.4 *PLANT EQUIPMENT INCLUDING MANDATORY SPARE PARTS*

ITEM NO.	DESCRIPTION	ESTIMATE QTY	DDU FIJI Foreign Currency		DDU FIJI FJD		ERECTION ON SITE FJD		TOTAL AMOUNT (Excluding Taxes & Duties)	
			Unit Rate	Amount	Unit Rate	Amount	Unit Rate	Amount	F/C	FJD
			(1)		(2)		(3)		(4=1)	(5=2+3)
	KALABU TAX FREE ZONE SUBSTATION									
1	**ELECTRICAL WORKS**									
1.1	INDOOR 33 kV SWITCHGEAR									
1.1.1	2000A, 36 kV, 31.5 kA, 3 phase circuit breaker complete with housing panel (Bus section breaker)	1 Nos								
1.1.2	1250A, 36 kV, 31.5kA, 3 phase circuit breaker complete with housing panel (transformer breaker)	2 Nos								
1.1.3	1250A, 36 kV, 3 phase circuit breaker complete with housing panel (feeder circuit breaker)	4 Nos								
1.1.4	36kV VT Three phase voltage transformers, ratio 33,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection	6 Nos.								
1.1.4	CTs									
1.1.4.1	800/600:1, Class 5P20	4 Nos								
1.1.4.2	2000/1200:1 Class 0.1PX	8 Nos								
1.1.4.3	2000/1200:1 Class 5P20	2 Nos								
1.1.4.4	800/600:1 Class 0.1 PX	4 Nos								
1.1.4.5	600/400:1 Class 0.1 PX	2 Nos								
1.1.4.6	600/400:1 Class 5P20	2 Nos								
1.2	INDOOR 11 kV SWITCHGEAR									

1.2.1	2000A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Bus section)	1 No								
1.2.2	1250A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Transformer breaker)	2 Nos								
1.2.3	1250A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Feeder breaker)	6 Nos								
1.2.4	1250A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Aux Transformer breaker)	1 Nos								
1.2.5	CTs									
1.2.5.1	800/400:1, Class 5P20	7 Nos								
1.2.5.2	1600/1200:1, Class 0.1PX	2 Nos								
1.2.5.3	1600/1200:1, Class 5P20	2 Nos								
1.2.5.4	300/1500:1, Class 0.1PX	2 Nos								
1.2.5.5	2000/1600:1, Class 5P20	1 No								
1.2.6	12kV VT Three phase voltage transformers, ratio 11,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection	4 Nos.								
1.3	LVAC SWITCHBOARD									
1.3.1	The two incoming supplies to switchboard are to be interlocked to automatically establish supply to the busbar in the event of failure of the selected supply (Incomer No.1 & 2) and not to parallel two of the incoming supplies at any time. Shall include at least 54 pole single chassis and 4 x MCCB (2 x 100A and 2 x 250A). Shall have provision for incoming energy metering.	1 Lot								
1.4	BATTERIES, CHARGERS AND DISTRIBUTION BOARDS									
1.4.1	110 V maintenance free battery banks with the capacity of 600 Ah (2.2V cell x 54 cells)	2 Nos.								

1.4.2	30A Single phase charger with surge protection/filter capacitors and voltage stabilizer/regulator	2 Nos.								
1.4.3	DC distribution board with 2 incomers, dual chassis with bus tie and with incoming metering. (Note: DC board shall be separate, not part of the charger panel)	1 No								
1.5	PROTECTION RELAYS									
1.5.1	33 kV Relays									
1.5.1.1	SEL311L	4 No								
1.5.1.2	SEL351S-7	7 No.								
1.5.1.3	SEL387E	2 No.								
1.5.1.4	SEL587Z	1 No								
1.5.1.5	Areva MVAJ13	2 No.								
1.5.1.6	VAMP Arc Flash Protection	2 No.								
1.5.1.7	Partial Discharge Monitoring System	2 No.								
1.5.1.8	SEL2515	As Required								
1.5.2	11 kV Relays									
1.5.2.1	SEL351S-7	10 No.								
1.5.2.2	VAMP Arc Flash Protection	2 No.								
1.5.2.3	Partial Discharge Monitoring System	2 No.								
1.5.2.4	SEL2515	As Required								
1.5.3	Others									
1.5.3.1	33 kV Control Panel to house relays, indications and manual controls. Control panel to come complete with LED's, switches, etc.	As Required								

1.5.3.2	33 kV Control Panel to house relays, indications and manual controls. Control panel to come complete with LED's, switches, etc.	As Required								
1.5.3.3	Contractor to add others									
1.6	COMMUNICATION & SCADA EQUIPMENT									
1.6.1	IP Telephone (Mitel 5312) – blue tooth wireless handset	2 Lot								
1.6.2	Radio Telephone (RT) - Tait 9355 VHF DMR mobile radio 136 – 174 Mhz	1 Lot								
1.6.3	Fiber distribution cabinet – Warren & Brown Rack 1200mm x 300mm x 2200mm	As required								
1.6.4	Fiber patch cords on both sides of the substations – SC – SC (20 x 3m duplex)	As required								
1.6.5	Fiber accessories on both sides of the substations – SC pigtails (144)	As required								
1.6.6	VHF Radio TM935	As required								
1.6.7	Cisco Switch, dual power supply (AC & DC) – Cisco CGS2520	2 Lot								
1.6.8	UPS	If required								
1.6.9	Fibre transceiver – GLC – EX (40km)	4 Lot								
1.6.10	SEL RTAC 3530 – 3530, 33 ports with both link ports to be Ethernet.	5 Lot								
1.6.11	SEL RS232 cable – 9 pin male	20 Lot								
1.6.12	Patch for RTU - Cat 6 cable (red)	As required								
1.6.13	Fibre patch for Switch - LC – SC duplex cable, single mode (4 x 3m length or as required)	As required								
1.6.14	Equipment Rack (cabinet) – Rital (790mm x 600mm x 2100mm – or as required), glass front door with build in fan and light.	1 Lot								
1.6.15	4RF Data Radio and Antenna									

1.6.16	CARDAX Access System									
1.6.17	CCTV System for indoor and outdoor monitoring capable of integrating with EFL system									
1.7	SUBSTATION EARTHING									
1.7.1	The earthing installation rates shall include the excavation, backfilling and reinstatement of the ground, driving the rods and making of the connections.	1 Lot								
1.8	LIGHTNING PROTECTION SYSTEM									
1.8.1	Design and erection of lightning protection system with earth wires as specified	1 Lot								
1.8.2	Galvanised E.H.S steel wires of size 7/3.35 complete with accessories, for lightning protection of entire substation	1 Lot								
1.9	GROUNDING SYSTEM									
1.9.1	Grounding system including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes	1 Lot								
1.10	POWER AND CONTROL CABLES									
1.10.1	All low voltage AC power cables and terminations	1 Lot								
1.10.2	All DC power and control cables and terminations	1 Lot								
1.10.3	Power and lighting cable for all works, including indoor and outdoor lighting and auxiliary supply	1 Lot								
1.11	TRANSFORMERS									
1.11.1	12/15 MVA 33/11kV Dyn1 Power Transformer with On-load Tap Changer	2 Nos.								

1.11.2	Digital temperature monitoring equipment for power transformers (Qualitrol)	2 Nos.								
1.12	OPTIC FIBER									
	Optic fiber equipment	1 Lot								
2	CIVIL AND ARCHITECTURAL WORKS									
2.1	Air condition and ventilation for building	1 Lot								
2.2	Firefighting system for control building	1 Lot								
2.3	Accessories for cable trench (indoor and outdoor)	1 Lot								
3	Others									
	TOTAL OF EQUIPMENT SUPPLY									

3.5 *CIVIL WORKS, INSTALLATION AND OTHER SERVICES*

ITEM NO.	DESCRIPTION	ESTIMATE QTY	DDU FIJI Foreign Currency		DDU FIJI FJD		ERECTION ON SITE FJD		TOTAL AMOUNT (Excluding Taxes & Duties)	
			Unit Rate	Amount	Unit Rate	Amount	Unit Rate	Amount	F/C	FJD
			(1)		(2)		(3)		(4=1)	(5=2+3)
	KALABU TAX FREE ZONE SUBSTATION									
1	**ELECTRICAL INSTALLATION**									
1.1	INDOOR 33 kV SWITCHGEAR									
1.1.1	2000A, 36 kV, 31.5 kA, 3 phase circuit breaker complete with housing panel (Bus section breaker)	1 Nos								
1.1.2	1250A, 36 kV, 3 phase circuit breaker complete with housing panel (transformer breaker)	2 Nos								
1.1.3	1250A, 36 kV, 3 phase circuit breaker complete with housing panel (feeder circuit breaker)	4 Nos								
1.1.4	36kV VT Three phase voltage transformers, ratio 33,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection	6 Nos.								
1.1.4	CTs									
1.2	INDOOR 11 kV SWITCHGEAR									
1.2.1	2000A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Bus section)	1 No								
1.2.2	1250A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Transformer breaker)	2 Nos								
1.2.3	12500A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Feeder breaker)	6 Nos								

