FIJI ELECTRICITY AUTHORITY

BIDDING DOCUMENT

TENDER NUMBER: MR09/2017

TENDER NAME: Replacement of 132kV Transmission Line Lattice Steel Towers

1.	**Scope of Bid**	The Fiji Electricity Authority (hereinafter referred to as "the Employer"), wishes to receive bids for Replacement of 132kV Transmission Line Lattice Steel Towers, as specified in these bidding documents.
2.	**Eligible Bidders**	This Invitation to Bid is open to bidders who have sound technical and financial background and have relevant previous experience. Bidders shall provide such evidence of their continued eligibility satisfactory to the Employer as the Employer may reasonably request. Bidders shall not be under a declaration of ineligibility for corrupt or fraudulent practices.
3.	**Site Visit**	**Monday 30th January 2017 and Tuesday 31st January 2017. Interested Bidders are to report to the Reception at FEA Navutu Depot in Lautoka at 09:00hrs for tender discussion, followed by Site Visit.** **Bidders are to arrange their own 4x4 vehicles for transportation to site.** **FEA Navutu Depot can be located on Google Maps as follows: https://www.google.com.fj/maps/place/Fiji+Electricity+Authority+-+Navutu+Depot+-+Lautoka/@-17.6278109,177.4286896,17z/data=!4m12!1m6!3m5!1s0x6e176712a626ac13:0xec45c17ac7885ca4!2sFiji+Electricity+Authority+-+Navutu+Depot+-+Lautoka!8m2!3d-17.6278109!4d177.4308783!3m4!1s0x6e176712a626ac13:0xec45c17ac7885ca4!8m2!3d-17.6278109!4d177.4308783?hl=en** **Bidders are to contact the following phone numbers for any guidance or directions for site visit: +679 – 8903198 or +679 – 9999299**
4.	**Qualification of the Bidder**	To be qualified for award of Contract, bidders shall submit proposals regarding manufacturing and construction methods, scheduling and resourcing which shall be provided in sufficient detail to confirm the bidder's capability to fulfil the supply contract.
5.	**Cost of Bidding**	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.
6.	**Sealing, Marking and Submission of Bids**	**Bidders are required to submit <u>both</u> Electronic copies of the Bid and hard copies of the Bid.** **<u>Tender Submission - Instruction to bidders</u>** **<u>Hard Copy Submission</u>** **<u>Three (3) hard copies</u>** of the tender bids in sealed envelope shall be deposited in the tender box located at the Supply Chain Office at the FEA Head Office, 2 Marlow Street, Suva, Fiji. The bidder shall seal the original hardcopy of the bid comprising of both the technical proposal and the price proposal, in one envelope, and clearly mark the envelope as: "ORIGINAL - PROPOSAL". Bidders shall also provide 2 copies of the original bid and mark them as "COPY - PROPOSAL". Each copy proposal shall also be individually sealed within an envelope. The 3 envelopes comprising the Original and Copies shall be sealed within an outer envelope. All inner and outer envelopes shall bear the following marking / identification: • **Bid for Tender MR09/2017 - Replacement of 132kV Transmission Line Lattice Steel Towers** • **DO NOT OPEN BEFORE TENDER CLOSING DATE AND TIME.**

		All envelopes shall also indicate the name and address of the Bidder on the reverse of the envelope. The inner and outer envelopes shall be addressed to the Employer as follows: **TENDER MR09/2017 – Replacement of 132kV Transmission Line Lattice Steel Towers** **The Secretary - Tender Committee,** **c/o Supply Chain Office,** **Fiji Electricity Authority,** **Private Mail Bag, 2 Marlow Street,** **Suva, Fiji Islands** All postage or courier charges for delivery of Tender documents must be paid by the bidders. It is the responsibility of the bidder to pay courier chargers and all other cost associated with the delivery of the hard copy of the Tender submission. **This tender closes at 4:00pm, on Wednesday 1st of March, 2017.** All late tenders, and inadequately marked envelopes shall be returned to the Tenderers unopened. (Bids via e-mail or fax will not be considered). For further information or clarification on the submission of bids, please contact our Supply Chain Office on phone **(+679) 3224360 or (+679) 9991587** **Hard copies of the Tender bid will also be accepted after the closing date and time provided a soft copy is uploaded in the e-Tender Box and it is dispatched before the closing date and time.** **Electronic Submission of Bids** It is mandatory for Bidders to upload an electronic submission their bid in the **TENDER LINK** Electronic Tender Box no later than **4:00pm, on Wednesday 1st of March, 2017.** To register your interest and tender a response, view 'Current Tenders' at: **https://www.tenderlink.com/fea** For further information contact The Secretary Tender Committee, by e-mail **TDelairewa@fea.com.fj** Tenders received after the closing date shall not be considered. ➢ will not be considered. ➢ Lowest bid will not necessarily be accepted as successful bid.
7.	**Deadline for Submission of Bids**	Bids must be received by the Employer at the address specified above **4:00pm or 16:00hrs, on Wednesday 1st of March, 2017.** The Employer may, at its sole discretion, extend the deadline for submission of bids by issuing an addendum, 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.
8.	**Late Bids**	Any bid received by the Employer after the deadline for submission of bids prescribed will be rejected and returned unopened to the bidder.
9.	**Modification and Withdrawal of Bids**	The bidder may modify or withdraw its bid after bid submission, provided that written notice of the modification or withdrawal is received by the Employer prior to the deadline for submission of bids. The bidder's modification or withdrawal notice shall be prepared, sealed, marked and delivered, with the outer and inner envelopes additionally marked "MODIFICATION" or "WITHDRAWAL", as appropriate. A withdrawal notice may also be sent by fax but must be followed by a signed confirmation copy. No bid may be modified by the bidder after the deadline for submission of bids.
10.	**Employer's Right to Accept any Bid and to Reject any or all Bids**	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.
11.	**Notification of Award**	Prior to expiration of the period of bid validity prescribed by the Employer, the Employer will notify the successful bidder by fax/email, confirmed by registered letter, that its bid has been accepted. This letter (hereinafter and in the Conditions of Contract called the "Letter of Award") shall name the sum which the Employer will pay the Bidder in consideration of the execution, completion and maintenance of the Works by the Bidder as prescribed by the Contract (hereinafter and in the Conditions of Contract called "the Contract Price"). The notification of award will constitute the formation of the Contract. The Employer will promptly notify the other bidders that their bids have been unsuccessful.
12.	**Corrupt or Fraudulent Practices**	The Employer requires that the Bidder 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 behavior 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 tender award if it is determined that the bidder has engaged in corrupt or fraudulent practices in competing for the contract in question.

Tender Submission - Instruction to bidders

It is mandatory for Bidders to upload a copy of their bid in the TENDER LINK Electronic Tender Box no later than 4:00pm, on Wednesday 1st of March, 2017.

To register your interest and tender a response, view 'Current Tenders' at: **https://www.tenderlink.com/fea**

For further information contact The Secretary Tender Committee, by e-mail **TDelairewa@fea.com.fj**

In additional, hard copies of the tender, one original and one copy must be deposited in the tender box located at the FEA Head Office, 2 Marlow Street, Suva, Fiji no later than **4:00pm, on Wednesday 1st of March, 2017 -** Addressed as

Tender – MR09/2017
Replacement of 132kV Transmission Line Lattice Steel Towers
The Secretary Tender Committee
Fiji Electricity Authority
Head Office
Suva
Fiji

- **Hard copies of the Tender bid will also be accepted after the closing date and time provided a soft copy is uploaded in the e-Tender Box and it is dispatched before the closing date and time.**

Tenders received after **4:00pm** on the closing date of **Wednesday 1st of March, 2017.**

- will not be considered.
- Lowest bid will not necessarily be accepted as successful bid.
- **It is the responsibility of the bidder to pay courier chargers and all other cost associated with the delivery of the hard copy of the Tender submission.**

TABLE OF CONTENTS

Note: Not all parts have been included in this document but were included in or were the Contractors Response to Phase 1 as shown below.

PART 1

FIDIC CONDITIONS OF CONTRACT FOR CONSTRUCTION FOR BUILDING WORKS DESIGNED BY THE EMPLOYER (RED BOOK)

THE FIDIC 'CONDITIONS OF CONTRACT FOR CONSTRUCTION FOR BUILDING WORKS DESIGNED' are available for purchase from http://fidic.org

PART 2

TENDER LETTER AND APPENDICES OF

SUPPLEMENTARY INFORMATION

TENDER LETTER AND APPENDICES OF

SUPPLEMENTARY INFORMATION

INDEX

TENDER LETTER

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

TO: Fiji Electricity Authority
Suva
FIJI

We have examined the Conditions of Contract, Specification, Drawings, Price Schedule, the other Schedules, the attached Appendix and Addenda Nos (list Addenda Nos if applicable) for the execution of the above-named Works. We offer to execute and complete the Works and remedy any defects therein in conformity with this Tender which includes all these documents, for the sum of (insert amount) or such other sum as may be determined in accordance with the Conditions of Contract.

We accept your suggestions for the appointment of the DAB, as set out in Schedule

> [*We have completed the Schedule by adding our suggestions for the other Member of the DAB, but these suggestions are not conditions of this offer*].*

We agree to abide by this Tender until 60 days from the date of this letter and it shall remain binding upon us and may be accepted at any time before that date. We acknowledge that the Appendix forms part of this Letter of Tender.

If this offer is accepted, we will provide the specified Performance Security, commence the Works as soon as is reasonably practicable after the Commencement Date, and complete the Works in accordance with the above-named documents within the Time for Completion.

Unless and until a formal Agreement is prepared and executed this Letter of Tender, 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 tender you may receive.

Signature (sign) in the capacity of (*insert position*)

duly authorised to sign tenders for and on behalf of

(*name and address of Contractor*)

Date: (date)

* If the Tenderer does not accept, this paragraph may be deleted and replaced by:

> We do not accept your suggestions for the appointment of the DAB. We have included our suggestions in the Schedule, but these suggestions are not conditions of this offer. If these suggestions are not acceptable to you, we propose that the DAB be jointly appointed in accordance with Sub-Clause 20.2 of the Conditions of Contract.

APPENDIX TO TENDER LETTER

[Note: with the exception of the items for which the Employer's requirements have been inserted, the following information must be completed before the Tender is submitted]

Item	Sub-Clause	Data
Employer's name and address	1.1.2.2 & 1.3 ...	Fiji Electricity Authority 2 Marlow Street Suva FIJI
Contractor's name and address	1.1.2.3 & 1.3 ...	(*name and address of Contractor*)
Engineer's name and address	1.1.2.4 & 1.3 ...	LineTech Consulting NZ Limited (or any other competent engineer, to be finalised prior to contract signing)
Time for Completion of the Works.....	1.1.3.3.....	De-energized periods of works: • 132kV Wailoa-Nadarivatu-Vuda Line, maximum of One (1) Line Outage of 14 hours duration • 132kV Nadarivatu Power House to Switchyard Double Circuit Transmission Line: Maximum of One (1) Line Outages of continuous 72 hours duration • All work to be completed by **30th November, 2017**
Defects Notification Period	1.1.3.7.....	180 days
Electronic transmission systems.....	1.3.....	365 days
Governing Law.....	1.4.....	Laws of Fiji
Ruling language	1.4.....	English
Language for communications	1.4.....	English
Time for access to the Site.....	2.1.....	From 1st May 2017 to 30th November, 2017 24 hours a day
Amount of Performance Security.....	4.2.....	28 days after Commencement Date 10% of the Accepted Contract Amount, in the currencies and proportions in which the Contract Price is payable

Normal working hours.....	6.5.....	8am to 6pm Monday to Saturday
Delay damages for the Works	8.7 & 14.15(b).	FJ$50,000 per hour for the 132kV Wailoa-Nadarivatu-Vuda Line that the de-energized work exceeds the periods specified above as Time for Completion of the Works FJ$30,000 per hour for the 132kV Nadarivatu Power House to Switchyard Double Circuit Transmission Line, that the de-energized work exceeds the periods specified above as Time for Completion of the Works 1% per day for each day that any pending works exceeds 30th November, 2017
Maximum amount of delay damages.....	8.7.....	25% of Contract Price

_____

Initials of signatory of Tender

Total advance payment	14.2	10% of the Accepted Contract Amount against Bank Guarantee from approved Bank
Number and timing of instalments.....	14.2	One payment within 30 days of Acceptance of the Contract
Currencies and proportions.....	14.2	(insert agreed currency)
Repayment of advance payment.....	14.2(a)	The advance payment shall be deducted from the Payment Certificate Amounts in proportion of those amounts relative to the Accepted Contract Amount
Percentage of retention	14.3	10% of the Payment Certificate Amounts
Limit of Retention Money.....	14.3	10% of the Accepted Contract Amount
Minimum amount of Interim Payment Certificates.....	14.6	10% of the Accepted Contract Amount

If payments are only to be made in a currency/currencies named on the first page of the Letter of Tender:

Currency/currencies of payment.....	14.15	as named in the Letters of Tender
Periods for submission of insurance:		
(a) evidence of insurance	18.1	Within 7 days after Commencement Date
(b) relevant policies.....	18.1	OR Within 7 days after Commencement Date of Signing of Contract (Whichever is earlier)
Maximum amount of deductibles for insurance of the Employer's risks	18.2(d).....	FJD $5000
Minimum amount of third party insurance	18.3	Contractor's All Risk Insurance: FJD $2M Public Liability Insurance: FJD $2M Workers Compensation: FJD $1M
Date by which the DAB shall be appointed.....	20.2	28 days after the Commencement Date
The DAB shall be	20.2	One sole Member/adjudicator
Appointment (if not agreed) to be made by	20.3	The President of FIDIC or a person appointed by the President

Initials of signatory of Tender

APPENDIX TO THE TENDER LETTER

1.0 SUPPLEMENTARY INFORMATION

The following information shall be submitted with the Tender:

1.1 Form A - Exceptions and Deviations

The Tenderer shall detail each exception to or deviation from the Tender Document including Part 4 General Conditions of Contract

1.2 Form B - Contract Programme

The Tenderer shall provide a programme for the Contract.

1.3 Form C - Sub-contractor Listing

The Tenderer shall provide a full list of sub-contractors and suppliers proposed for involvement in the Works.

1.4 Form D – Contract Specific Systems Information

The Tenderer shall answer questions on Form D detailing contract specific compliance with the safety, quality and environmental requirements of the Contract.

1.5 Form E - Labour, Plant and Equipment Rates

The Contractor shall provide a list of all labour, plant and equipment that will be utilised in executing the Works, indicating thereon the net hourly rates to apply in the format provided in Form E.

1.6 Form F - Overheads and Profit

The Contractor shall indicate the percentage additions required to net rates and costs of labour, plant and equipment, sub-contractors and materials supplied, where used in formulation of prices to relate to variations and for dayworks, in the format provided in Form F.

1.7 Form G – Project Methodology

The Tenderer shall provide a method statement in the format provided in Form G.

1.8 Form H – Organisation Structure

The Tenderer shall provide details on its proposed resources and Contract structure in the format provided in Form H.

1.9 Form I – Schedule of Prices

The Tenderer shall complete the Schedules of Prices indicating the make up of the Tender sum. The Schedules shall be completed in the format provided in Form I.

FORM A - EXCEPTIONS AND DEVIATIONS

Tenderer's Name_____

_____

List below any exceptions and deviations proposed to any part of the Tender Documents. Precise reference to appropriate clauses or sub-clauses is essential. No amendments to the Tender Document will be recognised unless expressly listed herein. If no exceptions or deviations are proposed by the Tenderer, **enter "None" below.**

If any modification to the original Tender is proposed after submission of the Tender, but before the closing date, a revised Form A should be submitted if appropriate.

_____

_____

FORM B - CONTRACT PROGRAMME

The Tenderer shall submit with the Tender a proposed Programme for carrying out the Works, incorporating the required key dates indicated in Part 2 - Scope and Programme of Works and showing the activities necessary throughout the Contract period. The response required will depend upon the price tendered for the work.

The Programme should include as a minimum, a logic diagram of approximately 20 activities, scheduled barchart, manpower histogram and cost `S' curves.

The logic network and respective barchart should include:

(i) The scheduled start and finish dates for each activity.
(ii) The float associated with the scheduled dates.
(iii) The identification of all milestone dates.
(iv) The critical path clearly shown.
(v) The key dates as listed in Part 2.
(vi) Material procurement delivery dates.

Additional information required is:

(i) Manpower histograms and cumulative `S' curves.

(ii) Details on holidays and/or shutdown work patterns.

(iii) And any other information the Tenderer considers will assist in understanding the Tenderers proposal and methodology.

FORM C - SUB-CONTRACTOR LISTING

Tenderer's Name _____

_____

Name and address of Sub-contractor	Description of Sub-contractor's Work Scope	Comments and Quality Assurance Standard

Sub-contractor means suppliers of materials, equipment or services that the Tenderer intends to use if awarded the Contract.

_____

FORM D – CONTRACT SPECIFIC SYSTEMS INFORMATION

Tenderer's Name _____
_____

Tenderers should enter information on their safety, quality and environmental management systems that are specific to this particular project, and any recognized independent accreditation for safety/quality/ etc.

SAFETY

1. Who will be the site representative responsible for local safety co-ordination?

QUALITY ASSURANCE

For the overall Contract e.g. coordination of all phases of the Works including design, procurement and installation

1. For this Contract, who has the responsibility for the quality of the work being carried out?

For Design

2. Which Company will have overall responsibility and control during the design phase?
3. Who has the overall responsibility for the achievement of quality during the design phase?

For Construction

4. Who has the day-to-day on-site responsibility for the quality of work?
5. Who has the responsibility for controlling and issuing of all documents required for use in the inspection, checking, and carrying out of Site Works?
6. Who is responsible for preparation and issue of the Work Instructions to your staff on Site?
7. Who has responsibility for the determination and submission to the Principal's Representative for approval of the necessary inspection plans for purchased materials, work in progress, and the finished work?
8. What specialist equipment will you be using to determine the finished quality of your work for this contract?

ENVIRONMENTAL PROCEDURES

For the overall Contract e.g. coordination of all phases of the Works including design, procurement and installation

1. Who has the responsibility for compliance with Fiji Environmental Policies, for this Contract?

For Design

2. Who has the overall responsibility for compliance with the spirit and letter of the Act during the design phase?

For Construction

3. On this Contract, who will be your site representative with day-to-day responsibility for compliance with requirements of the Act?
4. What are the areas of responsibilities of individuals within your site organisation for compliance with requirements of the Act?

_____

FORM E - LABOUR, PLANT AND EQUIPMENT RATES

Tenderer's Name _____

_____

GENERAL

The rates given below will be used in the evaluation of variation prices and when a portion of the Works is to be completed on a daywork basis during the Contract period.

PLANT AND EQUIPMENT RATES

The Contractor should list below all plant, equipment and vehicles including sub-contractor's plant, equipment and vehicles to be used on the Site in carrying out the Works, together with net hourly rates required for use. The rates should be for the **NET** running costs inclusive of fuel, lubricants, repairs, parts and service, maintenance, labour and applicable taxes, but **EXCLUSIVE** of overhead charges, profit and GST. If an operator is required, this labour rate shall be included in the hourly rate for the equipment.

	Plant and Equipment Type (Indicate whether an operator is included)	**Net Hourly Rate for Operating Equipment**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

LABOUR RATES

The Contractor should indicate below the **NET** hourly rates for all trades to be engaged on the Works. These rates should be the **NET** cost to the Contractor of all labour, tradesmen, foreman, sub-contractors, design staff, and management and should **EXCLUDE** overhead charges, profit and GST.

	Trade	**Rate Per Hour**
1.		$
2.		$
3.		$
4.		$
5.		$
6.		$
7.		$
8.		$
9.		$

FORM F - OVERHEADS AND PROFIT

Contractor's Name: _____

_____

The Contractor should indicate below, the following percentages which will be applied by the Principal's Representative in evaluating variations in accordance with General Conditions Clause 13:

(a) The percentages to be added to the net Cost of labour, materials, plant and equipment and sub-contractors for on-site and off-site overhead charges to derive the total costs.

(b) The percentages to be added to the total Costs in respect of profit, to derive the prices applicable for the variation.

	(a) Overheads %	**(b) Profit %**
Labour (Design)	____NA _____	_____NA _____
Labour (Site)	_____	_____
Materials	_____	_____
Plant and equipment	_____	_____
Sub-contractors	_____	_____

_____

FORM G – PROJECT METHODOLOGY

Tenderer's Name _____

_____

The Tenderer should to list below an outline of the proposed construction method. The outline should include such items as:

1. A step by step narrative of the proposed method of construction of the Works.
2. An indication of number and type of vehicles and plant required to be on site during the contract period.
3. An indication of other objects, structures, platforms that will be brought onto site to complete the Works.
4. For each tower, the procedures to minimise the time required for works during the de-energised period.
5. For each tower, the procedures prior to the de-energised period to mitigate the risks of unforeseen delays during the de-energised period.
6. For tower steel fabrication, the manufacture, sort, dispatch and quality control checks to ensure that the steel pieces are of the correct sizes and specifications.
7. For conductor, earthwire and OPGW stringing operations.

_____

FORM H – ORGANISATION STRUCTURE

Tenderer's Name _____

_____

The Tenderer should provide the following details:

1.0 Personnel

Give details of the proposed organisation structure including key personnel.

Competencies records and CV's for key staff to be involved with this project, as well as competency approval procedures for staff to be engaged for this project.

Training, as appropriate for site staff to be engaged for this project.

2.0 Facilities

Gives details on the following:

Specialist test equipment required for the Works
Site installation, staff accommodation, offices, etc.

_____

FORM I - SCHEDULE OF PRICES

Tenderer's Name _____

_____

NOTES TO THE SCHEDULE OF PRICES

1.0 The Tender is for a Fixed Price Lump Sum

(a) The Schedule of Prices should be completed and will be used to assess payments due to the Contractor in accordance with the terms of the Contract and where appropriate, will be used in valuation of the variations.

(b) The quantities and items included in the Schedule of Prices are not warranted as complete or accurate.

(c) Detailed descriptions of works and materials required have not been repeated in the Schedule of Prices.

(d) Anything not specifically listed in the Schedule of Prices but necessary to complete the Works in accordance with the Contract, shall be deemed to be included in the rates and prices listed against the appropriate item of the Schedule of Prices.

(e) The Schedule of Prices will be read in conjunction with the remainder of the documents comprising the Contract, including pricing information already supplied to the Principal by the Tenderer as required by the General Conditions of Contract TPWks4.

(f) The rates and prices indicated in the Schedule of Prices should include for labour, materials, sub-contractors, constructional plant and equipment, preliminary and general items, including clearance of site during the Works and on completion and making good, for all on-site and off-site overheads, other costs of whatever nature and profit.

(g) A rate or price should be entered against each item within the Schedule of Prices.

In the event that a price is not entered against any item, the cost of that item is deemed to be included elsewhere in the Schedule of Prices.

(h) All rates and prices should be exclusive of Goods and Services Tax.

(i) Where Milestone payments are the method of payment, the Tenderer may propose an alternative list of milestones, provided it can demonstrate some advantage to the Principal by way of lower Tender price or otherwise. However, the schedules below should be completed for Tender evaluation purposes.

_____

Tenderer's Name:
Contract Name: FEA 132kV Tower Replacement
Contract No.: MR09/2017

			Cost Amounts (FJ$)				
Item	Description	Qty	Labour Cost	Subcontractor	Materials & Plant	Indirect	Total
1	Project Management and Engineering Support	LS					
2	Establishment	LS					
3	Staff Accommodation	LS					
4	Safety Procedures and Monitoring	LS					
5	Temporary works - barriers, protection, guys etc.	LS					
6	Pre-work and as-build location survey	LS					
7	Provision of access and reinstatement to all sites	LS					
8	Allowance for risk to cover liquidated damages for time over run	LS					
9	Foundation construction - Wailoa-Vuda Tower 82	LS					
10	Tower Baseplate Connection - Nadarivatu Tower 1, 12 and 14 - Design, Supply and Installation	LS					
11	Tower 1 (Nadarivatu) - Design, Fabrication and Supply	LS					
12	Tower 12 (Nadarivatu) - Design, Fabrication and Supply	LS					
13	Tower 14 (Nadarivatu) - Design, Fabrication and Supply	LS					
14	Tower 82 (Wailoa-Vuda) - Design, Fabrication and Supply	LS					
15	Load testing of one tower to 95% ULS Loading	LS					
16	Tower 1 (Nadarivatu) - Installation	LS					
17	Tower 12 (Nadarivatu) - Installation	LS					
18	Tower 14 (Nadarivatu) - Installation	LS					
19	Tower 82 (Wailoa-Vuda) - Installation	LS					
20	Supply and Install Insulators and Hardware - Wailoa-Vuda	LS					
21	Supply and Install Dampers - Wailoa-Vuda	LS					
22	Supply and Install Conductor - Wailoa-Vuda	LS					
23	Supply and Install Earthwire - Wailoa-Vuda	LS					
24	Supply and Install Insulators and Hardware - Nadarivatu	LS					
25	Supply and Install Dampers - Nadarivatu	LS					
26	Supply and Install Conductor - Nadarivatu	LS					
27	Supply and Install OPGW - Nadarivatu	LS					
28	Disestablishment	LS					
29	Preparation and Submission of As-built Documentation	LS					
						Total =	

PART 3

ANNEX FORMS A, B, C, D, E, F, G, CONTRACT AGREEMENT & DISPUTE ADJUDICATION AGREEMENT

Annex A EXAMPLE FORM OF PARENT COMPANY GUARANTEE

[*See page 3, and the comments on Sub-Clause 1.14*]

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI
(together with successors and assigns).

We have been informed that (*name and address of Contractor*) (hereinafter called the "Contractor") is submitting an offer for such Contract in response to your invitation, and that the conditions of your invitation require his offer to be supported by a parent company guarantee.

In consideration of you, the Employer, awarding the Contract to the Contractor, we (*name of parent company*) irrevocably and unconditionally guarantee to you, as a primary obligation, the due performance of all the Contractor's obligations and liabilities under the Contract, including the Contractor's compliance with all its terms and conditions according to their true intent and meaning.

If the Contractor fails to so perform his obligations and liabilities and comply with the Contract, we will indemnify the Employer against and from all damages, losses and expenses (including legal fees and expenses) which arise from any such failure for which the Contractor is liable to the Employer under the Contract.

This guarantee shall come into full force and effect when the Contract comes into full force and effect. If the Contract does not come into full force and effect within a year of the date of this guarantee, or if you demonstrate that you do not intend to enter into the Contract with the Contractor, this guarantee shall be void and ineffective. This guarantee shall continue in full force and effect until all the Contractor's obligations and liabilities under the Contract have been discharged, when this guarantee shall expire and shall be returned to us, and our liability hereunder shall be discharged absolutely.

This guarantee shall apply and be supplemental to the Contract as amended or varied by the Employer and the Contractor from time to time. We hereby authorise them to agree any such amendment or variation, the due performance of which and compliance with which by the Contractor are likewise guaranteed hereunder. Our obligations and liabilities under this guarantee shall not be discharged by any allowance of time or other indulgence whatsoever by the Employer to the Contractor, or by any variation or suspension of the works to be executed under the Contract, or by any amendments to the Contract or to the constitution of the Contractor or the Employer, or by any other matters, whether with or without our knowledge or consent.

This guarantee shall be governed by the law of the same country (or other jurisdiction) as that which governs the Contract and any dispute under this guarantee shall be finally settled under the Rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with such Rules. We confirm that the benefit of this guarantee may be assigned subject only to the provisions for assignment of the Contract.

Date Signature(s)

Annex B EXAMPLE FORM OF TENDER SECURITY

[*See page 4*]

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI

(whom the tender documents define as the Employer).

We have been informed that (*name and address of Contractor*) (hereinafter called the 'Principal') is submitting an offer for such Contract in response to your invitation, and that the conditions of your invitation (the 'conditions of invitation', which are set out in a document entitled Instructions to Tenderers) require his offer to be supported by a tender security.

At the request of the Principal, we (*name of bank*) hereby irrevocably undertake to pay you, the Beneficiary/Employer, any sum or sums not exceeding in total the amount of
(5% of the contract value) upon receipt by us of your demand in writing and your written statement (in the demand) stating that:

(a) the Principal has, without your agreement, withdrawn his offer after the latest time specified for its submission and before the expiry of its period of validity, or

(b) the Principal has refused to accept the correction of errors in his offer in accordance with such conditions of invitation, or

(c) you awarded the Contract to the Principal and he has failed to comply with sub-clause 1.6 of the conditions of the Contract, or

(d) you awarded the Contract to the Principal and he has failed to comply with sub-clause 4.2 of the conditions of the Contract.

Any demand for payment must contain your signature(s) which must be authenticated by your bankers or by a notary public. The authenticated demand and statement must be received by us at this office on or before (*the date 35 days after the expiry of the validity of the Letter of Tender*) , when this guarantee shall expire and shall be returned to us.

This guarantee is subject to the Uniform Rules for Demand Guarantees, published as number 458 by the International Chamber of Commerce, except as stated above.

Date Signature(s)

Annex C: EXAMPLE FORM OF PERFORMANCE SECURITY - DEMAND GUARANTEE

[*See comments on Sub-Clause 4.2*]

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI

(whom the Contract defines as the Employer).

We have been informed that (*name and address of Contractor*) (hereinafter called the 'Principal') is your contractor under such Contract, which requires him to obtain a performance security.

At the request of the Principal, we (*name of bank*) hereby irrevocably undertake to pay you, the Beneficiary/Employer, any sum or sums not exceeding in total the amount of (10% of the contract value) (the 'guaranteed amount') upon receipt by us of your demand in writing and your written statement stating:

(a) that the Principal is in breach of his obligation(s) under the Contract, and

(a) the respect in which the Principal is in breach.

[Following the receipt by us of an authenticated copy of the taking-over certificate for the whole of the works under clause 10 of the conditions of the Contract, such guaranteed amount shall be reduced by 50 % and we shall promptly notify you that we have received such certificate and have reduced the guaranteed amount accordingly.] (1)

Any demand for payment must contain your [minister's/directors'] (1) signature(s) which must be authenticated by your bankers or by a notary public. The authenticated demand and statement must be received by us at this office on or before (*the date 70 days after the expected expiry of the Defects Notification Period for the Works*) (the 'expiry date'), when this guarantee shall expire and shall be returned to us.

We have been informed that the Beneficiary may require the Principal to extend this guarantee if the performance certificate under the Contract has not been issued by the date 28 days prior to such expiry date. We undertake to pay you such guaranteed amount upon receipt by us, within such period of 28 days, of your demand in writing and your written statement that the performance certificate has not been issued, for reasons attributable to the Principal, and that this guarantee has not been extended.

This guarantee shall be governed by the laws of (Insert Authority) and shall be subject to the Uniform Rules for Demand Guarantees, published as number 458 by the International Chamber of Commerce, except as stated above.

Date Signature(s)

(1) *When writing the tender documents, the writer should ascertain whether to include the optional text, shown in parentheses* [ ]

Annex D EXAMPLE FORM OF ADVANCE PAYMENT GUARANTEE

[*See comments on Sub-Clause 14.2*]

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI

(whom the Contract defines as the Employer).

We have been informed that (*name and address of Contractor*) (hereinafter called the 'Principal') is your contractor under such Contract and wishes to receive an advance payment, for which the Contract requires him to obtain a guarantee.

At the request of the Principal, we (*name of bank*) hereby irrevocably undertake to pay you, the Beneficiary/Employer, any sum or sums not exceeding in total the amount of (10% of the contract value)) (the 'guaranteed amount') upon receipt by us of your demand in writing and your written statement stating:

(a) that the Principal has failed to repay the advance payment in accordance with the conditions of the Contract, and

(b) the amount which the Principal has failed to repay.

This guarantee shall become effective upon receipt [of the first installment] of the advance payment by the Principal. Such guaranteed amount shall be reduced by the amounts of the advance payment repaid to you, as evidenced by your notices issued under sub-clause 14.6 of the conditions of the Contract. Following receipt (from the Principal) of a copy of each purported notice, we shall promptly notify you of the revised guaranteed amount accordingly.

Any demand for payment must contain your signature(s) which must be authenticated by your bankers or by a notary public. The authenticated demand and statement must be received by us at this office on or before (*the date 70 days after the expected expiry of the Time for Completion*) (the 'expiry date'), when this guarantee shall expire and shall be returned to us.

We have been informed that the Beneficiary may require the Principal to extend this guarantee if the advance payment has not been repaid by the date 28 days prior to such expiry date. We undertake to pay you such guaranteed amount upon receipt by us, within such period of 28 days, of your demand in writing and your written statement that the advance payment has not been repaid and that this guarantee has not been extended.

This guarantee shall be governed by the laws of (Insert Authority) and shall be subject to the Uniform Rules for Demand Guarantees, published as number 458 by the International Chamber of Commerce, except as stated above.

Date Signature(s)

Annex E EXAMPLE FORM OF PAYMENT GUARANTEE BY EMPLOYER

[*See page 18: Contractor Finance*]

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI

(whom the Contract defines as the Contractor).

We have been informed that Fiji Electricity Authority (whom the Contract defines as the Employer and who is hereinafter called the "Principal") is required to obtain a bank guarantee.

At the request of the Principal, we (*name of bank*) hereby irrevocably undertake to pay you, the Beneficiary/Contractor, any sum or sums not exceeding in total the amount of (100% of the contract value) upon receipt by us of your demand in writing and your written statement stating:

(a) that, in respect of a payment due under the Contract, the Principal has failed to make payment in full by the date fourteen days after the expiry of the period specified in the Contract as that within which such payment should have been made, and

(b) the amount(s) which the Principal has failed to pay.

Any demand for payment must be accompanied by a copy of the Payment Certificate approved by the Engineer, in respect of which the Principal has failed to make payment in full.

Any demand for payment must contain your signature(s) which must be authenticated by your bankers or by a notary public. The authenticated demand and statement must be received by us at this office on or before (*the date six months after the expected expiry of the Defects Notification Period for the Works*) when this guarantee shall expire and shall be returned to us.

This guarantee shall be governed by the laws of (Insert Authority) and shall be subject to the Uniform Rules for Demand Guarantees, published as number 458 by the International Chamber of Commerce, except as stated above.

Date Signature(s)

CONTRACT AGREEMENT

This Agreement made the (day) day of (month) **2017** between Fiji Electricity Authority, Suva, Fiji (hereinafter called 'the Employer') of the one part, and (*name and address of Contractor*) (hereinafter called 'the Contractor') of the other part.

Whereas the Employer desires that the Works known as '**MR09/2017** - Replacement of 132kV Transmission Line Lattice Steel Towers' should be executed by the Contractor, and has accepted a Tender by the Contractor for the execution and completion of these 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

   (b) Part 1 - FIDIC Conditions of Contract

   (c) Part 2 – Tender Letter and Appendices

   (b) Part 3 - Annex Forms A, B, C, D, E, F & G

   (d) Part 4 - Special Conditions of Contract

   (e) Part 5 - Scope and Programme of Work

   (e) Part 6 - Technical Specification

   (f) Part 7 - Drawings and Schedules

3. In consideration of the payments to be made by the Employer to the Contractor as herein after mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein, in conformity with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price at the times and in the manner prescribed by the Contract.

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.

SIGNED by:	SIGNED by:
for and on behalf of the Employer in the presence of	for and on behalf of the Contractor in the presence of
Witness: Name: Address: Date:	Witness: Name: Address: Date:

DISPUTE ADJUDICATION AGREEMENT

Contract No.: **MR09/2017**
Contract Name.: Replacement of 132kV Transmission Line Lattice Steel Towers

Fiji Electricity Authority
2 Marlow Street, Suva
FIJI

(Name and address of Contractor)
(Name and address of Member)

Whereas the Employer and the Contractor have entered into the Contract and desire jointly to appoint the Member to act as sole adjudicator who is also called the 'DAB'.

The Employer, Contractor and Member jointly agree as follows:

1. The conditions of this Dispute Adjudication Agreement comprise the 'General Conditions of Dispute Adjudication Agreement', which is appended to the General Conditions of the 'Conditions of Contract for Construction' First Edition 1999 published by the Fédération Internationale des Ingénieurs-Conseils (FIDIC), and the following provisions. In these provisions, which include amendments and additions to the General Conditions of Dispute Adjudication Agreement, words and expressions shall have the same meanings as are assigned to them in the General Conditions of Dispute Adjudication Agreement.

2. In accordance with Clause 6 of the General Conditions of Dispute Adjudication Agreement, the Member shall be paid as follows:

   A retainer fee of (insert amount) per calendar month,
   plus a daily fee of (insert amount) per day.

3. In consideration of these fees and other payments to be made by the Employer and the Contractor in accordance with Clause 6 of the General Conditions of Dispute Adjudication Agreement, the Member undertakes to act as the DAB (as adjudicator) in accordance with this Dispute Adjudication Agreement.

4. The Employer and the Contractor jointly and severally undertake to pay the Member, in consideration of the carrying out of these services, in accordance with Clause 6 of the General Conditions of Dispute Adjudication Agreement.

5. This Dispute Adjudication Agreement shall be governed by the law of (Insert Authority)

SIGNED by:	SIGNED by:	SIGNED by:
for and on behalf of the Employer in the presence of	for and on behalf of the Contractor in the presence of	the Member in the presence of
Witness: Name: Address: Date:	Witness: Name: Address: Date:	Witness: Name: Address: Date:

PART 4

SPECIAL CONDITIONS OF CONTRACT

There are no Special Conditions of Contract

PART 5

SCOPE AND PROGRAMME OF WORKS

1. SCOPE

1.1. Scope

The scope of work, (the Works), is as described in Section 1.0 of Part 6A and 6B – Technical Specification and generally incorporates the following:

SCOPE OF WORKS includes:

1.1. Construct foundations for one tower (Wailoa-Vuda T82).

1.2. Design, fabricate and construct one new towers on new foundations (Wailoa-Vuda T82).

1.3. Dismantle one tower (Nadarivatu T14).

1.4. Design, fabricate and construct three new towers on existing foundations (Nadarivatu T1, T12 and T14).

1.5. Supply and install insulators and associated hardware (Nadarivatu T1, T12 and T14 and Wailoa-Vuda T82).

1.6. Supply and install new conductor and associated hardware (Nadarivatu spans Power Station Gantry to T1 and Wailoa-Vuda T80-T82-T83).

1.7. Supply and install 50m lengths of new conductor, and associated hardware, and join to existing conductor (Nadarivatu T1 and T12).

1.8. Supply and install new OPGW and associated hardware (Nadarivatu spans Power Station Gantry to T1 and T1 to T2).

1.9. Supply and install new earthwire and associated hardware (Wailoa-Vuda spans T80-T82-T83)

1.10. Install Vibration Dampers on the conductor, earthwire and OPGW (Nadarivatu T1, T2, T10, T12, T13 and T14 and Wailoa-Vuda T80, T82 and T83)

2. Programme

The key scheduled dates are set out below and the Works are to be executed in the time frames given:

Site Inspection	Monday 30th January 2017 and Tuesday 31st January 2017
Tenders Close	Wednesday 1st March, 2017
Contract Award	Before 31st March, 2017
Outage Durations	132kV Wailoa-Nadarivatu-Vuda Line: maximum of One (1) Line Outage of 14 hours duration 132kV Nadarivatu Power House to Switchyard Double Circuit Transmission Line: Maximum of One (1) Line Outages of continuous 72 hours duration
Project Completion	30th November, 2017
Defects Liability Period Ends	One Year after actual date of completion

PART 6A

TECHNICAL SPECIFICATION
TOWER DESIGN AND FABRICATION

TABLE OF CONTENTS

1. GENERAL

1.1. Scope

This specification addresses the design, detailing, fabrication, trial assembly, load testing and supply of steel transmission structures.

The Scope of Work for the Contract shall be as defined in Part II to these Contract Documents.

Unless otherwise specified in Part II all structures shall be complete including all specified accessories and facilities and step bolts, but excluding structure swivels and swivel pins for the attachment of insulators and or earthwire sets.

1.2. Standards

This standard references New Zealand / Australian Standards for compliance. It may be acceptable to use other reputable international Standards provided that the equivalence to relevant sections of NZ/AS Standards can be demonstrated.

Except where otherwise specified or implied, the works shall comply with the latest applicable Standards or Recommendations given in the following table. The following Standards are referred to within this Specification. The latest revisions shall apply at all times, unless otherwise approved.

AS/NZS 4711	Qualification Tests for metal arc welders
AS/NZS 1554	Structural Steel Welding - Welding of steel Structures
AS 1544.2	Method for impact tests on metals Part 2: Charpy V-notch
AS/NZS 1559	Hot-dip galvanized steel; bolts and associated nuts and washers for structure construction
AS/NZS 3678	Structural steel - Hot rolled plates, floorplates and slabs
AS/NZS 3679	Structural steel - Hot rolled bars and sections
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
NZS 3404	Steel structures code
ASTM 143	Standard recommended practice for safeguarding against embrittlement of hot dipped galvanised structural steel products and procedure for defecting embrittlement.

Where another standard is proposed in place of the above, confirmation shall be provided that the provisions of the proposed standard is equivalent to or exceeds that of the replaced standard. A copy of any proposed substitution standard shall be submitted with the Tender accompanied, where necessary, by English translations of the appropriate sections.

Where the use of a standard or recommendation other than those listed above is agreed then this standard shall be used, where applicable, throughout the works.

1.3. Method statements

Prior to commencing work, the Contractor shall submit method statements setting out full details of his methods of working. This is a hold point.

2. DESIGN

2.1. General

Structures shall be of the self-supporting type in the configuration as specified in Part II and as shown in the drawings.

The structures shall be designed to carry the phase conductors with their insulator sets, earth conductors and all ancillaries and fittings under the conditions specified.

If specified earthwires shall be spatially arranged above the line conductors to provide the specified shielding angle. Horizontal and vertical spacing between phase conductors and or earth conductors shall maintain the specified phase-earth and phase-phase clearances in the span either side of the structure.

The structures shall be designed to facilitate inspection, cleaning and repairs, and for operation where continuity of electric supply is the first consideration.

The designs shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the Works.

2.2. Types of Structures

The structures shall be of bolted lattice steel construction of the types and geometry as specified on the drawings in Part 7 of the Tender Documents.

The arrangement of specified body extensions and or independent single leg extensions shall be common to standard and extended height structures.

Structures shall be designed for:

a) Simplicity and ease of erection;

b) Sub-assembly of panels on the ground;

c) Erection of panels by gin pole, derrick or crane.

2.3. Loading Conditions

The structures shall be designed for the loads and loading conditions specified in the drawings.

2.4. Design

All structures and their components shall be designed to withstand without failure the stresses resulting from the loading conditions, inclusive of specified capacity reduction factors. The ultimate stress of any structure or foundation member shall be determined in accordance with ASCE-10.

All members shall be of such size, shape and length to preclude damage or failure from vibration or stress reversal. Unless otherwise approved, tension members such as crossarm ties, which are liable to be set in vibration, shall consist of rolled steel sections and not flats.

The slenderness ratio, KL/r, shall not exceed the following values	max KL/r
Main legs and beam chords	120
Bracings having calculated stress	200
Redundant members (bracings without calculated stress)	250
Other Tension-only members	350

Where: L = the unsupported length of the member,

r = the radius of gyration of the member about the axis under consideration,

K= as defined in ASCE-10.

Unstressed members when employed to reduce the slenderness ratio of stressed leg or bracing members shall be designed together with their connections to resist a notional force of ±RN with a magnitude that is the calculated maximum of:

$$\mathbf{0.01P_N / \sin \theta_{min}, \quad or \quad 0.02P_N.}$$

where:

P_N is the ultimate compression load in a main member 'N' under its critical loading case arising under all possible utilisations of the structure; and,

Θ_{min} is the minimum included angle between the two primary members bounding the secondary member panel.

N is any member bounding the secondary panel.

The force, R_N, shall be considered to act in the face of the secondary member panel normal to the main member 'N' and either towards or away from the structure centre. RN shall be separately applied to each node between the secondary and main member N, and shall be resisted by the secondary panel as a whole. The individual secondary member forces shall be determined by stress diagram or static analysis making no allowance for load distribution back into the main members.

Structure members on which a man may stand (defined as being at an angle of less than 35° to the horizontal) shall be capable of withstanding an ultimate vertical point load of 2 kN at any point on the member.

All crossarm and bridge chord members shall be capable of supporting an ultimate vertical ladder load at any position within 1 m of each phase centre line of 4500 N. The ladder load shall be applied as two 2250 N point loads 0.3 m apart.

The Contractor shall submit design documents including Structure Outline drawings, stress analyses and calculations as required for the checking and approval of the designs of all structures. These documents shall document the design of all members and their connections, whether main or redundant, and the design of all plates, with particular attention to earth conductor and conductor take-off arrangements and any members that are subject to bending stresses.

Computations shall be presented in a clearly arranged format and identify

- the critical tensile and compressive loads from the structure analysis plus load case identifier,
- member section size, grade and length;
- number, size and grade of connection bolts;
- Design Length and kL/r value identifying critical axis;
- Allowable compression load;
- Number of holes out of critical section;
- Allowable tension load;
- Allowable rupture identifying shear and tension lengths;
- Bolt shear
- Bolt bearing on parent material(s)
- Member and connection utilisations (maximum ultimate load ÷ ultimate capacity)

The structure shall be modelled in Power Line Systems design software PLS-TOWER and a copy of the models supplied to the Engineer upon completion.

The minimum thickness of structural steel shall be as follows:

- Main leg, stub or chord members 8 mm
- Other member 5 mm
- Plate 6 mm
- Channels 5 mm

The minimum angle section shall be 45 mm × 45 mm × 5 mm and all sections shall be readily available.

The minimum nominal bolt diameter shall be M16. Only two different bolt diameters shall be employed on any one structure.

The structure design shall include the design of the structure connection to the foundation.

2.5. Foundation Reactions

Upon completion of the structure design the Contractor shall submit the structure specific global foundation reactions. For structures with stub connections to the foundation the foundation reactions shall include the in-line with leg reactions together with the horizontal bracing shears.

Foundation reactions shall be presented for the complete range of structure loading utilization and include the effects of self-weight and wind force applied at the structure base. The horizontal and vertical reactions shall be presented for each leg under each loading case considered for the structure design. A schedule shall be presented summarizing the loading cases which are critical for each of the primary reaction directions, e.g. compression, uplift, transverse shear, longitudinal shear and resultant shear.

2.6. Electrical Clearance Diagram

Before commencing detailed structure design the contractor shall submit, for approval, an electrical clearance diagram demonstrating electrical clearances are achieved under all conditions of structure utilisation. The clearance diagram shall be adopted for the erection purposes and shall identify actual insulator sets, set attachments and identify climbing corridors, etc. :

2.7. Design Outline

The Contractor shall prepare the structure design outline. This drawing shall be adopted as the master document for the control of the design and interface with structure detailing. The outline shall identify the following:

- Leading structure dimensions;
- Member design notation;
- Member section sizes and grade;
- Member connection requirements;
- Locations of facilities and accessories;

The design outline shall be subject to approval. The design outline shall form the basis from which the general arrangement and shop details are developed.

3. DRAWINGS AND DETAILING

3.1. General

Where required the Contractor shall detail the structures in accordance with this specification and to the approval of the Engineer.

Detailing shall be such as to minimise the number of different parts to facilitate transport, erection and inspection.

Pockets and depressions likely to hold water, if not avoidable, shall be provided with drainage facilities.

The maximum length of members with flanges less than 100mm shall be limited to 6.5m, and 9.5m for sections with flanges of 100mm and greater unless otherwise approved.

Leg splices shall be located as near as possible and immediately above structure panel points.

Wherever possible, horizontal members shall be detailed with the horizontal flange on the upper side.

3.2. Bolts and Bolt Holes

Bolt holes in members shall be 1.5mm larger than the nominal bolt diameter for bolts up to and including 20mm diameter. Bolt holes shall be 2mm larger than the nominal bolt diameter for bolt diameters greater than 20mm.

Bolt threads shall not form part of the shearing plane between members. Any thread in the bearing plane shall be to the approval of the Engineer. Bolts of any given diameter shall be of one grade of steel and suitably marked for identification.

When in position all bolts or screwed rods shall project through the corresponding nuts, for a minimum of two full turns but such projection shall not exceed 10mm. Suitable bolt grip tables shall be provided to demonstrate compliance with the above requirements.

The nuts of all bolts for the attachment of plates, brackets or angles that directly support insulator or earth conductor sets shall be locked by means of locknuts.

Member detailing shall maintain the following bolt spacing and edge distances unless specific design approval is obtained.

Nominal Bolt Diameter (mm)	Minimum Bolt spacing (mm)	Minimum Edge Distances (mm)	
		Rolled Edge	Sheared Edge
16	40	19	24
20	50	25	30
24	60	35	36

3.3. Tension-Only Members

Members designated “tension only” on the design outlines shall be detailed with a 1mm ‘draw’ per metre overall length of member with an additional 1.5mm for each joint in the member.

3.4. Structure Furniture and Accessories

The general arrangement drawings and the shop details shall make suitable provision for the following and as indicated in the design sketches and ancillaries details of which shall be provided to the Contractor.

a) Stringing and Maintenance facilities: Provision shall be made on all structure types for the attachment of stringing and maintenance equipment to the crossarms as indicated in the Drawings.

b) Earthing facilities; Two Ø13.5mm holes shall be provided on each leg of every structure leg extension and at the ends of the earthwire peak and or earthwire crossarm(s) to accommodate earth bond connection fittings. Earthing holes shall also be provided in the stub both above and below the design level of the top of concrete.

c) Step Bolts: Structure details shall make provision for the fixing of step bolts from immediately above the stub joint to the structure top on all main legs. A sufficient quantity of Step bolts shall be supplied to equip one leg of the structure only from 3m above ground level to the structure top;

d) Ladders shall be detailed and supplied as indicated in the Drawings.

e) Signage: Details shall make provision for the attachment of standard signage at the locations indicated on the drawings.

f) Maintenance Earthing facilities: The structures shall be detailed with 2Nos holes at the locations and to the dimensions as indicated on the Drawings for the future attachment of earth plates.

g) Climbing Deterrent Frames: Climbing deterrent frames (CDF) shall be detailed and supplied with each structure as indicated in the Drawings.

h) Livestock Guards: Approved means shall be detailed and supplied with all structure leg extensions to avoid the risk of livestock being caught and injured in the gaps between structure members near the structure base s indicated in the Drawings.

3.5. Drawings

The drawing types identified below shall be prepared and submitted by the contractor for approval:

a) General Arrangement (GA) Drawings: These drawings shall be suitable for the assembly and erection of the structure and shall show the location and orientation of all members, plates, accessories and facilities together with the number and length of bolts required for each connection. The first drawing of each series of GA drawings for each structure shall be a Key Drawing that shows the complete structure and the applicable GA drawing numbers.

   These drawings shall be approved by the Engineer before commencement of fabrication works if included in the scope of work.

b) Stub and Cleat General Arrangement drawing;

c) Stub Setting Dimensions: Drawing shall provide the top of stub heel-to-heel dimensions in the structure face and across the diagonal for all combinations of body and leg extensions. The drawings shall include stub setting tolerances (to be advised by the Engineer).

d) Bill of Quantities ADD FORMAT; and,

e) Member Shop Details (separate drawing sheets for each member). Multiple details per drawing sheet is not acceptable.

The Contractor shall produce ALL drawings in AutoCAD format on Employer's drawing borders. The associated AutoCAD print settings file (*.cts) shall be provided. PDF format files are acceptable for review and approval stages.

The Contractor shall provide their drawing list for which drawing number allocation are required prior to preparing the drawings.

4. MATERIALS

All steel used in the fabrication of structure components shall be new and comply with the delivery requirements as specified in AS/NZS 3678 and AS/NZS 3679.1, or as indicated on the drawings.

All rolled steel sections, flats and plates used shall consist of steel manufactured to the requirements of AS/NZS 3678 and AS/NZS 3679 for steel grades 300L0 and 350L0, or equivalent from other approved standards. The steel shall be free from blisters, scales, laminations or other defects.

Rolled steel angle sections shall be in accordance with the design. Any changes required by the Contractor to the section sizes from those shown on the drawings shall be subject to the Engineer's approval.

All structure bolts and nuts including step bolts shall be manufactured and supplied to the requirements of AS/NZS 1559 for low temperature, with the exception of impact tests which shall meet the requirements of Clause 0. The marking on the bolt head shall be "TM" to signify this modified property. All bolts and nuts shall be subject to the mechanical and dimension tests as specified in Clause 0.

All bolts attaching the plates, brackets or angles that support insulator sets or earth conductor fittings shall be locked by the provision of double nuts complying with AS/NZS 1559.

All bolts shall be fitted with a single spring washer type B complying to the requirements of BS 4464.

The quantity of bolts, nuts and washers supplied shall be the number necessary for erecting the structure components plus an additional 5%.

All steel shall comply with the requirements of ASTM 143 for embrittlement.

5. FABRICATION

5.1. General

All fabrication shall be completed in the shop and be carried out in a reliable and workmanlike manner to the best modern practice, and shall be to an accuracy that will permit erection of the structure without introducing permanent stresses therein.

Workmanship shall generally comply with the provisions of NZS 3404 and this specification and any additional provisions the Contractor considers necessary to meet the requirements of this specification. Any cuts shall be made to similar tolerances.

All members shall be cut to jig and all holes shall be drilled or punched to jig. All parts shall be carefully cut and holes accurately located so that when the members are in position the holes will be truly opposite to each other before being bolted up. Drifting of holes will not be allowed. The drilling, punching, cutting and bending of all fabricated steelwork shall be such as to prevent any possibility of irregularity occurring which might introduce difficulty in the erection of the structures on the Site.

The manufacturing process shall be such that the locating and punching or drilling of holes is an automated process. This is to ensure that components intended to be identical are identical. Individual hand-measuring and marking of members is not permitted.

All materials shall be free from oil, grease and paint and shall in every respect be suitable for hot dip galvanizing after fabrication.

When cutting to length and shape, sawing, shearing, grinding or flame cutting may be used as appropriate, but if either shearing or flame-cutting is used then sufficient metal shall be allowed beyond the neat lines to permit the machining or grinding to final shape; and any edge damage or roughness shall be ground out to avoid any notch effect.

The welding of short lengths to form longer members is not permitted except by a designed bolted joint connection.

All cut edges shall be lightly ground to remove all burrs and sharp edges. This includes die-joint lines at holes.

All holes shown on the drawings are to be formed, even if they are not required for the structure assembly.

5.2. Holes

Holes may be punched or drilled to correct size except as noted below when holes shall be drilled to the correct size or sub-punched 3mm undersized and reamed to the correct size for:

- Mild Steel grades > 20mm thick;
- High Tensile Steel grades > 12mm thick;
- Holes identified in the drawings as being in a member predominantly in tension; and,
- Holes in the vicinity of bends in angle or plate members.

Punches and dies are to be sharp and true to ensure all punched holes are round and free from ragged edges and burrs.

The metal surfaces around holes shall be flat and free from irregularities.

Plugging or welding of incorrectly punched or drilled holes is not permitted.

Holes that are adjacent to the bend line in a bent member or where they are located in the area to be heated during the bending process shall be drilled after bending.

5.3. Bending

Bent angle and plate members shall be formed to the requirements in the table below:

Profile	Material	Thickness	Extent of Bend	Temperature
Angle	Mild Steel & High Tensile Steel	All	≤ 5°	Cold
			> 5°	Hot
Plate	Mild Steel	≤ 12mm	≤ 15°	Cold
			> 15°	Hot
		> 12mm	All	Hot
	High Tensile Steel	All	≤ 5°	Cold
			> 5°	Hot

The hot temperature is between 850°C and less than 1000°C. Temperature shall be determined by a reliable method – for example Tempilstiks or Pyrometer.

Bent angles and plate members shall be air-cooled following forming of the bend.

The formation of bends by the cut and weld method is not permitted unless called up in the detail and not without prior consent by the Engineer.

5.4. Marking

Before galvanising, all structure members shall be stamped, employing low stress hard stamps, with distinguishing identification marks comprising numbers and or letters. These identification marks will correspond to the piece marks on the erection drawings and the fabrication or relevant shop drawings.

The identification mark shall be 15mm high, placed in the same relative position on each member, and shall be clearly visible after galvanising and assembly.

The identification shall take the format of a nine or 10 character string as follows:

'SSS-DDF####G', where:

- 'SSS' is the structure family identifier (for multi-tower family projects);
- 'DD' corresponds to the structure type designation;
- 'F' corresponds to a single letter designation for the fabricator;
- '####' corresponds to the member item number as designated in the fabrication detail; and,
- 'G' corresponds to the steel grade and comprises 'blank' for mild steel, 'H' for High tensile steel, 'S' for Special High tensile Steel.'

Details of required structure type and family designations will be advised to the contractor.

Weld writing shall not be permitted under any circumstances.

5.5. Tolerances

The tolerances for member's profiles and fabrication shall be as follows:

- Straightness: after galvanising the offset to length ratio shall not exceed 1 in 1000 measured at the worst position. Where members exceed 3m in length the offset shall be measured over any 3m length, as well as the overall length;
- Overall member length: ± 1mm;
- Pitch between holes: ±0.5mm for hole groups and ±0.5mm for member end-holes;
- Hole centre to member end distance ±0.5mm;
- Hole diameters +0.5mm, -0.00mm, measured in the black state;
- Holes shall be formed perpendicular to the surface; and
- Draw on the diameter of punched holes shall not exceed 0.5mm for members ≤5mm thick; 1.0mm for members ≥8mm thick; 2.0mm for members >8mm thick.

Dimensions and tolerances are measured at standard temperature and are not accumulative.

5.6. Welding

Welding is only permitted for the fabrication of special components as detailed on the drawings.

Unless otherwise stated on the fabrication drawings, all welds shall be Class SP welds in accordance with AS 1554.4 for fatigue welds and shall be carried out in accordance with AS 1554 by welders who are qualified for the appropriate work in terms of NZS 4711.

Welds connecting primary elements, where a single failure would result in the collapse of either the structure or a major part of the structure, shall be subjected to ultrasonic or radiographic tests in addition to crack detection by either magnetic or dye penetrant methods. If a defect is found, the Engineer shall be informed and the remedial measures agreed before proceeding.

All welding procedures shall be submitted for consent to the Engineer prior to fabrication commencing.

The Contractor shall supply to the Engineer evidence that all proposed welders have the appropriate qualifications.

All welds shall be made in the shop.

6. GALVANISING AND PROTECTIVE COATINGS

All steelwork employed in the structure shall be hot dipped galvanised in accordance with AS 4680 after fabrication and marking has been completed. Surfaces to be galvanised shall be sound, clean, and free of mill scale, rust, grease, moisture or any other foreign matter which may in any way detract from the life and usefulness of the zinc coating.

The following minimum zinc coating mass and thicknesses shall be provided:

Hot Dip Galvanised Articles		Min. Individual	Min. Average
Fabricated steelwork of thickness (t) measured as per AS/NZS4680 & AS1650	t ≥ 5mm	500g/m^2 70µm	600g/m^2 84µm
	3mm < t < 5mm	390g/m^2 55µm	500g/m^2 70µm
	t = 3mm (non-structural)	320g/m^2 45µm	390g/m^2 55µm
Threaded parts (bolts and nuts) of nominal diameters measured as per AS/NZS4680 & AS1214	≥ M16	450g/m^2 63µm	500g/m^2 70µm
	< M16	300g/m^2 42µm	390g/m^2 55µm

All galvanised parts shall be dipped in a suitable solution such as sodium dichromate, or treated with a synthetic resin, to protect the galvanised surface from white rust during shipping and storage.

Where required, after galvanising, a protective coating shall be applied to all stubs for a height of 150 mm below to 500 mm above the design top of concrete. The coating shall be of silicone or epoxy formulation, shall not be less than 200 microns thick, and shall be to the approval of the Engineer.

7. TESTING

7.1. General

Factory acceptance tests: Test (mill) certificates shall be obtained to cover the mechanical, chemical and the impact properties of all materials, and shall clearly show the cast numbers. In addition, for all structural welded items the maximum carbon equivalent value shall be shown on the certificate.

Steel shall not, generally, be issued for fabrication until such time that the test certificates have been checked and verified against the relevant delivery specification.

All manufactured items shall be thoroughly tested, as required below.

Testing shall be carried out at an approved laboratory having the proper equipment which shall have a valid calibration certificate.

Test Reports shall be prepared by the Contractor for all tests carried out on the contract materials. These reports shall show full details including methodology, loadings, results and observation of any significant points.

7.2. Material Tests

Material Sample Tests: Samples of the material for the structures, fittings and ancillaries shall be tested in accordance with this Specification. Bolts and nuts shall be tested in accordance with the requirements of AS 1559.

Impact tests shall be carried out on samples taken from each heat of each size of rolled steel as received from the steel mill. These tests shall be Charpy V-notch impact tests to AS 1554.2 with acceptance criteria in accordance with AS/NZS 3678 and AS/NZS 3679 tabulated below:

Size of Sample	Minimum Energy (J) @ 0°C	
	Average of 3 Tests	Individual Test
10mm x 10mm	27	20
10mm x 7.5mm	22	17
10mm x 5mm	19	13
10mm x 2.5mm	12	8

The above minimum impact values are applicable to all materials, whether of angle, section, plate or bar.

The Contractor shall supply to the Engineer test certificates for all structural steel used in the work.

7.3. Trial Assembly Tests

In order to check the workmanship (detailing and fabrication) and to verify the fit of each structure section, the fit of each individual member, plate and bolt, and to verify overall dimensional compliance with the drawings, one structure of each standard type and any special structure, inclusive of all body and leg extensions being supplied shall be subject to a check assembly.

The Engineer is to be present at the assembly of one of the towers, which will be selected at random by the Engineer.

The members employed for the check assembly test shall be assembled to form complete structures employing the correct bolt lengths and plates, in the presence of the Engineer, at the manufacturer's works.

The Contractor shall carry out trial assemblies of the structure components to verify the fit of each section, the fit of each individual member, plate and bolt, and to verify overall dimensional compliance with the drawings. Each assembled section must be connected to adjoining sections. It is acceptable for the steel components to be erected in the horizontal and in sections.

Trial assembly at the works shall be carried out prior to the steel being galvanised. Bolts used in the check assembly shall be of the same size and length as those specified on the drawings.

The Engineer is to be provided with a minimum of three weeks notice of such assembly trials.

7.4. Structure Tests

One structure type randomly selected by the Engineer shall be assembled at the Manufacturer's Works or other approved place and shall be tested on rigid foundations. This test is intended to verify the overall design, detailing and fabrication.

The structure is to be tested such that the members are loaded to 95% of the ULS design load

Testing shall be in accordance with IEC 60652 and subjected to such test load cases and combinations as the Engineer may specify. (For the purposes of Tendering a total of 10 load combinations and one destruction test per structure type shall be included.)

Should the structure fail prematurely and the failure attributed to detailing, fabrication or erection errors, the contractor shall be responsible for all costs of the test and subsequent re-test.

Provided that they have successfully withstood the proving tests the structure shall be carefully inspected after dismantling to ensure that no parts are damaged or deformed. The structure may be re-used on the contract providing all damaged or deformed members are replaced. All bolts shall be replaced.

The test structure shall be galvanised and shall employ the actual bolts to be supplied under the contract.

The Contractor shall allow for all and any additional steelwork and rigging necessary for the performance of the structure test including load attachment points and base plates.

The Engineer is to be provided with a minimum of five weeks' notice of structure tests.

The Test Station test programme shall be submitted to the Engineer for approval at least four weeks before the programmed test date. The programme shall provide dimensional details of the test station layout, details of the proposed rigging and all load corrections to cater for the effects of the rigging and other test details.

8. QUALITY ASSURANCE

The contractor shall ensure that efficient quality assurance procedures are implemented at his works, and at the works of all sub-contractors and that the procedures include necessary check and hold points to ensure design, drafting, fabrication works are performed to quality, schedule and budget.

The Contractor shall supply a project specific inspection and test plan detailing the quality assurance procedures they have in place, and that will be used to meet the requirements of the contract. These shall address all hold points from design to delivery and identify that commencement of fabrication will be subject to design approval.

The Contractor's quality assurance documentation and procedures shall address, but not necessarily be limited to, the following:

a) Designs are reviewed, checked and approved internally prior to submission for approval;
b) That materials and parts used in the manufacture of the specified works are free from defects and meet this specification. This shall include checking against specified tolerances, and obtaining the manufacturers test and or analysis certificates where appropriate;
c) Inspection at all critical stages of all phases of the specified works;
d) That steel of different grades are segregated and identifiable during all stages of manufacture;
e) Include a full traceability system. For sections or plates of High Tensile Grade, the cast mark or an equivalent code letter shall be transferred to each piece, cut from that item. A material stock register shall be kept identifying the mill certificate number, cast mark/code letter and the corresponding member identification mark.
f) Ensure the manufacturing processes maintain strict dimensional control so as to ensure that all components are fabricated with exactly the same dimensions as the prototype components used in the trial assemblies;
g) Verify the accuracy of gauges and test instruments used for checking and/or testing the specified works;
h) Ensure that components, materials and processes are fitted/used/applied in accordance with their manufacturer's instructions;
i) Ensure that the qualifications and training of personal used in the production, trial assemblies, testing and inspection processes are adequate for their functions;
j) Ensure that all parts have their cut edges rounded and are free from burrs and sharp edges;
k) Ensure that all parts showing a fissure or surface defect are rejected, including whole batches whenever the rejection rate of a batch is high or a particularly serious defect is identified;
l) Ensure that all parts have their correct identification markings;
m) Ensuring that after galvanising all excessive zinc runs, drips, dross, and excess zinc on threaded parts is removed; and,
n) Ensure that components and materials are tested as required by this specification.

The Purchaser reserves the right to appoint an independent authority to inspect the works and verify that the Contractor's production, testing and quality assurance facilities and procedures are appropriate for the specified work.

The programme of quality assurance and the standard of execution may be subject to approval and surveillance respectively, by the Engineer as a prerequisite to acceptance.

9. PACKING AND SHIPPING

Structures shall be shipped by structure type and by structure component in complete sub-assemblies as required, including bolts, nuts and washers, plates, and any attachments. Incomplete sub-assemblies shall not be accepted for shipment.

Foundation stub angles and associated cleats, bolts, nuts and washers are required to be packaged and shipped separately.

All items shall be shipped disassembled to be bolted together in the field. Similar parts shall be bundled together except such parts as would make too heavy a bundle for convenience in handling.

All items shall be adequately packed and protected against damage and deterioration during transit. Any damage or deterioration occurring in transit that is attributed to inadequate packing or protection shall be made good by the Contractor at his own expense and within a reasonable time.

All bundles of steelwork shall be secured with galvanised steel strip or wire or other approved method. Care shall be taken that individual members are tied or secured in such a way that they cannot slip out of the end of the bundle. Spacers shall be provided to separate and permit air flow between members in each bundle.

It is preferred that the weight of each bundle does not exceed 1000 kg.

Bolts are to be bagged according to their length before further bagging according to structure component

Bundles shall be tagged to the satisfaction of the Engineer a bar coded or similar system is preferred. Parts which cannot be bundled, such as plates, shall, if practical and possible, be tied together with galvanised wire and packed in light boxes not exceeding 25kg in weight , and these in turn shall be packed in cases, not exceeding 1000kg, on non-returnable pallets 1200mm x 1200mm in accordance with ISO 6780.

Each package, case, bag or light box shall be clearly marked with the project, structure type and component type, and shall include a parts list of the contents.

All shortages of parts identified upon debundling the packages shall be made good at the Contractor's cost and within a reasonable time.

All packing material shall comply with the Import and Export Regulations of Fiji.

The Contractor shall provide an itemised Packing List for each shipment, showing the number, dimensions, marks, weights and contents of each package.

PART 6B

TECHNICAL SPECIFICATION
CONSTRUCTION WORKS

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1. PRELIMINARY AND GENERAL

1.1. Scope of Work

The general scope of this Contract is to replace 4 lattice steel transmission line towers that failed during the cyclone in early 2016. Three of these structures are on the Nadarivatu Power Station 132kV spur line which was built in 2012. The other structure is on the Wailoa-Vuda 132kV line which was built in 1980.

This scope covers the generic scope for this Contract. Refer to Part 2 of the Contract Documents for the specific detailed scope of works.

The scope of work for this Contract includes the supply of all management, administration, engineering, labour, plant, materials, equipment, tools, etc., required to complete the Works as described below or implied in any of the Contract Documents.

a) Project establishment and site mobilisation.

b) Project management, complete site management and full time safety representative.

c) Photographic recording of all access ways and equipment setup areas, prior to site works start.

d) Project material take-off and scheduling to determine the specific materials required for the works.

e) Provision of all materials.

f) Construction of any required access to sites, including tracks, temporary fences and/or gates, stock control, storm water and erosion control, additional to those in place. Such work to include reinstatement of all surfaces and services upon completion of the works.

g) Detailed work as listed in Part 2 of this Tender.

h) Preparation of comprehensive work programmes to ensure site works are undertaken within the outage time frames provided.

i) Development and implementation of a construction project specific quality assurance plan.

j) Determination and documentation of the level of safety precautions required with relation to the operations.

k) Removal and disposal of all recovered material from the sites.

l) Traffic control required during the Works.

m) Install, as appropriate, temporary hurdles and scaffolding to facilitate the dismantling and re-conductoring of the transmission line across fences, roads, highways and other power lines.

n) Clear or trim existing trees and shrubs or other obstructions as required on the transmission line easement to facilitate stringing in accordance with local authority restrictions.

o) Install/replace towers as detailed in the schedule

p) Install new foundations as detailed in the schedule

q) Install insulators and fittings as detailed in the schedule

r) Removal and installation of conductor using the tension stringing techniques as detailed in the schedule

s) Inspection and preparation for the livening of the lines

t) Removal of all construction debris and reinstate all sites to their original condition

u) Weekly progress reports and monthly meetings with the Employer and his representatives.

v) Return to the Engineer a complete set of all drawings marked-up for as-built, and Quality Assurance records

w) Project Close-out Report, and project disestablishment

x) Inspect and commission the line as per the specified procedures.

y) Remove all construction debris and reinstate all sites.

z) Return to the Engineer a complete set of drawings marked up “as built”.

aa) Project disestablishment.

1.2. Drawings

The work to be undertaken is indicated on the drawings listed in Part 7 of this document as well as other clauses of this specification .

1.3. Operational Constraints

In addition operational restrictions may necessitate conductor run-outs being shorter than the These lines are critical to the Fiji power supply, so only minimal outages are acceptable. The operational constraints are as follows:

Wailoa - Vuda 132kV Line
Maximum line outage duration is 14 hours.
Liquidated damages of Fiji $30,000 per hour that the line outage exceeds this duration.

Nadarivatu Power Station 132kV Line
Maximum line outage duration is 72 hours.
Liquidated damages of Fiji $30,000 per hour that the line outage exceeds this duration..

1.4. Site Access for the Engineer

The Contractor shall allow the Engineer and/or his Representative ready access to sites at all times.

1.5. Site Works Planning

A comprehensive and detailed work sequence plan / programme shall be prepared by the Contractor for each and every de stringing section. The programme shall detail all activities required for the works. The detailed programmes shall be submitted to the Engineer one month prior to the planned de-stringing section.

2. MATERIALS

2.1. Material Supplied by the Employer

No materials are to be supplied by the Employer.

2.2. Materials Supplied by the Contractor

The Contractor shall supply all materials.

2.3. Disposal of Scrap Materials

All surplus scrap materials shall be removed from site to a dump approved by the Employer at the Contractors cost.

2.4. Security of Dismantled Materials

Possession of recovered materials shall pass to the Contractor at the time de-energised access is given to that section of the line. The Contractor shall be responsible to ensure the security of dismantled materials from the date of possession. Any losses which occur after that date shall be to the Contractor's expense.

3. LANDOWNER LIAISON AND ACCESS

3.1. General

The Employer is responsible for liaison with landowners and authorities for the purpose of provision of access and implementation of the site works. The Employer will obtain, the appropriate regulatory and statutory approvals for the works. The Contractor must obtain confirmation from the Employer that all necessary approvals are in place before they begin site works.

The Contractor is required to view the sites during the Tender period and provide details of proposed construction plant, traffic movements and durations as part of their Tender Documents.

3.2. Access Standards

For construction purposes the Contractor shall form, upgrade and maintain both existing and temporary access tracks to provide access for the range of vehicles and plant intended for use on the site.

3.3. Barricading and Fencing of Excavations

The Contractor shall provide all temporary fencing, covers and barricading as required to prevent persons, machinery and livestock from falling into excavations. Barricades shall remain in place while the site is unattended. Barricades and fencing shall only be removed once the excavations have been filled and re-surfaced.

3.4. Fences

All existing fences that are affected by the works shall only be dismantled with the Engineer's approval and in accordance with the Stakeholder's instructions. The dismantled materials shall be stored in an area approved by the Stakeholder. The fences shall be reinstated as close as possible to the original line and to the approval of the Stakeholder and Engineer.

Any fences that are not approved for removal and are damaged or destroyed by the Contractor shall be reinstated by the Contractor immediately at the Contractor's own expense to the satisfaction of the Engineer and the Stakeholder. The Contractor will be held entirely responsible for any loss or damage arising from whatever cause associated with the unauthorised damage or removal of existing fences.

3.5. Clearing of Vegetation

The Contractor shall advise the Engineer of any vegetation which the Contractor deems to be within statutory clearance limits.

3.6. Site Photos

The Contractor shall take photographs of ALL access ways off formed tracks, which require vehicular traffic and the ground level environment surrounding each structure. Access photos shall be taken such that any damage, caused as a result of Contractor activities, can be easily identified. These photos shall be taken before ANY vehicle traffic to any sites and before commencement of work at any site. These photos shall be provided to the Employer in digital format prior to commencement of site works.

The Contrator shall also take the following photos:

- Each completed excavation before the placing of reinforcement or concrete
- Finished foundation prior to backfill

Each photo to be clearly identified as to which tower (and leg where appropriate) is the subject of the photo.

3.7. Traffic Control

It is not envisaged that special traffic control measures will be required as part of this works, but the Contractor is to notify of special provisions if required.

4. SURVEYING AND SETTING OUT

4.1. General

All surveys, check surveys and setting out works shall be performed by suitably qualified, competent and experienced personnel.

4.2. Survey Verification

The Contractor is responsible for measurements and surveying to determine the locations and sizes of existing foundations on the structures to be replaced and adjacent structures. This survey is to be carried out within 4 weeks of award of the Contract, to allow accurate fabrication of the towers and confirmation of span lengths.

4.3. As-built Survey

The Contractor shall provide to the Employer, an as-built survey of the conductor and earthwire/OPGW attachment points, for the new towers and for the towers immediately before and after the new towers. This survey is to be provided in XYZ format in an Excel spreadsheet, within 4 weeks of completion of the works.

5. DISMANTLING

5.1. General

The Contractor shall dismantle the structures as detailed in the schedule.

An evaluation of each structure shall be made by the Contractor to determine the appropriate methodology for the works, incorporating the Engineer assessment.

At the completion of the dismantling works, the Contractor must diligently inspect the site to ensure that no tower bolts are left anywhere on the site. Tower bolts, nuts and washers etc. must not be buried anywhere on the site. The site must be left in a condition that is satisfactory to the Stakeholder.

6. FOUNDATIONS

6.1. General

Before commencing any foundation work, the Contractor shall present to the Engineer an appropriate Inspection and Test Plan (ITP) covering all aspects of the work including the following Engineer's hold and witness points.

6.2. Soil Conditions

Where actual foundation conditions are found to vary from those indicated on the drawings or the foundation cannot be constructed as designed for any reason, the Contractor shall advise the Engineer before proceeding.

The Contractor shall record the classification of the soil at each tower site in accordance with the following criteria. This classification is with respect to the natural soil – not the backfill above any grillages.

The information shall be included on the as-built drawings:

Weak Soft Cohesive Soil: Easily moulded by fingers, Scala Penetrometer values < 5 blows / 300 mm

Medium Firm Cohesive Soil: Moulded by strong pressure of fingers, Scala Penetrometer values between 5 to 10 blows / 300 mm

Strong Stiff Cohesive Soil: Dented by strong pressure of fingers, Scala Penetrometer values > 10 blows / 300 mm

Weak Loose Granular Soil: Scala Penetrometer values < 10 blows / 300 mm, Easily penetrated with 12 mm rod pushed by hand.

Medium Dense Granular Soil: Scala Penetrometer values 10 to 30 blows / 300 mm, Easily penetrated with 12 mm rod driven with 2.3 kg hammer

Strong Dense Granular Soil: Scala Penetrometer values > 30 blows / 300 mm, Penetrate 300 mm with 12 mm rod driven with 2.3 kg hammer

Rock

6.3. Disposal of Surplus Material

At any site, surplus excavated material, de-watering and site run-off shall be disposed of in a manner that meets the requirements of the Stakeholder, the Employer.

6.4. Safety During Excavation

Excavated holes shall be protected at all times to eliminate any danger to persons or property, including livestock. Covers shall be designed to prevent removal by children or wind, or collapse under traffic or stock. The Contractor shall ensure that appropriate measures are used at all times to protect workers from the hazards of the excavation.

6.5. Stockpiling

Stockpile excavated materials in positions such that they can be reused as backfilling or removed from Site as may be agreed with the individual Stakeholders. Excavated or other material shall not be deposited under or near an overhead electric line so as to reduce the conductor distance to ground.