1.2.4	1250A, 12 kV, 25 kA, 3 phase circuit breaker complete with housing panel (Aux Transformer breaker)	1 Nos								
1.2.5	CTs									
1.2.6	12kV VT Three phase voltage transformers, ratio 11,000/√3:110/√3:110/3 V Class 0.2 for Metering and Protection	4 Nos.								
1.3	LVAC SWITCHBOARD									
1.3.1	The two incoming supplies to switchboard are to be interlocked to automatically establish supply to the busbar in the event of failure of the selected supply (Incomer No.1 & 2) and not to parallel two of the incoming supplies at any time. Shall include at least 54 pole single chassis and 4 x MCCB (2 x 100A and 2 x 250A). Shall have provision for incoming energy metering.	1 Lot								
1.4	BATTERIES, CHARGERS AND DISTRIBUTION BOARDS									
1.4.1	110 V maintenance free battery banks with the capacity of 600 Ah	2 Nos.								
1.4.2	Charging equipment	2 Nos.								
1.4.3	DC distribution board	1 Nos								
1.5	PROTECTION RELAYS									
1.5.1	33 kV Relays									
1.5.1.1	SEL311L	4 No								
1.5.1.2	SEL351S-7	7 No.								
1.5.1.3	SEL387E	2 No.								
1.5.1.4	SEL587Z	1 No								
1.5.1.5	Areva MVAJ13	2 No.								
1.5.1.6	SEL2515	As Required								

1.5.1.7	VAMP Arc Flash Protection	2 Nos.								
1.5.1.8	Partial Discharge Monitoring System	2 Nos.								
1.5.2	11 kV Relays									
1.5.2.1	SEL351S-7	10 Nos.								
1.5.2.2	VAMP Arc Flash Protection	2 Nos.								
1.5.2.3	Partial Discharge Monitoring System	2 Nos.								
1.5.2.4	SEL2515	As Required								
1.5.3	Others									
1.5.3.1	33 kV Control Panel to house relays, indications and manual controls. Control panel to come complete with LED's, switches, etc.	As Required								
1.5.3.2	33 kV Control Panel to house relays, indications and manual controls. Control panel to come complete with LED's, switches, etc.	As Required								
1.6	COMMUNICATION & SCADA EQUIPMENT									
1.6.1	IP Telephone (Mitel 5312) – blue tooth wireless handset	2 Lot								
1.6.2	Radio Telephone (RT) - Tait 9355 VHF DMR mobile radio 136 – 174 Mhz	1 Lot								
1.6.3	Fiber distribution cabinet – Warren & Brown Rack 1200mm x 300mm x 2200mm	As required								
1.6.4	Fiber patch cords on both sides of the substations – SC – SC (20 x 3m duplex)	As required								
1.6.5	Fiber accessories on both sides of the substations – SC pigtails (144)	As required								
1.6.6	VHF Radio TM935	As required								
1.6.7	Cisco Switch, dual power supply (AC & DC) – Cisco CGS2520	2 Lot								

1.6.8	UPS	If required								
1.6.9	Fibre transceiver – GLC – EX (40km)	4 Lot								
1.6.10	SEL RTAC 3530 – 3530, 33 ports with both link ports to be Ethernet.	5 Lot								
1.6.11	SEL RS232 cable – 9 pin male	20 Lot								
1.6.12	Patch for RTU - Cat 6 cable (red)	As required								
1.6.13	Fibre patch for Switch - LC – SC duplex cable, single mode (4 x 3m length or as required)	As required								
1.6.14	Equipment Rack (cabinet) – Rital (790mm x 600mm x 2100mm – or as required), glass front door with build in fan and light.	1 Lot								
1.6.15	4RF Data Radio and Antenna									
1.6.16	CARDAX Access System									
1.6.17	CCTV System for indoor and outdoor monitoring capable of integrating with EFL system									
1.7	SUBSTATION EARTHING									
1.7.1	The earthing installation rates shall include the excavation, backfilling and reinstatement of the ground, driving the rods and making of the connections.	1 Lot								
1.8	LIGHTNING PROTECTION SYSTEM									
1.8.1	Design and erection of lightning protection system with earth wires as specified	1 Lot								
1.8.2	Galvanised E.H.S steel wires of size 7/3.35 complete with accessories, for lightning protection of entire substation	1 Lot								
1.9	GROUNDING SYSTEM									

1.9.1	Grounding system including connections of all steel structures and electrical apparatus to earth mesh and grounding electrodes	1 Lot								
1.10	POWER AND CONTROL CABLES									
1.10.1	All low voltage AC power cables and terminations	1 Lot								
1.10.2	All DC power and control cables and terminations	1 Lot								
1.10.3	Power and lighting cable for all works, including indoor and outdoor lighting and auxiliary supply	1 Lot								
1.11	TRANSFORMERS									
1.11.1	12/15 MVA 33/11kV Dyn1 Power Transformer with On-load Tap Changer	2 Nos.								
1.11.3	Digital temperature monitoring equipment for power transformers	2 Nos.								
1.12	OPTIC FIBER									
	Optic fiber equipment	1 Lot								
2	CIVIL AND ARCHITECTURAL WORKS									
2.1	Carry out Environmental Impact Assessment (EIA)	1 Lot								
2.2	Soil investigation	1 Lot								
2.3	Clearing, site formation and slope protection (retaining wall, etc)	1 Lot								
2.4	Filling of earth to a height of 1 foot	1 Lot								
2.5	Construction of Control Building	1 Lot								
2.6	Construction of boundary fence	1 Lot								
2.7	Construction of Switchyard Fence (not applicable)	1 Lot								
2.8	Construction of approach road (not applicable)	1 Lot								

2.9	Air condition and ventilation for control building	1 Lot								
2.10	Firefighting system for control building	1 Lot								
2.11	Accessories for cable trench (indoor and outdoor)	1 Lot								
2.12	Concrete drain	1 Lot								
2.13	Concrete cable trench with accessories (outdoor)	1 Lot								
3	Others									
	TOTAL OF EQUIPMENT SUPPLY									

3.6 *GRAND SUMMARY*

ITEM	DESCRIPTION	TOTAL PRICE	
		F/C	FJD
1.0	Design, drawings and documentation		
2.0	Plant and equipment including mandatory spares		
3.0	Civil Works, installation and other services		
GRAND TOTAL			

3.7 *RECOMMENDED TOOLS &SPARE PARTS*

As per clause 1.10 of the technical specifications, the bidder is required to provide a list of spare parts as recommended by the Manufacturer. These shall be divided into two categories i.e. Mandatory and Optional. Thus the bidders are required to provide two separate tables for the two categories.

Item	Description	Qty	Unit Price		Total Price	
			F/C	FJD	F/C	FJD

3.8 *SUMMARY OF PRICES*

	Foreign Cost	**Local Cost**
1. MAIN OFFER: (a) Kalabu Tax Free Zone 33-11kV Substation (b) Recommended Spares; Tools &Equipment		
2. ALTERNATIVE OFFERS: (Briefly describe) A. B.		

TOTAL CONTRACT PRICE:

Main Offer: Foreign Currency (in words)

……
and Local Currency (in words)

……
*Alternative A: Foreign Currency (in words)

……..
and Local Currency(in words)

……..
*Alternative B: Foreign Currency (in words)

……..
and Local Currency (in words)

……..

Signature of Tenderer .....

Witness .....

Note: Details to be included in Part II of this Section in the Departures from Specifications.

3.9 *BIDDERS TOOLS & EQUIPMENTS*

During the pre-commissioning and commissioning tests, a lot of specialised tools and equipment will be required to carry out the acceptance testing. Thus the bidders shall provide a list of such tools and equipment that they currently have. These are the tools which will be used for commissioning switchgears, transformers, cables, etc.

Item No.	Description	Model No.	Manufacturer

3.10 *RATES FOR VARIATION*

The Contractor shall aim to carry out the project without any variations. However, if unforeseen circumstances and event warrant any variation, the Contractor shall only proceed with a written approval from the Employer's Representative. The agreed price variation shall be documented.

The rates stated in this schedule shall be applicable to variations ordered by the Employer's Representative and not covered by the Schedule of Prices. These rates shall be deemed to include the cost of construction facilities, professional and technical services, royalties, taxes, transport of equipment, labour and other changes necessary to perform the work.

The Contractor shall not be entitled to any allowance above unit rates stated in the schedule by reason of any amount of work being required under such items during the currency of the Contract.

3.10.1 Materials

Materials required for variations or day work shall be paid for on the basis of the net quantities actually used in accordance with the Employer's Representatives.

Payment will be at the cost on site based on evidence of purchased prices after deductions of all trade and bulk discounts, transport, and any other charges applicable to the materials plus the percentage stated below to cover contractor's profit and overheads.

Materials supplied by the Contractor will be at prices to be agreed, due regard being paid to the prices for similar materials if supplied from outside sources.

3.10.2 Labour

Payment of labour shall be in accordance with the table of hourly rates below which shall include Contractor's profit, overheads, superintendence, insurance, time keeping and all clerical and office work and use of hand operated tools and all incidental chargers whatsoever. The time of technicians or leading hands working with the crews will be paid for at rates stated but the time of the supervisors and foremen shall be covered by the overhead component of the hourly rates.