6.6. Backfilling

All backfilling to foundations shall be carried out using approved compactable free-draining hard fill.

All filling shall be placed in 150 mm maximum loose thickness layers then well compacted by approved mechanical compaction equipment appropriate to the type of materials being compacted and any space limitations prevailing.

Care shall be taken during backfilling to ensure that no damage is caused to any new construction works, particularly the recently cast concrete. Backfill and compaction is to take place a minimum of 18 hours after new concrete is cast.

The backfill compaction shall be tested as directed by the Engineer.

6.7. Top Soiling and Grassing

Where suitable, excavated material shall be used for top soiling above the hard fill. If not suitable, topsoil shall be imported.

The contractor shall reinstate all surfaces as near as possible to their original profile, and shall confirm proposed grass seed type with the Stakeholder.

The Contractor may be required to install temporary fencing to enable new grass growth. Temporary fencing requirements are to be agreed with the Stakeholder. Temporary fencing must be removed when requested and to the satisfaction of the Stakeholder.

6.8. Slab and Pedestal Foundations

Slab and Pedestal foundations shall be installed in accordance with the drawings and this specification at the locations indicated in the drawings.

The pad shall be formed or the concrete placed against the in-situ soil. A construction joint formed in accordance with NZS 3109 shall be made at the slab/pedestal interface. The pedestal shall be adequately formed with either recoverable or sacrificial formers and fully supported while the concrete cures.

6.9. Painting of Stubs

The Contractor shall apply additional corrosion protection to the new stubs to 300 mm above and below the final concrete level as follows:

a) Remove any oil or grease from interface area by wiping affected surfaces with clean rags and paint thinner (using rubber gloves) or wash with detergent and rinse.
b) Lightly roughen galvanised surfaces to be painted with 150 grade sandpaper or a 3M 'Scotchbrite' scouring pad to remove any white rust or shiny surfaces and to produce a fine 'suede like' finish. Alternatively surfaces may be sweep blasted as specified in Appendix I of AS/NZS 4680:2006. Minimise removal of zinc from edges.
c) Neatly mask the boundaries of the area to be coated and apply the approved paint system by brushing on to dry surfaces free from dust or any other contaminants. Coating to be stored, mixed, and applied strictly as recommended by the manufacturer. Likewise, the manufacturers' recommendations shall be adhered to with regard to curing times between coats and prior to encasing in concrete.
d) Where the concrete interface occurs at a splice in the steelwork; the paint shall extend at least 75 mm above the splice or 150 mm above the concrete interface, whichever is greatest. All surfaces within 150 mm of the interface are to be coated prior to bolting except for contact (faying) surfaces which shall be masked off to between 5 and 10 mm of the edges.

Coat any splice bolts at the interface after assembly/erection and allow curing before placement of concrete.

Approved paint systems for protection of the interface include:

- High-build high-solids epoxy recommended by an APAS recognised manufacturer for direct application to prepared galvanising (e.g. Altex Coatings 'Bar-Rust 236'). Apply two heavy coats to give a minimum of 200 microns total DFT.
- Epoxy system consisting of inhibited primer recommended by an APAS recognised manufacturer for application to prepared galvanising and their high-build epoxy finish coat (e.g. Altex Coatings 'Devran 201' and 'Altra~Tar'). Apply a coat of each to give a minimum of 200 microns total DFT.

High-build epoxy finish coatings used as a barrier to protect against corrosion at the interface shall not contain metallic pigmentation (e.g. Aluminium).

6.10. Stub Setting

The accurate setting of a tower's foundation stub legs is paramount and must strictly follow the manufacturer's drawings and meet the tolerances set out below so as no additional stresses are induced in the structure and reduce its strength capacity.

Regardless of foundation type the use of a robust setting jig suitable for both the type of excavation and the size of stub leg shall be designed and approved prior to use.

The contractor shall supply a methodology for all aspects of foundation construction and with a specific section on the actual setting of the tower stub legs, as a minimum this will describe how each of the following will be achieved:

- Distance measurement on plan form for both level and split level sites
- Orientation, the position of the stub legs to reflect whether the tower is in a straight line or on an angle to the two adjacent towers
- The rake of the stub leg
- Verticality or lateral rake
- Level, for both flat and split level sites
- Individual leg "slew", consideration that even with lateral and compound rake the leg is square to its adjacent legs.

The methodology shall emphasize what equipment, backup check methods and personnel requirements are required to achieve the specification.

6.11. Foundation Resistivity Testing

The Contractor shall carry out testing of footing resistances at all sites following installation of the foundations. Testing is to be carried out after three months to allow for the soils to consolidate. Refer to TP.SS 02.17 Part B Appendix E for the test method. The Contractor shall provide to the Engineer full details of the testing at each site. If testing finds that the foundation resistance exceeds 10Ω, additional earthing may be required. If this is the case the Engineer must be notified immediately.

7. CONCRETE WORKS

7.1. General

This section comprises the supply of concrete materials and plant, the supply, bending, and fixing of reinforcement, the supply and construction of form work, the supply, fabrication and installation of cast-in items and the casting, finishing and curing of concrete for all reinforced concrete structures in this contract, where and as shown in the documents.

Unless otherwise specified or otherwise shown on the drawings all reinforced concrete work shall be carried out in strict accordance with NZS 3109 Specification for Concrete Construction.

Lime in concrete is highly alkaline and toxic in water bodies. All concrete wastewater should be prevented from reaching water bodies. Concrete wastewater should be collected prior to disposal by a liquid waste disposal contractor. Dry sediment should be collected and disposed with clean/hard fill. Delivery machinery should be cleaned at their depot.

Refer also the concrete and related notes on the Drawings.

7.2. Cement

Cement shall be ordinary Portland Cement, complying with NZS 3122.

If requested, the Contractor shall provide the test certificate produced by the cement manufacturer for each and every consignment of cement that has been delivered for use in the Works or used in batching the concrete supplied. The certification shall include positive identification of the individual batch of cement, with special reference to the date of manufacture.

No cement that is older than three months shall be used in the Works without the written consent of the Engineer, and under no circumstances whatsoever shall any that is older than six months be used.

7.3. Aggregates

Aggregates shall comply with NZS 3121. Aggregates derived from Andesite rock shall not be used in the Works.

The nominal maximum size of aggregates for reinforced concrete shall be 20 mm.

7.4. Reinforcement

Reinforcing bars shall be either Grade 300E or Grade 500E to AS/NZS 4671, as designated on the drawings. All bends, hooks, splices, and the like shall be made in accordance with NZS 3109. Unless specifically detailed otherwise on the drawings, all reinforcing bars shall be deformed.

Welded wire mesh reinforcement shall conform to the requirements of AS/NZS 4671 and shall have a 0.2 % proof stress of not less than 480 MPa.

If reinforcing bars are welded together, only low-hydrogen electrodes shall be used. The Contractor shall have their reinforcing Supplier confirm the proposed electrodes are suitable. Welding shall not be carried out within 150 mm of a bend in a reinforcing bar.

7.5. Admixtures

An approved air entraining agent, complying with NZS 3113, shall be incorporated in the concrete mix. Use of the air entraining agent shall conform strictly with the recommendations and (unless, contrary to explicit recommendations of the manufacturer) also with the commendations contained in Committee Report No. ACI 212.1R-81 published by the American Concrete Institute.
No other admixture than the above mentioned air entraining agent shall be used unless prior approval in writing is obtained by the Contractor from the Engineer. Such approval shall in turn be subject to the Contractor submitting a written request to the Engineer, fully detailing the reasons for wanting to use the admixtures, their properties, and their proposed quantities and mixing procedures.

7.6. Chlorides

The calculated total chloride content of reinforced concrete as defined in NZS 3109 shall not exceed 0.8 kg/m3 of concrete.

7.7. Concrete Quality

Unless specified otherwise herein or indicated otherwise on the Drawings, all concrete shall be at least High Grade, complying with NZS 3104, with a minimum specified compressive strength at 28 days as shown on the drawings.

Maximum nominated slump shall not exceed the values specified on the drawings.

7.8. Concrete Mix Design

The Contractor shall submit the concrete mix designs for all different proposed mixes and for all proposed concrete batching plants to the Engineer for approval prior to commencing work on site.

Mix design shall take account of construction methodology, including but not limited to:

- Concrete placement techniques;
- Distance from batching plant to site; and,
- Required surface finishing.

7.9. Formwork

Formwork shall conform as follows:

Design:
The Contractor shall be responsible for the design of all formwork and secondary support structures to meet the requirements of NZS 3109.

Finishes:
Formed surfaces shall be as specified on the drawings. All defects shall be repaired to give the surface specified. The cost of all repairs shall be included in the tendered rates.

Formwork is to be braced and tied together in accordance with NZS 3109.

In addition to the requirements of NZS 3109, all reinforcement shall be accurately positioned and supported by one of the following methods, as applicable:

- Plastic spacers, manufactured for the correct bar diameter and cover
- Concrete cubes of an appropriate size to suit the cover, and with a 28 day compressive strength of 30MPa.
- Steel saddles and spacers, minimum 6 mm diameter plain round, between double layers of steel.

The distribution of the above spacers shall depend on bar sizes and bar spacing but shall be sufficient in every case to secure the reinforcement rigidly and ensure the minimum concrete cover is provided.

Any bar bending schedules required shall be provided by the Contractor. The Contractor shall be entirely responsible for the accuracy of the bar bending schedules and any effect to the Work as a result of an error in the bar bending schedule.

7.10. Concrete Cover

The minimum concrete cover to any reinforcing bar shall be as shown on the drawings.

7.11. Construction Joints

Construction joints shall not be used unless shown on the drawings or approved by the Engineer.

All unplanned Construction Joints shall be detailed on the As-built drawings.

7.12. Inspection Prior to Concreting

In addition to the provisions of NZS 3109, no concrete shall be placed until the Engineer has inspected the corresponding formwork, reinforcement, and any construction joint and foundation surfaces that may be involved.

The Contractor shall give not less than 48 hours notice to the Engineer of his intention to carry out a concreting operation.

7.13. Concrete Mixing and Records

It is anticipated that concrete will be produced close to the placement site

The mixing records at the place of concrete production shall be the minimum required by NZS 3104, and shall be immediately available to the Engineer whenever requested.

Each batch of concrete delivered to the site shall be accompanied by duplicate copies of a docket, which shall contain all the following information:

- Date and time that the batch was discharged
- Quantity delivered
- Specified strength of the concrete
- Grade of the concrete
- Slump of the mix
- Cement content in kg/m3
- A marking identifying the agitator unit delivering the concrete.

One copy of each delivery docket shall be retained by the Contractor at their site office, and be available to the Engineer within 24 hours when required.

7.14. Concrete Placement

The Contractor shall comply with the requirements of NZS 3109 and this specification.

Concrete shall be conveyed from the mixer or agitator truck to the foundation as rapidly as possible and in a manner that prevents segregation. All concrete shall be placed using a flexible drop chute, with a maximum free fall of 1.5 m, or a pump. Where possible, holes shall be de-watered before placing concrete. Where this cannot be achieved, concrete shall be placed using proven underwater placing techniques in compliance with clause 7.5 of NZS 3109.

Excavations shall be cleared of all debris prior to concrete placement.

Concrete shall be placed in layers not more than 0.5 m deep and compacted using a vibrator before subsequent layers are placed. Concrete for each foundation shall where possible be placed in one continuous pour, with no more than 45 minutes between layers.

All concrete shall be properly compacted to remove entrapped air. In particular, the concrete shall be well compacted around the grillage base and the shear keys.
Dirt, water and debris shall be removed from the top of the concrete so as to leave a sound surface. Where a hole is shored, the shoring shall be withdrawn as the concrete is placed to ensure that material from the hole walls, including water, does not fall onto or contaminate the concrete. The Contractor shall ensure the method of withdrawing the shoring avoids any sudden upward movement. Any concrete within the casing must not be so compacted so that the concrete column may break when the casing is lifted. Each time the shoring is lifted the concrete below the casing must be vibrated to at least the depth that the shoring was before it was lifted.

Water shall not be added to the mixed concrete, except under controlled circumstances as detailed in NZS 3104.

Where concrete requires compaction, vibrators shall be used in accordance with NZS 3109.

7.15. Surface Finishes

Unless otherwise specified on the drawings, finishes to concrete surfaces shall be one of the following Classes to NZS 3114 as directed:

Formed surfaces covered by backfill:	F1
Formed surfaces exposed to view:	F3

All exposed corners of concrete foundations shall have 25 mm x 25 mm chamfers or fillets.

The Contractor should discuss with the Stakeholder if they require any above ground exposed corners of concrete to be “rounded-off”. This is particularly important if horses or livestock are likely to come into contact with the exposed concrete.

The repair of minor surface defects and structural defects shall be in accordance with the requirements of NZS 3109.

7.16. Removal of Formwork

Unless otherwise approved by the Engineer, formwork shall not be removed until the minimum periods set down in NZS 3109 have elapsed.

7.17. Concrete Curing

All concrete shall be continuously cured for a minimum of 7 days in accordance with NZS 3109 and the drawings. Where the size of the slab is significant, the slab shall be covered with wet sacking for the curing period. The sacking should be covered with polythene or equivalent and thoroughly weighed down.

7.18. Embedded Items

In addition to the provisions of NZS 3109 the Contractor shall make provision for, and shall accurately cast or drill into concrete, all necessary bolts, brackets, and fastenings and other such devices as may be required. Such devices may be required for new steelwork, formwork, screens, miscellaneous steelwork, pipe work, brackets, electrical items (e.g. junction boxes), handrails, ladders and similar items. The Contractor shall coordinate with the various sub-trades to ensure accurate positioning and sizing of all fixings.

Holding down bolts shall be firmly fixed in the configuration in which they are to be installed as shown on the drawings. The upper ends shall be attached to a rigid template, which will be used to fix the holding down bolts in the correct position, orientation, configuration and level.

The tolerances of bolt cages shall be in accordance with the drawings. Under no circumstances shall the galvanising be removed from the holding down bolt threads. Cover and protect threads during concrete placement. Ensure they are left clean and ready for pole erection.

7.19. Concreting of Built-in Parts

The concreting methods adopted for the building in of plates, anchors, etc. shall be such as to ensure that the concrete is well compacted without risk of displacing the built-in parts. Lift heights shall be limited to those that will allow satisfactory placement. Concrete shall be placed carefully and compacted so that no air voids exist between the concrete and access for placing and compacting.

7.20. Testing of Concrete

The cost of testing for both slump and compressive strength, according to the routine and number of test specimens described in NZS 3109, shall be included in the rates for the supply and placement of concrete.
As a minimum, the following number of tests is required per batch:

- One seven day concrete test
- Two 28-day concrete tests.

The Engineer shall be entitled to have additional testing carried out on any hardened concrete. If, from concrete aged 28 days or more, the average compressive strength from the additional tests fails to meet the requirements of NZS 3109, then the full cost of such additional testing (together with the cost of obtaining the test specimens) shall be borne by the Contractor.

8. TOWER INSTALLATION

8.1. General

Towers shall be erected in accordance with the drawings.

At least 14 days prior to the planned erection commencement date, the Contractor shall provide the Engineer with a copy of the proposed tower erection procedures.

Tower erection shall not commence until at least 14 days after the foundation concrete is placed unless the required compressive strength is proven.

Prior to any tower erection taking place the contractor shall provide evidence a lift plan has been written and reviewed by a competent Engineer. As a minimum the lift plan will describe a methodology for ensuring:

- Sub-assembly weights are known and within safe working capacity of the lifting mechanism whether it be by crane, helicopter or other means i.e. gin pole.
- All slings shackles and other lift devices are rated and within recommended safety limits.
- The position of slings has been analysed so as not to induce additional stress into sub-assemblies that could cause damage.
- Site layout is acknowledged for the lift method so that sub-assemblies are moved without damage if they are outside the safe range of the erection method.
- There is a method to ensure site specific hazards are encompassed into a lift plan.
- Crane pads are designed and constructed to match the size of crane and weight of proposed lifts with adequate safe margin should the weight or operating radius be exceeded. This design will need to be progressed in advance of the lift plan, but may be done in sections to reflect number of towers to be erected and variable soil conditions that may be encountered.

8.2. Tower Assembly

Due care by the Contractor is needed to ensure that the tower steel and fastener galvanising are not damaged during the transport, sorting, assembly and erection stages of the tower installation process. Any damage to the tower steel or steel galvanising shall be made good by the Contractor and to the satisfaction of the Engineer and at the expense of the Contractor.

The filing, reaming or enlarging holes in any steel member by any method is not permitted. Forced fitting of bolts, e.g. hammering is not permitted.

Tower bolts shall be installed such that the nuts are in the “up” and “out” position.

Tower bolts shall not be fully tightened prior to erection; they shall allow movement of members. Pneumatic tools to tighten bolts (e.g. rattle guns and similar devices) shall not be used as their use can damage galvanising.

8.3. Tower Erection

Erection of steel work shall be in accordance with NZS 3404:1992 and shall be carried out in such a manner that members are not over stressed or damaged. Any damaged or over stressed members as a result of the Contractor’s activities shall be replaced at the Contractor’s expense.
Before the stringing of conductors, any missing or replacement tower steel shall be installed, and the nuts of all bolts in the towers shall be tightened to the required specification.
After a minimum period of 2 weeks and after the time of clamping and terminating of the conductors in the relevant strain sections, all bolts in the strain and angle suspension towers shall be re-tightened to the required specification.

8.4. Climbing Deterrent Frames

Climbing Deterrent Frames shall be installed at the completion of the tower erection in accordance with TP.SS 02.14.

8.5. Fall Arrest System

The specified fall arrest system shall be installed at the completion of tower erection in accordance with the manufacturer's instructions/requirements.

8.6. Structure Signage

The Contractor shall supply and install all new signage to match existing signage on the line.

Signage shall be installed before the commissioning of the line.

The Engineer will provide final structure numbering and circuit names before signage fabrication commences.

9. INSTALLATION OF CONDUCTORS

9.1. General

The Contractor shall install all conductors, insulators, fittings and attachments in the locations and to the tensions indicated in this Specification.

All conductor stringing practices and insulator handling methods shall be such that damage to conductors and insulators is prevented and loadings on towers are limited to less than those allowed.

When stringing over public areas, precautions shall be taken to mitigate the risk of injury to members of the public. This may involve preventing access to the site in some cases.

The Contractor shall carry out all stringing activities in accordance with Contractor developed and approved work instructions, procedures or method statements. These shall relate to the specific transmission line to be wired, equipment and tooling to be used, and shall detail the intended method of hanging running blocks and insulators, running of pull rope and conductor, proposed pulling tensions and method of monitoring, the applied loads arising from the conductor stringing operation compared with the allowable loads on the towers, and precautions to be taken to ensure the safety of the operation. At least 14 days before the Contractor's planned commencement of stringing the Contractor shall provide the Engineer with a copy of all applicable work procedures.

Any damage to conductor, insulators or fittings incurred during handling or installation shall be repaired or replaced at the Contractor's expense.

9.2. Care of Insulators

Particular care shall be taken to ensure that insulators are not damaged during the reconductoring process. Composite post insulators are particularly susceptible to damage. Temporary protective covers should be installed where there is a risk of damage.

9.3. Care of Conductors

All installed conductor shall be clean and free from damage and defects.

The Contractor shall take precautions to prevent damage to conductor during lifting, handling or installation processes. The Contractor's installation methods shall include precautions to prevent damage to conductor from abrasion, over stressing through bending or over tensioning, movement of lays, bird caging or impact. Vehicles shall not be permitted to drive over unprotected conductor.

Damaged conductor shall be replaced.

9.4. Stringing Equipment Requirements

The dimensions and configurations of tensioner bullwheels, conductor stringing pulleys and other such equipment shall generally comply with the requirements of IEEE standard 524:2003 unless otherwise approved by the Engineer. The Contractor shall provide equipment specification details and inspection sheets to the Engineer on request, or if any equipment intended for use is at variance with the above.

The Contractor shall provide evidence that equipment is rated to operate at the required loadings and test certificates not more than 30 days old verifying the current condition shall be provided upon request by the Engineer.

Stringing pulley grooves shall be free of burrs and shall be suitable to take the pulling bearing pressures.

The Contractor shall maintain live communications between operators and observers along the wiring run, and have a fully operational back up system.

9.5. Conductor Stringing

All conductors shall be strung by the tension stringing method.

Pull rope shall be a spin resistant, non-rotating type of appropriate rating to safely handle the applied loads. Pull rope shall be thoroughly inspected for mechanical damage before use. Synthetic pull rope over two years old shall only be used where its tensile strength has been confirmed as adequate by destructive test by a certified testing laboratory within the previous six months. Evidence of date of purchase, test certificates and inspection records shall be made available to the Engineer on request.

During pulling of conductor at a site adjacent to or crossed by other in-service power lines or when the line could inadvertently be livened through any means a temporary earth grid shall be formed. All plant shall be electrical boded to the grid in a manner that eliminates possible step-and-touch potential differences at the site, should the plant be accidentally livened. The perimeter of the effective earth grid site shall be fenced to avoid accidental ingress and one designated point of entry provided which shall provide an electrically safe access from the zone outside of the earth grid to the zone protected by the earth grid**.** Running earths shall be applied to the conductor in accordance with TP Standards. Temporary earthing shall be applied at structures when clamping in if there is discomfort to workers due to induction voltages.

Secondary (backup) conductor holding mechanisms for tensioned conductors shall be used when conductors are held on construction tools.

9.6. Stringing OPGW

OPGW shall be installed strictly in accordance with the manufacturer's specifications and installation instructions. The installation contractor's comprehensive methodology shall be submitted to the Principles Representative in a timely manner prior to the work commencing.

9.7. Vegetation

Within seven days of clamping in conductors on any section of the line, the Contractor shall inspect that section of line and provide a report to the Employer that identifies any instances of vegetation clearance that do not comply with statutory clearance requirements.

9.8. Line Crossings over Other Services

Where the transmission line crosses any other overhead line, road, railway or any other service or utility whatsoever, the Contractor shall make all arrangements and obtain any permits and approvals necessary from the owner of the service being crossed. The Contractor shall comply with all requirements of that owner, including hazard control requirements, for the erection of the transmission line across that service.

The cost of any fees or services provided by the owners of other utilities that result from the crossing of their utility shall be met by the Contractor.

The Contractor shall plan his work in a way that causes minimum disruption to the owners and users of other services.

Temporary structures such as scaffolding , hurdles, nets and support structures used as a means of protecting the conductor or other services or facilities crossed by the conductor shall be designed and constructed to withstand the maximum potential service loads with an applied factor of safety of two. The Contractor shall provide the Engineer with design information for any temporary structures, including the maximum allowable loads, the method of calculation, assumptions made and structural details, on request.

9.9. Anchors, Guys and Makeoffs

Anchors used to restrain pullers and tensioners or to temporarily restrain conductor shall have a minimum factor of safety of two on the loads applied.

The use of structure bases or foundations shall not be permitted unless approved by the Engineer.

Tensioned conductors shall be made off with two bolted come-alongs linked by an equalising pulley. In areas easily accessible to the public a chicago grip shall also be fitted and connected directly to the anchor at reduced tension. All grips shall be at least 2m from the end of the conductor and shall be a minimum of 5m from the anchor.

9.10. Conductor Sagging

The Contractor shall sag the conductor in accordance with the tension shown on the drawings.

Immediately after any section of line has been sagged and clamped, the tension of the conductor shall be within -0% and +3% of the design tension. The sag of any one conductor in spans other than terminal spans shall not depart by more than 150mm from the mean sag of all conductors in the span.

The conductor temperature at sagging shall be determined by averaging the temperature of the conductor at either end of the span to be sagged or from lengths of similar conductor suspended from the tower at a similar elevation to the conductor being sagged.

The Contractor shall record and supply with the quality records the actual sagging details such as: method of sagging, sagging temperature, instrument location and settings, sufficient to allow repeat observations.

9.11. Conductor Clamping

Conductors shall be clamped at suspension structures such that at 20 degrees C and under no wind, suspension strings hang plumb apart from any deflection due to turn off angle. The Contractor shall determine clamping offsets as necessary. Armour rods shall be applied in accordance with the manufacturer's instructions and centred to within 10mm of the center of the suspension clamp. The quality documentation shall indicate clamping offset dimensions, the method of calculation and confirm their application.

9.12. Vibration Dampers

The number, location and installation of vibration dampers for each span shall be in accordance with the damper installation schedule.

Care shall be taken during fitting of dampers not to crush or damage conductor strands. All bolts shall be tightened using torque wrenches that have been calibrated immediately prior to use on this project. Torque wrenches shall be recalibrated following any significant drop or impact and no less than once a week during the course of the work..

9.13. Compression Joints and Dead Ends

Jointing and dead ending of conductor shall comply fully with industry Standards. There shall be no mid span joint within 5m of a suspension clamp or within 10m of a dead end joint. There shall be no more than one mid span joint in each conductor in any one span without prior approval of the Engineer.

Compressors and dies used for making compression joints shall be tested, and the sample joints tested to ensure that they meet the required electrical and mechanical test parameters, a minimum of 7 days prior to the undertaking the permanent works.

All compression joints shall be tested after completion of the works. The Contractor will be responsible for replacing any joints that fail testing.

The Contractor shall:

- Prepare a full written procedure that includes a time scale, for the work to be completed, and provide a copy to the Engineer for information, as part of their Tender.
- Have at least one spare fully operational compressor with appropriate dies at each location that pressing is to be carried out.
- Have at least two spare compression fittings of each type of fitting to be applied, at each location that pressing is carried out.

10. INSPECTION AND COMMISSIONING

10.1. General

The Contractor is responsible for developing and implementing a commissioning plan.

Prior to the issue of the Operational Acceptance Certificate, the Engineer's Representative shall undertake a visual inspection of the line and any other electrical tests deemed necessary and the Contractor shall undertake the rectification of any defects to the satisfaction of the Engineer.

10.2. Livening

Overall responsibility for commissioning the transmission line and terminations will be the responsibility of the Contractor.

10.3. Phasing

The Contractor shall connect the conductors so as to obtain the phasing to match the existing configuration.

10.4. Phase Testing

Testing of the completed transmission line shall be completed prior to commissioning of the line.

The Contractor shall complete the following tests:

a) Megger test on all phases of each circuit to detect any improper earths.

b) Resistance test to measure DC resistance between each pair of phases on each circuit.

Two copies of the test results shall be handed to the Engineer prior to the issue of the Take Over Certificate.

11. CONTRACT CLOSE-OUT

11.1. Reinstatement

The Contractor is responsible for restoring all ground within the construction area, including access tracks, to a condition equivalent to that existing before the works.

11.2. Disestablishment

All clean-up work shall be completed to return the work area and access roads to their condition prior to commencement.

11.3. As Built Drawings

As sections of work are completed a complete set of hand marked up prints of drawings for each section of work is to be prepared by the Contractor. These shall be made available throughout the course of the work.

Changes to or deviations from the approved installation drawings shall be marked up accurately in red and in such a way that they can be readily interpreted on a daily basis as the work proceeds.

One set of drawings shall be used by the Contractor specifically for recording as-built changes or deviations. This set of drawings and any additions or amendments shall be kept at all times solely for recording as-built information.

All drawings shall be stamped in the lower right hand corner of the sheet with a stamp as shown and filled in accordingly.

AS BUILT	
No Change/As Marked*	
Signed:	Date:

*Delete as appropriate.

12. CONTRACT CLOSE-OUT

12.1. Reinstatement

The Contractor is responsible for restoring all ground within the construction area, including access tracks, to a condition equivalent to that existing before the works.

APPENDIX A - DETAILED SCOPE OF WORKS

Below is a detailed scope of works for this Contract which is to be read in conjunction with the general scope items in section 1.1 of this Specification.

Item	Description	Reference Drawings
1	Measurement survey to determine the levels and relative locations of the existing Tower 1, 12 and 14 foundations on the Nadarivatu line	
2	Topographic survey to determine the ground contours at the site of Tower 82 on the Wailoa-Vuda 132kV line	NA
3	Excavate the ground, construct the foundation and backfill at the site of Tower 82 on the Wailoa-Vuda 132kV line	
4	Design, supply and installation of tower baseplate and stub legs at Towers 1, 12 and 14 on the Nadarivatu 132kV line. This requires drilling and grouting of anchors into the existing foundations.	
5	Design, fabrication, supply and installation of Towers 1, 12 and 14 on the Nadarivatu 132kV line	
6	Design, fabrication, supply and installation of Tower 82 on the Wailoa-Vuda 132kV line	
7	Load testing of one tower to 95% ULS Loading	
8	Supply and install insulators and associated hardware to attach to the conductor and tower at Towers 1, 12 and 14 on the Nadarivatu 132kV line	
9	Supply and install insulators and associated hardware to attach to the conductor and tower at Tower 82 on the Wailoa-Vuda 132kV line	
10	Supply and install new Grape ACSR conductors (6 phases) between Towers 1 and the power station gantry on the Nadarivatu 132kV line, connecting to Towers 1 and the power station gantry with full tension compression dead-ends	
11	Supply and install 50m per phase (6 phases) of new Grape ACSR conductors from Tower 1, in the span to Tower 2 on the Nadarivatu 132kV line, connecting to the existing conductor and tower 1 with full tension compression joints and dead-ends	
12	Supply and install 50m per phase (6 phases) of new Grape ACSR conductors (12 lengths total) from Tower 12, in the spans to T10 and T13 on the Nadarivatu 132kV line, connecting to the existing conductor with full tension compression joints	
13	Lower the existing Grape ACSR conductors (6 phases) close to ground at T14 on the Nadarivatu 132kV line, and lifting onto the replacement tower. This is likely to require pulling away from the tower to avoid conductor damage.	
14	Supply and install new Grape ACSR conductors (3 phases) between Towers 80 and 83 on the Wailoa-Vuda 132kV line, connecting to Towers T80, T82 and T83 with full tension compression dead-ends	

Item	Description	Reference Drawings
15	Supply and install new OPGW between Towers 1 and the power station gantry on the Nadarivatu 132kV line, connecting to Towers 1 and the power station gantry with tension dead-ends and joint boxes	
16	Supply and install new OPGW between the power station gantry and Tower 2 on the Nadarivatu 132kV line, connecting to Towers 1, 2 and the power station gantry with tension dead-ends and joint boxes	
17	Supply and install new OPGW between Tower 10 and Tower 13 on the Nadarivatu 132kV line, connecting to Towers 10, 12 and 13 with tension dead-ends and joint boxes	
18	Lower the existing OPGW close to ground at T14 on the Nadarivatu 132kV line, and lifting onto the replacement tower taking care not to damage the OPGW.	
19	Supply and install new 7/3.25 SC/AC earthwire between Towers 80 and 83 on the Wailoa-Vuda 132kV line, connecting to Towers T80, T82 and T83 with tension dead-ends	
20	Supply and Install Dampers at Towers 1, 2, 10, 12, 13 and 14 on the Nadarivatu 132kV line	
21	Supply and Install Dampers at Tower 80, 82 and 83 on the Wailoa-Vuda 132kV line	
22	Topographic survey to determine the as-built conductor, OPGW and earthwire attachment points at Towers 1, 2, 10, 12, 13, 14, 15 on the Nadarivatu 132kV line and Towers 80, 82 and 83 on the Wailoa-Vuda 132kV line	

PART 7

DRAWINGS AND INFORMATION

A)– PRELIMINARY SCHEDULE OF MATERIALS

Below is a list of the required materials for construction of the line. This list excludes structure, guy and foundation materials. These will be determined as part of the detailed design.

Wailoa – Vuda T82

Material / Assembly	Quantity (* - including additional 10%)
Conductor	4350m *
Earthwire	1,450m *
Strain Insulator Assembly	12
Jumper Insulator Assembly	3
EW Strain Assembly	4

Nadarivatu

Material / Assembly	Quantity (* - including additional 10%)
Conductor	3300m *
Earthwire	800m *
OPGW	1800m *
Strain Insulator Assembly	18
Suspension Insulator Assembly	12
Jumper Insulator Assembly	6
OPGW Suspension Assembly	2
OPGW Strain Assembly	4
EW Strain Assembly	4

B) – STRUCTURE LOAD SCHEDULES - NADARIVATU

The following pages give the attachment loads for the structures. Refer to the drawings in Section D, for the locations and direction of the attachment loads.

Maximum Wind

The loads below are specified for Tower 1 and are to be applied at each conductor attachment as shown on drg. no. 13556/N/1 :

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - C1	63.2	48.3	34.1	50.4
1 - C2	51	4.2	3.3	-31.8

The loads below are specified for Tower 1 and are to be applied at each OPGW/EW attachment as shown on drg. no. 13556/N/1 :

Str #	Earthwire/OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - O	92.0	38.3	30.0	7.2
1 - E	42.6	37.4	29.3	51.7

The loads below are specified for each structure and are to be applied at each conductor attachment:

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	72.5	14.0	13.5	41.4
14	83.6	-3.0	-3.9	8.7

The loads below are specified for each structure and are to be applied at the OPGW attachment.

Str #	OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	59.1	11.9	11.7	42.6
14	69.2	-3.2	-3.5	4.1

The wind on the structure is to be 110m/s x M_zCat x M_t (1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Serviceability Wind (V_{25})

The loads below are specified for Tower 1 and are to be applied at each conductor attachment as shown on drg. no. 13556/N/1 :

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - C1	18.1	20.0	13.2	24.0
1 - C2	14.9	2.4	2.1	-17.8

Str #	Earthwire/OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - O	37.3	19.2	14.5	11.6
1 - E	25.0	18.0	14.3	25.0

The loads below are specified for each structure and are to be applied at each conductor attachment:

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	28.7	5.8	5.5	13.7
14	32.4	0.6	0.3	5.0

The loads below are specified for each structure and are to be applied at the OPGW attachment.

Str #	OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	23.6	4.8	4.7	16.2
14	27.3	0.3	0.2	3

The wind on the structure is to be 53 m/s x M_zCat x M_t (1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Broken Wire (Failure Containment)

The Broken Wire attachment loads are to be applied at the worst case scenarios for two of the conductor/OPGW attachments. The other attachments are to have the intact loading. Note that Structure 1 has two additional earthwire deadend attachment loads.

The loads below are specified for Tower 1 and are to be applied at each conductor attachment as shown on drg. no. 13556/N/1 :

Str #	Intact Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - C1	18.3	16.7	10.6	23.3
1 - C2	17.0	2.5	2.2	-13.6
Str #	**Intact EW / OPGW Attachment Loads (kN)**			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - O	35.4	28.1	0.0	7.2
1 - E	23.0	22.7	0.0	26.0
Str #	**Broken Conductor /OPGW Attachment Loads (kN)**			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1 - C1	0.0	0.0	0.0	0.0
1 - C2	0.0	0.0	0.0	0.0
1 - O	19.4	13.5	1.8	29.1

The loads below are specified for each structure and are to be applied at each conductor attachment:

Str #	Intact Conductor /OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	18.0	8.4	0.0	11.0
14	22.1	1.7	0.0	2.7

Str #	Broken Conductor /OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
12	16.0	5.0	0.0	52.1
14	11.1	2.7	-0.5	46.8

The wind on the structure is to be 55m/s x M_zCat x M_t(1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Maintenance Loading

The Maintenance Working attachment load are to be applied at the worst case scenario for one of the conductor attachments. The other attachments are to have the intact loading. Note that Structure 1 has two additional earthwire deadend attachment loads.

Str #	Working Conductor /OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1	18.5	11.1	9.5	1.3
12	1.8	4.4	4.4	0.1
14	3.1	2.1	2.0	0.1

Str #	Intact Conductor /OPGW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
1	13.8	11.1	9.5	0.9
1 - E	6.2	7.4	7.4	8.1
12	1.6	4.4	4.4	0.1
14	2.5	2.1	2.0	0.1

The wind on the structure is to be 100Pa.

C) – STRUCTURE LOAD SCHEDULES – WAILOA - VUDA

The following pages give the attachment loads for the structures. Refer to the drawings in Section C, for the locations and direction of the attachment loads.

Maximum Wind

The loads below are specified for Tower 82 and are to be applied at each conductor attachment as shown on drg. no. 13556/N/1 :

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	60.2	29.1	26.5	-60.0
82 - C2	42.1	15.0	14.4	90.0

The loads below are specified for Tower 1 and are to be applied at each EW attachment as shown on drg. no. 13556/WV/1 :

Str #	Earthwire Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - E	61.4	30.0	28.3	27.3

The wind on the structure is to be 110m/s x M_zCat x M_t (1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Serviceability Wind (V_{25})

The loads below are specified for Tower 82 and are to be applied at each conductor attachment as shown on drg. no. 13556/WV/1:

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	20.2	12.8	11.7	-63.0
82 - C2	13.7	7.2	7.0	40.9

Str #	Earthwire Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - E	21.2	14.0	13.5	11.0

The wind on the structure is to be 53 m/s x M_zCat x M_t (1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Broken Wire (Failure Containment)

The Broken Wire attachment loads are to be applied at the worst case scenarios for two of the conductor/OPGW attachments. The other attachments are to have the intact loading.

The loads below are specified for Tower 82 and are to be applied at each conductor attachment as shown on drg. no. 13556/WV/1 :

Str #	Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	15.3	10.8	10.0	-60.2
82 - C2	10.3	6.6	6.5	38.9

Str #	Intact EW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - E	16.7	11.3	10.9	11.4

Str #	Broken EW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	0.0	0.0	0.0	0.0
82 - C2	0.0	0.0	0.0	0.0
82 - E	9.7	6.7	6.4	42.7

The wind on the structure is to be 55m/s x M_zCat x M_t(1.40). M_zCat is obtained from Table 4.1 (b) of AS/NZS 1170.2, using Terrain Category 2 and height (z) equivalent to 2/3 of structure height.

Maintenance Loading

The Maintenance Working attachment load are to be applied at the worst case scenario for one of the conductor attachments. The other attachments are to have the intact loading.

Str #	Working Conductor Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	4.0	5.1	5.0	-26.1
82 - C2	4.2	4.9	4.9	26.1

Str #	Intact Conductor /EW Attachment Loads (kN)			
	Transverse	Vertical (-ve up)		Longitudinal
		Max	Min	
82 - C1	3.1	5.1	5.0	-19.5
82 - C2	3.3	4.9	4.9	19.5
82 - E	3.1	6.7	6.5	0.0

The wind on the structure is to be 100Pa.

D) – – LINES DRAWING SCHEDULE

The following pages contain the schedule of drawings for the lines component.