Item No.	Grade of Officer/Workman	Rate/hour F/C	Rate/hour FJD

Section 7

Schedules – Part II

Schedules of Supplementary Information

TABLE OF CONTENTS

1 MANUFACTURERS, PLACES OF MANUFACTURE & TESTING

ITEM	*MANUFACTURER*	*PLACE OF MANUFACTURE*	*PLACE OF TESTING & INSPECTION*
36 kV Switchgear			
Indoor switchgear			
Indoor circuit breaker			
Busbar			
Current Transformer			
Voltage Transformer			
11 kV Switchgear			
Indoor switchgear			
Indoor circuit breaker			
Busbar			
Current Transformer			
Voltage Transformer			
400 V Switchboard			
Protection, Metering & Control			
36 kV panels			
11 kV panels			
Instruments			
Relays			
Meters			
DC Equipment			
Batteries			
Chargers			
Distribution Boards			
Earthing			
Copper Conductors			
Clamps			
Earthing Rods			
Site Erecting			
To be carried out by: -			
Transformers			
Power Transformer 33/11 kV			
Transformers Complete			
Windings			
33 kV terminal			
11 kV terminal			
Insulators			
Tap changers			

Copper			
Core Parts			
Tanks			
Radiators			
Fan motors			
Temperature Indicators			
Oil valves			
Pressure relief device			
Motor control equipment			
Alarm devices			
Gas and oil actuated relays			
Dissolved gas analyser			
Digital temperature monitoring			
Automatic voltage regulator panel			
Pad Mount Auxiliary Transformer			
Transformer complete			
HV bushings			
LV bushings			
Insulators			
Steel structures			
SCADA equipment			
Fiber optic equipment			

2 TECHNICAL PARTICULARS AND GURANTEES

2.1 BUSBARS 36KV

	Item	***Units***	***Required***	***Tendered***
			36 kV	***36 kV***
1.	Rated Normal Current	A	2000	
2.	Rated current at Max. ambient temperature	A		
3.	Conductor Material		Cu	
4.	Standard Applicable			
5.	Single conductor Cross section	mm^2		
6.	Insulation material			
7.	Fire Certification (IEC 60466, etc)			

2.2 BUSBARS 11KV

	Item	***Units***	***Required***	***Tendered***
			12 kV	***12 kV***
1.	Rated Normal Current	A	2000	
2.	Rated current at Max. ambient temperature	A		
3.	Conductor Material		Cu	
4.	Standard Applicable			
5.	Single conductor Cross section	mm^2		
6.	Insulation material			
7.	Fire Certification (IEC 60466, etc)			

2.3 12/15 MVA 33/11 kV TRANSFORMER

Employer's List of Preferred Manufacturers is:

1. Tyree Transformers of Australia
2. Wilson Transformers of Australia

ITEM	MANUFACTURER	PLACE OF MANUFACTURE	PLACE OF TESTING & INSPECTION
33/11kV TRANSFORMER			
Transformer Complete			
Windings	SAM DONG KOREA		
33 kV terminal	ABB Sweden		
Neutral terminal	ABB Sweden		
11 kV terminal	ABB Sweden		
33kV & 11kV cable end box			
33kV and 11kV Insulators	ABB Sweden Micafil		
ON LOAD Divertor Switch	MR Reinhausen		
Copper	Sam Dong Korea		
Core parts	JFE Japan		
Tanks			
Radiators	MENK Germany		
Oil level indicators	MR Reinhausen		
Oil Valves			
Pressure relief device	MR Reinhausen / Qualitrol		
Dehydrating breather	MR Reinhausen DB200 MESSKO® MTraB® DB 200		
Alarm devices			
Gas and Oil actuated relays	MR Reinhausen		
Digital Temperature Monitoring	Qualitrol 509DW		
Transformer Fan and Controller	ZHEIL ABEGG		

	Item	*Units*	*Required*	*Tendered*
(a)	**RATING & PERFORMANCE**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Continuous Maximum rating (CMR) (ONAN/ONAF)	MVA	12/15	
4.	Number of phases		3	
5.	Number of Windings		2	
6.	Applicable Standard – IEC		60076	
7.	System maximum voltage for both windings Um	HV	36 kV	
		MV	12 kV	
8.	Insulation type	HV	Graded	
		MV	Uniform	
9.	Highest Voltage for equipment	HV	36 kV	
		MV	12 kV	
10.	Winding Insulation Level	HV		
		N		
		MV		
11.	Transformer Nominal ratio		33/11 kV	
12.	Phase Connections	HV	Delta	
		MV	Star	
	Vector group		Dyn1	
13.	Short circuit withstand fault level at terminals of			
	36kV busbars	kA	25	
	12kV busbars	kA	25	
14.	Type of Cooling		ONAN/ONAF	
15.	External cooling medium		Air	
16.	Service conditions :			
	Altitude not exceeding	m	200	
	Air temperature not exceeding	^{o}C	50	
	Average air temperature in any one year not exceeding	^{o}C		
	In any one day	^{o}C	32	
	Average in one year	^{o}C	30	
17.	Tap Changer (On load)		On load	
	(A) Type			
	(B) Category of voltage control		CFVV	
	(C) HV or LV winding		HV	
	(D) Range (+ & -)	%	+12% to -15%	
	(E) Step size	%	1.5	
	(F) Power frequency withstand test voltage between first and last contacts of the selector switch between any two adjacent contacts of the selector between diverter and switch contacts	(kV)		
	(G) Type test certificate reference			
18.	Size of tapping step with position nos.		+8/-10 x 1.5%	

19.	Approximate ONAN rating	MVA		
20.	Hot spot temperature rise at CMR under service and at 30°C ambient temperature	°C	55	
21.	Top oil temperature rise (average daily ambient air temperature 32°C)			
	(A) CMR	°C	50	
	(B) ONAN rating			
22.	Maximum hot spot temperature when loaded according to IEC 60354	°C		
23.	Winding hot spot temperature on emergency overload not exceeding	°C		
24.	Flux density in iron at normal voltage and frequency and at normal ratio - (no load).			
	(A) Core	Tesla		
	(B) Yokes	Tesla		
25.	Magnetising current (approx) at nominal ratio and			
	at 0.9 x nominal voltage	%		
	at 1.0 x nominal voltage	%		
	at 1.1 x nominal voltage	%		
	at 1.2 x nominal voltage	%		
26.	Guaranteed Losses at nominal ratio			
	(A) No Load losses	kW		
	(B) Copper losses at CMR	kW		
	(C) Auxiliary losses at CMR	kW		
27.	Regulation at 75°C and normal ratio -			
	(A) At unity power factor	%		
	(B) At 0.8 lagging power factor	%		
28.	Impedance voltage at 75°C and CMR. Between HV and LV Windings at Tap			
	Maximum	%		
	Nominal	%	5	
	Minimum	%		
29.	Equivalent circuit zero sequence impedance between HV and LV windings			
	Maximum Tap (1)	Ω/phase		
	Nominal Tap (5)	Ω/phase		
	Minimum Tap (9)	Ω/phase		
30.	Maximum current density in windings at C.M.R.			
	(A) HV Winding	A/mm^2		
	(B) LV Winding	A/mm^2		
31.	Efficiency	%	99.5	
32.	Digital Temperature Monitoring Equipment:			
	Manufacturer's Name		Qualitrol	
	Manufacturer's Address			
	Equipment Model		IED 509-100	
	Number of inputs			
	Number of outputs			
	Number of fiber optic sensor probes			
	Tank wall plate assembly		Welded on tank	
	Number of optical feed throughs			
	Communications options			

	Rated voltage	V		
	Frequency	Hz	50	
	Power	W		
33	DGA Monitoring Equipment:			
	Manufacturer's Name		Calisto	
	Manufacturer's Address			
	Equipment Model			
	Number of inputs			
	Number of outputs			

	Item	***Units***	***Required***	***Tendered***
(b)	**CONTROL CIRCUITS**			
1.	Type of controls for cooler			
2.	Whether automatic control required and the		Yes	
	reference voltage (VT output line to line)	V	110 V AC 50 Hz	
3.	Whether load compensation required on the AVR.		N/A	
4.	Whether separate remote control panel required		No (use existing)	
5.	Estimated distance between remote control point and transformer	m	N/A	
6.	DC supply (control voltage) :			
	Nominal	V	110	
	Maximum float voltage	V	120	
7.	AC supply voltage for tap changer operating motor 3 phase.	V	415	
8.	Whether provision for supervisory control required, including AVR setting		yes	
9.	Whether marshalling kiosk required		Yes	
10.	Number of transformers for which automatic control is to be provided		All	
11.	Transformer terminals for line and neutral			
	(i) HV line		Cable box	
	(ii) Neutral		Cable box	
	(iii) MV line		Cable box	
12.	Accommodation for current transformers in bushings at			
	(i) HV line		Yes	
	(ii) Neutral		No	
	(iii) MV line		Yes	
13.	Accommodation of tank for outdoor weatherproof HV neutral current transformers		Yes	
14.	Pollution category of bushings High-25mm/kV based on system highest voltage	mm/kV	25	

	Item	*Units*	*Required*	*Tendered*
(c)	**COOLING**			
1.	Minimum number of radiators per transformer			
2.	Maximum rating of each radiator as percentage of total loss at CMR			
(d)	**GENERAL**			
1.	Type of oil preservation system		Silica Gel	
2.	Whether wheels, skid or flat bottom base required		Flat bottom	
3.	Whether anti-vibration pads required		Yes	
4.	Transformer sound pressure acceptance level	dB	65	
(d)	**DETAILS OF CONSTRUCTION**			
1.	Types of winding -			
	(A) HV			
	(B) MV			
2.	Material of Insulation			
	(A) HV Windings			
	(B) MV Windings			
3.	Insulation of tapping connections			
4.	Insulation of -			
	(A) Yoke bolts.			
	(B) Side plates.			
5.	Winding connections brazed or crimped Specify material (winding material and the joint material)			
6.	Is facility provided for adjustment of axial pressure on windings?	Yes/No		
7.	Thickness of transformer tank			
	(A) Sides	mm		
	(B) Bottom	mm		
8.	Material used for gaskets for oil tight joints.			
9.	Top Cover flange:-			
	Level: Low/High			
	Joint: WELDED/GASKETTED		Welded	

	Item	*Units*	*Required*	*Tendered*
(f)	**RADIATORS VALVES & FANS**			
1.	Thickness of radiator plates and/or cooling tubes.	mm		
2.	Valve type/material:			
	75mm and below			
	above 75mm			
3.	Equipment for ONAN cooling state (A) or (B) -		A	
	(A) Radiator on main tank			
	(B) Separate cooler bank			
4.	Number of cooling air blowers per transformer			

5.	Speed of air blowers and air flow	rpm/m^3 per min		
6.	Rating of each air blower motor	kW		
7.	Starting current of each blower motor,	A		
(g)	**OIL VOLUMES & WEIGHTS**			
1.	Total oil required including cooler system	Litres		
2.	Volume of oil to fill transformer to above the top yoke.	Litres		
3.	Total volume of conservator	Litres		
4.	Volume of oil in conservator between highest and lowest visible	Litres		
5.	Weight of core and winding assembly	Tons		
6.	Weight of each oil cooler bank complete with oil if mounted separately from transformer	Tons		
7.	Total weights of complete transformers, including attached coolers, voltage regulating equipment, all fittings and oil	Tons		
8.	Weight of transformer arranged for transport	Tons		

	Item	***Units***	***Required***	***Tendered***
(h)	**TRANSFORMER OIL**			
1.	Manufacture, type and class of oil to BS 148-1972	mm		
(i)	**TRANSFORMER PARTS SUBJECT TO SHORT-CIRCUIT TEST**			
1.	Brief description of Transformer or parts thereof subjected to short circuit test for which short-circuit calculations are available.	Yes/No		
(j)	**TRANSFORMER BUSHING (IF APPLICABLE)**			
1.	Manufacturer			
2.	Insulator material (solid/oil-paper):			
	a. HV bushing			
	b. Neutral bushing			
	c. MV bushing			
3.	Manufacturer's type reference and rated voltage			
4.	Rated current			
	a. HV bushing			
	b. Neutral bushing			
	c. MV bushing			
5.	Manufacturer of porcelain			
6.	Length of insulator (overall).			
	a. HV bushing	mm		
	b. Neutral bushing	mm		
	c. MV bushing	mm		
7.	Weight of insulator.			
	a. HV bushing	kg		
	b. Neutral bushing	kg		

	c. MV bushing	kg		
8.	Electrostatic capacity of complete bushings.			
	a. HV bushing	pF		
	b. Neutral bushing	pF		
	c. MV bushing	pF		
9.	Dry lightning impulse voltage withstand. (1.2/50 wave)			
	a. HV bushing	kV		
	b. Neutral bushing	kV		
	c. MV bushing	kV		
10.	50Hz dry voltage withstand			
	a. HV bushing	kV		
	b. Neutral bushing	kV		
	c. MV bushing	kV		
11.	50Hz wet withstand voltage without arcing horns			
	a. HV bushing	kV		
	b. Neutral bushing	kV		
	c. MV bushing	kV		
12.	Total Creepage distance of shed (specified minimum 25mm/kV based on maximum system voltage)			
	a. HV bushing	mm		
	b. Neutral bushing	mm		
	c. MV bushing	mm		

2.3 *CIRCUIT BREAKERS 36KV*

	Item	***Units***	***Required***	***Tendered***
			36 kV	***36 kV***
1.	Manufacturer's Name			
2.	Country of Manufacture			
3.	Place of Testing			
4.	Applicable Standards – IEC62271,IEC60694, etc			
5.	Manufacturer's type designation, and type ref or model number			
6.	Type tested	Yes/No	Yes	
7.	Type test Report, Ref No.			
8.	Rated Voltage	kV	36	
9.	Rated Frequency	Hz	50	
10.	Rated Normal Current at 20^{o}C			
	- Line feeder circuit breaker	A	1250	
	- Transformer circuit breaker	A	1250	
	- Generator Breaker	A	N/A	
	- Bus section circuit breaker	A	2000	
11.	Rated Current at Max. ambient temperature			
	- Line feeder circuit breaker	A		
	- Transformer circuit breaker	A		
	- Generator Breaker	A		
	- Bus section circuit breaker	A		
12.	Rated Lightning Impulse Withstand	kA	170	
12.	Rated 1 min Power Frequency Withstand	kV	70	
14.	Rated short circuit breaking current (symmetrical, r.m.s)	kA	31.5	
15.	Rated short circuit breaking current (asymmetrical, r.m.s)	kA	31.5	
16.	Rated making current (peak)	kA	50	
17.	Rated Duration of Short Circuit Current	s	3	
18.	Rated cable charging breaking current	A		
19.	Rated line charging breaking current	A		
20.	Rated small inductive breaking current	A		
21.	Voltage drop across terminals of one pole at rated current	mV		
22.	Amplitude factor			
23.	First pole-to-clear fault		1.5	
24.	Rated operating sequence		O-0.3 sec-CO-3 min-CO	
25.	Min. time t" between two successful three phase auto reclosures at full rated breaking current (sequence O-0.3-C-t"-O-0.3-C)	min		
26.	Closing time	ms		
	- tolerances	ms		
27.	Dead time (max)	ms		
	- tolerances	ms		
28.	Break time (max.) at full rated breaking current	ms		
	- tolerances	ms		
29.	Make time (max.)	ms		

	- tolerances	ms		
30.	Arcing time (max.) at full short circuit duty	ms		
	- tolerances	ms		
31.	Life duration of main contacts (no load mechanical operations)	Operations		
32.	Number of switching operations at rated breaking capacity before contact maintenance becomes necessary	No.	Min 100	
33.	Auxiliary contacts:			
	- number NO/NC			
	- voltage rating	V DC	110	
	- current rating	A DC		
34.	Making coil			
	- Rated voltage	V DC	110	
	- min. operating voltage	V	88	
	- Rated power each	W		
35.	Trip coil			
	- Rated voltage	V DC	110	
	- min. operating voltage	V	55	
	- Rated power each	W		
36.	Motor Voltage	V DC	110	
37.	Motor Power	W		
38.	Max. temperature rise of contacts at rated normal Current	K		
39.	Arc quenching medium		Vacuum/SF6	
40.	Material of main contacts			
41.	Maximum Shock load imposed on floor or foundation when opening under fault conditions (compression or tension)	N		
42.	Minimum Clearances in air			
	(a) Between phases	mm	480	
	(b) Phase to earth	mm		
	(c) Across CB poles	mm	700	
43.	Material of filter employed for the absorption of the products of combustion			
44.	Method of controlling voltage distribution between breaks (capacitor, resistor etc.)			
45.	Weight of complete 3 pole breaker	kg		
46.	Weight of heaviest part for shipment	kg		
47.	Period the equipment has been in commercial operation	years	> 5	

2.4 *CIRCUIT BREAKERS 12KV*

	Item	***Units***	***Required***	***Tendered***
			12 kV	***12 kV***
1.	Manufacturer's Name			
2.	Country of Manufacture			
3.	Place of Testing			
4.	Applicable Standards – IEC62271,IEC60694, etc			
5.	Manufacturer's type designation, and type ref or model number			
6.	Type tested	Yes/No	Yes	
7.	Type test Report, Ref No.			
8.	Rated Voltage	kV	12	
9.	Rated Frequency	Hz	50	
10.	Rated Normal Current at 20^{o}C			
	- Line feeder circuit breaker	A	630	
	- Transformer circuit breaker	A	1250	
	- Generator Breaker	A	N/A	
	- Bus section circuit breaker	A	2000	
11.	Rated Current at Max. ambient temperature			
	- Line feeder circuit breaker	A		
	- Transformer circuit breaker	A		
	- Generator Breaker	A		
	- Bus section circuit breaker	A		
12.	Rated Lightning Impulse Withstand	kA	75	
12.	Rated 1 min Power Frequency Withstand	kV	28	
14.	Rated short circuit breaking current (symmetrical, r.m.s)	kA	25	
15.	Rated short circuit breaking current (asymmetrical, r.m.s)	kA	28	
16.	Rated making current (peak)	kA	50	
17.	Rated Duration of Short Circuit Current	s	3	
18.	Rated cable charging breaking current	A		
19.	Rated line charging breaking current	A		
20.	Rated small inductive breaking current	A		
21.	Voltage drop across terminals of one pole at rated current	mV		
22.	Amplitude factor			
23.	First pole-to-clear fault		1.5	
24.	Rated operating sequence		O-0.3 sec-CO-3 min-CO	
25.	Min. time t" between two successful three phase auto reclosing at full rated breaking current (sequence O-0.3-C-t"-O-0.3-C)	min		
26.	Closing time	ms		
	- tolerances	ms		
27.	Dead time (max)	ms		
	- tolerances	ms		
28.	Break time (max.) at full rated breaking current	ms		
	- tolerances	ms		
29.	Make time (max.)	ms		

	- tolerances	ms		
30.	Arcing time (max.) at full short circuit duty	ms		
	- tolerances	ms		
31.	Life duration of main contacts (no load mechanical operations)	Operations		
32.	Number of switching operations at rated breaking capacity before contact maintenance becomes necessary	No.	Min 100	
33.	Auxiliary contacts:			
	- number NO/NC			
	- voltage rating	V DC	110	
	- current rating	A DC		
34.	Making coil			
	- Rated voltage	V DC	110	
	- min. operating voltage	V	88	
	- Rated power each	W		
35.	Trip coil			
	- Rated voltage	V DC	110	
	- min. operating voltage	V	55	
	- Rated power each	W		
36.	Motor Voltage	V DC	110	
37.	Motor Power	W		
38.	Max. temperature rise of contacts at rated normal Current	K		
39.	Arc quenching medium		Vacuum	
40.	Material of main contacts			
41.	Maximum Shock load imposed on floor or foundation when opening under fault conditions (compression or tension)	N		
42.	Minimum Clearances in air			
	(d) Between phases	mm	120	
	(e) Phase to earth	mm	120	
	(f) Across CB poles	mm	120	
43.	Material of filter employed for the absorption of the products of combustion			
44.	Method of controlling voltage distribution between breaks (capacitor, resistor etc.)			
45.	Weight of complete 3 pole breaker	kg		
46.	Weight of heaviest part for shipment	kg		
47.	Period the equipment has been in commercial operation	years	> 5	