Fiji Tower Failures 2016
Drawing List

General

Drawings #	Description
LEH5788_1_0	10 & 20 OHM Tower Earthing

Wailoa - Vuda 132kV Line

Drawings #	Description
13556/WV/1	Tower 82 Replacement, Tower and Foundation Geometry
13556/WV/2	Tower 82 Replacement, New Foundation Details
13556/WV/RPP	Route Plan and Profile, Tower 79 to 83

Nadarivatu Power Station 132kV Line

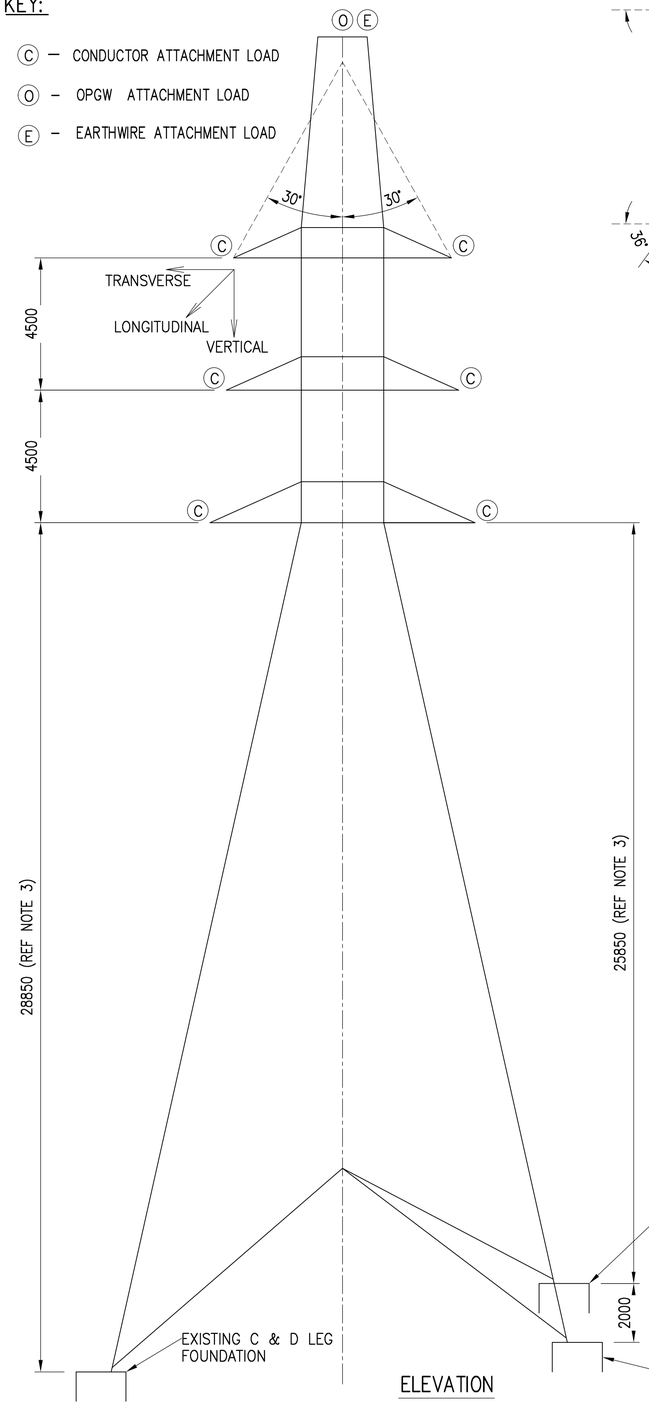
Drg. No.	Description
13556/N/1	Tower 1 Replacement, Tower and Foundation Geometry
13556/N/2	Tower 12 Replacement, Tower and Foundation Geometry
13556/N/3	Tower 14 Replacement, Tower and Foundation Geometry
13556/N/4	Towers 12 and 14, Insulator Swing Clearance Requirements
13556/N/5	Tower Foundation Anchorage, General Arrangement
LEH5788/RPP	Route Plan and Profile, Sheets 1 to 4
LEH5788_9	Tower Types TDT, TDH & TDL, Existing Foundation Type PAI

E) - TOWER GENERAL ARRANGEMENT DRAWINGS

The following pages contain the outline structure drawings applicable for the construction of the works.

KEY:

- (C) – CONDUCTOR ATTACHMENT LOAD
- (O) – OPGW ATTACHMENT LOAD
- (E) – EARTHWIRE ATTACHMENT LOAD



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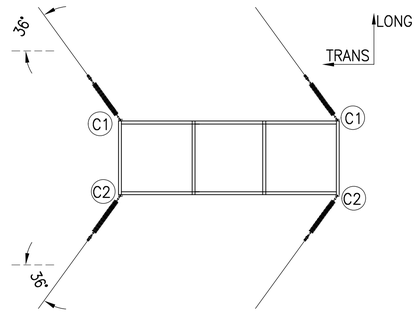
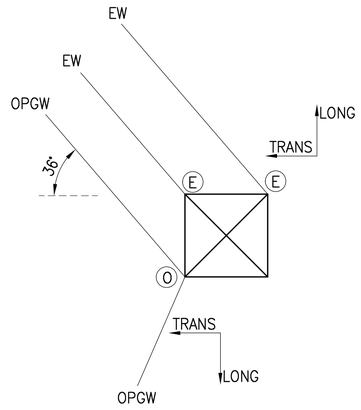
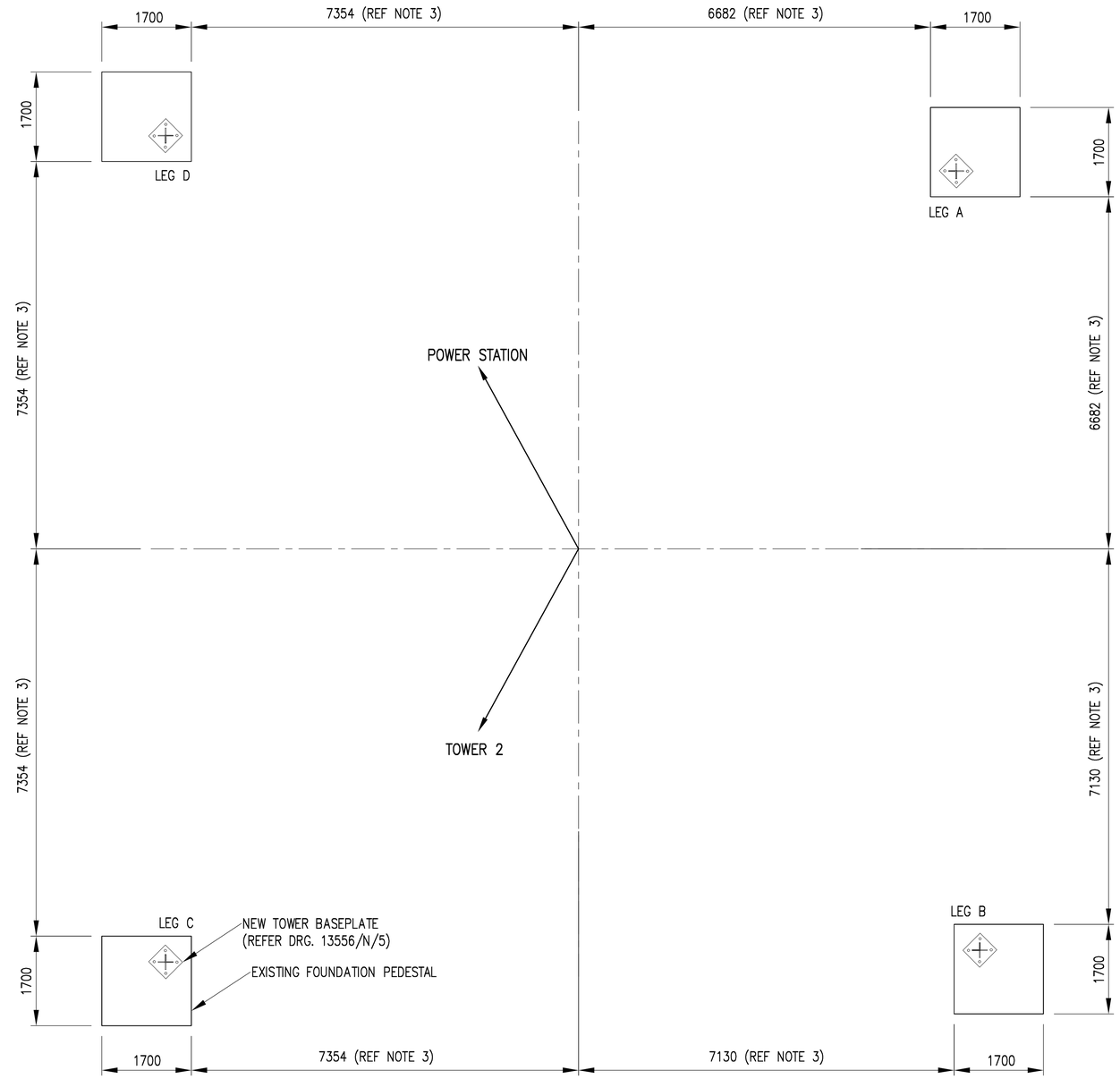


PLAN ON CROSSARM SHOWING CONDUCTOR LOAD LOCATIONS & DIRECTIONS



PLAN SHOWING EARTH PEAK LOAD LOCATIONS & DIRECTIONS



PLAN

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Dimensions are indicative and may be changed. Minor changes may be incorporated by approval.
3. Foundation locations and levels to be confirmed by the Contractor.
4. Tower geometry to be confirmed by the Contractor.
5. Refer to Tender Documents, Part 7, Section B for the tower loading.
6. Refer to drg. LEH5788_1_0 for tower earthing details.

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CONTRACT No.: MRXYZ 2016

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1	Tender Issue	–	–	–
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Nadarivatu Power Station 132kV Line

Tower 1 Replacement
Tower and Foundation Geometry

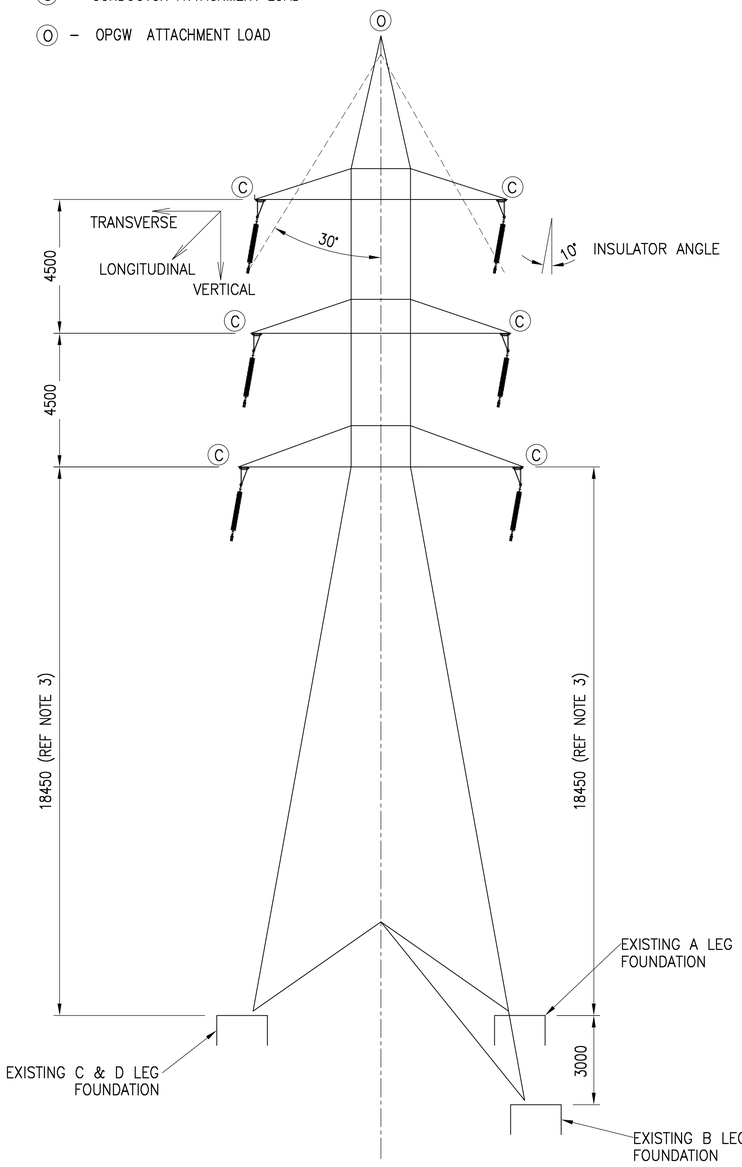
SCALE
DRAWING TYPE A3
DRAWING NUMBER 13556/N/1
REV 1
CAD FILE REFERENCE 13556-N-1

A3

KEY:

Ⓒ – CONDUCTOR ATTACHMENT LOAD

Ⓞ – OPGW ATTACHMENT LOAD



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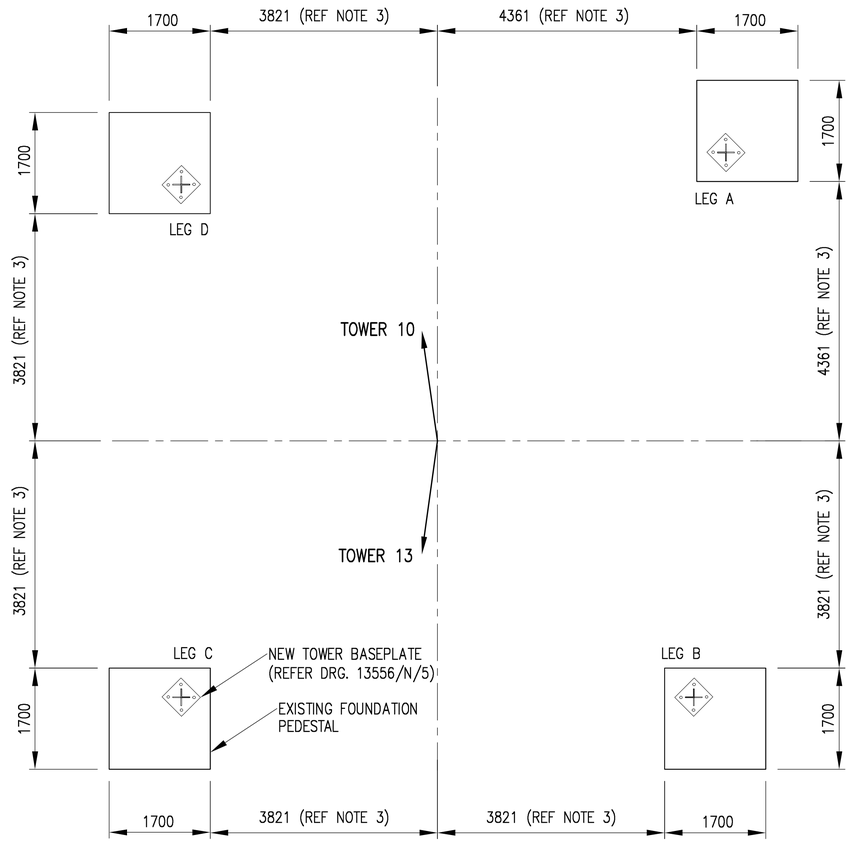

PLAN

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Dimensions are indicative and may be changed. Minor changes may be incorporated by approval.
3. Foundation locations and levels to be confirmed by the Contractor.
4. Tower geometry to be confirmed by the Contractor.
5. Refer to Tender Documents, Part 7, Section B for the tower loading.
6. Refer to drg. LEH5788_1_0 for tower earthing details.
7. Refer to drgs. 13556/N/4 for tower 12 & 14 head geometry requirements.

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Nadarivatu Power Station 132kV Line

Tower 12 Replacement
Tower and Foundation Geometry

SCALE

DRAWING TYPE A3

DRAWING NUMBER 13556/N/2

REV 1

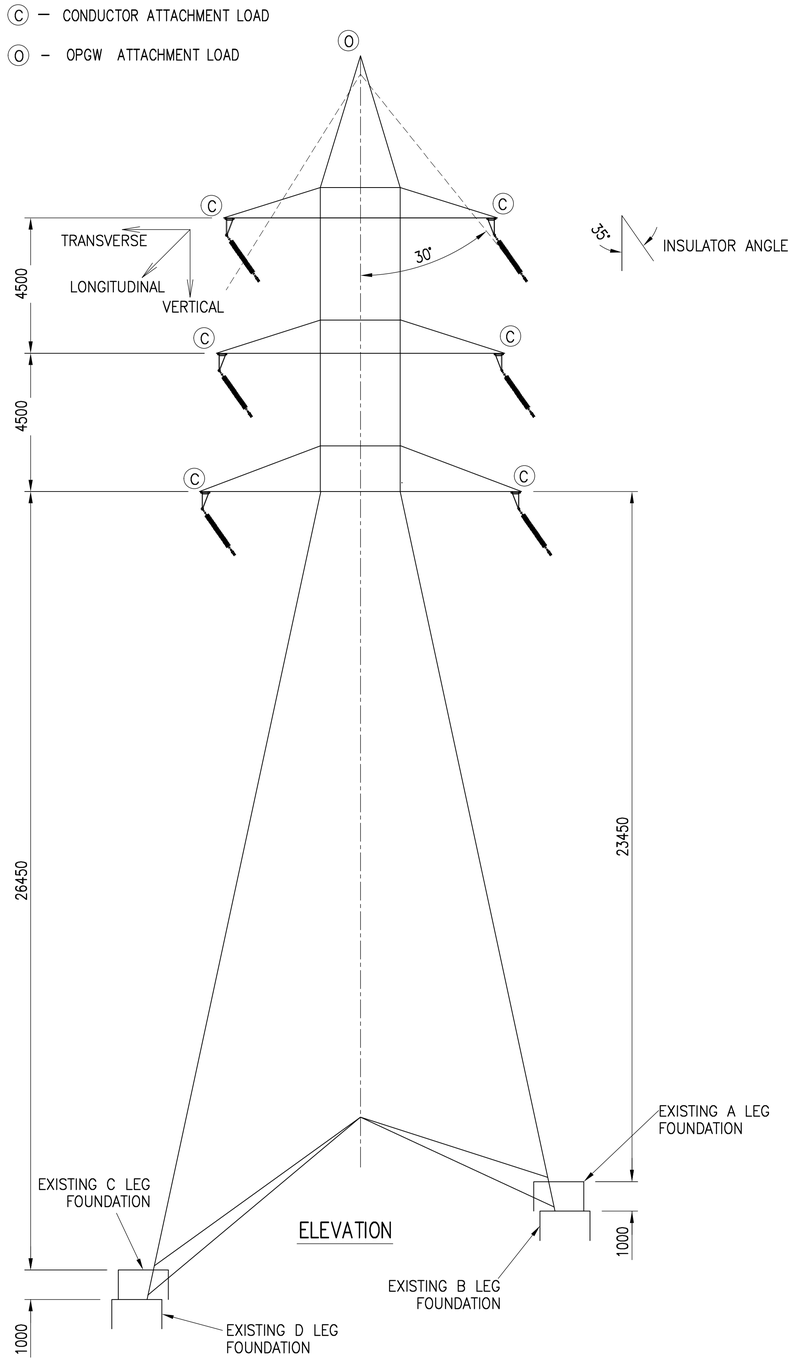
CAD FILE REFERENCE 13556-N-2

A3

KEY:

Ⓒ – CONDUCTOR ATTACHMENT LOAD

Ⓞ – OPGW ATTACHMENT LOAD



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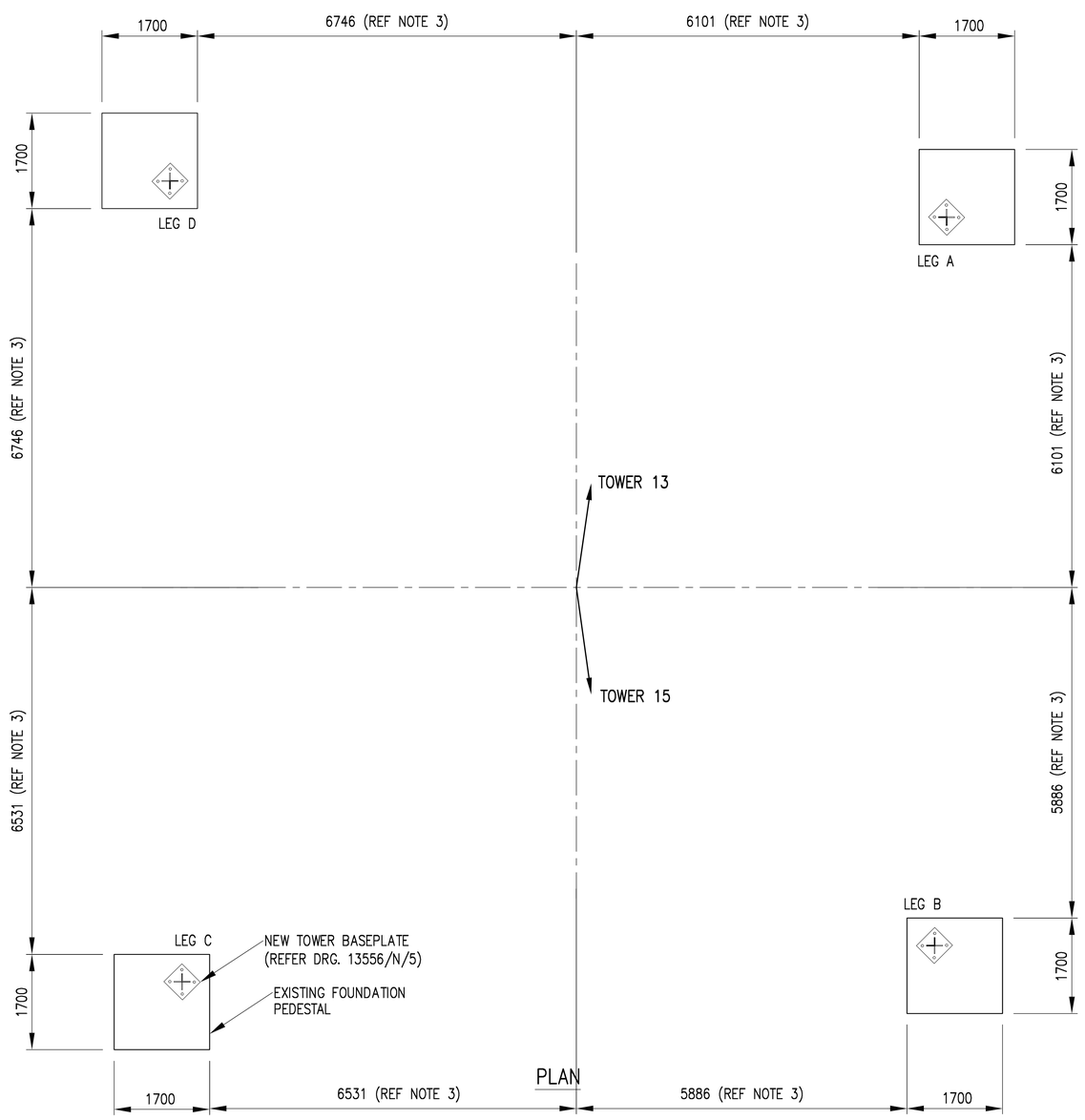

PLAN

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Dimensions are indicative and may be changed. Minor changes may be incorporated by approval.
3. Foundation locations and levels to be confirmed by the Contractor.
4. Tower geometry to be confirmed by the Contractor.
5. Refer to Tender Documents, Part 7, Section B for the tower loading.
6. Refer to drg. LEH5788_1_0 for tower earthing details.
7. Refer to drgs. 13556/N/4 for tower 12 & 14 head geometry requirements.

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CONTRACT No.: MRXYZ 2016

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Nadarivatu Power Station 132kV Line

Tower 14 Replacement
Tower and Foundation Geometry

SCALE

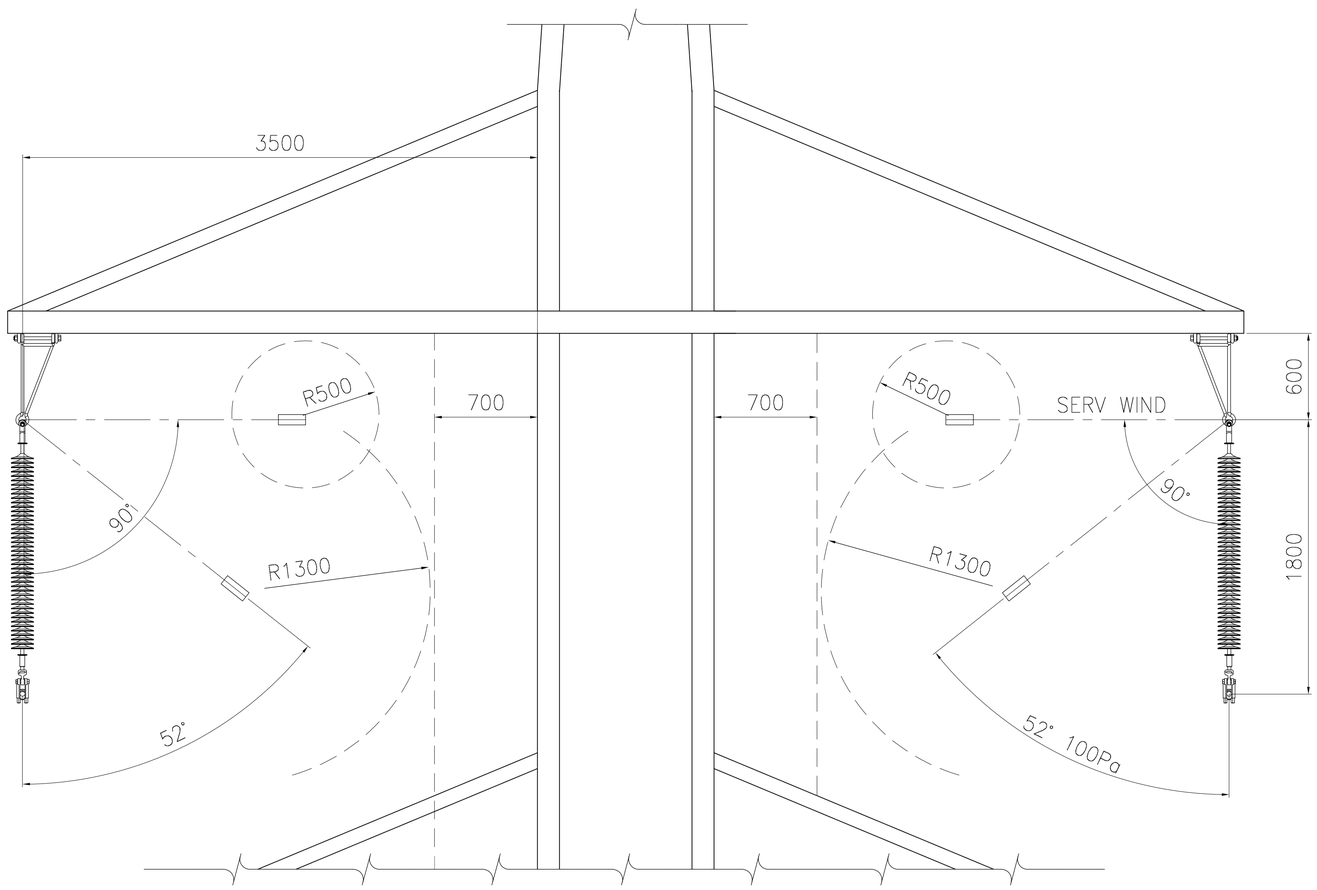
DRAWING TYPE A3

DRAWING NUMBER 13556/N/3

REV 1

CAD FILE REFERENCE 13556-N-3

A3



CLEARANCE DIAGRAM

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Tower geometry to be confirmed by the Contractor.
5. Refer to drgs. 13556/N/2 & 3 for general arrangement of towers.

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CONTRACT No.: MRXYZ 2016

REV	AMENDMENT	BY	CHKD	DATE
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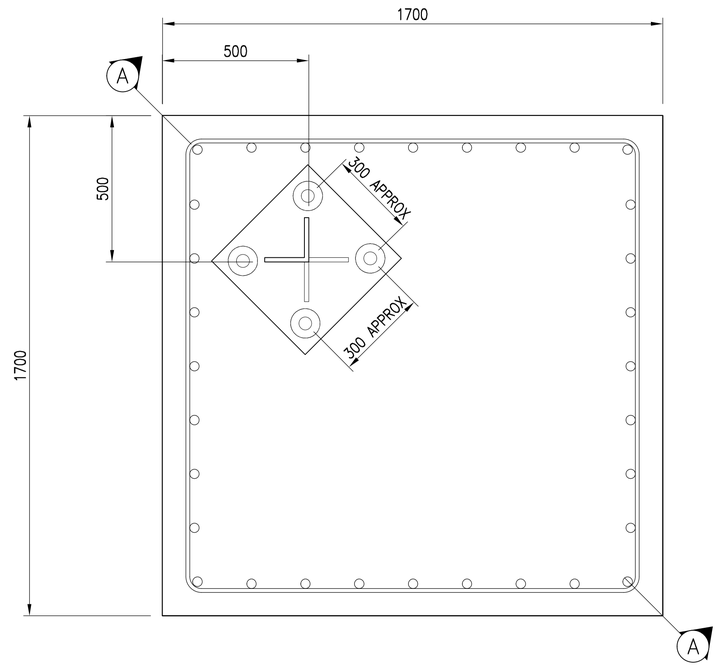
Nadarivatu Power Station 132kV Line

Towers 12 and 14
Insulator Swing Clearance Requirements

SCALE
DRAWING TYPE A3
DRAWING NUMBER 13556/N/4
REV 1
CAD FILE REFERENCE 13556-N-4

A3



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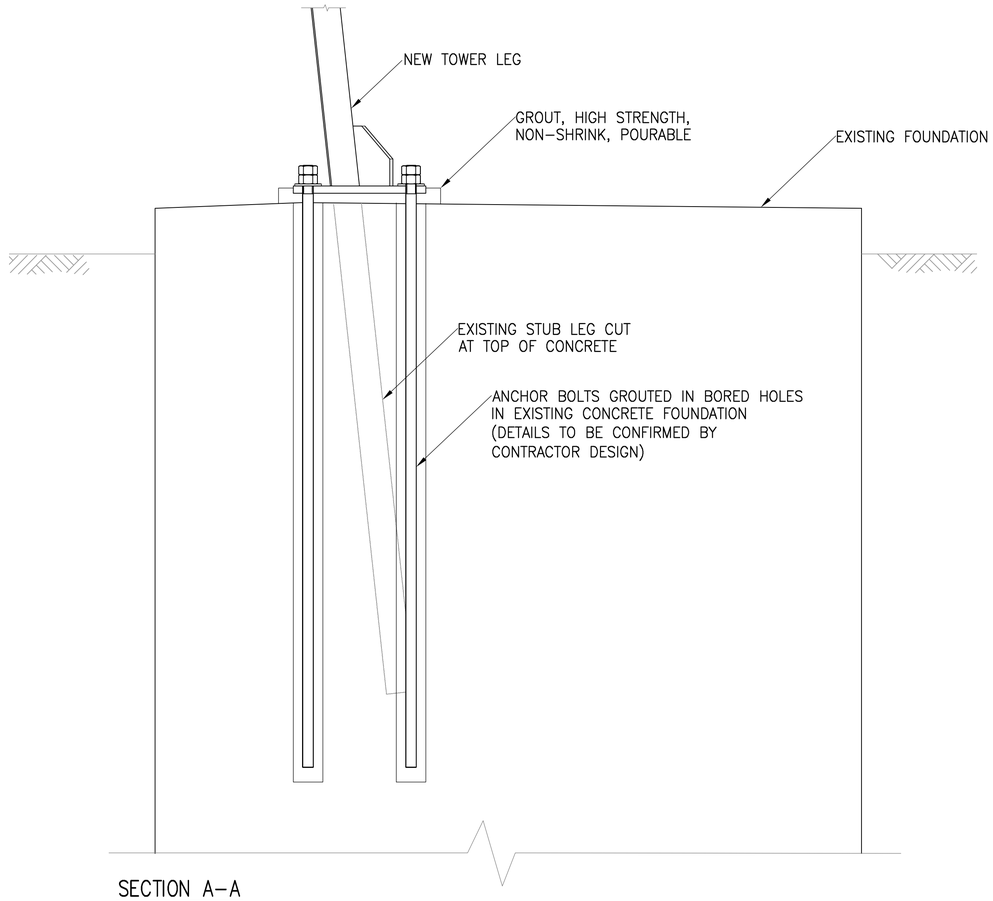

SECTION A–A

Tower 14 is in service, so likely to require an alternative solution proposed by the Contractor to allow the tower to be attached to the existing foundations within the outage duration, by strengthening or connecting away from the existing stub leg.

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Dimensions are indicative and may be changed. Minor changes may be incorporated by approval.
3. Foundation locations and levels to be confirmed by the Contractor.
4. Tower geometry to be confirmed by the Contractor.
5. Refer to Tender Documents, Part 7, Section B for the tower loading.
6. Refer to drg. LEH5788_1 for tower earthing details.
7. Refer to drgs. LEH5788_9, Sht 1 & 2 for existing foundation details.

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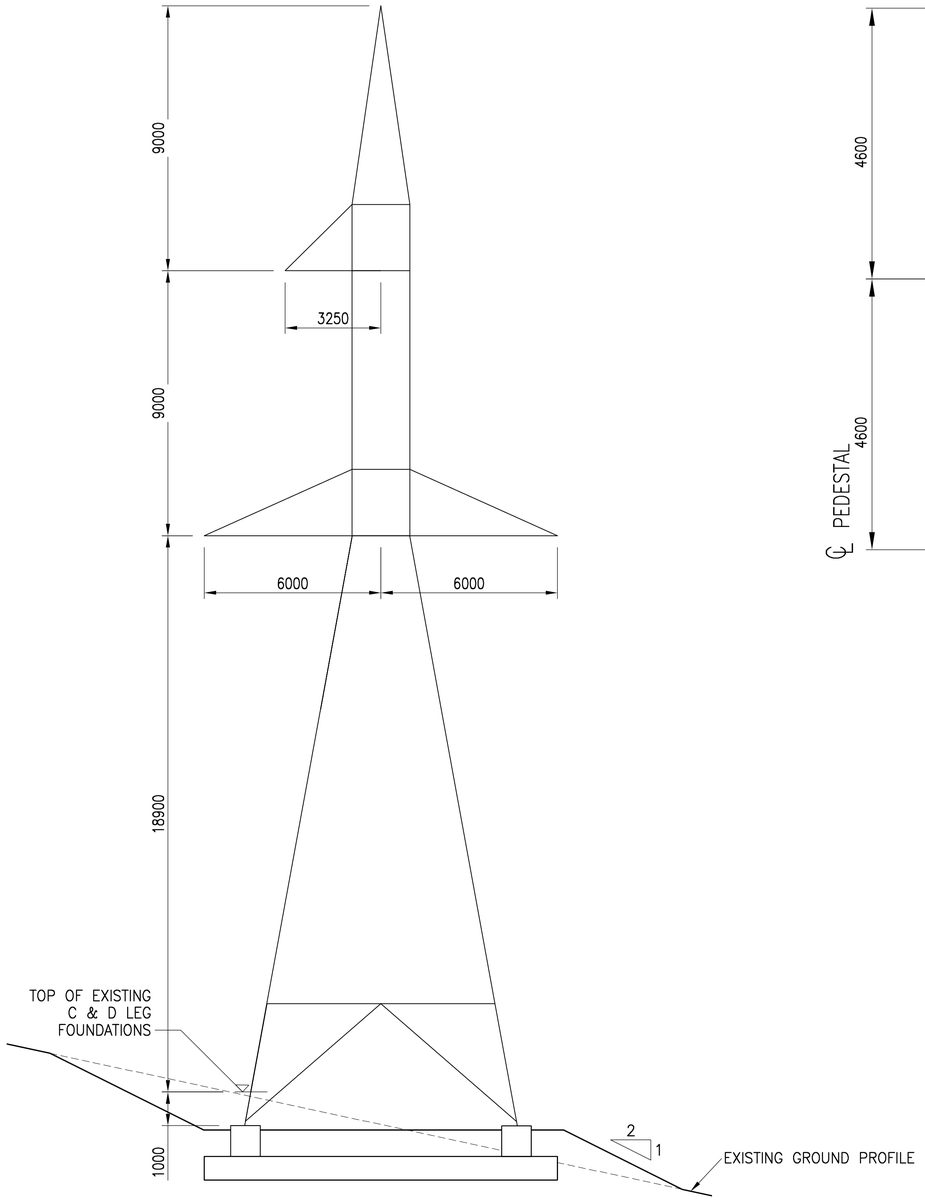
CONTRACT No.: MRXYZ 2016

Nadarivatu Power Station 132kV Line

Tower Foundation Anchorage
General Arrangement

SCALE
DRAWING TYPE A3
DRAWING NUMBER 13556/N/5
REV 1
CAD FILE REFERENCE 13556-N-5

A3



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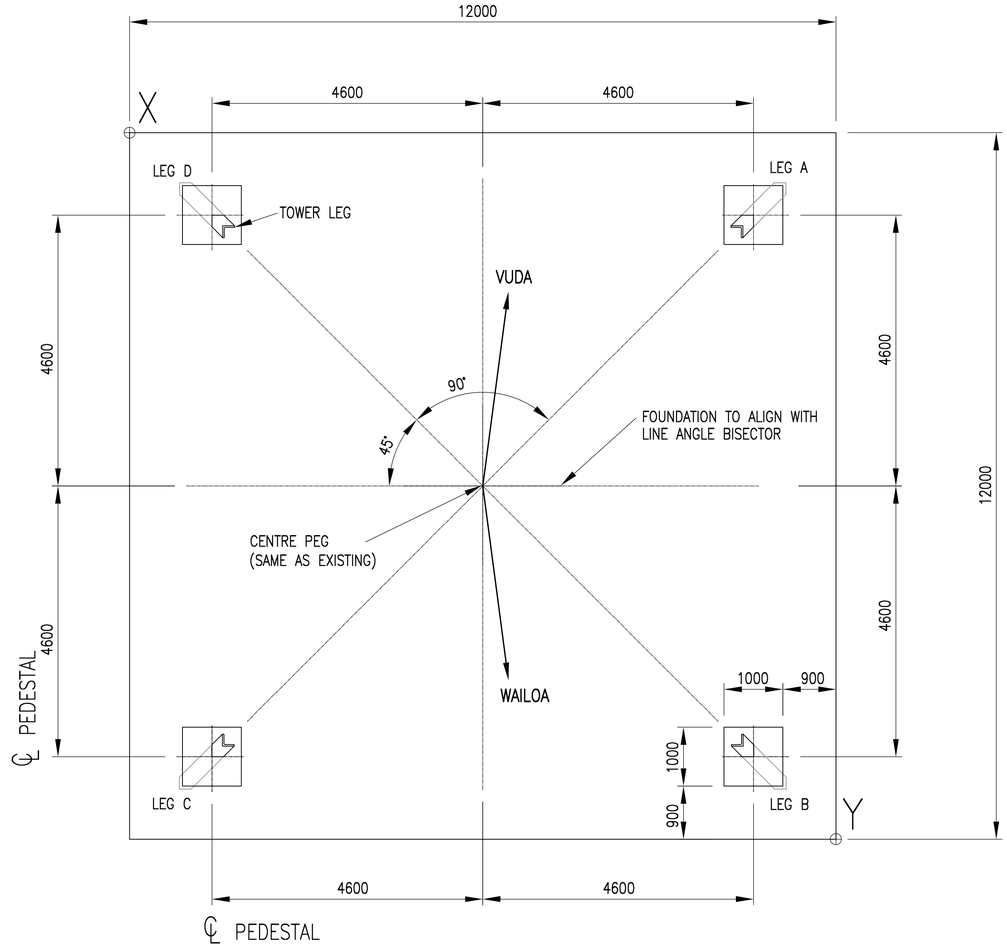

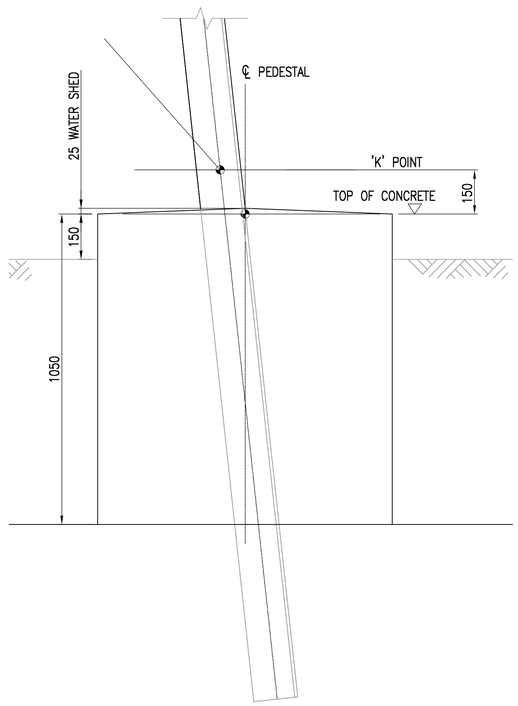

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Dimensions are indicative and may be changed. Minor changes may be incorporated by approval.
3. Foundation locations and levels to be confirmed by the Contractor.
4. Tower geometry to be confirmed by the Contractor.
5. Refer to Tender Documents, Part 7, Section B for the tower loading.
6. Foundation design to be confirmed following receipt of Tower design loads
7. Refer to drg. LEH5788_1_0 for tower earthing details.

REV	AMENDMENT	BY	CHKD	DATE	REV	AMENDMENT	BY	CHKD	DATE
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APPROVED		
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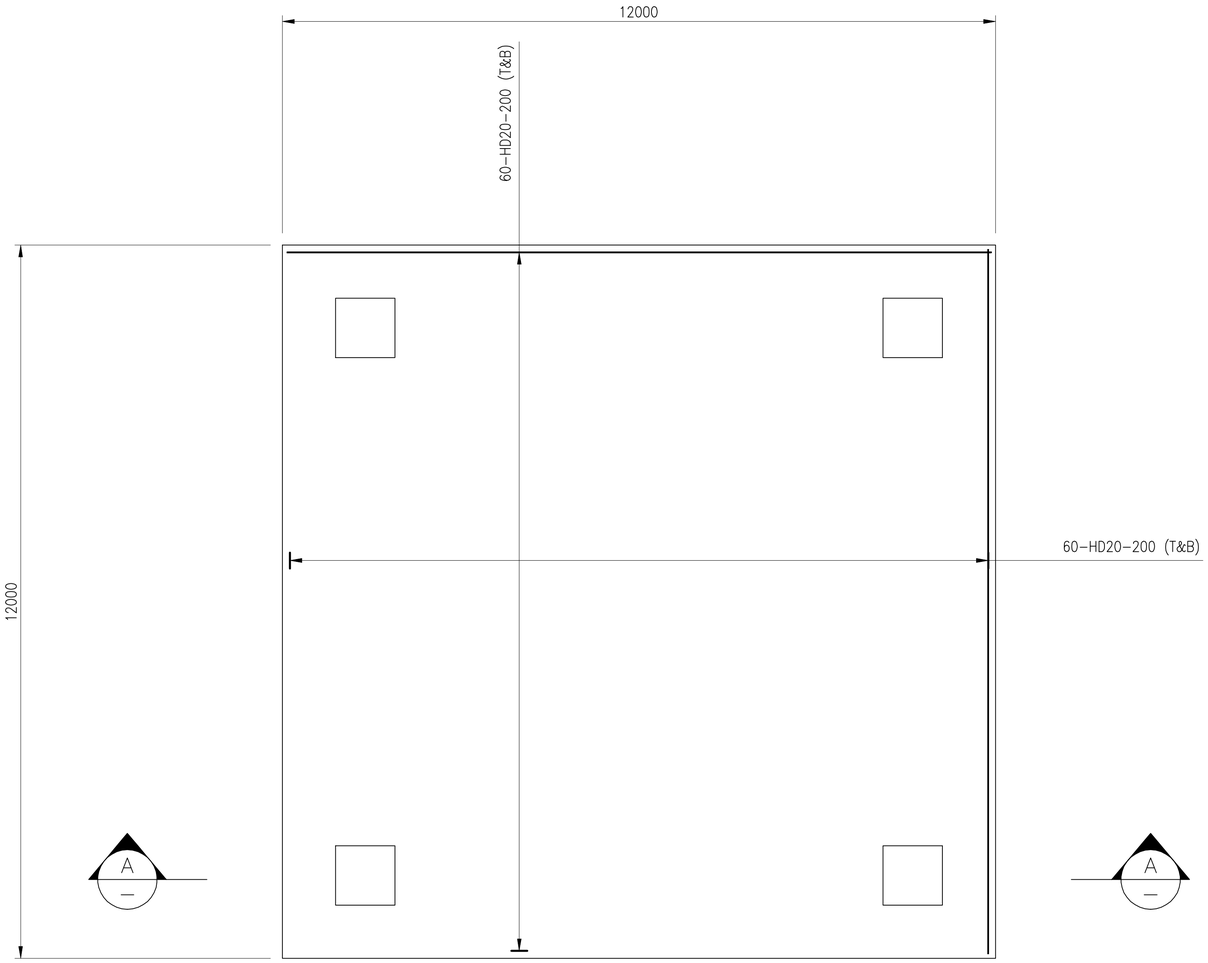
Wailoa – Vuda 132kV Line

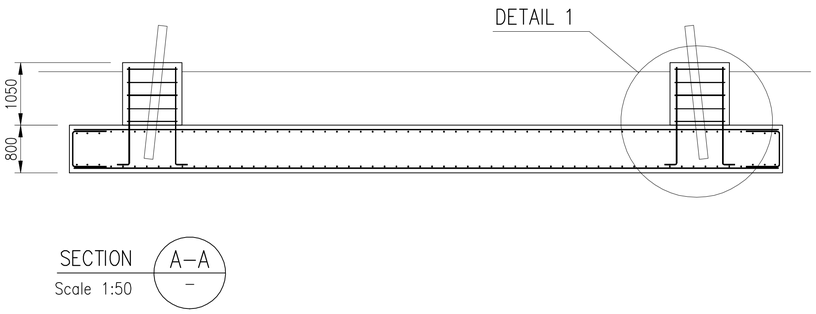
Tower 82 Replacement
Tower and Foundation Geometry

SCALE	DRAWING TYPE
	A3
DRAWING NUMBER	REV
13556/WV/1	1
CAD FILE REFERENCE	
13556-WV-1	

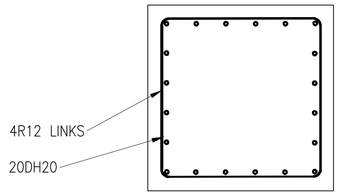
A3

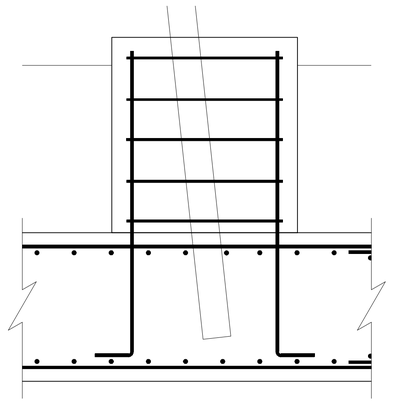


PLAN 1 / – Scale 1:50



SECTION A–A / – Scale 1:50





DETAIL 1 / –

Notes:

1. All dimensions in millimetres unless noted otherwise.
2. Concrete shall achieve a 28–day compressive strength of 30MPa.
3. Minimum cover to reinforcement is 75mm.
4. Reinforcing steel bars marked HD are Grade 500E MA (micro–alloy). Notation of reinforcement shall be as follows:

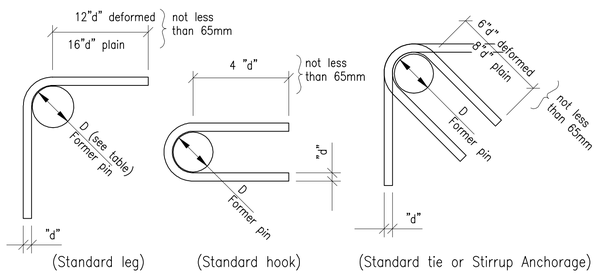
5. Unless specified otherwise on the drawing, minimum splice lap lengths for deformed bars shall be as follows:

Diameter	Splice Length [mm]
10	650
12	750
16	1000
20	1250
25	1600
32	2000

Note 1: Splice lap length shall be increased by 100% for plain round steel.

Note 2: If more than 50% of bars are lapped at any one location, required lap lengths shall be increased by 30%

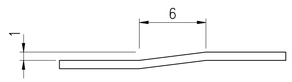
6. Standard hooks and bends shall conform to the following:



(Standard leg) (Standard hook) (Standard tie or Stirrup Anchorage)

All dimensions are from outside to outside of bars except radii which are to inside of bar. "d" denotes bar diameter.

7. When main bars are offset (i.e. for cranked laps), the slope of the inclined portion of the bar shall not exceed 1 in 6, thus:



REV	AMENDMENT	BY	CHKD	DATE
1	For Tender	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–
–	–	–	–	–

DRAWN	RJO	9/16
DESIGNED	ID	9/16
CHECKED		
APPROVED		
PLOT DATE	10/12/16 13:50:31	

LINETECH Consulting
210 Hazeldean Road, PO Box 8373,
Christchurch, New Zealand
PH +64 (03) 3771546

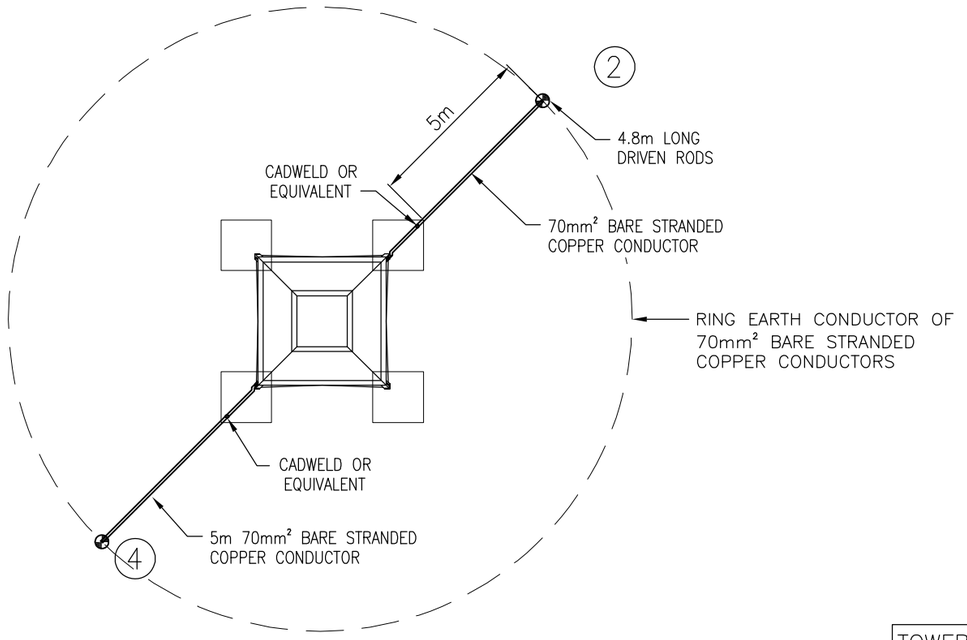
CLIENT
Fiji Electricity Authority
FEA Tower Replacements 2016
CONTRACT No.: MRXYZ 2016

Wailoa – Vuda 132kV Line

Tower 82 Replacement
New Foundation Details

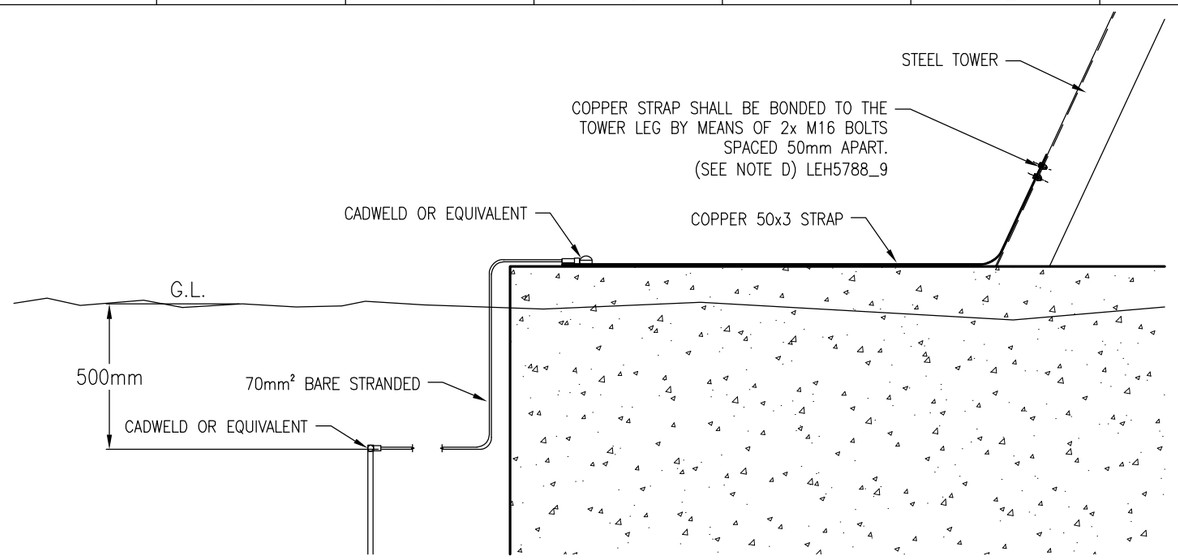
SCALE
DRAWING TYPE A3
DRAWING NUMBER 13556/WV/2
REV 1
CAD FILE REFERENCE 13556–WV–2

A3



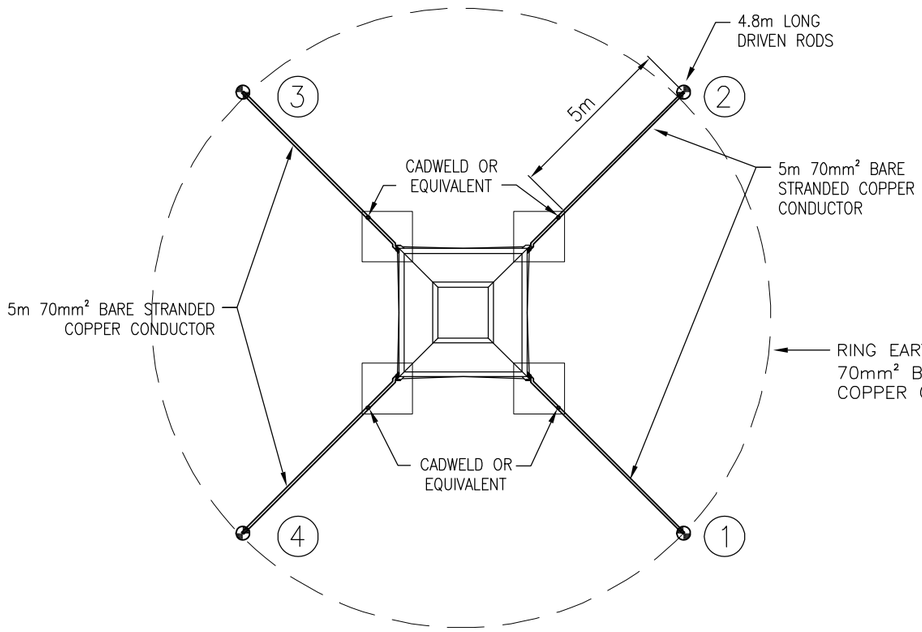
EARTHING FOR THE 20 OHM FOOTING RESISTANCE

N.T.S.



EARTH GRID CONSTRUCTION DETAIL

NTS



EARTHING FOR THE 10 OHM FOOTING RESISTANCE

N.T.S.

TOWER No	FOOTING RESISTANCE (OHM)
P1	10
P2	10
P3	10
P4	10
P5	20
P6	20
P7	20
P8	20
P9	20
P10	20
P11	–
P12	20
P13	20
P14	10
P15	10
P16	10
P17	10

LEGEND:

– ø20 mm DRIVEN ROD

NOTES

1. INSTALL 4.8m LONG DRIVEN STEEL COPPER CLAD RODS AS DETAILED BELOW.
2. THE TOP OF THE RODS SHALL BE BURIED AT LEAST 0.5m BELOW GROUND LEVEL.
3. 70mm² BARE STRANDED COPPER CONDUCTORS & RING EARTH CONDUCTOR SHALL BE CADWELDED TO THE DRIVEN RODS AND BE INSTALLED BETWEEN THE DRIVEN RODS AND THE TOWER AT A DEPTH OF 0.5m.
4. AT THE TOWER, THE 70mm² BARE STRANDED CONDUCTORS SHALL BE BONDED TOGETHER AND TO A 50 X 3mm COPPER STRAP USING CADWELDING. THE COPPER STRAP SHALL BE RUN UP THE TOWER AND CONNECTED TO THE EARTHING POINT ON THE TOWER. THE COPPER STRAP SHALL BE TINNED OVER A LENGTH OF 100mm WHERE IT CONNECTS TO THE EARTHING POINT SEE ABOVE.
5. THE COPPER STRAP SHALL BE BONDED TO THE TOWER LEG BY MEANS OF 2xM16 BOLTS SPACED 50mm APART.
6. TOWER STEEL WORK TO BE SOLIDLY BONDED TO FOUNDATION STEEL REINFORCING.
7. ALL 70mm² BARE STRANDED COPPER TO ROD CONNECTIONS TO BE CADWELDED OR EQUIVAVENT
8. ALL COPPER 50x3 STRAP CONNECTIONS TO BE CADWELDED OR EQUIVALENT.
9. FOR CONDITIONS WHERE SOIL RESISTIVITY EXCEEDS 100 OHM-M A SPECIFIC EARTHING DESIGN WILL BE REQUIRED.
10. SEE DRAWING LEH5788_09 FOR FOUNDATION DESIGN.

EMPLOYER

Fiji Electricity Authority

Nadarivatu Renewable Energy Project

CONTRACT No.: FEA/NHP-01&NHP-02

MANAGEMENT CONSULTANT

MWH Global, Inc.

CONTRACTOR

SINOHYDRO CORPORATION LIMITED

	AMENDMENT	BY	CHKD	DATE
A	PRILIMINARY DESIGN	T.A	T.A.	12.10
B	DETAILS AMENDED 22/12/10	C.E	T.A.	12.10

DRAWN	CRAIG EWINS	12/10
DESIGNED	T.AUDITORE	12/10
CHECKED	T.AUDITORE	12/10
APPROVED	–	
CAD FILE	LEH5788_1_0	

LINETECH Consulting
9 Sussex Street, Chartwell
PO Box 3210
Hamilton, New Zealand
Tel +64 (0)7 853 3548

NADARIVATU HYDRO 132kV LINE

SCALE AS SHOWN

10 & 20 OHM TOWER EARTHING
(MAX SOIL RESISTIVITY OF 100 OHM-M)

LEH5788_1_0

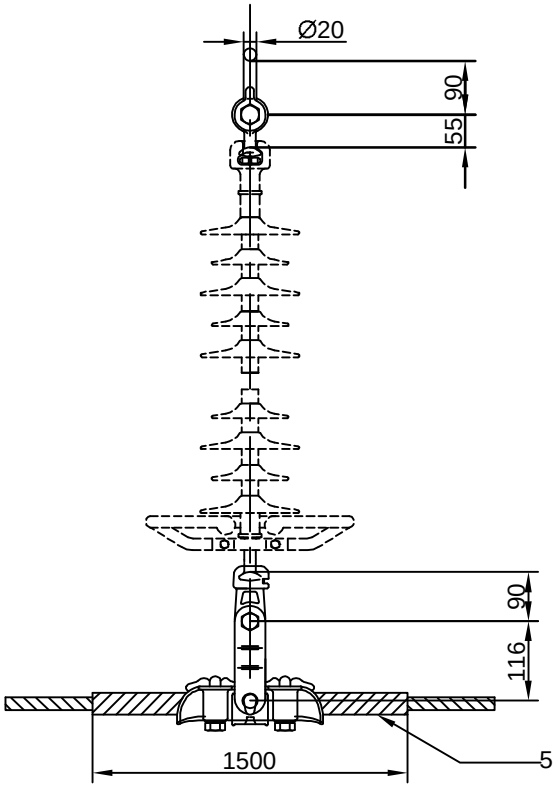
ISS. –

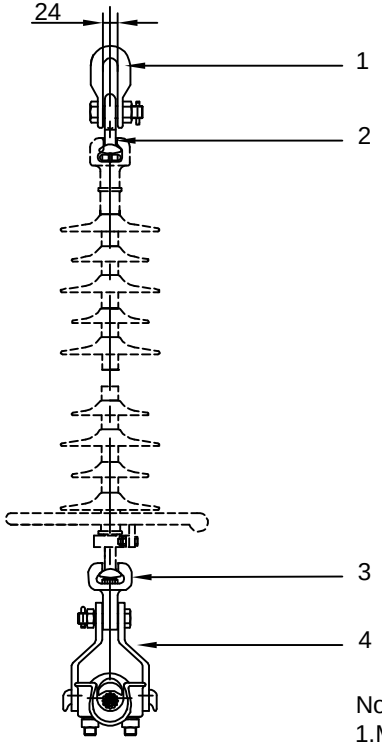
A3

F) – INSULATOR DRAWINGS

The drawings show the proposed insulator arrangements which we understand are the same as used for the existing Wailoa-Vuda 132kV line and were provided as information to the Contractor for construction of the Nadarivatu line.

FEA NADARIVATU 132KV TEE LINE





Note:
1.Minimum breaking load: 120kN ,except suspension clamp;
2.The slip strength of clamp is not less than 18% RTS of conductor;
3.Galvanized to BS729;
4.All dimensions are in millimetres;
5.Coupling IEC 120:16 ;
6.Manufacturing based on the standard:IEC 61284.

Item	Description	Cat. No.	Material	Quantity	U.T.S.
5	Armour Rods	FYH-150/35	Aluminium Alloy	1	
4	Suspension Clamp	PSC-30	Al alloy&Galv.steel	1	
3	Socket Eye	W-12	Galv.steel	1	120kN
2	Ball Eyes	QP-12	Galv.steel	1	120kN
1	U Shackle	U-12	Galv.steel	1	120kN

General Tolerance		
<=30	±1.5mm	ANGLE: ±
>30	±5%	
Weight	±15%	
Drawing	Kevin	2010/12/06
Checked		
Approved		

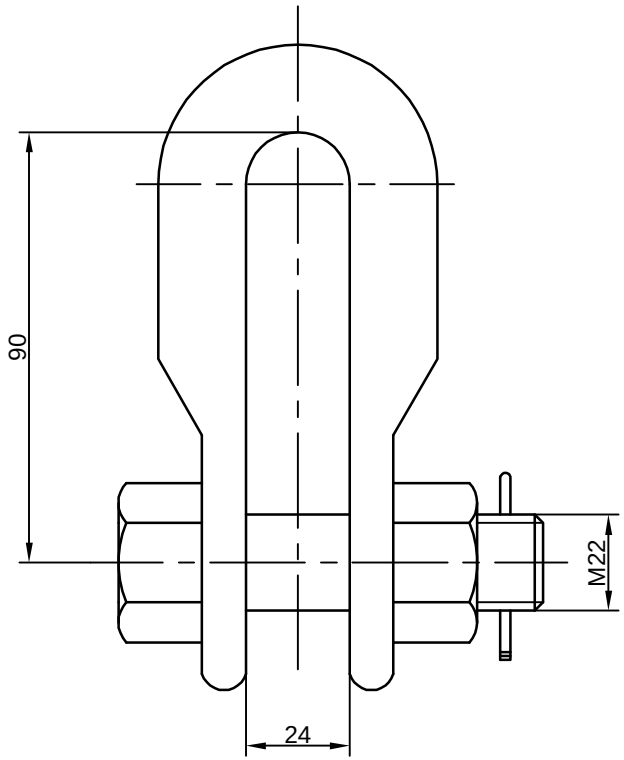
Suspension assembly

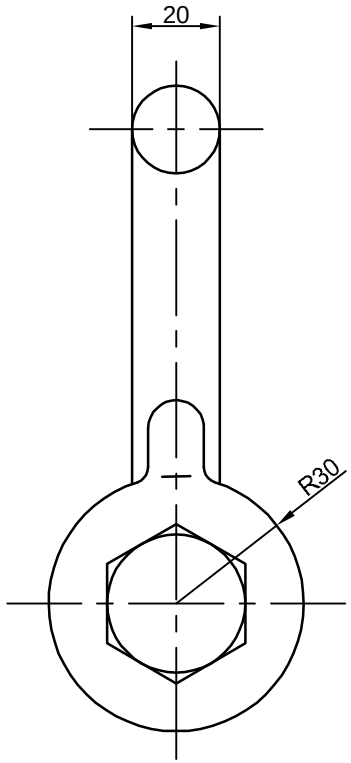
ZTT 中天科技

Jiangsu Zhongtian Technology Co., Ltd.

Mass		Scale	NTS
JSH-1077		REV	C

FEA NADARIVATU 132KV TEE LINE

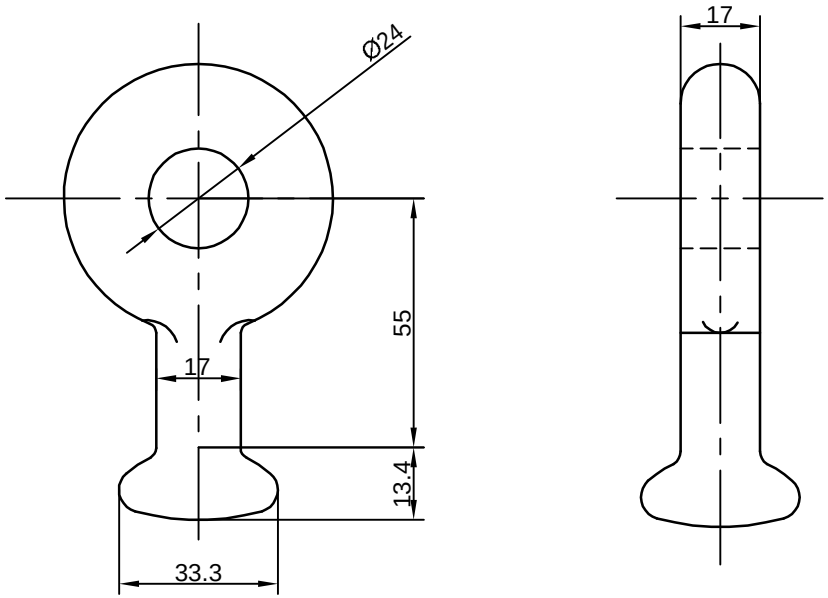




Note:
1.Min.failing load :120kN;
2.Material:hot-dip galvanized steel;
3.Manufacturing process:forged;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Manufacturing based on the standard:IEC 61284.

General Tolerance			U Shackle U-12	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0156		REV A
Approved						

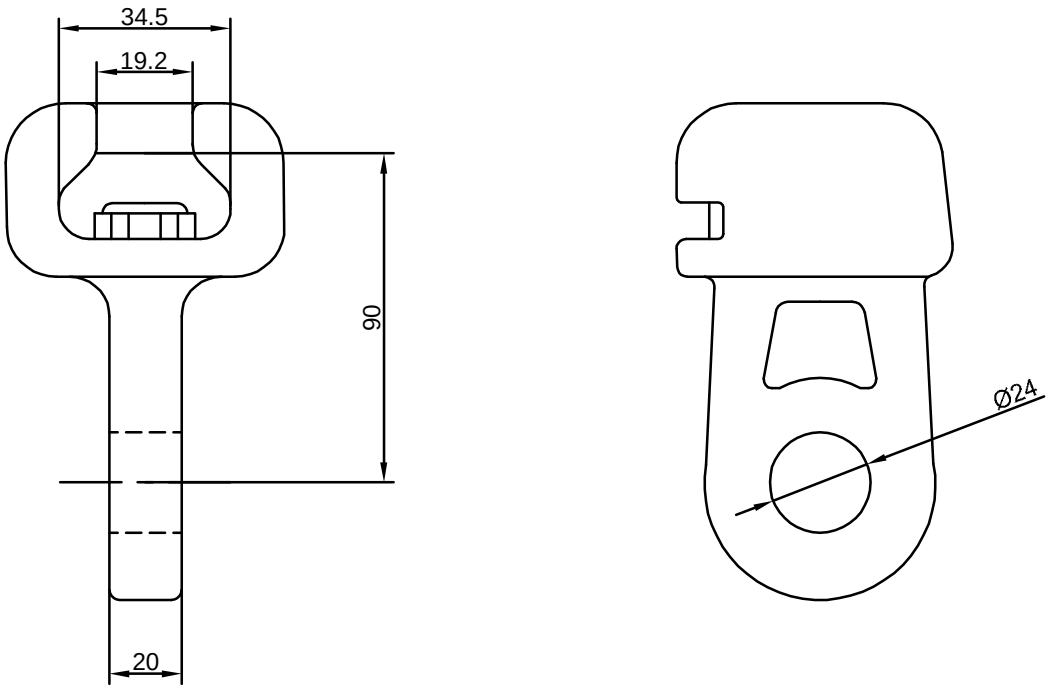
FEA NADARIVATU 132KV TEE LINE



Note:
1.Min.failing load :120kN;
2.Material:hot-dip galvanized steel;
3.Manufacturing process:forged;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Coupling standard: IEC 120:16;
7.Manufacturing based on the standard:IEC 61284.

General Tolerance			Ball Eye QP-12	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0405		REV A
Approved						

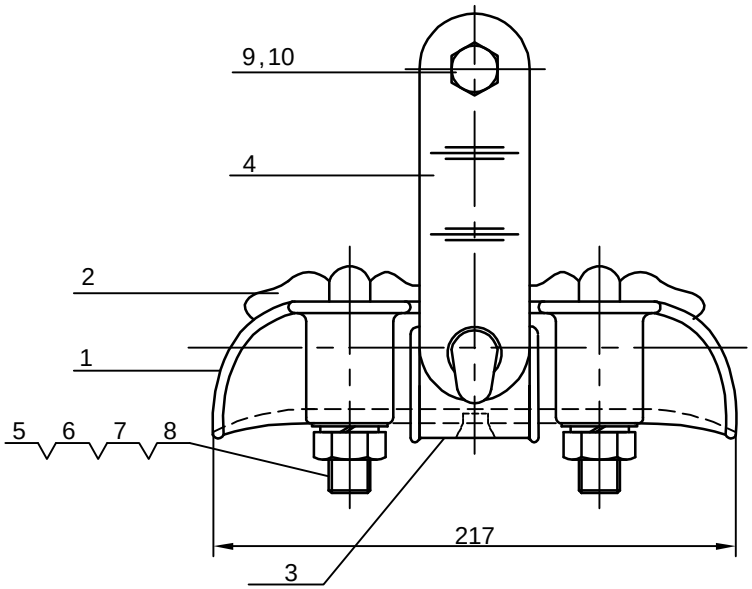
FEA NADARIVATU 132KV TEE LINE

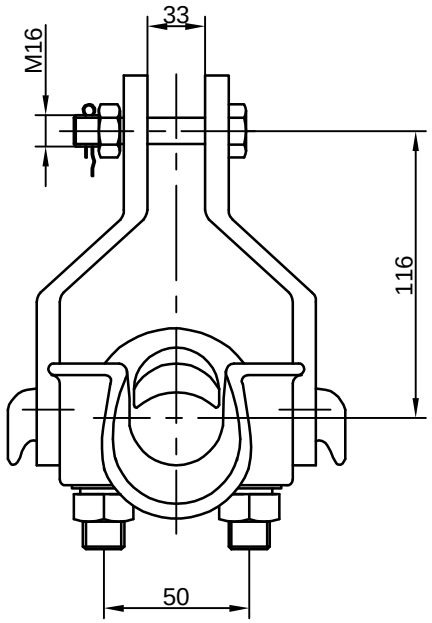


Note:
1.Material:The socket eyes is malleable iron,hot-dip galvanized;
2.Manufacturing process:casting;
3.Minimum failing load:120kN;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Coupling standard: IEC 120:16;
7.Manufacturing based on the standard:IEC 61284.

General Tolerance			Socket Eye W-12	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0336		REV A
Approved						

FEA NADARIVATU 132KV TEE LINE



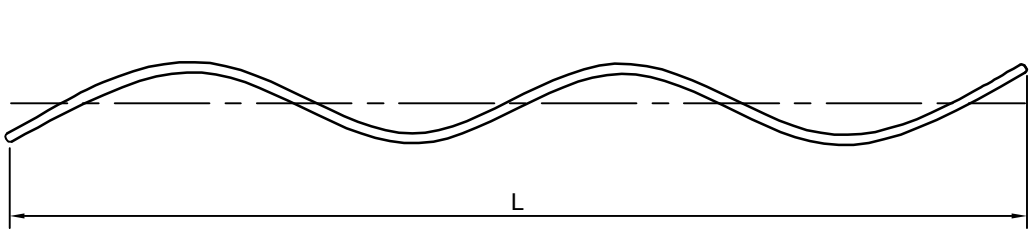


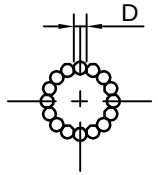
Note:
2.Suitable conductor diameter range:18.0-30.0mm;
3.Rated Failure Load：80kN;
4.Galvanized to BS729;
5.U bolt torrques (recomend):36N.m;
6.All dimensions are in millimetres;
7.Manufacturing based on the standard:IEC 61284.

Item	Q'TY	Description	Material
10	1	Split pin	Stainless steel
9	1	Bolt & Nut M16	Galv.steel
8	4	Plain washer	Galv.steel
7	4	Spring washer	Galv.steel
6	4	Nut	Galv.steel
5	2	U bolt M12	Galv.steel
4	2	Strap	Galv.steel
3	1	Clamp support	Galv.steel
2	1	Keeper	Aluminium alloy
1	1	Body	Aluminium alloy

General Tolerance			Suspension Clamp PSC-30	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0149	REV	A
Approved						

FEA NADARIVATU 132KV TEE LINE

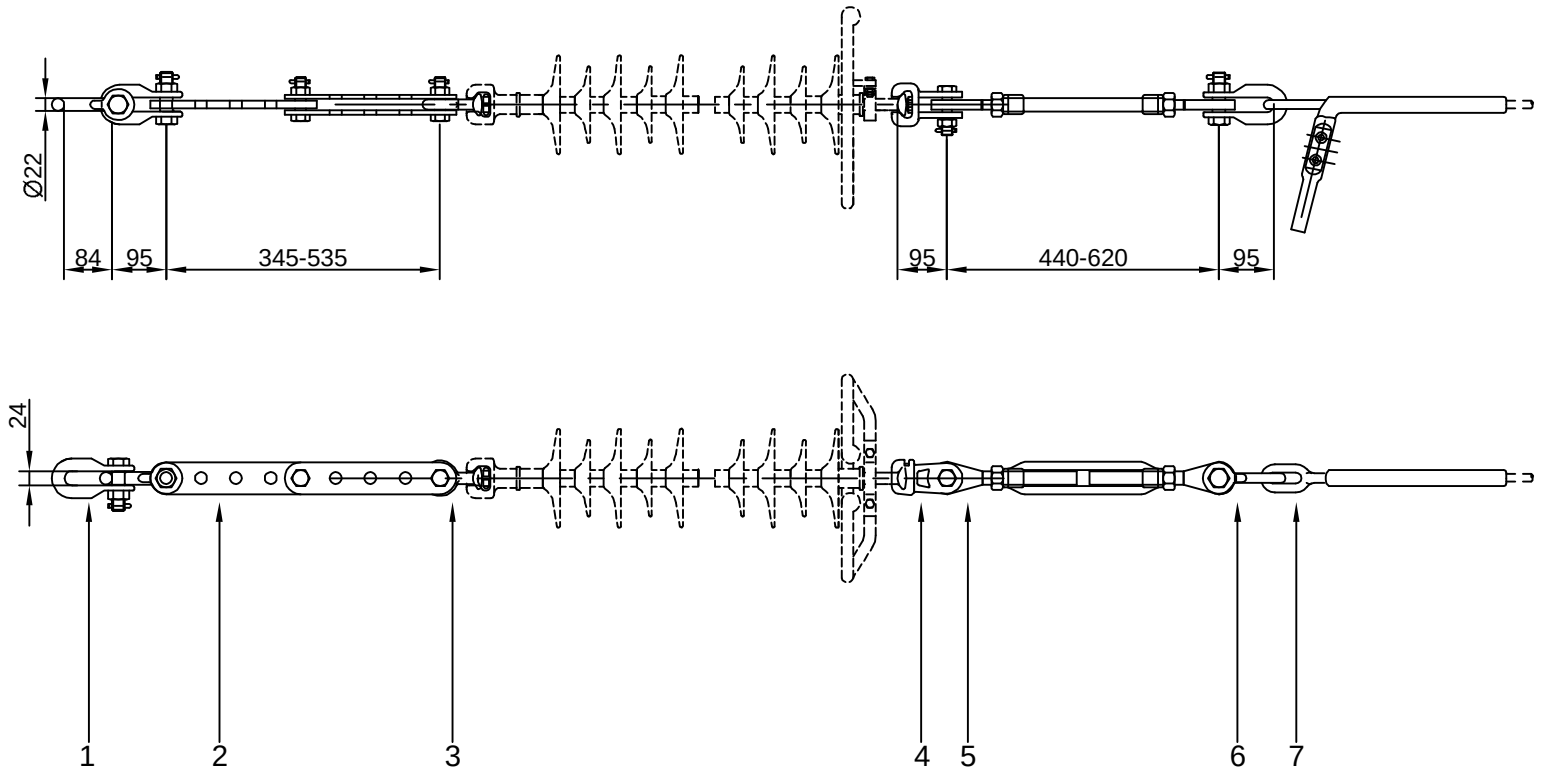




Note:
1.Number of Rods: 16;
2.Wire Diameter "D" : 3.5mm;
3.Length "L" : 1500mm;
4.Material: Aluminium alloy;
5.Direction of Lay:Right Hand;
6.All dimensions are in millimetres;
7.Manufacturing based on the standard:IEC 61284.