2.5 *CURRENT TRANSFORMER*

	Item	***Units***	***Required***	***Tendered***	***Required***	***Tendered***
			12 kV	***12 kV***	***36 kV***	***36 kV***
1.	Manufacturer					
2.	Type					
3.	Applicable Standards - IEC		60044-1		60044-1	
4.	Rated secondary current	A	1		1	
5.	Rated lightning impulse withstand voltage (primary)	kV	75		170	
6.	Rated Power Frequency withstand voltage (primary)	kV	28		95	
7.	Rated short-time current					
8.	Protection cores (Transformer Diff):					
	- Rated Primary Current	A				
	- Accuracy class	Class	0.1PX		0.1PX	
	- Resistance of secondary winding at 75^{o}C	Ohms	< 3		< 3	
	- Rated Burden	VA	15		15	
9.	Protection cores(OC & EF for feeders):					
	- Rated Primary Current	A				
	- Accuracy class	Class	5P20		5P20	
	- Resistance of secondary winding protection cores at 75^{o}C	Ohms	< 3		< 3	
	- Rated Burden	VA	min 15		min 15	
10	Protection cores(Bus Section):					
	- Rated Primary Current	A				
	- Accuracy class	Class	0.1PX		0.1PX	
	- Resistance of secondary winding protection cores at 75^{o}C	Ohms	< 3		< 3	
	- Rated Burden	VA	min 15		min 15	
11.	Number of Cores	No.	See scope of works and Drawings		See scope of works and Drawings	
12.	Knee point e.m.f. of protection cores	V	Min 415		Min 415	
13.	Knee point e.m.f. of busbar protection cores	V	Min 415		Min 415	
14.	Insulation material for windings					
15.	Limits on exciting current	A				
16.	Partial discharge	pC	< 50		< 50	

2.6 *VOTLAGE TRANSFORMER*

	Item	***Units***	***Required***	***Tendered***	***Required***	***Tendered***
			12 kV	***12 kV***	***36 kV***	***36 kV***
1.	Manufacturer					
2.	Type		magnetic		magnetic	
3.	Applicable Standards - IEC		60044-2		60044-2	
4.	Method of transformation		inductive		inductive	
5.	System Voltage	kV	12		36	
6.	Type of supply		3 phase		3 phase	
7.	Frequency	Hz	50		50	
8.	Basic Insulation Level	kV	75		95	
9.	Creepage distances	Mm				
10.	Transformation ratio					
11.	Class of accuracy					
12.	Class of insulation					
13.	Number of secondaries and accuracy class		See scope of works & drawings		See scope of works & drawings	
14.	Thermal capacity of ground-fault detection winding	A/h				
15.	Rated burden (total on all secondaries)	VA				
16.	Partial discharge		Acc. IEC 60044-4		Acc. IEC 60044-4	
17.	Height	Mm				
18.	Weight of single pole unit	Kg				

2.7 *SWITCH PANELS*

	Item	***Units***	***Required***	***Tendered***	***Required***	***Tendered***
			12 kV	***12 kV***	***36 kV***	***36 kV***
1.	Manufacturer					
2.	Type		Metal-Clad		Metal-Clad	
	rated voltage	kV	12		36	
3.	Applicable Standards - IEC		IEC 60694		IEC 60694	
	Impulse withstand voltage kV peak	kV	75		170	
	Power frequency withstand voltage	kV	28		70	
4.	Thickness	mm				
5.	Short time rating, 3 sec	kA	25		25	
6.	Integral earthing switch for feeder and busbar	Yes/No	Yes		Yes	
7.	Short circuit rating of earth switch					
8.	Making capacity of earth switch					
9.	Voltmeter					
	- Manufacturer		Crompton		Crompton	
	- Dial Size and scale length					
	- Scale	kV	0 - 15		0 – 40	
10.	Ammeter					
	- Manufacturer		Crompton		Crompton	
	- Dial Size and scale length					
	- Scale	A	0 - 400		0 – 200	
11.	kW/kVAR meter					
	- Manufacturer					
	- Dial Size and scale length					
	- Scale					
12.	Transducer					
	- Manufacturer and model		Areva M253		Areva M253	
	- protocol		DNP3		DNP3	
13.	Anti-Condensation heater					
	- Manufacturer					
	- Heater voltage					
	- Heater Output	W				
	Is heater switch provided		Yes		Yes	
14.	Material					
	Surface Finish					
	Dimensions					
	Length	mm				
	Width	mm				
	Height	mm				
15.	Total Net Weight	kg				

2.8 LVAC EQUIPMENT

	Item	*Units*	*Required*	*Tendered*
(a)	**DISTRIBUTION BOARD**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Manufacturer's type designation and type ref number or Model number			
4.	Rating	A	250	
5.	Fault Rating	kA	16	
6.	Voltage	V	415/240	
(b)	**MCCB**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Manufacturer's type designation and type ref number or Model number			
4.	Type			
5.	Rating	A		
6.	Fault Rating	kA	16	
(c)	**ACB**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Manufacturer's type designation and type ref number or Model number			
4.	Type			
5.	Rating	A		
6.	Fault Rating	kA	16	

2.9 BATTERIES & CHARGERS

	Item	*Units*	*Required*	*Tendered*
			110 V	*110 V*
(a)	**BATTERY**			
1.	Manufacturer's Name			
2.	Country of Manufacture			
3.	Place of testing			
4.	Applicable Standard – IEC		60623	
5.	Manufacturer's type designation and type ref number or Model number			
6.	Voltage	V DC	110	
7.	Capacity at 6 hour rate	Ah		
8.	Number of Cells			
9.	Voltage per Cell	V		
10.	Battery voltage at the end of the duty cycle	V		
11.	Normal charging current	A		
12.	Maximum charging current	A		
13.	Ampere-hour efficiency at ten hour rate	%		
14.	Ampere-hour efficiency at one hour rate	%		
15.	Dimensions of Cells	mm		
16.	Dimensions of Battery complete	mm		
17.	Weight of Cell complete with electrolyte	kg		
18.	Total weight of Battery complete	kg		
19.	Internal resistance per cell when fully charged	ohms		
20.	Material of battery case			
(b)	**BATTERY CHARGER**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Place of testing			
4.	Manufacturer's type designation and type ref number or Model number			
5.	Applicable Standard – IEC			
6.	Number of Phases	Three	3	
7.	Type of Charger Control	Micro Processor		
8.	AC Input Nominal Voltage	V	415	
9.	AC Input Voltage range	%		
10.	Operating Frequency	Hz		
11.	AC input to charger at full load	kVa		
12.	AC Input current	A		
13.	DC Nominal voltage	V	110	
14.	DC output of the charger	kW		
15.	Constant Voltage			
	(i) Floating charge	V		
	(ii) Equalizing Charge	V		
16.	Maximum output voltage			
	(i) at automatic Control	V		

	(ii) at Boost charge	V		
17.	Regulation	%		
18.	Range of DC Voltage Control			
19.	Output ripple voltage	%	4	
20.	Protection class		IP 51	
21.	Operating ambient temperature	deg.	40°C	
22.	Dimensions			
	(i) Height	mm		
	(ii) Width	mm		
	(iii) Depth	mm		
23.	Normal and Boost charge are independent units	Yes/No		
24.	Test report reference no:			
(c)	**DC SWITCHBOARDS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Place of testing			
4.	Type of construction			
5.	Manufacturer's type designation and type ref number or Model number			
6.	Busbars:-			
	(i) Maximum current rating	A		
	(ii) Dimensions	mm		
7.	Boost charge contactors:-			
	(i) Manufacturer			
	(ii) Maximum current rating	A		
	(iii) Coil rating	W		
	(iv) Method of interlocking			
8.	Alarm relays:-			
	(i) Manufacturer			
	(ii) Type and reference			
	(iii) Power consumption:-			
	a) Quiescent	A		
	b) Operated	mA		
9.	Number and rating of distribution circuits			
10.	Overall dimensions	mm		
11.	Total weight	kg		

2.10 FIBER OPTIC & SCADA EQUIPMENT

	Item	*Units*	*Required*	*Tendered*
(a)	**Optical Fiber Terminal Equipment**			
	Multiplexer			
1.	Manufacture's name & address			
2.	Manufacturer's type designation and model number			
3.	Applicable Standard(s)			
4.	Working temperature range	^{o}C		
5.	Relative humidity			
6.	Working Voltage	V DC		
7.	Power Consumption	W		
8.	Number of 64 Kb tributaries			
9.	Output aggregate stream	Mb		
10.	User interface	RS232		
(b)	**IP Telephone**			
1.	Manufacture's name & address		Mitel, USA	
2.	Communications Platform		3300 ICP	
3.	Running Version		7.2	
4.	Model of Phone			
(c)	**SCADA Equipment**			
1.	Manufacturer's Name		SEL	
2.	Model		SEL 3530	
(d)	**VHF RADIO**			
1.	Manufacturer's Name		TAIT	
2.	Model		TM935	

2.11 GROUNDING MATERIALS

	Item	*Units*	*Required*	*Tendered*
(a)	**SHIELD WIRE SYSTEM**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Material			
4.	Overall diameter	mm		
5.	Nominal Section	mm^2		
6.	Cross Section & Make up			
7.	Maximum rated current (3 sec)	A		
8.	Maximum working tension of main connections	kg/ m^2		
9.	Resistance of conductor per 100 m at 30°C	ohm		
10.	Tensile breaking stress of material	N/ mm^2		
11.	Maximum permissible span length	m		
12.	Maximum sag under own weight of maximum span	mm		
(b)	**EARTHING GRID**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Material			
4.	Overall diameter	mm		
5.	Nominal Section	mm^2		
6.	Maximum rated current (3 sec)	A		
7.	Resistance of conductor per 100 m at 30°C	ohm		
(c)	**GROUNDING ELECTRODES**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Material			
4.	Dimensions			
5.	Number of electrode per group			
6.	Number of earthing points per substation			
7.	Calculated resistance of combined earth grid and points			

2.13 PAD MOUNT AUXILIARY/EARTHING TRANSFORMER

Not in scope.