General Tolerance			Armour Rod FYH-150/35	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1077-5		REV A
Approved						

FEA NADARIVATU 132KV TEE LINE



Note:
1.Minimum breaking load: 160kN,except slip strength of tension clamp 95% RTS of conductor;
2.The ball & socket size according to IEC 120:20;
3.Galvanized to BS729;
4.All dimensions are in millimetres;
5.Manufacturing based on the standard:IEC 61284.

Item	Description	Cat. No.	Material	Quantity	U.T.S.
7	Tension Clamp	NY-150/35	Al alloy&Galv.steel	1	
6	Anchor Shackle	U-16.B	Galv.steel	1	160kN
5	Turnbunckle	TB-16	Galv.steel	1	160kN
4	Socket Clevis	WS-16.B	Galv.steel	1	160kN
3	Ball Eyes	QP-16	Galv.steel	1	160kN
2	Adjuster Plate	PT-16	Galv.steel	1	160kN
1	Anchor Shackle	U-16	Galv.steel	2	160kN

General Tolerance		
<=30	±1.5mm	ANGLE: ±
>30	±5%	
Weight	±15%	
Drawing	Kevin	2010/12/06
Checked		
Approved		

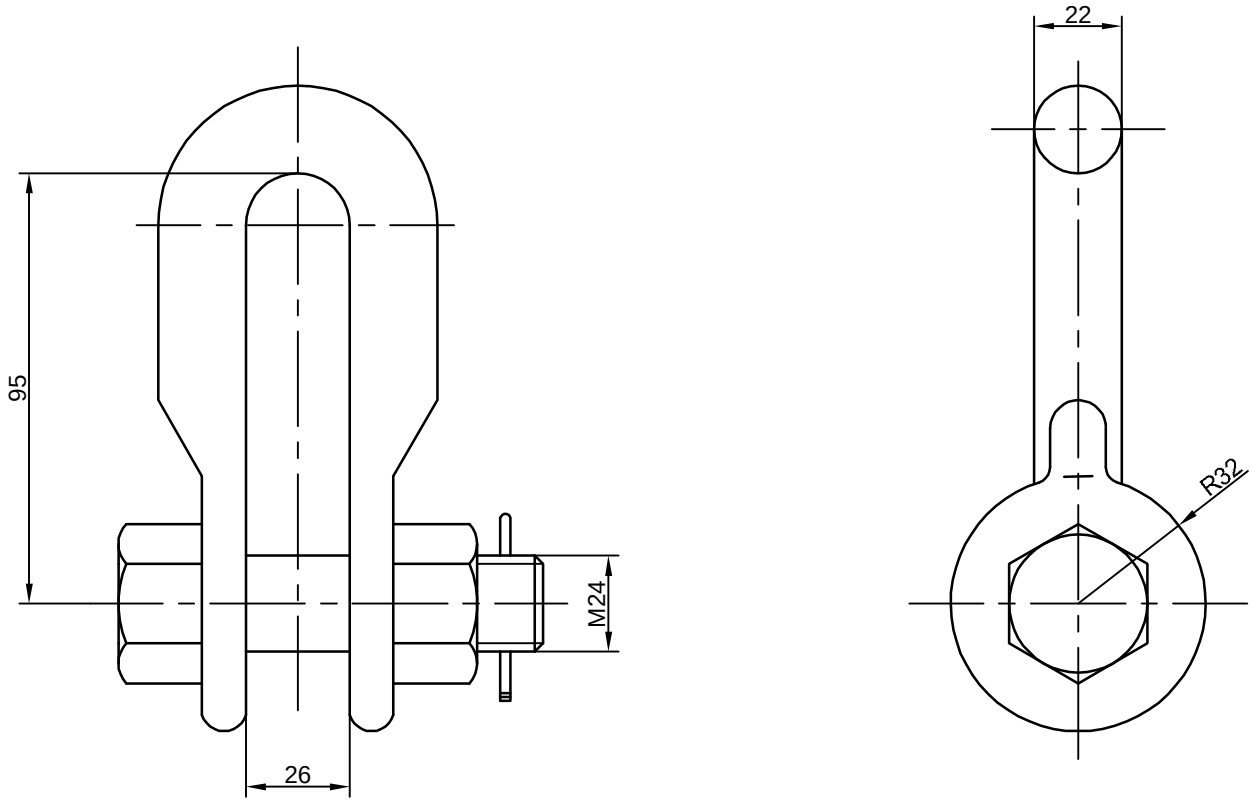
Tension assembly

ZTT 中天科技

Jiangsu Zhongtian Technology Co., Ltd.

Mass		Scale	NTS
JSH-1078		REV	A

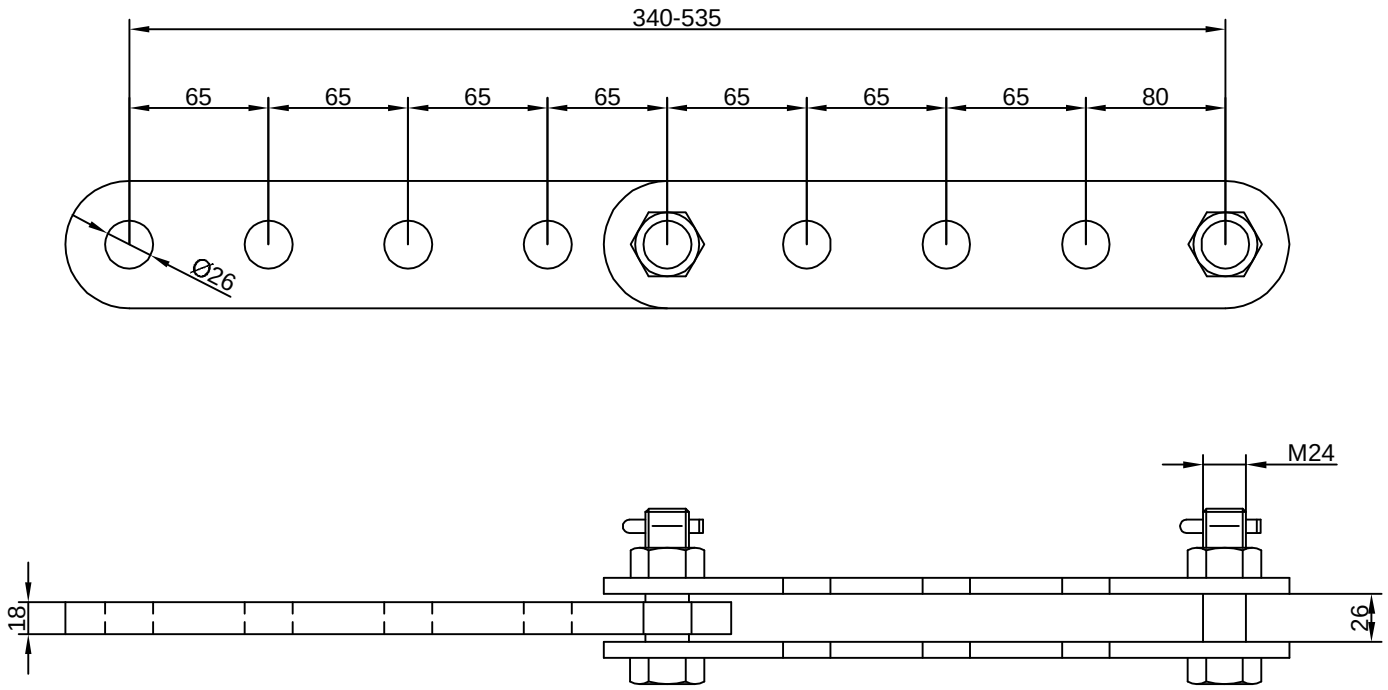
FEA NADARIVATU 132KV TEE LINE



Note:
1.Min.failing load :160kN;
2.Material:hot-dip galvanized steel;
3.Manufacturing process:forged;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Manufacturing based on the standard:IEC 61284.

General Tolerance			U Shackle U-16	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0171		REV A
Approved						

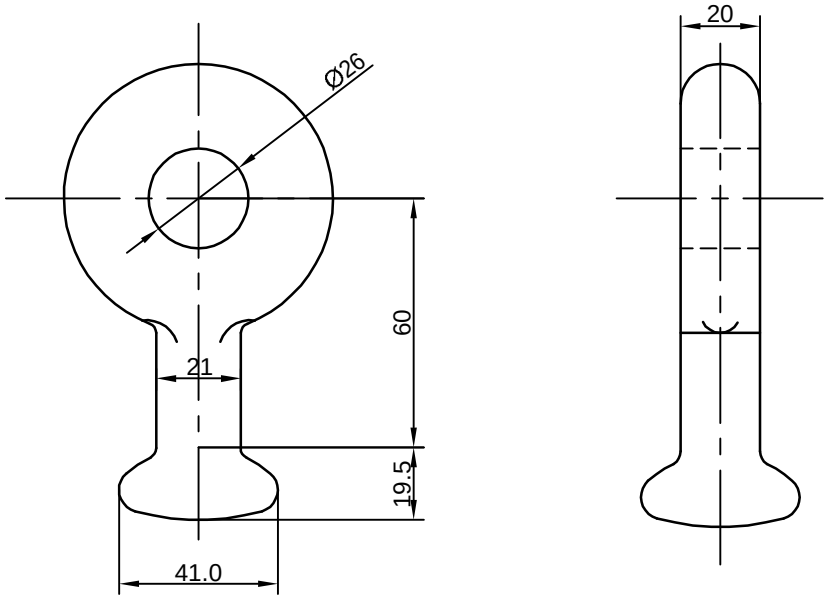
FEA NADARIVATU 132KV TEE LINE



Notes:
1.Material: Galvanized steel;
2.Minimum failing load:160kN;
3.Galvanized to BS729;
4.All dimensions are in millimetres;
5.Manufacturing based on the standard:IEC 61284.

General Tolerance			Adjuster Plate PT-16	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-0170		REV A
Approved						

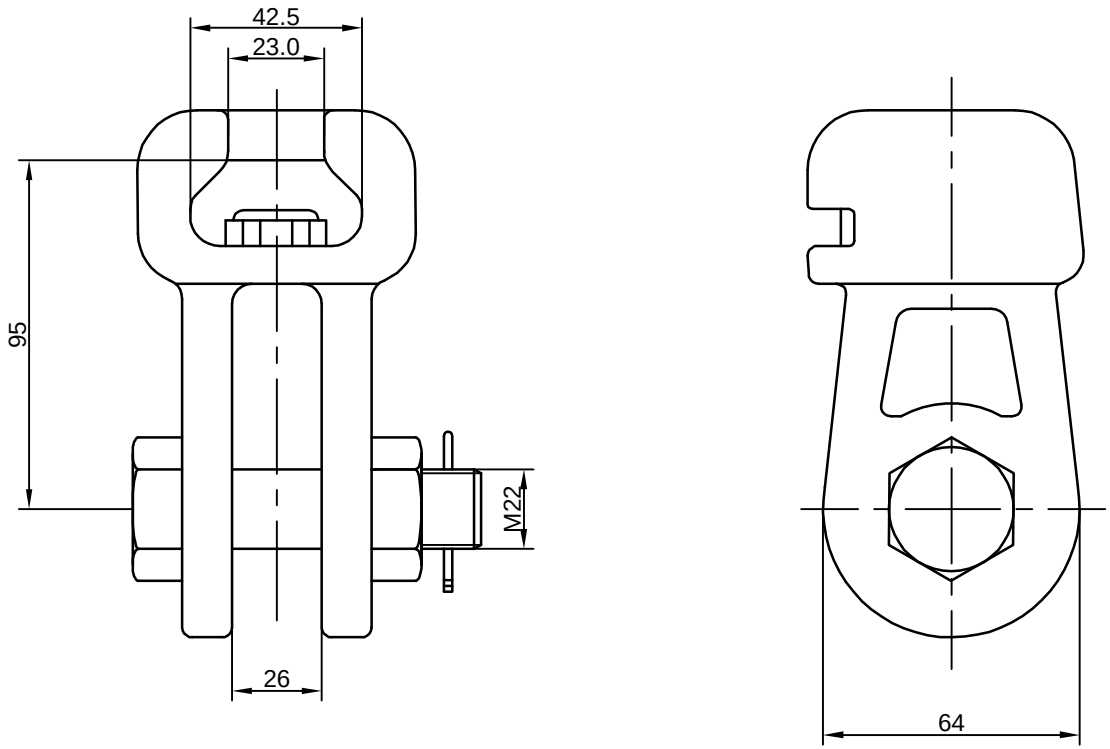
FEA NADARIVATU 132KV TEE LINE



Note:
1.Min.failing load :160kN;
2.Material:hot-dip galvanized steel;
3.Manufacturing process:forged;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Coupling standard: IEC 120 :20;
7.Manufacturing based on the standard:IEC 61284.

General Tolerance			Ball Eye QP-16	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1259		REV A
Approved						

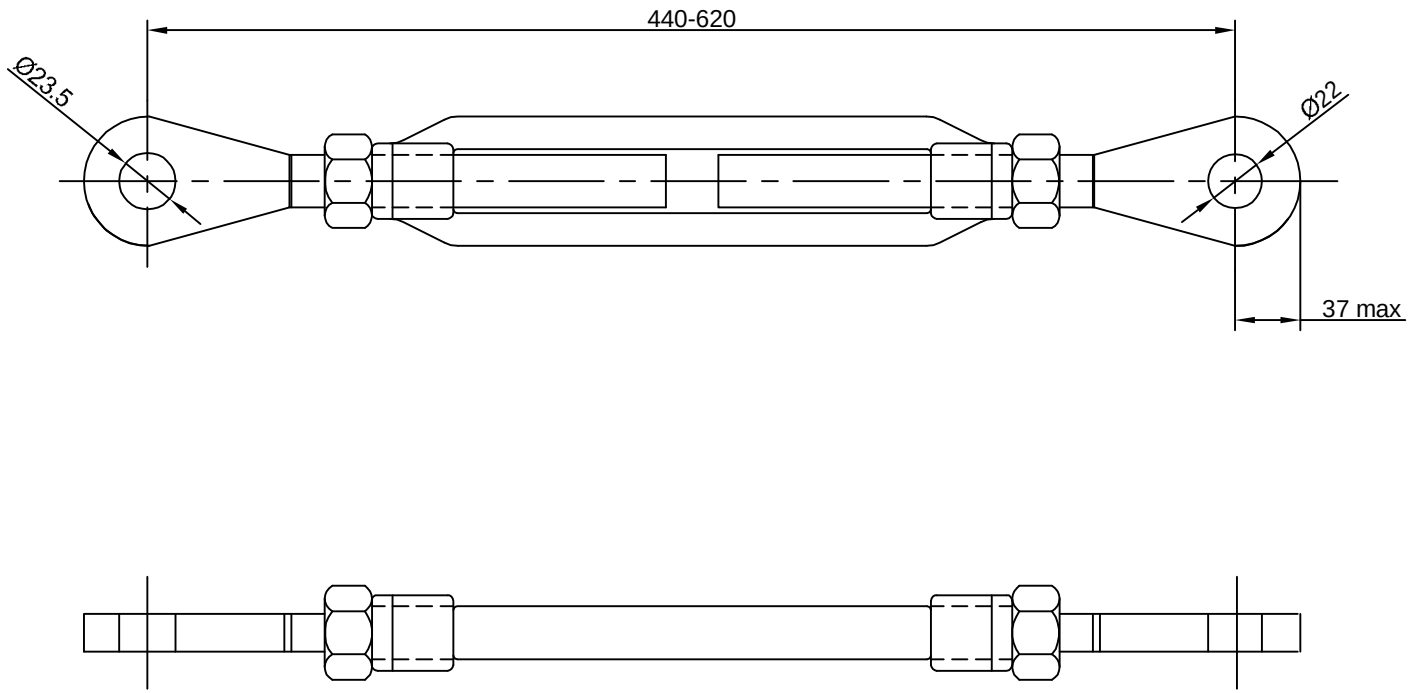
FEA NADARIVATU 132KV TEE LINE



Note:
1.Material: hot-dip galvanized steel;
2.Minimum failing load:160kN;
3.Galvanized to BS729;
4.All dimensions are in millimetres;
5.Coupling standard: IEC 120 :20;
6.Manufacturing based on the standard:IEC 61284.

General Tolerance			Socket Clevis(M22) WS-16.B	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1078-4	REV	A
Approved						

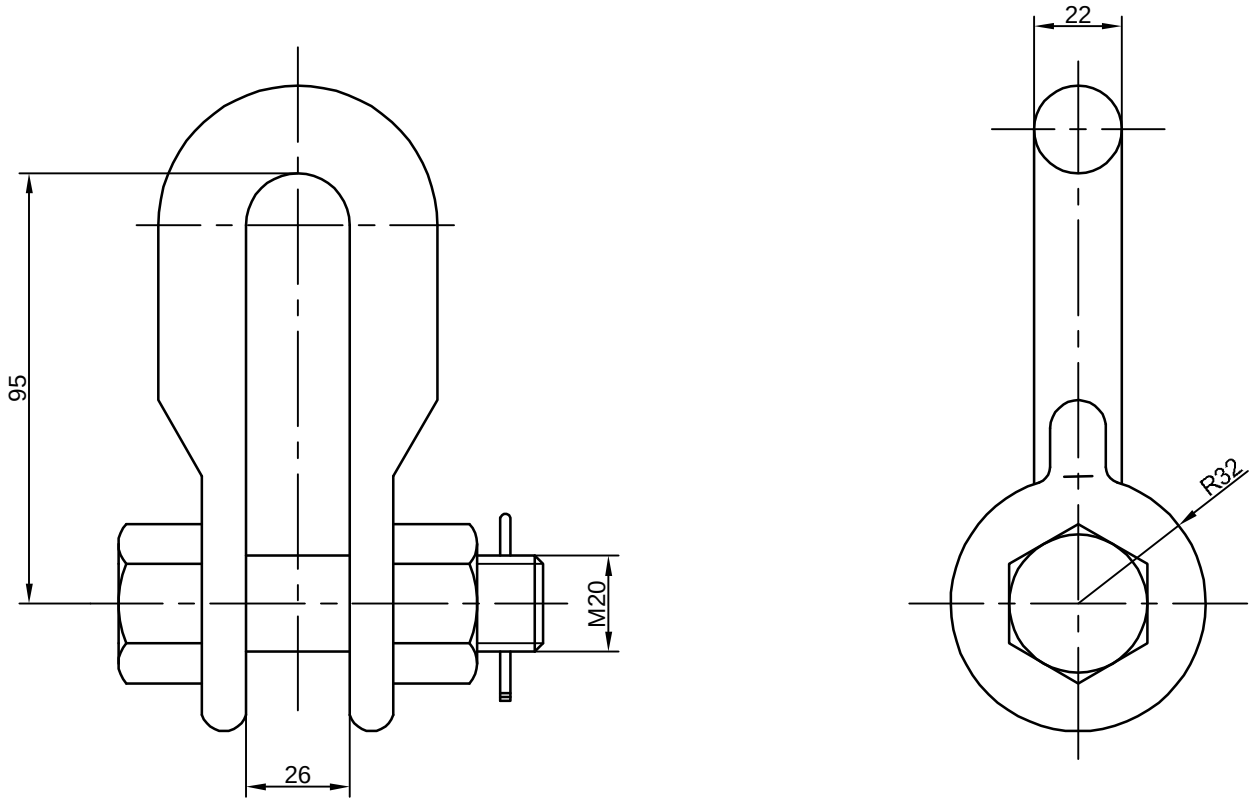
FEA NADARIVATU 132KV TEE LINE



Note:
1.Material: Galvanized steel;
2.Minimum failing load:160kN;
3.Galvanized to BS729;
4.All dimensions are in millimetres.
5.Manufacturing based on the standard:IEC 61284.

General Tolerance			Turnbuckle TB-16	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1078-5	REV	A
Approved						

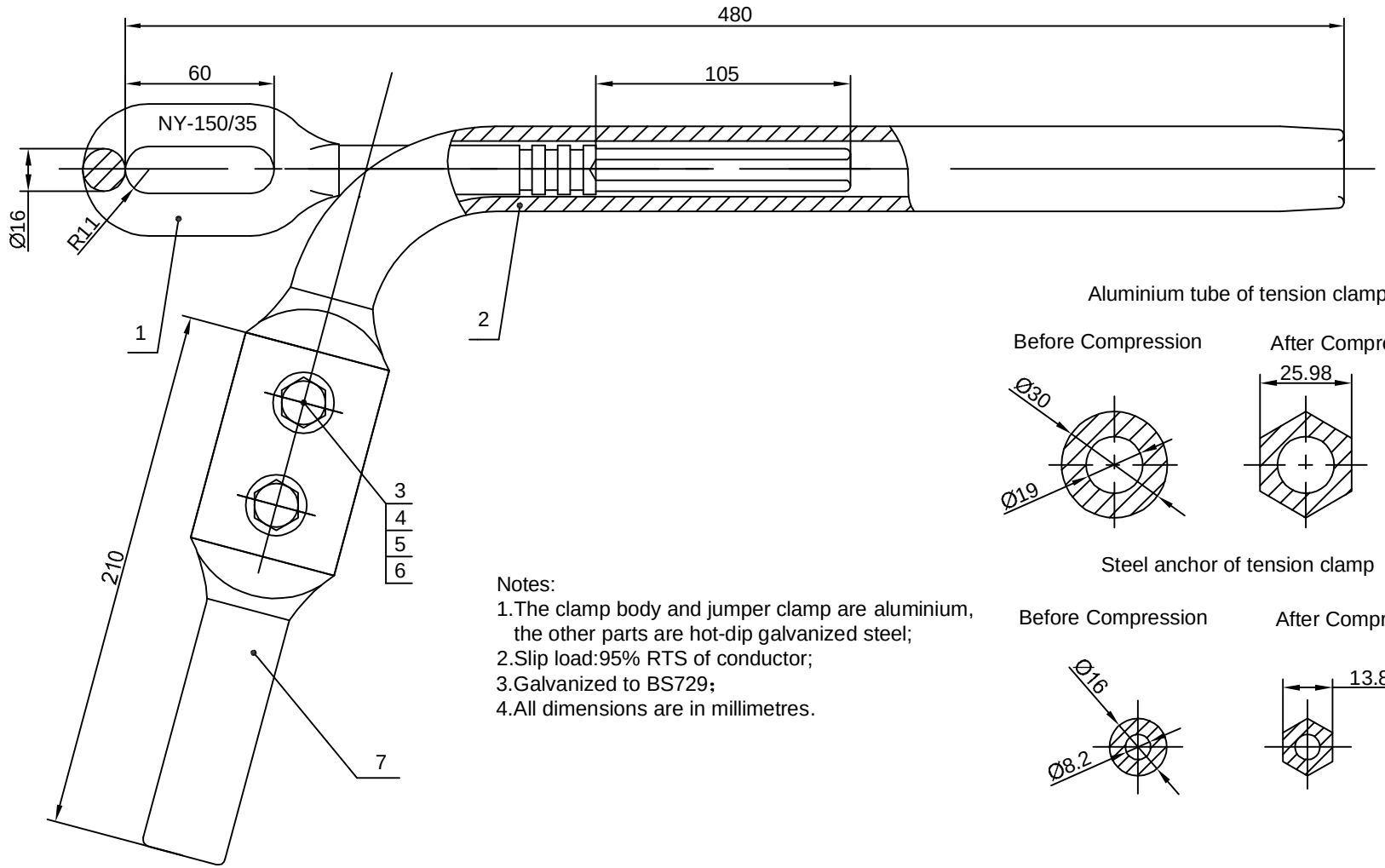
FEA NADARIVATU 132KV TEE LINE



Note:
1.Min.failing load :160kN;
2.Material:hot-dip galvanized steel;
3.Manufacturing process:forged;
4.Galvanized to BS729;
5.All dimensions are in millimetres;
6.Manufacturing based on the standard:IEC 61284.

General Tolerance			U Shackle U-16.B	ZTT 中天科技			
<=30	±1.5mm	ANGLE: ±					
>30	±5%						
Weight	±15%						
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale	NTS
Checked				JSH-1078-6		REV	A
Approved							

FEA NADARIVATU 132KV TEE LINE



Aluminium tube of tension clamp

Before Compression

After Compression

Steel anchor of tension clamp

Before Compression

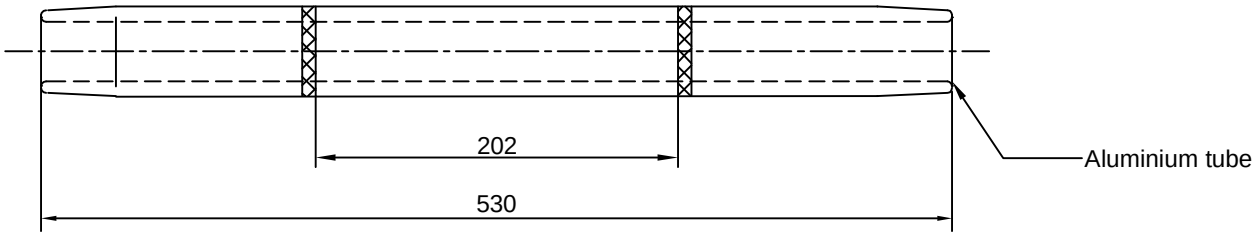
After Compression

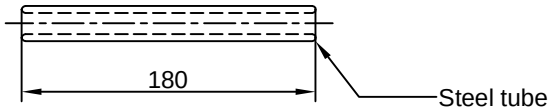
Notes:
1.The clamp body and jumper clamp are aluminium, the other parts are hot-dip galvanized steel;
2.Slip load:95% RTS of conductor;
3.Galvanized to BS729;
4.All dimensions are in millimetres.

S/N	Description	Qty	Material	Remark
7	Jumper terminal	1	Aluminium	
6	Hexagon Bolt M12×50	2	Galv. steel	C Crade GB5780
5	Spring washer Ø12	2	Galv. steel	GB93
4	Hexagonal Nut M12	2	Galv. steel	C Crade GB 41
3	Washer Ø12	4	Galv. steel	
2	Clamp body	1	Aluminium	
1	Steel Anchor	1	Galv. steel	Hot dip galvanizing

General Tolerance			Dead end Joint for Grape ACSR conductor NY-150/35	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1078-7	REV	A
Approved						

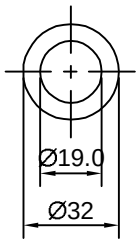
FEA NADARIVATU 132KV TEE LINE



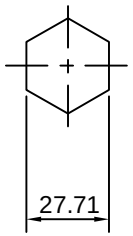


Aluminium tube

Before Compression

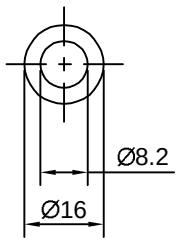


After Compression

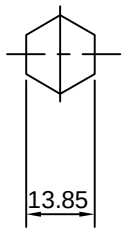


Steel tube

Before Compression

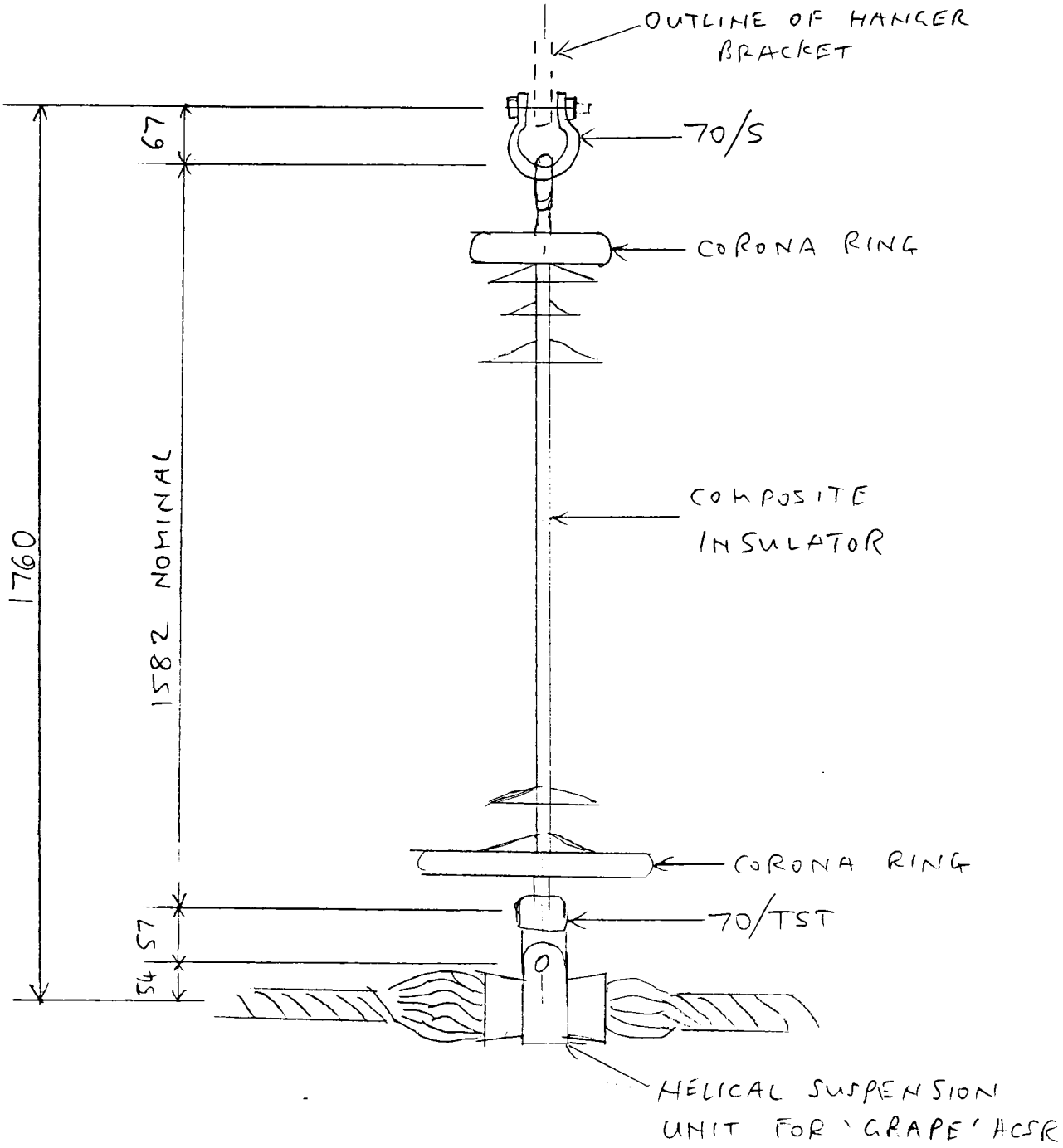


After Compression

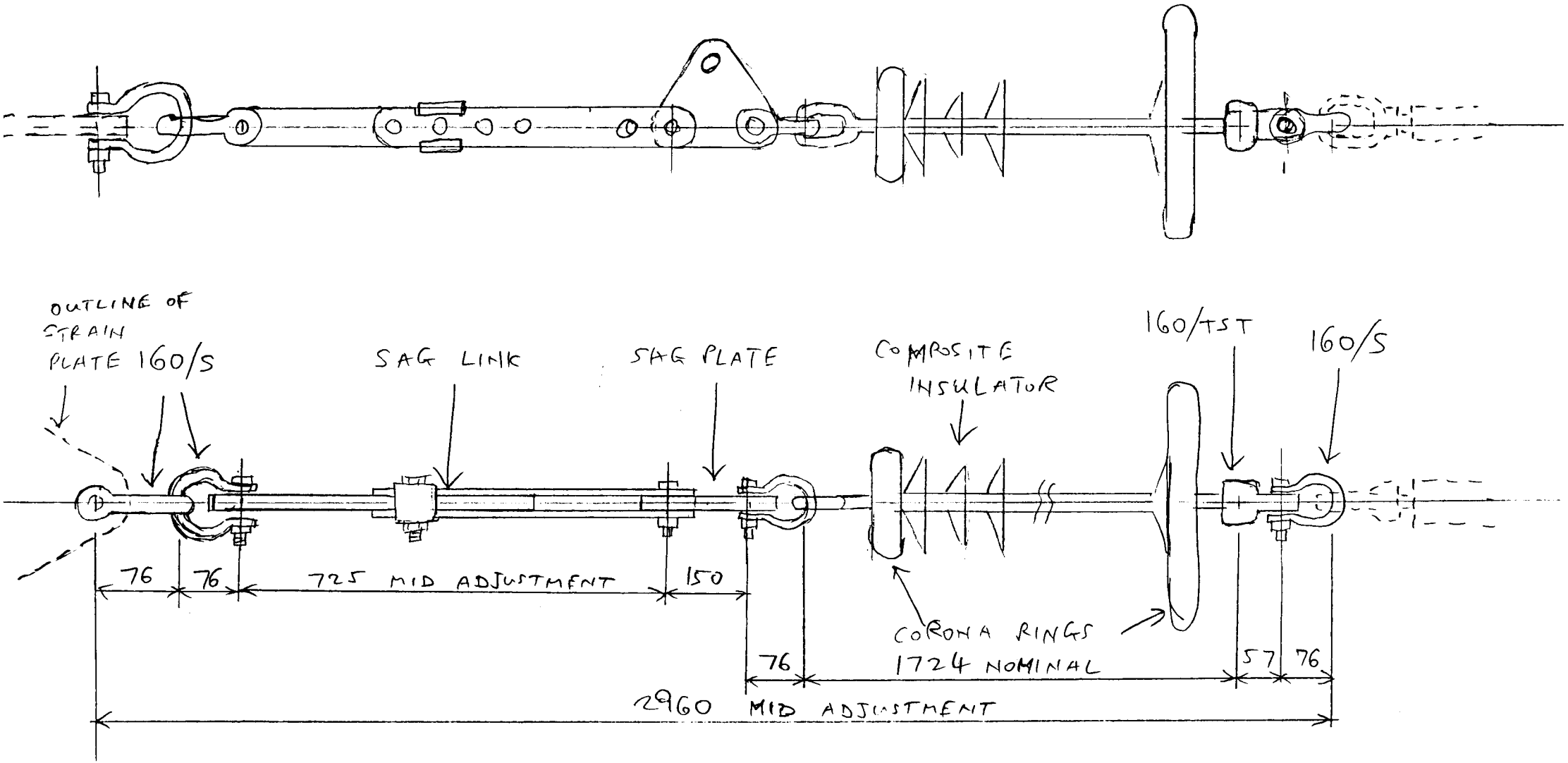


Note:
1.Material:The inner sleeve is hot-dip galvanized steel,the outer sleeve is aluminium;
2.Slip strength is notless than 95% RTS of the conductor;
3.All demensions are in millimeters;
4.Manufacturing based on the standard:IEC 61284.

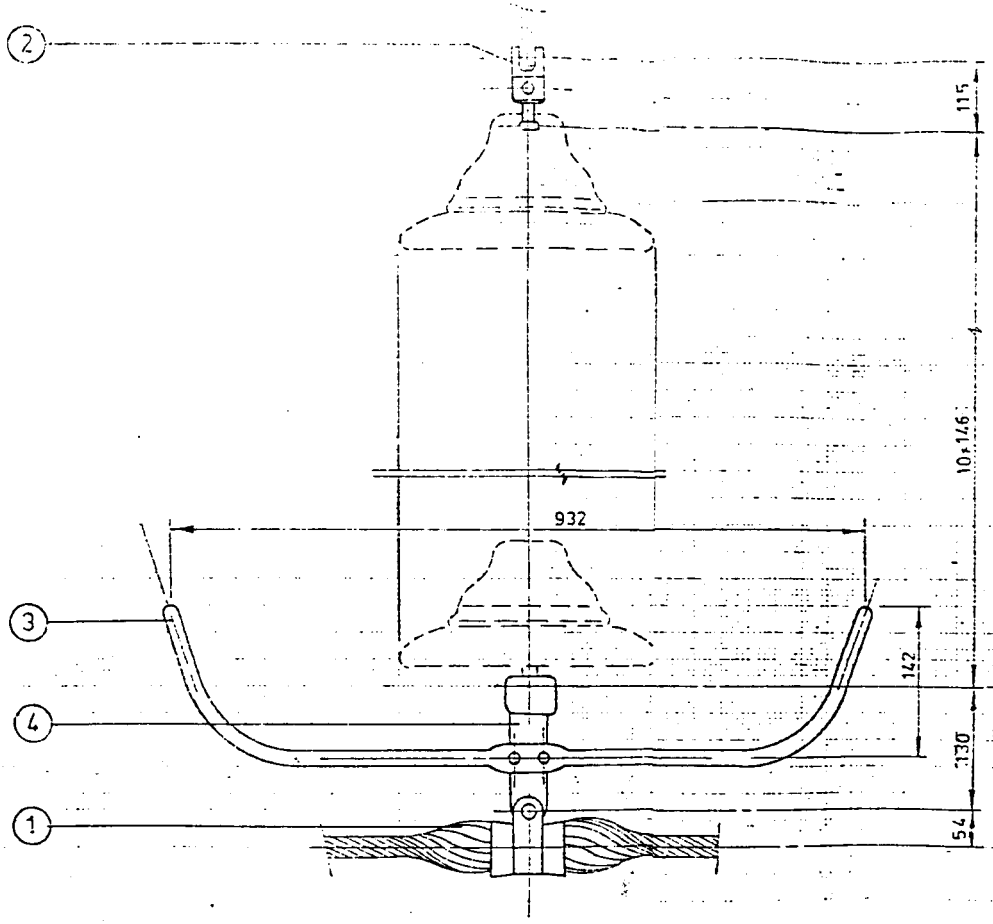
General Tolerance			Mid span Joint JY-150/35	ZTT 中天科技		
<=30	±1.5mm	ANGLE: ±				
>30	±5%					
Weight	±15%					
Drawing	Kevin	2010/12/06	Jiangsu Zhongtian Technology Co., Ltd.	Mass		Scale NTS
Checked				JSH-1205		REV A
Approved						



SINGLE SUSPENSION SET, 70kN M.F.L.



SINGLE TENSION SET, 160kN M.F.L.



SET TO BE USED OUTSIDE
1.5 KM. OF SUBSTATION

REF. EPTSIM DRG. NO A2 1524

EPTSIM ITEM	REF. NO.	QTY.	DESCRIPTION	MATERIAL
14	A4 DD 1015	1	SOCKET TONGUE FOR A/H	GALV. MCI.
37	A3 DD 1004 T/1	1	DOUBLE LIVE END A/H	GALV. M.S.
12	A4 DD 1008 T/1	1	BALL CLEVIS FOR A/H	GALV. M.S.
21	A3 DD 1385	1	ARMOUR GRIP SUSP. UNIT	AL. ALLOY

DRAWN	DATE	SCALE	APPV'D.
B.S	7.12.78	1:5.	

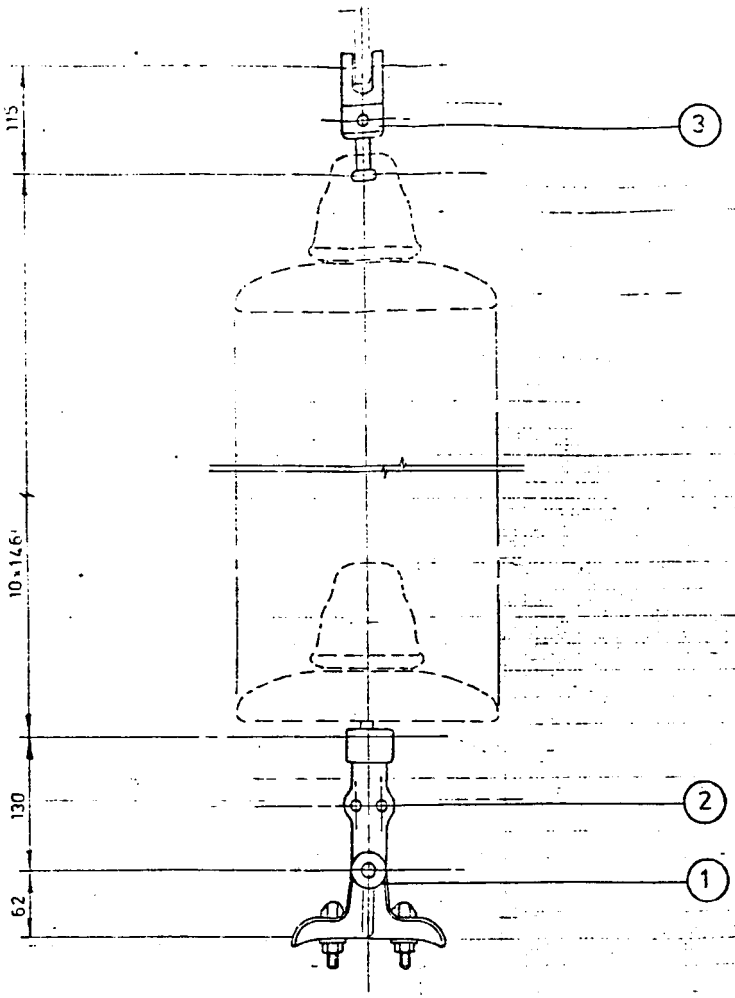
GENERAL TOLERANCE
DIMENSIONS UP TO 300 INCLUDING
± 1 mm
DIMENSIONS GREATER THAN
± 3%

TITLE

SINGLE SUSP. SET
'GRAPE' 132 KV.

EDULMESON (THAILAND) CO. LTD.

A3-DT 0221/3



REF. EPT. DRG. NO. A2-1522

EPT. NO.	ITEM	REF. NO.	QTY.	DESCRIPTION	MATERIAL
2	3	A4 DD 1006T/1	1	BALL CLEVIS FOR A/H	GALV. M.C.I.
14	2	A4 DD 1015	1	SOCKET TONGUE FOR A/H	GALV. M.C.I.
6	1	A3 DD 1083A	1	CLEVIS SUSPENSION CLAMP	AL. ALLOY

DRAWN	DATE	SCALE	APPV'D.
B.S	25.1.79	NTS.	

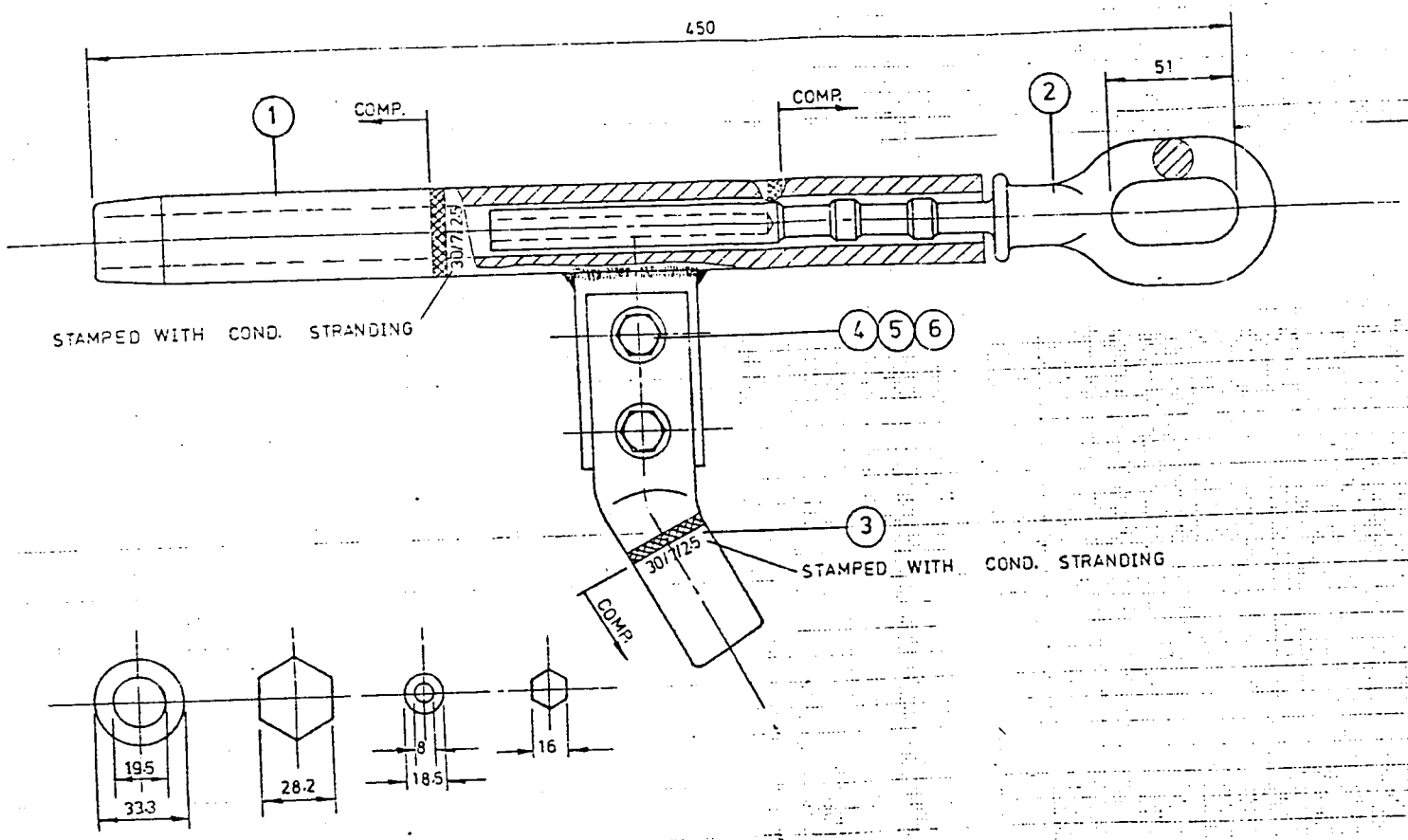
GENERAL TOLERANCE
DIMENSIONS UP TO AND INCLUDING
[illegible] ± 1 mm
DIMENSIONS GREATER THAN
[illegible] ± 1%

TITLE

PILOT STRING ASSY.
FOR 'GRAPE' 132 KV.

BULLWIRE

A3 DT 025 GT 1



ITEM 1 ITEM 2

EPT. ITEM NO. 19/20

ITEM	REF. NO.	QTY.	DESCRIPTION	MATERIAL
6		2	SPRING WASHER	GALV. M.S.
5		2	PLAIN WASHER	GALV. M.S.
4		2	BOLT & NUT	GALV. M.S.
3		1	JUMPER	AL. ALLOY
2		1	EYE TAIL	GALV. FORGED ST.
1		1	BODY	AL. ALLOY

DRAWN	DATE	SCALE	APP'D.
B.S	25.1.79	1:2	

GENERAL TOLERANCE
DIMENSIONS UP TO AND INCLUDING
40 mm ± 1 mm
DIMENSIONS GREATER THAN
40 mm ± 2½

TITLE

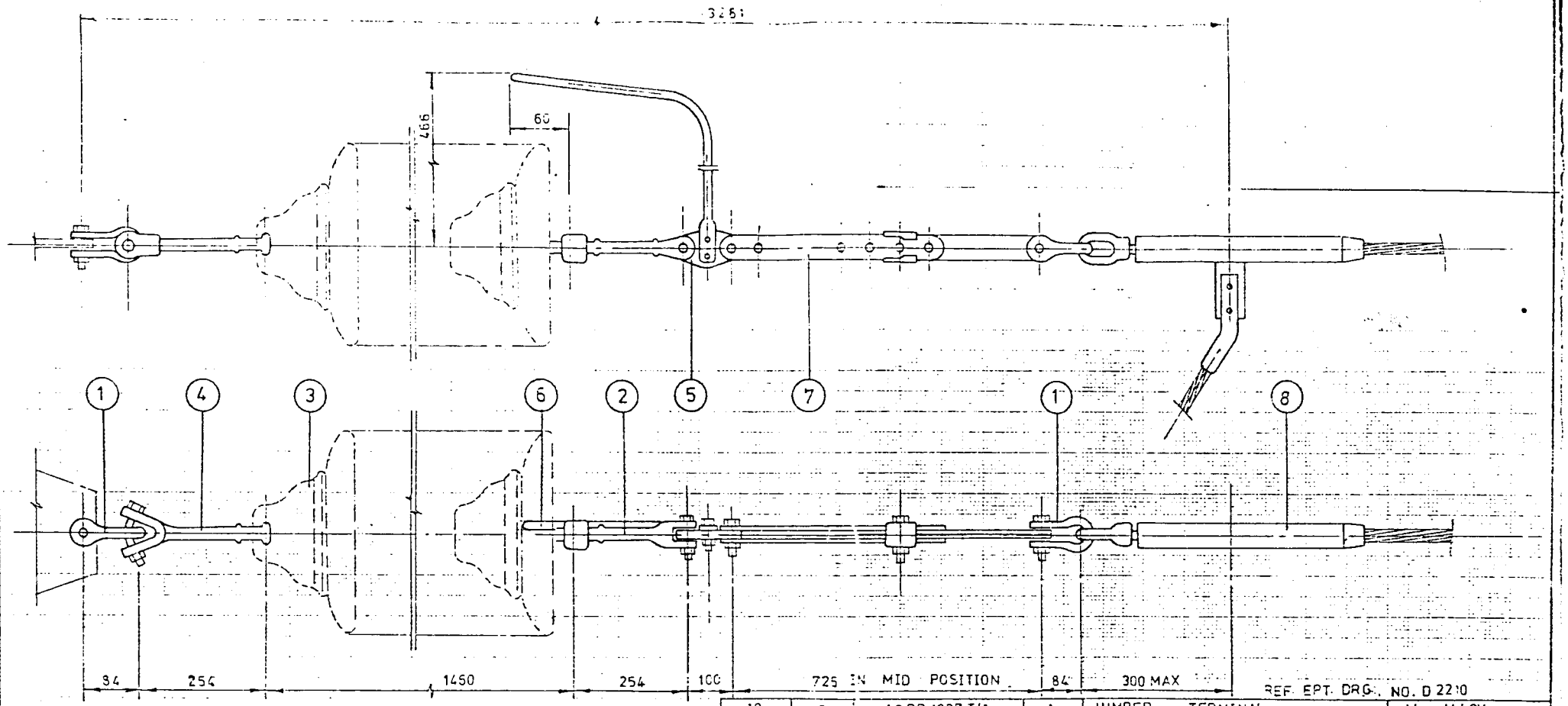
COMPRESSION DEAD END
WITH EYE TAIL FOR 'GRAP
MIN UTS 60 KN.

DULMISON
(THAILAND) CO.,LTD.

A3 DD 1027/1/1

REVISIONS

V/ STRANDING 30/7/25



REF. EPT. DRG. NO. D 2210

EPT'SITE	ITEM	REF. NO.	QTY.	DESCRIPTION	MATERIAL
19	9	A3 DD 1027 T/1	1	JUMPER TERMINAL	AL. ALLOY
20	8	A3 DD 1027 T/1	1	COMP. DEAD END 'GRAPE'	AL. ALLOY
16	7	A3 DD 1009 T/2	1	SAG LINK	GALV. M.S.
3	6	A3 DD 1011 T/1	1	SINGLE LIVE END A/H	GALV. M.S.
11	5	A3 DD 1010 T/2	1	PLATE LINK FOR A/H	GALV. M.S.
12 A	4	A3 DD 1007 T/1	1	BALL 'Y' CLEVIS EXT. LINK	GALV. FORGED ST.
13	3			INSULATOR	
15	2	A3 DD 1008 T/1	1	SOCKET CLEVIS EXT. LINK	GALV. FORGED ST.
10	1	A4 DD 1007 B/2	2	BOW SHACKLE	GALV. FORGED ST.

THIS SET IS FOR USE OUTSIDE THE SUBSTATION LIMIT

DRAWN	DATE	SCALE	APPV'D.
B.S	6.12.78	1:10	

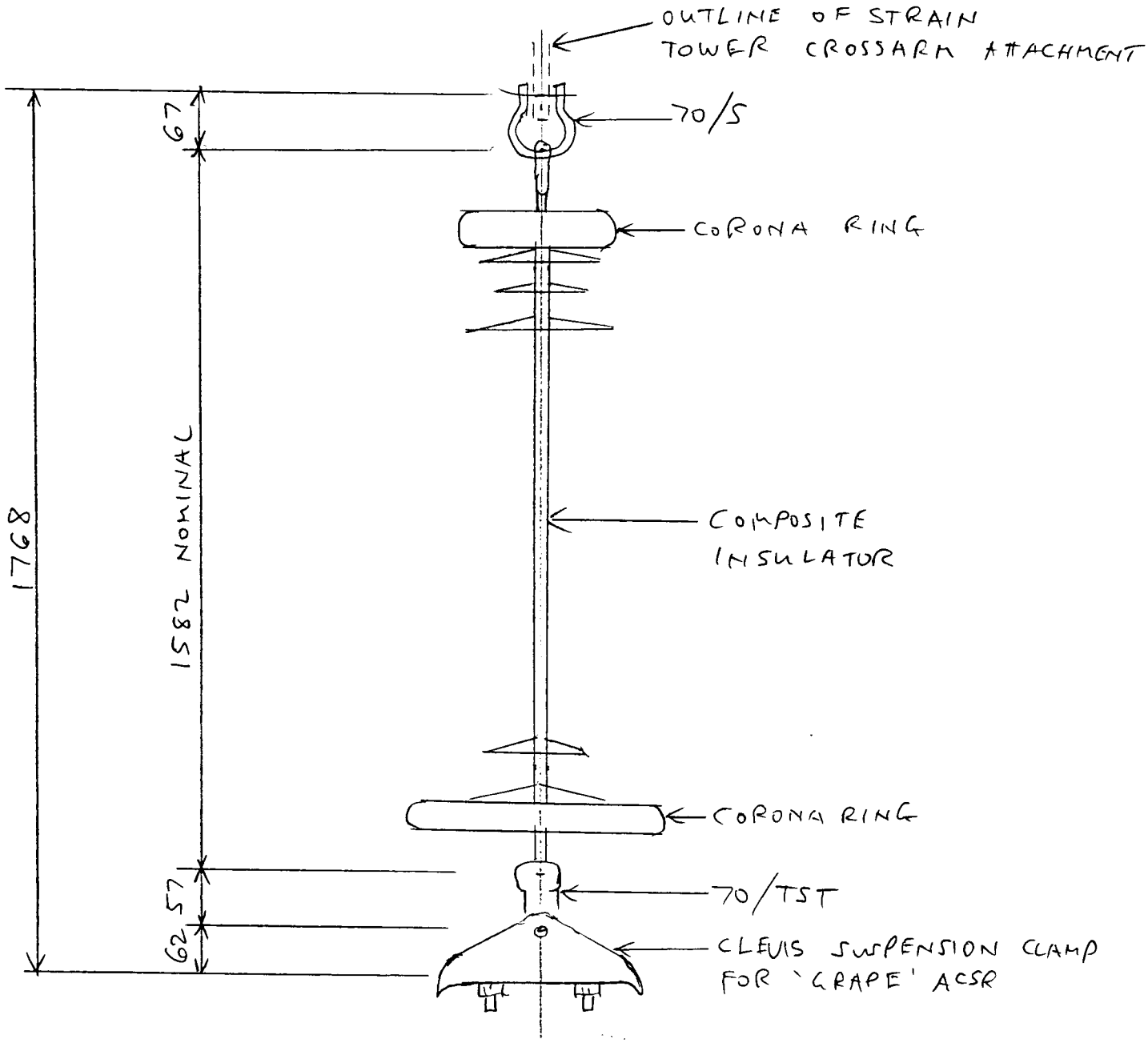
GENERAL TOLERANCE
DIMENSIONS UP TO AND INCLUDING
[illegible]
DIMENSIONS GREATER THAN
[illegible]

TITLE

SINGLE TENSION SET
'GRAPE' 132 KV

DUTTON

A3-D T 0218 T/2



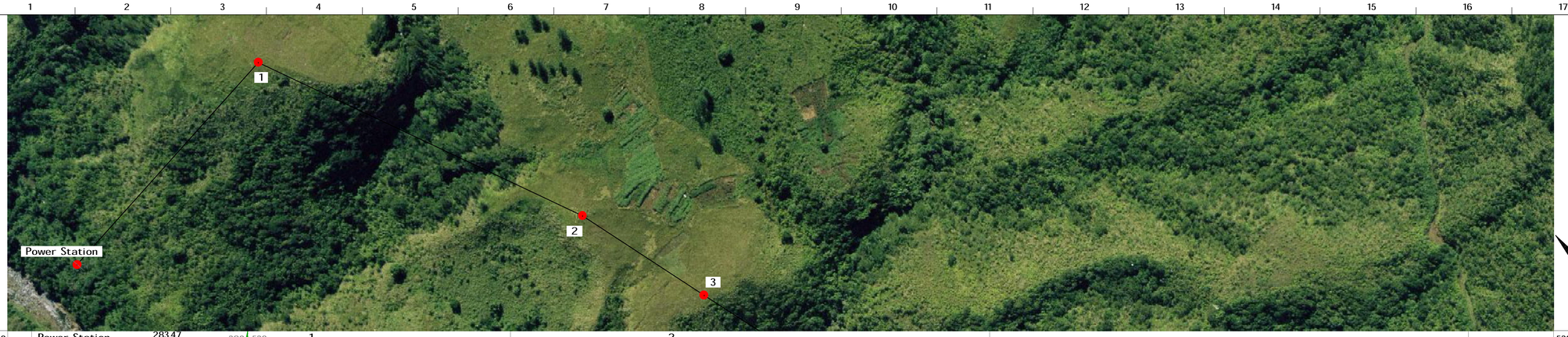
JUMPER SET, 70 kN M.F.L.

G) - ROUTE PLAN AND PROFILE DRAWINGS

The following pages contain the original route plan and profile drawings applicable for the Nadarivatu 132kV line.

Also included is a route plan and profile drawing for the Wailoa-Vuda Tower 82 section.

PLS-CADD Drawing



Power Station
Strain
Gantry
E = 1,911,205.5
N = 3,924,802.2
RL = 199.6
TA = 0.0
Sw = 176
Sb = -531
-

283.47

1
Strain
TDT
E = 1,911,486.0
N = 3,924,843.0
RL = 385.3
TA = 73.5
Sw = 363
Sb = 1152
-

2
Susp
TDH
E = 1,911,643.0
N = 3,924,503.0
RL = 385.4
TA = 7.9
Sw = 263
Sb = 206
-

374.50

151.53

0

500

- STRUCTURE FUNCTION
- TOWER TYPE
- E = EASTING
- N = NORTHING
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP
- WEIGHTS (KG)

NOTES:

1. ALL DIMENSIONS IN METRES
2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)
3. EARTHWIRE: OPGW (GREEN SOLID LINE)
4. TENSION (AVERAGE):
   CONDUCTOR - 7.0kN AT 20°C BEFORE CREEP
   OPGW - 7.0kN AT 20°C BEFORE CREEP
5. SURVEY TO: TBC
6. LEVELS TO: TBC
7. SURVEY CARRIED OUT: TBC
8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)
9. MAX. DESIGN OPERATING TEMPERATURE: 75°C
10. CONDUCTOR SHOWN AT MAX. DESIGN
    OPERATING TEMPERATURE (CREEP FE)
11. GROUND CLEARANCE SHOWN AT 6.7m
    (DASHED BLACK LINE)
12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

1:2500 1:500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR APPROVAL	LTC	ID	3/10	PLS	3/10	DR	3/10	EH	3/10		
3	T9-T10 RELOCATED, T11 REMOVED	LTC	ID	8/10	PLS	8/10	DR	8/10	EH	8/10		
4	TOWER TYPE ADDED	LTC	ID	11/10	PLS	11/10	ID	11/10	EH	11/10		

DESIGNED	I DYSON	MAR 2010
DRAWN	PLS-CADD	MAR 2010
CHECKED	D REID	MAR 2010
APPROVED	E HARDIE	MAR 2010
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

SINOHYDRO CORPORATION LTD

NADARIVATU 132kV TEE LINE

ROUTE PLAN AND PROFILE

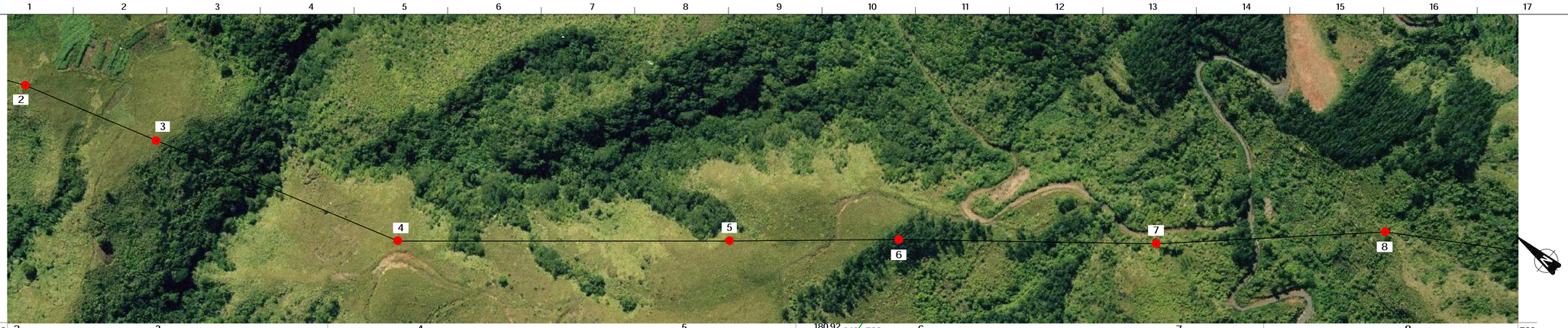
SHEET 1 - TOWER Power Station TO 2

SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

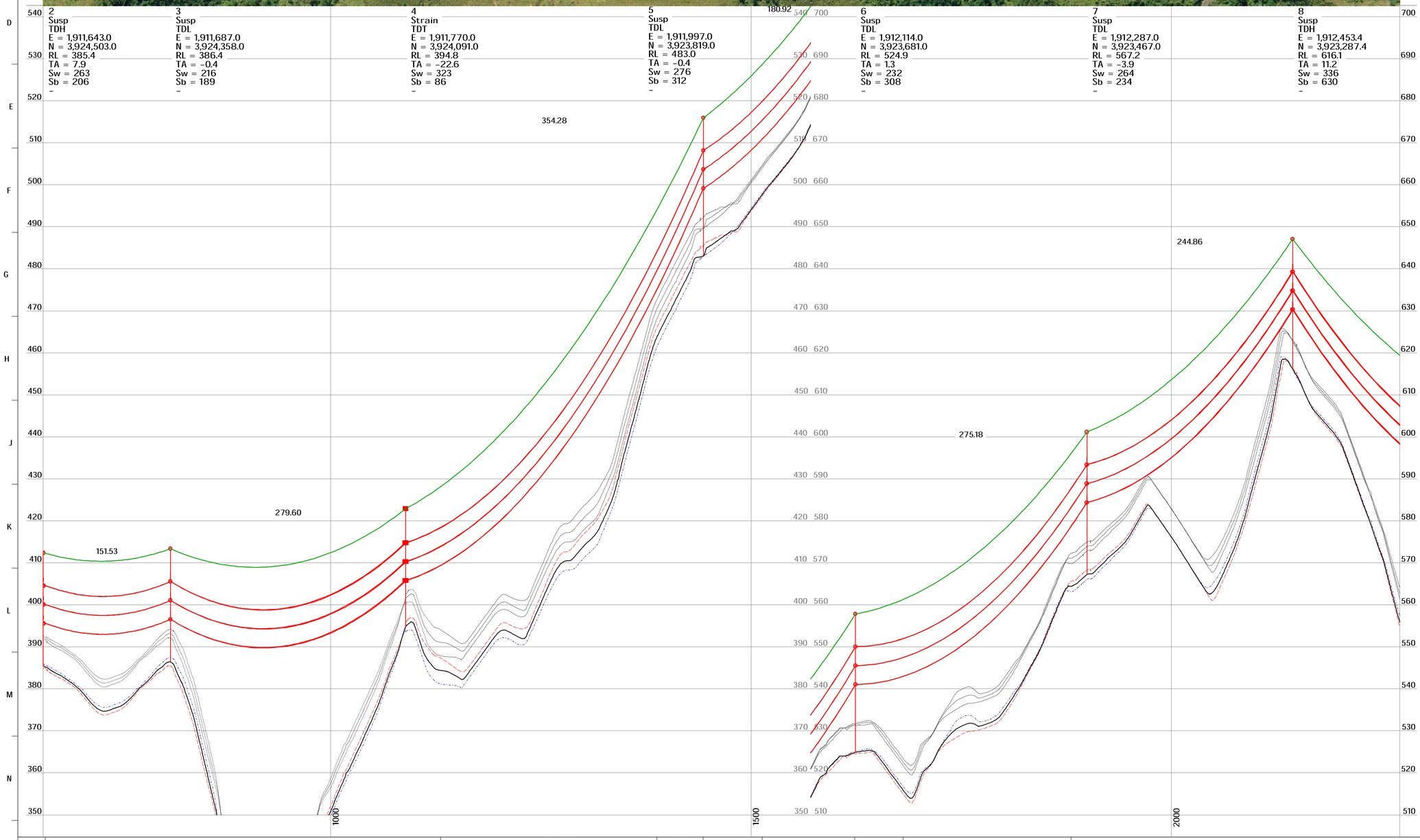
DRAWING NUMBER: LEH5788/RPP | SHEET: 1 | REV: 4

CAD FILE NAME: SINOHYDRO-R4-V1 DR.XYZ

PLS-CADD Drawing



2	3	4	5	6	7	8
Susp	Susp	Strain	Susp	Susp	Susp	Susp
TDH	TDL	TDT	TDL	TDL	TDL	TDH
E = 1,911,643.0	E = 1,911,687.0	E = 1,911,770.0	E = 1,911,997.0	E = 1,912,114.0	E = 1,912,287.0	E = 1,912,453.4
N = 3,924,503.0	N = 3,924,358.0	N = 3,924,091.0	N = 3,923,819.0	N = 3,923,681.0	N = 3,923,467.0	N = 3,923,287.4
RL = 385.4	RL = 386.4	RL = 394.8	RL = 483.0	RL = 524.9	RL = 567.2	RL = 616.1
TA = 7.9	TA = -0.4	TA = -22.6	TA = -0.4	TA = 1.3	TA = -3.9	TA = 11.2
Sw = 263	Sw = 216	Sw = 323	Sw = 276	Sw = 232	Sw = 264	Sw = 336
Sb = 206	Sb = 189	Sb = 86	Sb = 312	Sb = 308	Sb = 234	Sb = 630
-	-	-	-	-	-	-



- STRUCTURE FUNCTION
- TOWER TYPE
- E = EASTING
- N = NORTHING
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP
- WEIGHTS (KG)

NOTES:

1. ALL DIMENSIONS IN METRES
2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)
3. EARTHWIRE: OPGW (GREEN SOLID LINE)
4. TENSION (AVERAGE):
   CONDUCTOR - 7.0kN AT 20°C BEFORE CREEP
   OPGW - 7.0kN AT 20°C BEFORE CREEP
5. SURVEY TO: TBC
6. LEVELS TO: TBC
7. SURVEY CARRIED OUT: TBC
8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)
9. MAX. DESIGN OPERATING TEMPERATURE: 75°C
10. CONDUCTOR SHOWN AT MAX. DESIGN
    OPERATING TEMPERATURE (CREEP FE)
11. GROUND CLEARANCE SHOWN AT 6.7m
    (DASHED BLACK LINE)
12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

1:2500 1:500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR APPROVAL	LTC	ID	3/10	PLS	3/10	DR	3/10	EH	3/10		
3	T9-T10 RELOCATED, T11 REMOVED	LTC	ID	8/10	PLS	8/10	DR	8/10	EH	8/10		
4	TOWER TYPE ADDED	LTC	ID	11/10	PLS	11/10	ID	11/10	EH	11/10		

DESIGNED	I DYSON	MAR 2010
DRAWN	PLS-CADD	MAR 2010
CHECKED	D REID	MAR 2010
APPROVED	E HARDIE	MAR 2010
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

SINOHYDRO CORPORATION LTD

NADARIVATU 132kV TEE LINE

ROUTE PLAN AND PROFILE

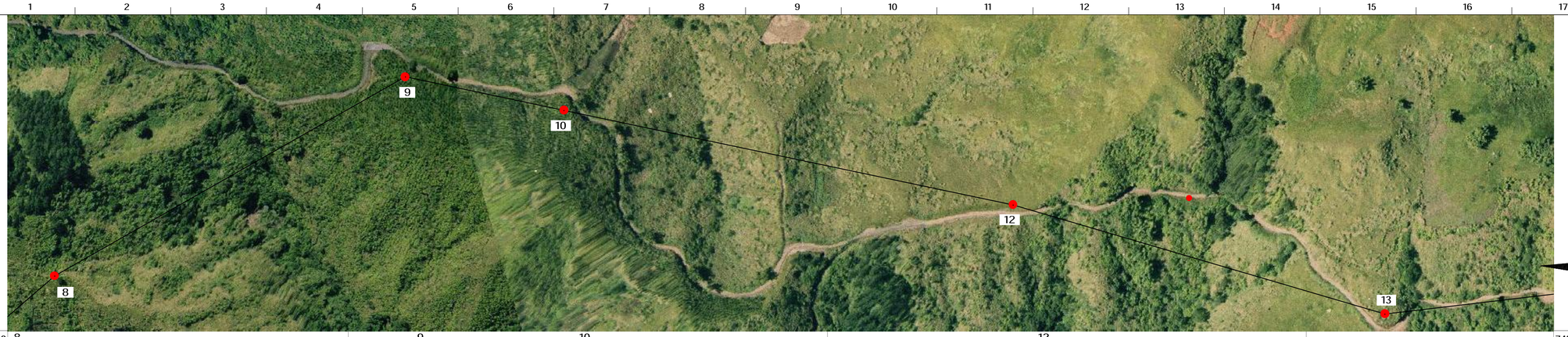
SHEET 2 - TOWER 2 TO 8

SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

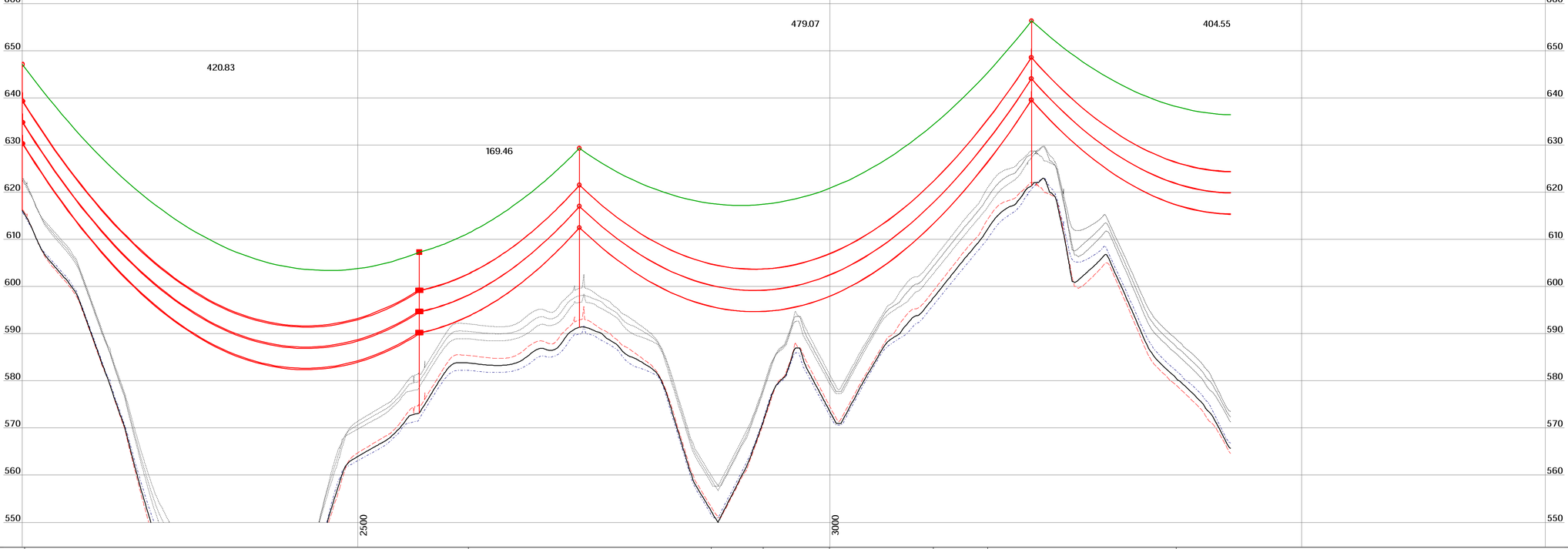
DRAWING NUMBER	SHEET	REV
LEH5788/RPP	2	4

CAD FILE NAME: SINOHYDRO-R4-V1 DR.XYZ

PLS-CADD Drawing



8	9	10	12
Susp	Strain	Susp	Susp
TDH	TDT	TDL	TDL
E = 1,912,453.4	E = 1,912,674.0	E = 1,912,645.0	E = 1,912,563.0
N = 3,923,287.4	N = 3,922,929.0	N = 3,922,762.0	N = 3,922,290.0
RL = 616.1	RL = 573.2	RL = 591.3	RL = 621.4
TA = 11.2	TA = 41.5	TA = 0.0	TA = 4.5
Sw = 336	Sw = 297	Sw = 325	Sw = 442
Sb = 630	Sb = 64	Sb = 404	Sb = 520
-	-	-	-



- STRUCTURE FUNCTION
- TOWER TYPE
- E = EASTING
- N = NORTHING
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP
- WEIGHTS (KG)

NOTES:

1. ALL DIMENSIONS IN METRES
2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)
3. EARTHWIRE: OPGW (GREEN SOLID LINE)
4. TENSION (AVERAGE):
   CONDUCTOR - 7.0kN AT 20°C BEFORE CREEP
   OPGW - 7.0kN AT 20°C BEFORE CREEP
5. SURVEY TO: TBC
6. LEVELS TO: TBC
7. SURVEY CARRIED OUT: TBC
8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)
9. MAX. DESIGN OPERATING TEMPERATURE: 75°C
10. CONDUCTOR SHOWN AT MAX. DESIGN
    OPERATING TEMPERATURE (CREEP FE)
11. GROUND CLEARANCE SHOWN AT 6.7m
    (DASHED BLACK LINE)
12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR APPROVAL	LTC	ID	3/10	PLS	3/10	DR	3/10	EH	3/10		
3	T9-T10 RELOCATED, T11 REMOVED	LTC	ID	8/10	PLS	8/10	DR	8/10	EH	8/10		
4	TOWER TYPE ADDED	LTC	ID	11/10	PLS	11/10	ID	11/10	EH	11/10		

DESIGNED	I DYSON	MAR 2010
DRAWN	PLS-CADD	MAR 2010
CHECKED	D REID	MAR 2010
APPROVED	E HARDIE	MAR 2010
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

SINOHYDRO CORPORATION LTD

NADARIVATU 132kV TEE LINE

ROUTE PLAN AND PROFILE

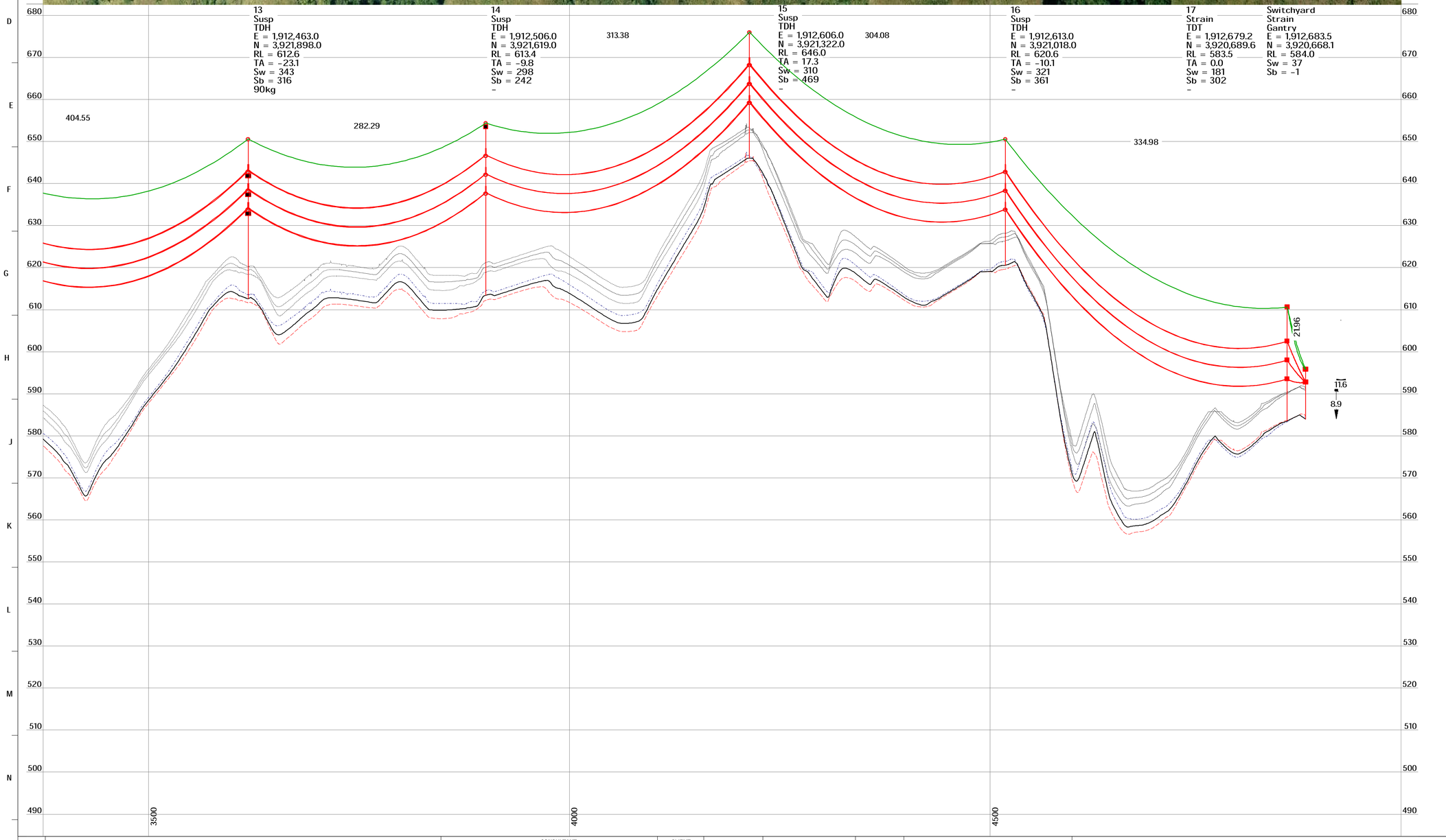
SHEET 3 - TOWER 8 TO 12

SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

DRAWING NUMBER	SHEET	REV
LEH5788/RPP	3	4

CAD FILE NAME: SINOHYDRO-R4-V1 DR.XYZ

PLS-CADD Drawing



- STRUCTURE FUNCTION
- TOWER TYPE
- E = EASTING
- N = NORTHING
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP
- WEIGHTS (KG)