2.14 VENTILATION INSTALLATIONS

	Item	*Units*	*Required*	*Tendered*
(A)	**SPLIT TYPE AIR CONDITIONING UNIT**			
1	Number of Units			
2	Manufacturer's Name and Address			
3	Country of Origin			
4	Type			
5	Model No.			
6	Cooling duty (latent)	kW		
7	Cooling duty (Sensible)	kW		
8	On – Coil Condition	DB/WB ^{o}C		
9	Off – Coil Condition	DB/WB ^{o}C		
10	Total Electrical Input	kW		
11	Air Volume	m^3/hr		
(B)	**AIR COOLED CONDENSING UNITS**			
1	Number of Units			
2	Manufacturer's Name and Address			
3	Country of Origin			
4	Type			
5	Model No.			
6	Refrigeration Effect	kW each		
7	Compressor type			
8	Compressor input	kW each		
9	Suction temperature	^{o}C		
10	Condenser ambient temperature	^{o}C		
11	Fan Motor(s)	Total kW		
12	Capacity Steps	%		
(C)	**SELF CONTAINED AIR CONDITIONING UNITS**			
1	Number of Units			
2	Manufacturer's Name and Address			
3	Country of Origin			
4	Type			
5	Model No.			
6	Refrigeration Effect	kW each		
7	Compressor input	kW each		
8	Fan Motor	kW each		
(D)	**VENTILATION WORKS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Number of units			
4.	Air volume	m^3/hr		
5.	System resistance	N/m^2		
6.	Fan Motor Size	kW		
7.	Corrosion Protection			

2.15 FIRE SAFETY EQUIPMENT

	Item	*Units*	*Required*	*Tendered*
(a)	**FIRE DETECTION SYSTEM**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Voltage	V		
4.	Power	W		
5.	Number of outputs			
6.	Number of alarms			
(b)	**TROLLY MOUNTED EXTINGUISHERS, CO_2, 50kg**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Dimensions	mm		
4.	Total Weight	kg		
5.	Length of Hose	mm		
6.	Type of Powder			
7.	Working pressure	kg/cm^2		
8.	Test Pressure	kg/cm^2		
(c)	**WALL MOUNTED EXTINGUISHERS, CF, 5.5kg**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Dimensions	mm		
4.	Total Weight	kg		
5.	Length of Hose	mm		
6.	Type of Powder			
7.	Working pressure	kg/cm^2		
8.	Test Pressure	kg/cm^2		
(d)	**TROLLY MOUNTED EXTINGUISHERS, BCF, 50kg**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Dimensions	mm		
4.	Total Weight	kg		
5.	Length of Hose	mm		
6.	Type of Powder			
7.	Working pressure	kg/cm^2		
8.	Test Pressure	kg/cm^2		

2.16 LIGHTING AND SMALL POWER

	Item	*Units*	*Required*	*Tendered*
(a)	**DISTRIBUTION BOARDS (fitted with Fuse)**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type and/or figure no.			
4.	Rating	A		
5.	Fault Rating	kA		
6.	Voltage	V		
(b)	**DISTRIBUTION BOARDS (fitted with circuit breakers)**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type and/or figure no.			
4.	Rating	A		
5.	Fault Rating	kA		
6.	Voltage	V		
(c)	**PVC CABLE**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Voltage rating	V		
(d)	**CONDUIT**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
(e)	**CONDUIT ACCESSORIES**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
(f)	**CABLE TERMINATIONS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Material			
(g)	**SWITCHES**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Rating	W		
(h)	**SOCKET OUTLETS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type and/or Figure No.			
4.	Rating	W		
5.	Finish			
(i)	**CONTACTORS**			
1.	Manufacturer's Name			

2.	Manufacturer's Address			
3.	Type			
4.	Rating	W		
5.	Number of Contacts			
6.	Rating of Coil AC	VA		
(j)	**MINIATURE CIRCUIT BREAKERS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Rating	A		
5.	Fault rating	kA		
(k)	**EARTHING MATERIAL**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Material and Size			
(l)	**LIGTHING FITTINGS - FLUORESCENT**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Rating			
5.	Harmonic content			
(m)	**LIGTHING FITTINGS**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Rating	W		
(n)	**LIGTHING FITTINGS - EMERGENCY**			
1.	Manufacturer's Name			
2.	Manufacturer's Address			
3.	Type			
4.	Rating	W		

2 WORK PROGRAMME

The bidder is required to state the commencement and completion timeline for the following tentative work programme. The contractor is to also submit a Gantt chart for the programme outlining the activity, duration, start date, completion date, milestones, resources, etc.

	Component	***Start***	***Finish***
	Design of plant and equipment and approval by employer	Week 1	
	Manufacture of plant		
	Testing at Manufactures premises (witness testing)		
	Shipping of plant and equipment		
	Installation of switchgear (may be carried out in stages)		
	Completion of wiring for controls and protection equipment		
	Inspection and pre-commissioning tests		
	Testing and commissioning		

Note that the items in the work programme are the responsibility the contractor. Certain items which have been omitted, such as removal of existing switchgear panels, and cable terminations will be carried out by the Employer. of All site tests to be carried out as per the contract are an absolute minimum. Additional tests may be required by the employer's representative.

3 DEPARTURES FROM SPECIFICATIONS

(To be completed by the Contractor)
All deviations shall be forwarded in the format given below. Any details that will lead to deductions of final Bid price shall not be inserted.

Section	***Clause No.***	***Proposed Deviations***

4 BIDDER'S STATEMENT OF EXPERIENCE

Bidder shall state hereunder a brief resume of his experience in the design, supply and erection of 33 kV and 11kV indoor switchgear, stating the employer's name, contact person, telephone number and fax number. Failure to complete this schedule with full satisfactorily details and documentary proof will render the offer liable to rejection.

Country		
System Voltage kV		
Type of Construction		
Purchaser		
Consultant		
No. of Bays and Capacity of Grid Substation (MVA)		
Contract Award Date		
Contractual Completion Date		
Actual Completion Date		
Contract Value		

5 SCHEDULE OF FINANCIAL INFORMATION

The Tenderer shall state hereunder:

(a) The full name, business address, nationality and type of organization.

(b) The full name and business address of any Fijian agent.

(c) The date of the Tenderer's formation.

(d) The Tenderer's capitalization and total sales over the preceding three fiscal years.

(e) Details of supply and erection contracts of a similar nature undertaken in the previous five years, giving details of at least three contracts stating the location, purchaser, dates of commencement and completion and value of the contract in the total foreign currency equivalent.

(f) Details of any contracts on which the Tenderer has defaulted or on which liquidated damages have been applied in the previous five years giving location, purchaser, value of the contract, and nature of the default or penalty.

(g) Name and address of two banks and the name and address of an independent accountant, all of whom shall be authorized to provide promptly on request any information about the financial status of the Tenderer which is required by the EFL on the understanding that such information will be kept confidential and will only be used to assess the financial ability of the Tenderer to undertake the Contract.

6 PERSONNEL

The tenderer shall provide a detailed bio-data of all the personnel that would be involved in the execution of the project - from the design stage till the completion stage.

The Tenderer shall list herein the personnel he wishes to establish in Fiji for the periods stated, to discharge his responsibilities as laid down in the Specification.

Designation	***Name of Nominee***	***Year of Birth***	***Required Experience in Similar Works (Years)***	***Actual Experience in Similar Works (Years)***
Headquarters				
Project Director			10	
Project Manager			10	
Engineering Design Staff			7	
Substation Design Engineer			7	
Other key staff (Give designation)				
Site Office				
Site Manager			10	
Deputy Site Manager			7	
Supervising Engineers			7	
Construction Supervisors			7	
Safety Manager			10	
Other key staff				
Specialised Staff				
Cable Jointer			10	
Optic Fiber Splicer			10	
Substation Testing Technician/Engineer			10	
Electrical Technicians			7	

7 CONTRACTOR'S SITE PERSONNEL

Erection Staff

The contractor shall give below the status and numbers of staff required for erection of the plant and the estimated period for which they will be retained on site.

Supervisory and expatriate staff : -	
(a) Bachelor status	
(b) Married status	

Position	***Months***
Headquarters	
Project Director	
Project Manager	
Other Key Staff	
Site Office	
Site Manager	
Deputy Site Manager	
Supervising Engineers	
Construction Supervisors	
Other key staff	

8 SUBCONTRACTORS

Item	*Element of Work*	*Approximate Value*	*Name and Address of Sub Contractor*	*Statement of Similar works Executed*

The Bidder shall enter in this schedule a list of the sections and appropriate value of the work for which the purposes to use sub-contractors, together with the names and addresses of the proposed sub-contractors. The Bidder shall also enter a statement of similar works previously executed by the proposed sub-contractors, including description, location and value of works, year completed, and name and addresses of the Employer. Notwithstanding such information the Bidder, if awarded the contract, shall remain entirely and solely responsible for the satisfactory completion of the Works.

9 CONTRACTOR HEALTH & SAFETY PLAN

The bidder shall complete the following sub-sections to provide details in relation to the Health and Safety plans for the project.

CONTRACT DETAILS

Contractor Name: _____
Contractor Address: _____
Contractor Representative: _____
Contract Description: _____
Location of Works: _____
Timing of Works (approximate): Start Date:_____ End Date:_____

RESPONSIBILITIES

Name	***Position Held***	***Safety Responsibilities***	***Contact Number (Direct)***

EMERCENGY CONTACT DETAILS

Contact	***Name***	***Position***	***Contact Number (Direct)***
First Contact			
Second Contact			
Third Contact			
Forth Contact			

SCOPE & TASK DETAILS

List Major Tasks

RISK ASSESSMENT

Risk assessment is a fundamental tool in management of risk. It Involves the identification of hazards and control measures. Describe how you plan to carry out this process for this particular application contract.

SAFE WORK PROCEDURES

After completing the risk assessment, you must compile a safe system of work describing how you plan to control the hazards you have identified. Complete the following section outlining how you will ensure that all employees and subcontractors understand the Safe Work Procedures (SWP). Also attach copies of the relevant SWP.

PERSONAL PROTECTIVE EQUIPMENT

Where risk assessment identifies the need for personal protective equipment (PPE), then PPE must be made available. List down below the PPE you will require for this project.

ACCESSING SITE/TIMES OF WORK

If work is going to be carried out at EFL premises, then it is important to determine when you will be accessing the Site. You may need to sign a PASS and sign in and out. This will avoid conflicts with other activities which may be continuing on site during contract works. Describe below your site access requirements.

FENCING & SEPARATION OF WORK

In order to protect our employees as well as general members of the public, the work areas should, so far as is possible, be physically isolated with barriers like bollards, cones, tapes, netting, etc. Describe below how you will fence or separate your work.

SIGNS AND WARNINGS

Sufficient signs should be erected or placed so that adequate warning is afforded around the worksite. Describe the kinds of notices you will be putting up and places where you will be putting this.

GENERAL STORAGE & DISPOSAL OF WASTE

Describe below what waste you anticipate producing and how you plan to store and/or dispose off waste. You must take into account the nature of the waste e.g. hazardous/flammable.

FIRST AID & INJURY MANAGEMENT

A first aid program for contractors is outlined in EFL Safety Manual. Please describe below any additional first aid needs and specific Injury management process for this contract.

EMERGENCY PROCEDURES

Identify specific emergency procedures or equipment required for the contract.

INCIDENT REPORTING & INVESTIGATION

Describe how incidents will be reported and investigated during the contract.

SPECIALISED WORK OR LICENSING

List any special licences required for the contract.

TRAINING & INDUCTION REQUIREMENTS

Training and inductions for contractors are to be completed in accordance with the EFL Training requirements. List any training required for the contract works in relation to safety, for example safe procedure training and attach training certificates:

SAFETY MONITORING

List any ongoing inspections, hazards management or incident reporting or investigation processes to be used during the works, if relevant.
Describe below your site access requirements.

SUBCONTRACTOR MANAGEMENT

Complete the attached Subcontractor List detailing the subcontractors to be used and the details of the subcontractor management:

Sub-Contractor Name	Sub-Contractor Representative Name	Description of Work	Date of Local Induction

10 PLANT & EQUIPMENT REGISTER

Complete the following table:

Type	***Registration Include: Design, Design No. Item, Item No.***	***Purpose (Use on Site)***	***Inspection Date and Frequency***	***Inspected by***

Contractor Signature: _____

Date: _____

11 CONTRACTOR CHEMICAL REGISTER

Complete the following table:

Product Name	*Hazard*	*Controls Required*	*Location*	*Quantity*

1 Contractor Signature: _____

2 Date: _____

12 OTHER DOCUMENTS & DRAWINGS TO BE SUBMITTED WITH BID

As a minimum, the following documents & drawings shall be submitted with the Bid.

1. Typical plan and section drawings
2. Detail layouts of Indoor 36kV &12kV switchgear
3. Detail layout of transformer pads, Blast wall (two for installation of 12/15 MVA transformer), etc.
4. Single line diagrams
5. Manufacturer's Technical Brochures, type number, reference number and Drawings showing details of construction and dimensions of
    a. Circuit breakers
    b. Disconnectors
    c. Surge arresters
    d. Current transformers
    e. Voltage transformers
    f. Energy meters and transducers
    g. Power transformers
    h. All HV cables and accessories
    i. 36 kV indoor switchgear panels
    j. 12 kV indoor switchgear panels
    k. Communications equipment
    l. Other major equipment.
6. Typical arrangement drawing of control, metering and relay panel
7. Diagrams indicating functions of Control & Protection IED's in each bays
8. Protection block diagrams and typical diagrams of unit protective equipment
9. Cross section drawings of transformer terminal boxes and terminal sealing ends
10. General structural drawings of buildings
11. Foundation drawings including static and dynamic load, General arrangement drawings, plans, sections, elevations.
12. Independent type test certificates for,
    i. 36kV kV Indoor switchgear
    ii. 12 kV Indoor switchgear
    iii. Disconnecting switches
    iv. Earthing Switches
    v. Insulators
    vi. Current Transformers
    vii. Voltage Transformers
    viii. Power transformers
    ix. All HV cables and accessories

x. Communication equipment

xi. Other major equipment

13. General bar chart of the design, manufacturing, shipping, erection and commissioning schedule

14. Evidence of Bidder's experience in works similar to this

15. Certificates issued by an independent International Organization to ensure compliance with the ISO 9001:2000 standards by Bidder

16. List of standards the Bidder intends to follow, for electrical ,civil and mechanical works

17. Evidence of manufacturer's experience in manufacturing comparable type of equipment or equivalent as offered under this contract

18. Descriptive information for equipment being offered including:

- List of recommended spare parts with prices.
- List of special tools or fixtures required for installation, testing, maintaining and operating the equipment
- List and cost of special tools, lifting devices required for installation, operation and maintenance.
- List of exceptions to and deviations from this specification. All exceptions shall be clarified and separately itemized. It shall not be necessary for the employer to examine the standard literature and documents of the manufacturer to determine the existence and extent of any exceptions or deviations from this specification.
- Evidence of field service experience of main equipment.

13 EVALUATION OF BIDS

This section provides information to the bidder of the bid screening and evaluation criteria for the bids.

SCRENING CRITERIA

The screening criteria for the bids when opening of the technical proposals will be as stipulated in Section 1 (Instruction to Bidders), Clause 13.2 (i) – (xiv). The financial proposals for those bids will be opened which have passed the technical proposal screening criteria and meet the cut-off mark of 60% in the evaluation of the Technical Proposals.

EVALUATION CRITERIA

The following criteria with corresponding scoring and weightings which will be utilised for evaluating the bids forms the Technical Evaluation Section. Those bids which score above 60% for the Technical Evaluation will be considered for further evaluation, and their financial proposals will be opened. The Financial Evaluation has a weighting of 30% on the overall Value for Money and the Technical score is 70%

	Criteria for Evaluation	***Weighting***	***Score Range***		
			10 - 8	***7 - 4***	***3 - 0***
1	Manufacturer's years of experience in production of 11kV Switchgear	5.00	Company has more than 20 years' experience	Company has 15 – 20 years' experience	Company has 10 – 15 years' experience
2	Manufacturer's experience in Similar projects – Design, Build, Supply and Install	5.00	Company has done more than 10 projects of similar nature	Company has done 5 - 10 projects of similar nature	Company has done less than 5 projects of similar nature
3	Number of years the offered model has been in production and in the market	2.50	Model has been in the market for more than 7 years	Model has been in the market for 5 – 7 years	Model has been in the market for 3 – 5 years
4	Number of units of offered model sold in Pacific – Fiji/NZ/Australia	2.50	More than 750	Less than 500	Less than 250
5	Number of years of experience of key personnel to be involved in project	5.00	More than 10 years for most of the key personnel	Less than 10 years for most of the key personnel	Less than 5 years for most of the key personnel
6	Manufacturer's Warranty on Switchgear	5.00	More than 2 years	1 – 2 years	Less than 1 year
7	Type test reports on Switchgear	5.00	Results meet and exceed the requirements as per IEC standards	Results do not meet minimum specifications	Type test reports not submitted or not as per IEC standards
8	Conformance to acceptable values for routine tests as specified in tender	2.50	Submits evidence that switchgear will conform to and exceed the requirements	Submits evidence that switchgear will conform to most of the test requirements	No evidence of conformance to test requirements
9	Comprehensiveness of proposed design	2.50	All the design details are addressed as that would be expected in an ideal proposal.	Relevant design details are addressed in terms of design as that compared to an ideal proposal. The proposal conforms to most of the items stated in the specifications	Extent of consideration placed into design is significantly less than that expected in a reasonable proposal. Most of the items stated in specifications are not met.

10	Nominal Circuit Breaker parameters	20.00	Circuit breaker parameters exceed the nominal required performance ratings	Circuit breaker parameters are equal to the nominal required performance ratings	Circuit breaker parameters are below the nominal required performance ratings
11	Evaluation of Current Transformers	5.00	Offered CT ratings exceed the specifications	Offered CT ratings are equivalent to the specifications	CTs Offered are below the specification
12	Evaluation of Voltage Transformers	5.00	Offered VT ratings exceed the specifications	Offered VT ratings are equivalent to the specifications	VTs Offered are below the specification
13	Switchgear Panel Evaluation	5.00	Meets all the technical requirements as in the specification. All technical details match with requirements for the design	Meets only the basic requirements of the specification. Proposed technical data is acceptable but does not match with specification	Meets only the mandatory requirements of the specification
14	Maintenance Requirements for Switchgear	5.00	Needs maintenance every 3 years or more or after 10000 operations	Needs Maintenance every 2 - 3 years	Needs Maintenance every 1 - 2 year
15	Safety Requirements for Switchgear	5.00	Meets and exceeds the safety requirements of the switchgear, with added consideration to safe design and operation	Meets most of the safety requirements for the switchgear	Does not meet the level of safety EFLtures for the switchgear
16	Innovation in Design	7.50	High degree of innovation incorporated into design compared to similar products in market over 5-10 years	Evidence of some innovation incorporated into design	No evidence showing any innovation in design
17	Installation of Switchgear and replacement of existing switchgear	2.50	Will require minimal tools and equipment from EFL for installation	Will require some tools and equipment from EFL for installation	Will require all tools and equipment from EFL for installation
18	Delivery period and timeline	5.00	Delivery period is within 18 - 24 weeks and installation is within 2 - 3 weeks	Delivery period is within 24 - 28 weeks and installation is within 3 - 4 weeks	Delivery period would exceed 28 weeks and installation would also exceed 4 weeks

19	Quality Control	5.00	Manufacturer has quality system in accordance with international standards and produced evidence of regular third party audits	Manufacturer appears to have a quality system in place.	Manufacturer has a record of providing reasonable quality material but provides no evidence of a quality system
	Total	**100%**			

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14 PREFERED SUPPLIERS OF MAJOR EQUIPMENT

	EQUIPMENT	***Suppliers***
1	Power Transformer	ABB, Tyree, Wilson
2	36kV Circuit Breaker	Hawker Siddeley, ABB
3	11kV Circuit Breaker	Hawker Siddeley, Reyrolle
4	36kV Disconnector and earth Switch	ABB, NGK, Schneider
5	Current Transformers	TWS
6	Relays	SEL, Alstom/Areva
7	Voltage Transformers	ABB
8	Battery Systems	Clay Engineering
9	LV Boards	Becca
10	Temperature Monitoring on Tx	Qualitrol
11	DGA Monitoring	Calisto
12	Panels	Rittel
13	On load Tap Changer	MR, ATL, UBB

Section 8
Drawings

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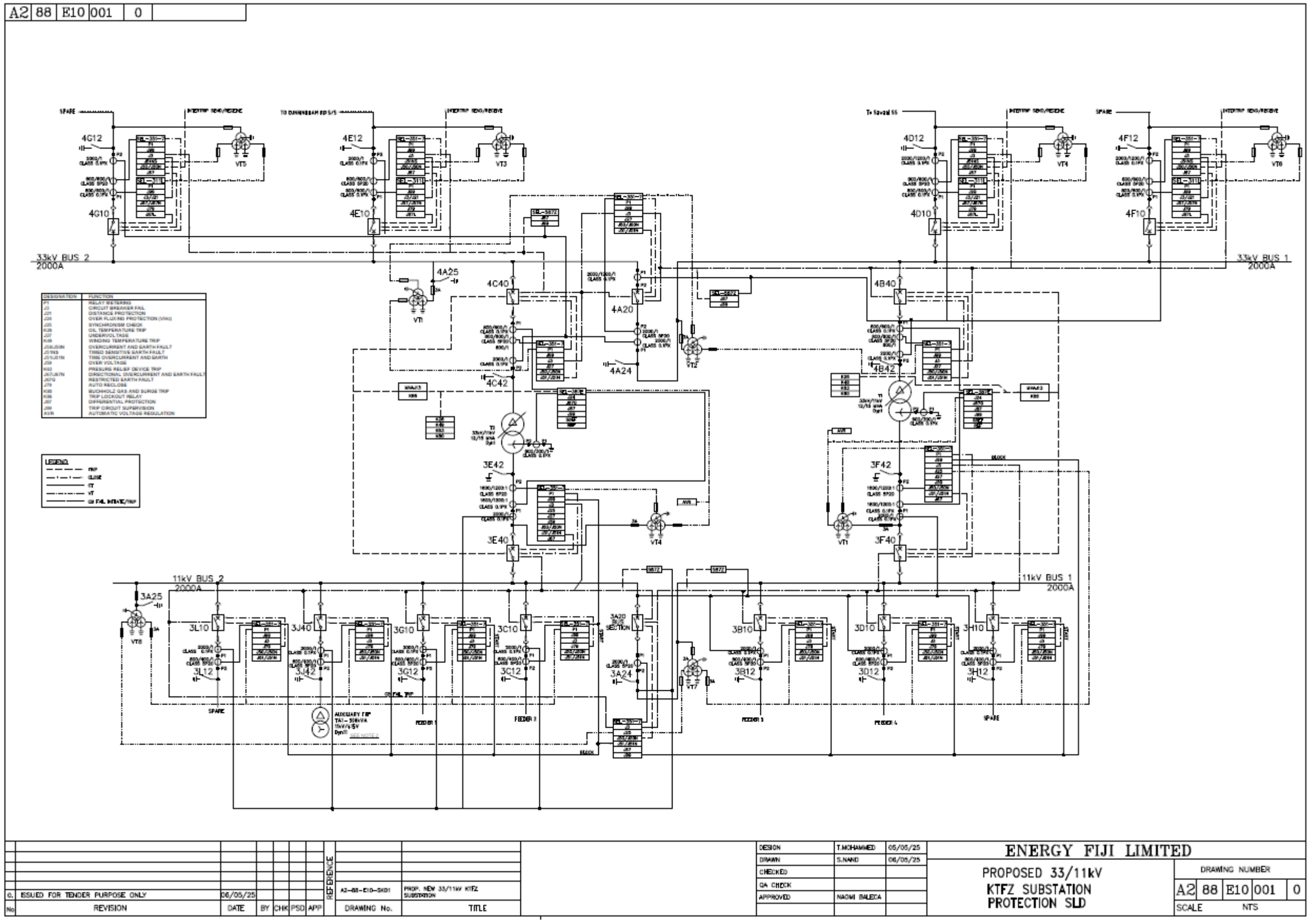
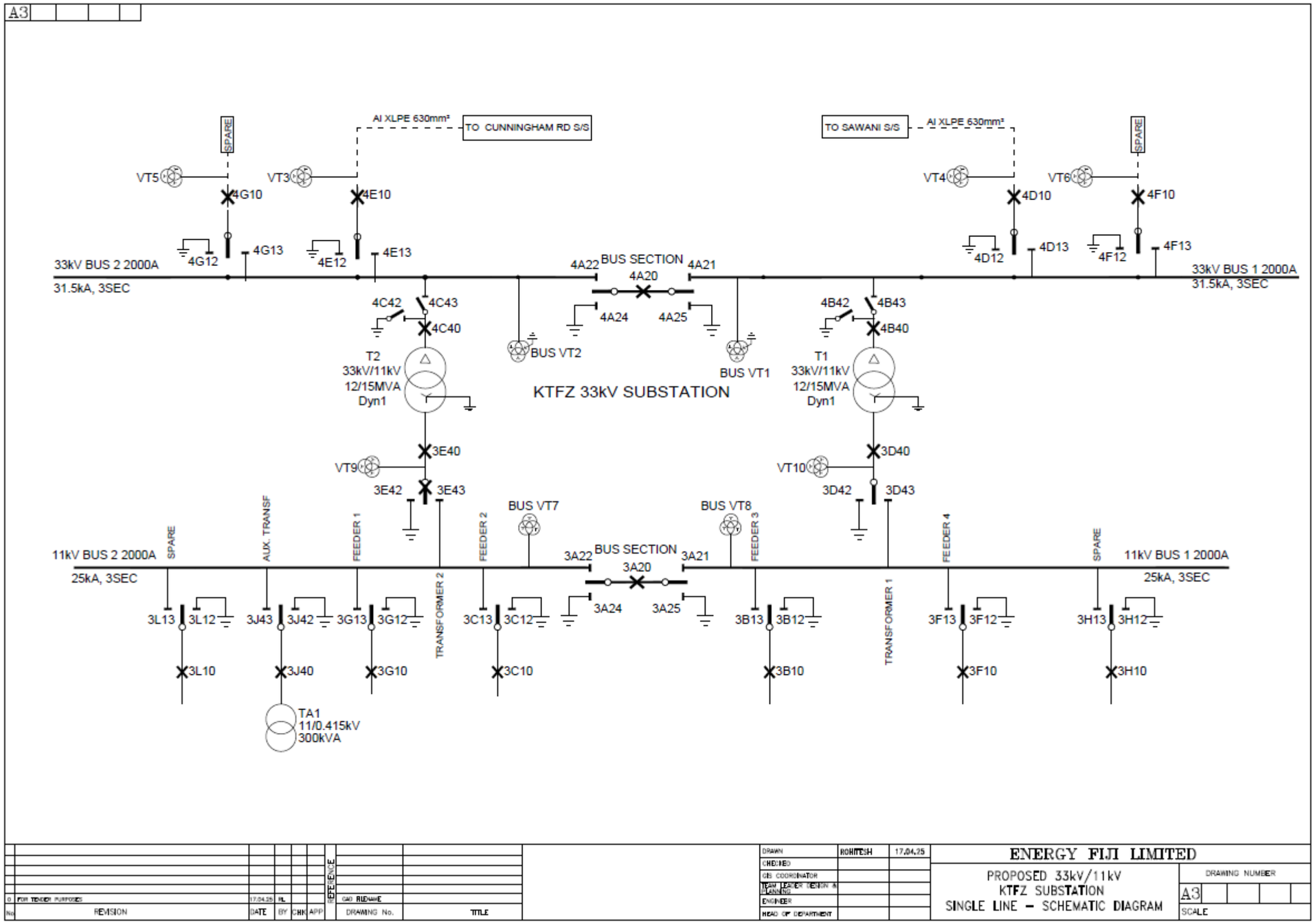
1. Kalabu Tax Free Zone Substation Protection Single Line Diagram



2. Single Line Diagram of Kalabu Tax Free Zone Substation, Nasinu.



3. Proposed Kalabu Tax Free Zone Substation Site

4. Proposed Kalabu Tax Free Zone Substation Building Layout