NOTES:

1. ALL DIMENSIONS IN METRES

2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)

3. EARTHWIRE: OPGW (GREEN SOLID LINE)

4. TENSION (AVERAGE):
   CONDUCTOR - 7.0kN AT 20°C BEFORE CREEP
   OPGW - 7.0kN AT 20°C BEFORE CREEP

5. SURVEY TO: TBC

6. LEVELS TO: TBC

7. SURVEY CARRIED OUT: TBC

8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)

9. MAX. DESIGN OPERATING TEMPERATURE: 75°C

10. CONDUCTOR SHOWN AT MAX. DESIGN
    OPERATING TEMPERATURE (CREEP FE)

11. GROUND CLEARANCE SHOWN AT 6.7m
    (DASHED BLACK LINE)

12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

1:2500

1:500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR APPROVAL	LTC	ID	3/10	PLS	3/10	DR	3/10	EH	3/10		
3	T9-T10 RELOCATED, T11 REMOVED	LTC	ID	8/10	PLS	8/10	DR	8/10	EH	8/10		
4	TOWER TYPE ADDED	LTC	ID	11/10	PLS	11/10	ID	11/10	EH	11/10		

DESIGNED	I DYSON	MAR 2010
DRAWN	PLS-CADD	MAR 2010
CHECKED	D REID	MAR 2010
APPROVED	E HARDIE	MAR 2010
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

SINOHYDRO CORPORATION LTD

NADARIVATU 132kV TEE LINE

ROUTE PLAN AND PROFILE

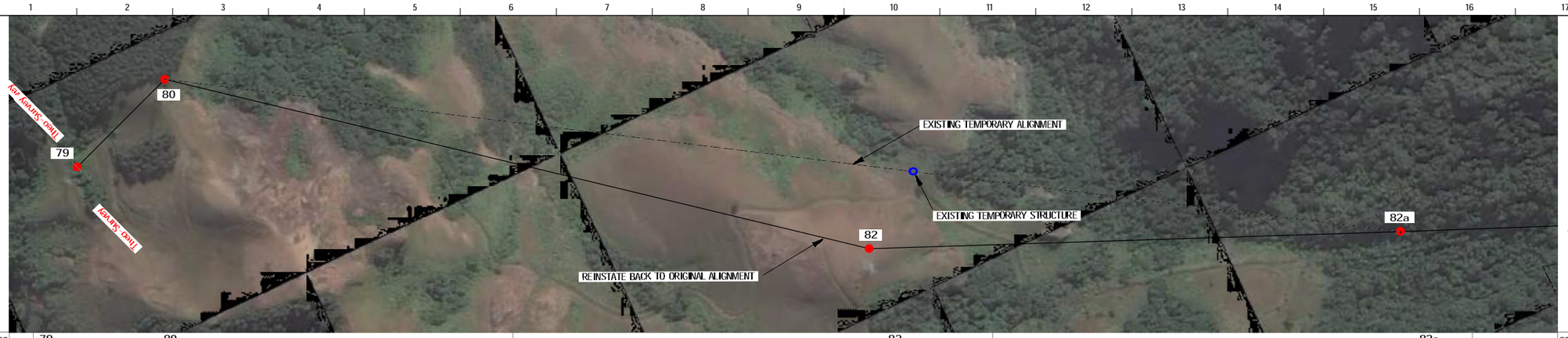
SHEET 4 - TOWER 13 TO 23-3

SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

DRAWING NUMBER	SHEET	REV
LEH5788/RPP	4	4

CAD FILE NAME: SINOHYDRO-R4-V1 DR.XYZ

PLS-CADD Drawing



79	80	82	82a
SUSP	STRAIN	STRAIN	STRAIN
S2G+3	DGL+3	NEW	S30G-3
647m	680m	761m	695m
-	447m	659m	462m
-	805m	1143m	-203m

755.4

554.0

129.3

THERE IS NO PROFILE SURVEY AVAILABLE
THE LINE IS BEING REINSTATED TO THE ORIGINAL ALIGNMENT AND STRUCTURE HEIGHTS, SO GROUND CLEARANCES ARE ASSUMED ACCEPTABLE

- STRUCTURE NUMBER
- STRUCTURE FUNCTION
- TOWER TYPE
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP

NOTES:

1. ALL DIMENSIONS IN METRES
2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)
3. EARTHWIRE: 7/3.25 SC/AC (GREEN SOLID LINE)
4. TENSION (AVERAGE):
   CONDUCTOR - 12.8kN AT 22°C AFTER CREEP
   OPGW - 10.6kN AT 22°C AFTER CREEP
5. SURVEY TO: TBC
6. LEVELS TO: TBC
7. SURVEY CARRIED OUT: TBC
8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)
9. MAX. DESIGN OPERATING TEMPERATURE: 75°C
10. CONDUCTOR SHOWN AT MAX. DESIGN OPERATING TEMPERATURE (CREEP FE)
11. GROUND CLEARANCE SHOWN AT 6.7m (DASHED BLACK LINE)
12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR TENDER	LTC	ID	9/16	PLS	9/16	WD	9/16	PG	9/16		

DESIGNED	I DYSON	SEPT 2016
DRAWN	PLS-CADD	SEPT 2016
CHECKED	W DOWLING	SEPT 2016
APPROVED	P GREENWAY	SEPT 2016
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

WAILOA - VUDA 132kV TEE LINE

ROUTE PLAN AND PROFILE

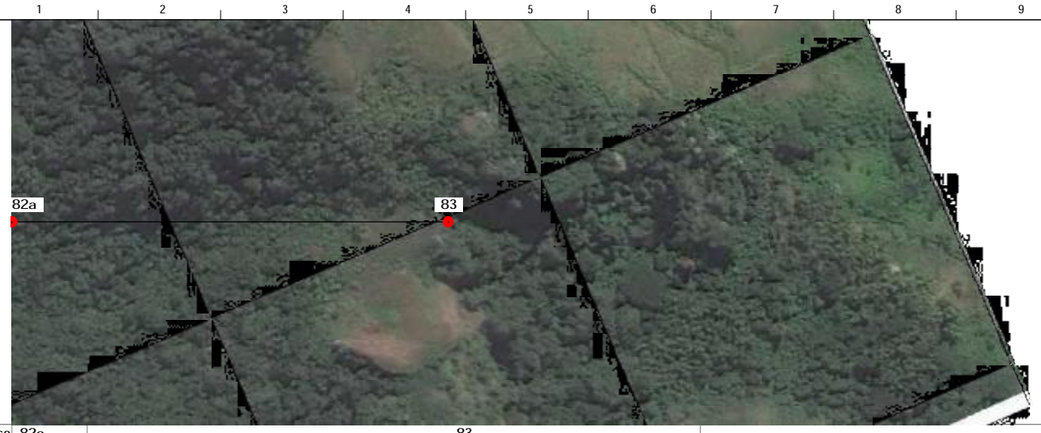
SHEET 1 - TOWER 79 TO 82a

SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

DRAWING NUMBER	SHEET	REV
13566/WV/RPP	1	1

CAD FILE NAME: WAILOA-VUDA-T82.XYZ

PLS-CADD Drawing



82a	83
STRAIN	STRAIN
S30G-3	S30G+0
695m	758m
462m	-
-203m	-

356.0

1500

- STRUCTURE NUMBER
- STRUCTURE FUNCTION
- TOWER TYPE
- GRL = GROUND RL (M)
- TA = TURN ANGLE (°)
- Sw = WIND SPAN (M)
- Sb = WEIGHT SPAN (M) AT 20°C STILL AIR AFTER CREEP

NOTES:

1. ALL DIMENSIONS IN METRES

2. CONDUCTOR:
   GRAPE AACSR (RED SOLID LINE)

3. EARTHWIRE: 7/3.25 SC/AC (GREEN SOLID LINE)

4. TENSION (AVERAGE):
   CONDUCTOR - 12.8kN AT 22°C AFTER CREEP
   OPGW - 10.6kN AT 22°C AFTER CREEP

5. SURVEY TO: TBC

6. LEVELS TO: TBC

7. SURVEY CARRIED OUT: TBC

8. PROFILE WIDTH = 15M EITHER SIDE OF CENTRE LINE
   GROUND (BLACK SOLID LINE)
   LHS PROFILE WIDTH OF -4.5m (BLUE DASH-DOT)
   RHS PROFILE WIDTH OF 4.5m (RED DASH-DASH)

9. MAX. DESIGN OPERATING TEMPERATURE: 75°C

10. CONDUCTOR SHOWN AT MAX. DESIGN
    OPERATING TEMPERATURE (CREEP FE)

11. GROUND CLEARANCE SHOWN AT 6.7m
    (DASHED BLACK LINE)

12. SCALES: HORIZONTAL = 1 : 2500
    VERTICAL = 1 : 500

REV	DESCRIPTION	CONSULTANT NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	CLIENT APP	CLIENT DATE
1	ISSUED FOR TENDER	LTC	ID	9/16	PLS	9/16	WD	9/16	PG	9/16		

DESIGNED	I DYSON	SEPT 2016
DRAWN	PLS-CADD	SEPT 2016
CHECKED	W DOWLING	SEPT 2016
APPROVED	P GREENWAY	SEPT 2016
CLIENT APPRV.		
PREPARED BY:	LINETECH CONSULTING LTD 3rd FLOOR 151 KILMORE ST. CHRISTCHURCH, NZ	

WAILOA - VUDA 132kV TEE LINE

ROUTE PLAN AND PROFILE

SHEET 2 - TOWER 82a TO 83

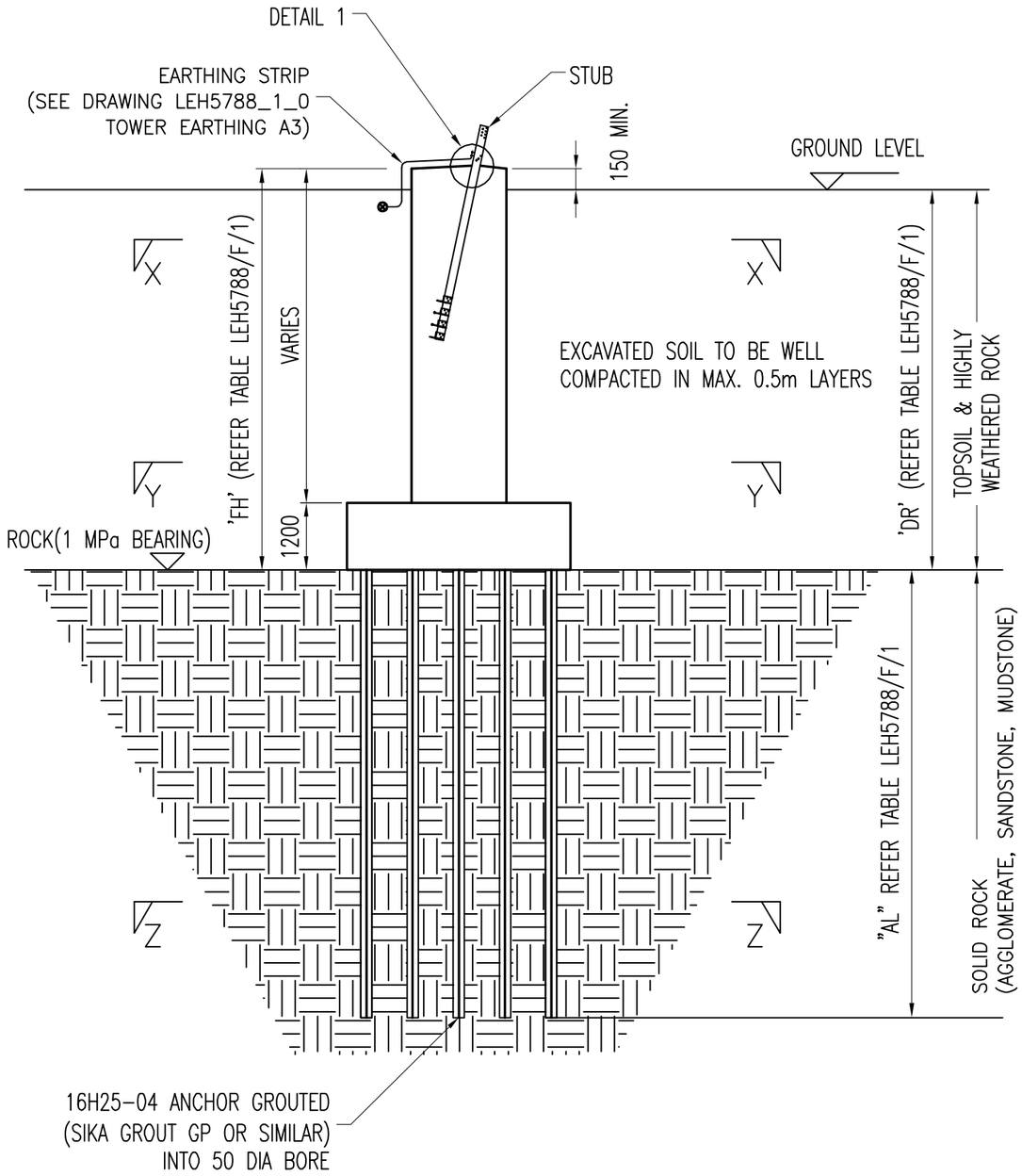
SIZE	SCALE	FOLDER
A1	SEE NOTE 12	-

DRAWING NUMBER	SHEET	REV
13566/WV/RPP	2	1

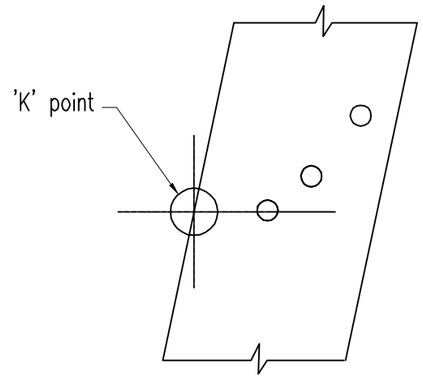
CAD FILE NAME: WAILOA-VUDA-T82.XYZ

H) – EXISTING TOWER FOUNDATION DRAWINGS

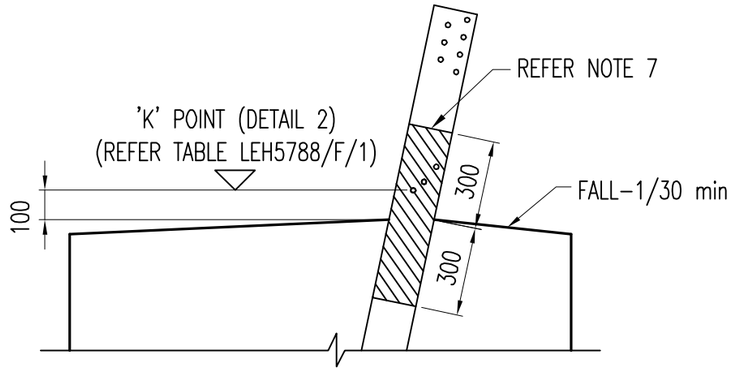
The following pages contain the construction details for the existing foundation types on the Nadarivatu line.



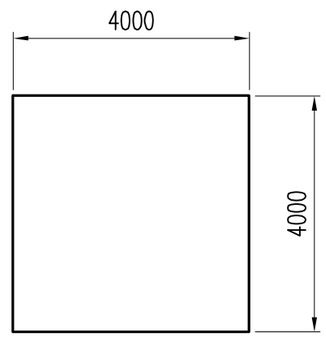
FOUNDATION DETAIL



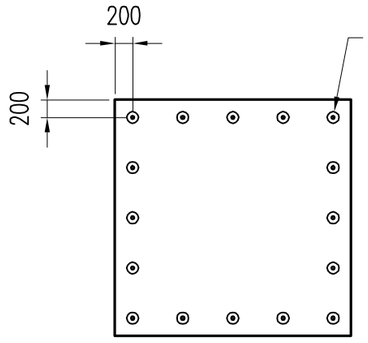
DETAIL 2



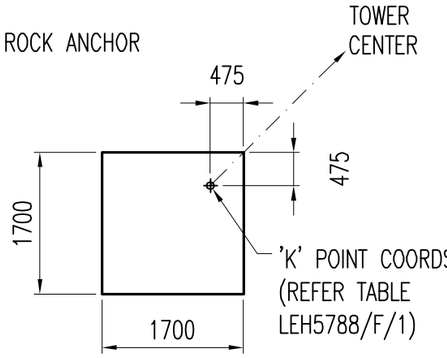
DETAIL 1



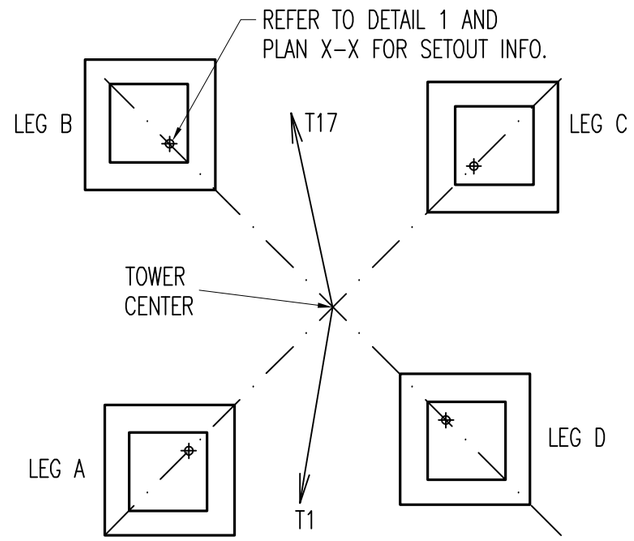
PLAN ON Y-Y



PLAN ON Z-Z



PLAN ON X-X



PLAN ON TYPICAL FOUNDATION LAYOUT

NOTES

1. ALL DIMENSIONS IN (mm) UNLESS NOTED OTHERWISE.
2. ALL CONCRETE SHALL BE CONSTRUCTED IN ACCORDANCE WITH ACI STANDARDS.
3. ALL CONCRETE SUPPLIED SHALL BE 32 MPa HIGH GRADE TO ACI STANDARDS.
4. ALL REINFORCING BARS SHALL BE GRADE G60 (DENOTED H WITH BAR SIZE) ASTM A616.
5. MINIMUM COVER TO REINFORCEMENT SHALL BE 100mm.
6. EXCAVATION AND REINFORCING TO BE INSPECTED BY ENGINEER PRIOR TO POURING CONCRETE.
7. STUB TO BE PAINTED 150 MICRON PAINT COATING TO PREVENT 'RING BARK' CORROSION. 2 COAT ZINC EPOXY OR 3 COAT ZINC VINYL.
8. SEE DRAWING LEH5788_16_0 TOWER EARTHING A3 FOR TOWER EARTHING DETAILS

EMPLOYER
Fiji Electricity Authority
Nadarivatu Renewable Energy Project
CONTRACT No.: FEA/NHP-01&NHP-02

MANAGEMENT CONSULTANT
MWH Global, Inc.

CONTRACTOR
SINOHYDRO CORPORATION LIMITED

	AMENDMENT	BY	CHKD	DATE
A	PRELIMINARY DESIGN	LTC	I.D.	11.10
B	REVISED FOLLOWING SYNO REVIEW COMMENTS	LTC	I.D.	11.10
C	REVISED AS PER SYNO COMMENTS	LTC	I.D.	11.10

DRAWN	I.MOTOVILOV	11.10
DESIGNED	I.DYSON	11.10
CHECKED	E.HARDIE	11.10
APPROVED	–	11.10
CAD FILE	LEH5788_9_1	

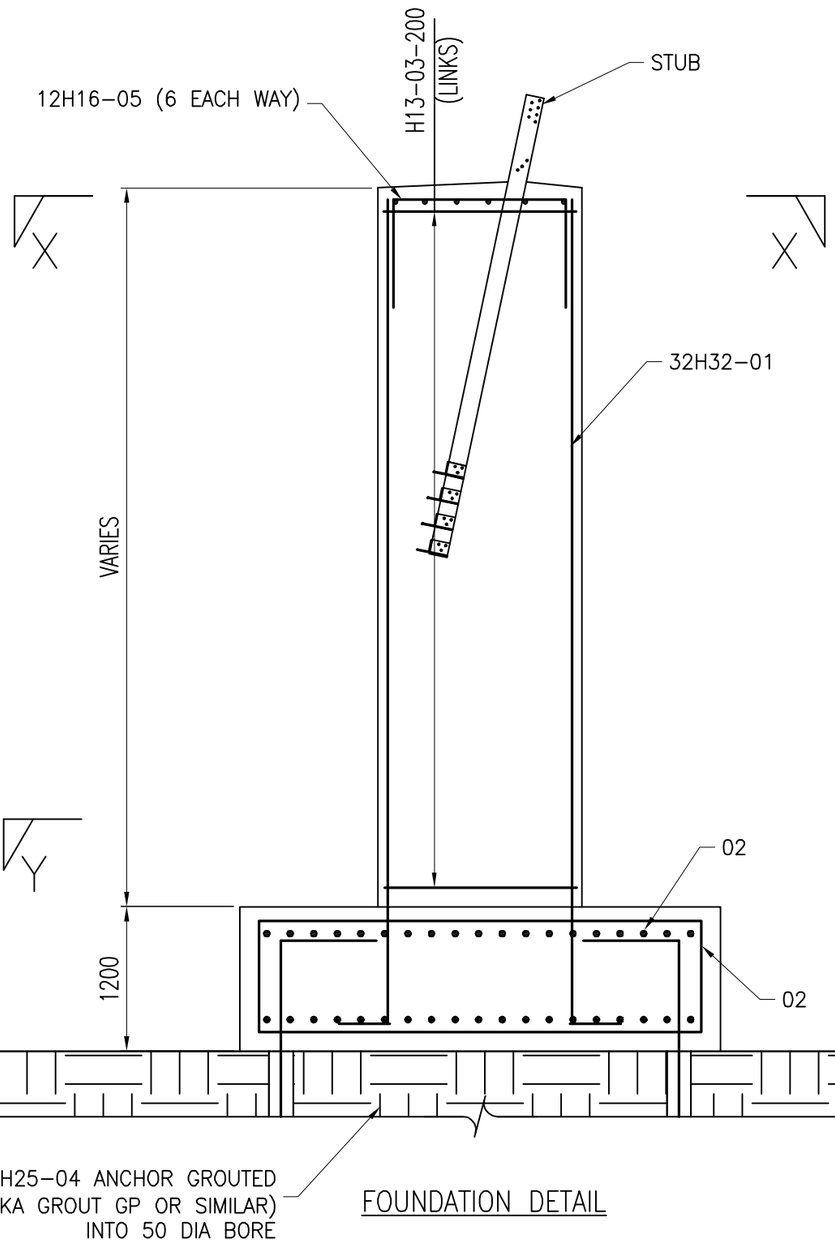
LINETECH Consulting
9 Sussex Street, Chartwell
PO Box 3210
Hamilton, New Zealand
Tel +64 (0)7 853 3548

NADARIVATU HYDRO 132kV LINE

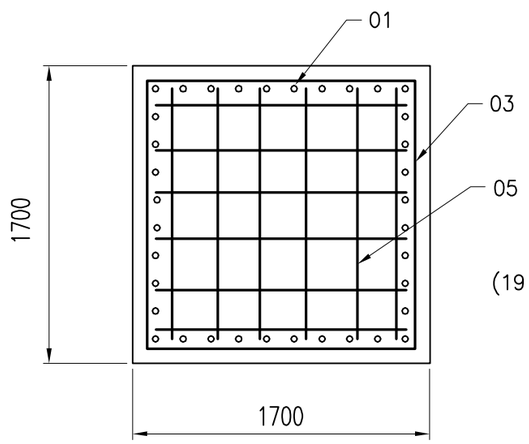
TOWER TYPES TDT, TDH & TDL
PAD AND ANCHOR FOUNDATION TYPE PAI.
GENERAL ARRANGEMENT AND SETOUT

SCALE N.T.S.
SHEET 1
LEH5788_9
ISSUE Rev. C

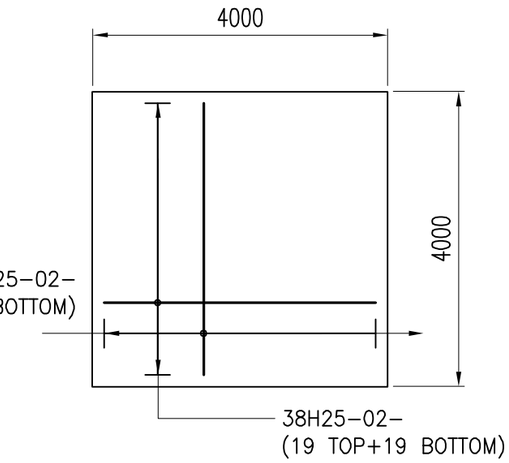
A3



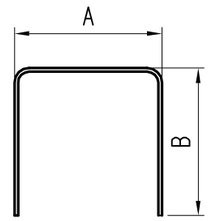
FOUNDATION DETAIL



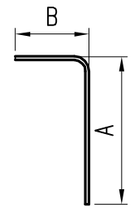
PLAN ON X–X



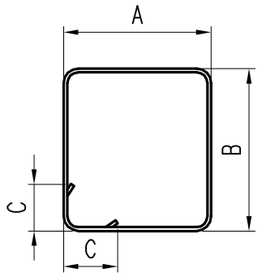
PLAN ON Y–Y



U–BAR



L–BAR



LINK BAR

TABLE 1

BAR MARK	DIAMETER	GRADE	TYPE	DIMENSION		
				A	B	C
01	32	G60	L–BAR	VARIES	300	–
02	25	G60	U–BAR	3840	1000	–
03	13	G60	LINK BAR	1540	1540	150
04	25	G60	L–BAR	VARIES	400	–
05	16	G60	U–BAR	1510	600	–

NOTES

1. ALL DIMENSIONS IN (mm) UNLESS NOTED OTHERWISE.
2. ALL CONCRETE SHALL BE CONSTRUCTED IN ACCORDANCE WITH ACI STANDARDS.
3. ALL CONCRETE SUPPLIED SHALL BE 32 MPa HIGH GRADE TO ACI STANDARDS.
4. ALL REINFORCING BARS SHALL BE GRADE G60 (DENOTED H WITH BAR SIZE) ASTM A616.
5. MINIMUM COVER TO REINFORCEMENT SHALL BE 100mm.
6. EXCAVATION AND REINFORCING TO BE INSPECTED BY ENGINEER PRIOR TO POURING CONCRETE.

EMPLOYER
Fiji Electricity Authority
Nadarivatu Renewable Energy Project
CONTRACT No.: FEA/NHP–01&NHP–02

MANAGEMENT CONSULTANT
MWH Global, Inc.

CONTRACTOR
SINOHYDRO CORPORATION LIMITED

	AMENDMENT	BY	CHKD	DATE
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C	REVISED AS PER SYNO COMMENTS	LTC	I.D.	11.10

DRAWN	I.MOTOVILOV	11.10
DESIGNED	I.DYSON	11.10
CHECKED	E.HARDIE	11.10
APPROVED	–	11.10
CAD FILE	LEH5788_9_2	

LINETECH Consulting
9 Sussex Street, Chartwell
PO Box 3210
Hamilton, New Zealand
Tel +64 (0)7 853 3548

NADARIVATU HYDRO 132kV LINE

TOWER TYPES TDT, TDH & TDL
PAD AND ANCHOR FOUNDATION TYPE PAI
REINFORCING DETAILS

SCALE N.T.S.

SHEET 2

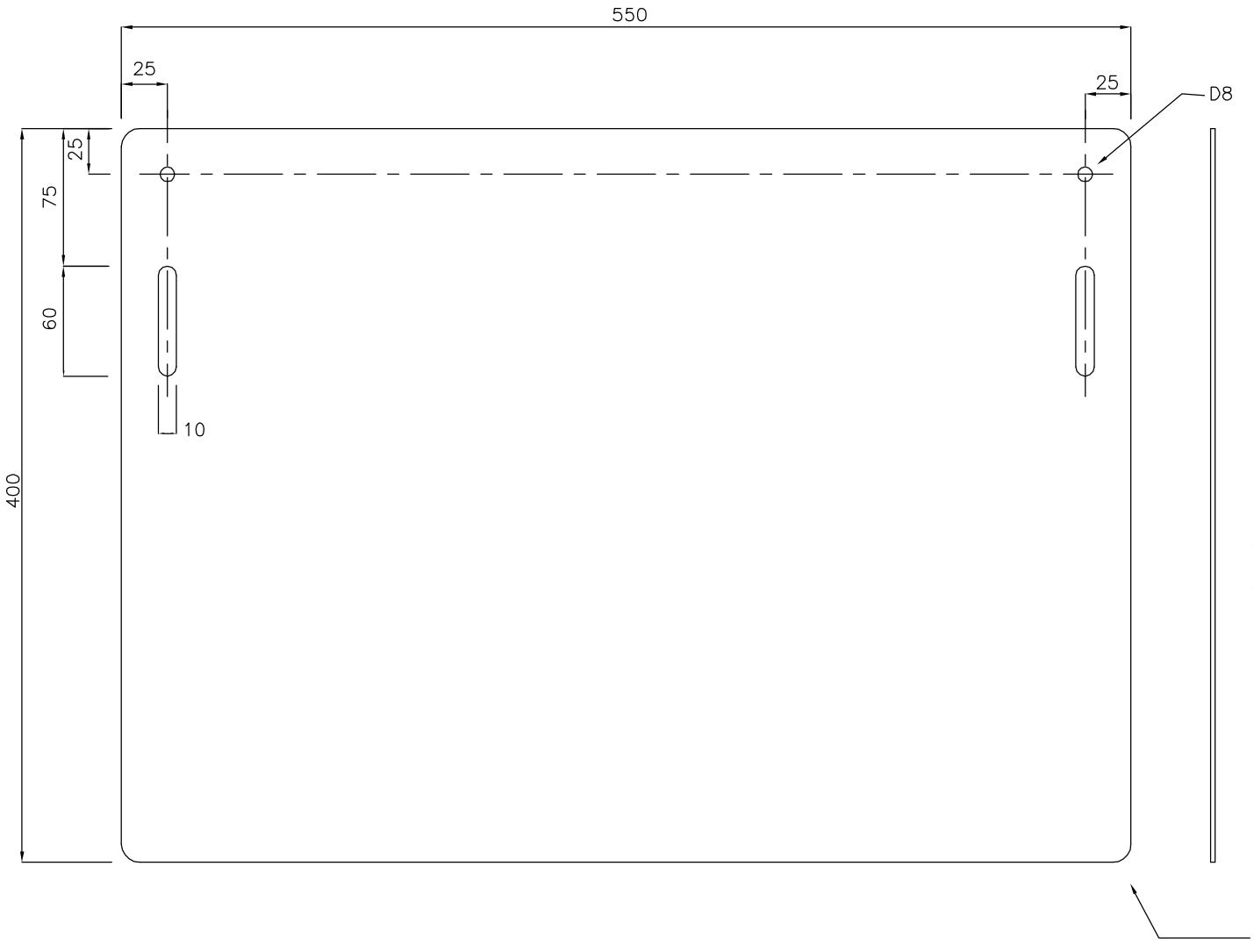
LEH5788_9

ISSUE Rev. C

A3

I) – STRUCTURE SIGNAGE

The following pages contain a sample of the signage requirements for the structures. The actual numbering is yet to be advised by FEA.



NOTES:

1. EACH MOUNTING PLATE SHALL BE MANUFACTURED AND SUPPLIED TO COMPLY WITH THE SPECIFICATION
2. ALL DIMENSIONS ARE IN MILLIMETRES
3. MATERIAL SHALL BE 2.5MM MS PLATE
4. FOR USE WITH DANGER SIGN TO DRAWING FIJI–S1
5. ALL SHARP EDGES SHALL BE REMOVED BEFORE GALVANISING
6. AFTER FABRICATION HOT–DIP GALVANISE IN ACCORDANCE WITH THE SPECIFICATION
7. AFTER FABRICATION THE SIGN MOUNTING SHALL BE ATTACHED TO THE TOWER HORIZONTAL STEEL WITH 1/2 INCH 201 STAINLESS STEEL BAND–IT STRAP AND BUCKLES.

REV	DESCRIPTION	NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE

DESIGNED	K.M.	4.06
DRAWN	M.LAYTON	4.06
CHECKED		
APPROVED		

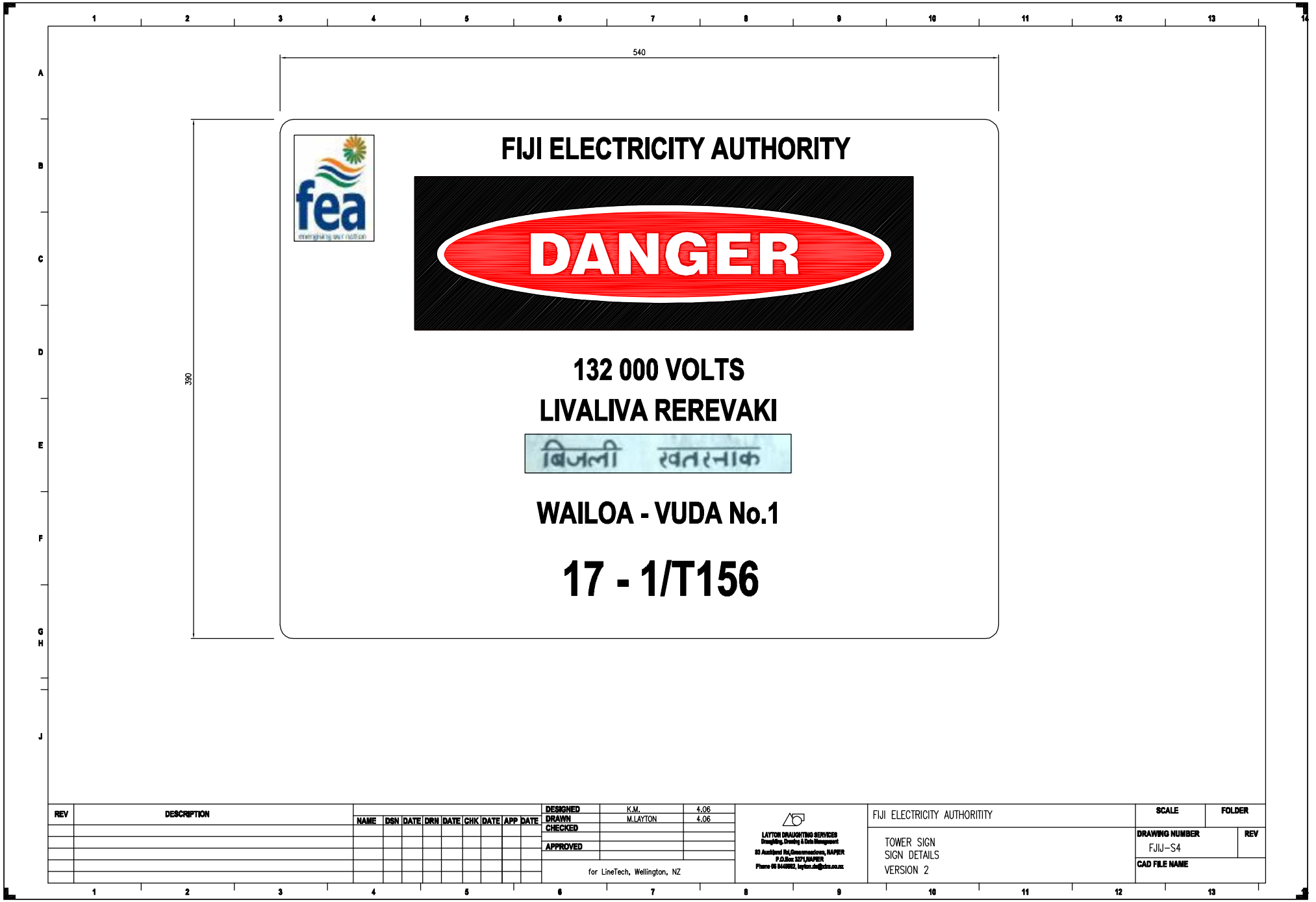
for LineTech, Wellington, NZ

LAYTON DRAUGHTING SERVICES
Draughting, Drawing & Data Management
83 Auckland Rd,Greenmeadows, NAPIER
P.O.Box 3271,NAPIER
Phone 06 8449992, layton.ds@xtra.co.nz

FIJI ELECTRICITY AUTHORITY

TOWER SIGN
SIGN MOUNTING DETAILS
VERSION 2

SCALE	FOLDER
DRAWING NUMBER: FIJI–S3	REV
CAD FILE NAME	



REV	DESCRIPTION	NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE

DESIGNED	K.M.	4.06
DRAWN	M.LAYTON	4.06
CHECKED		
APPROVED		

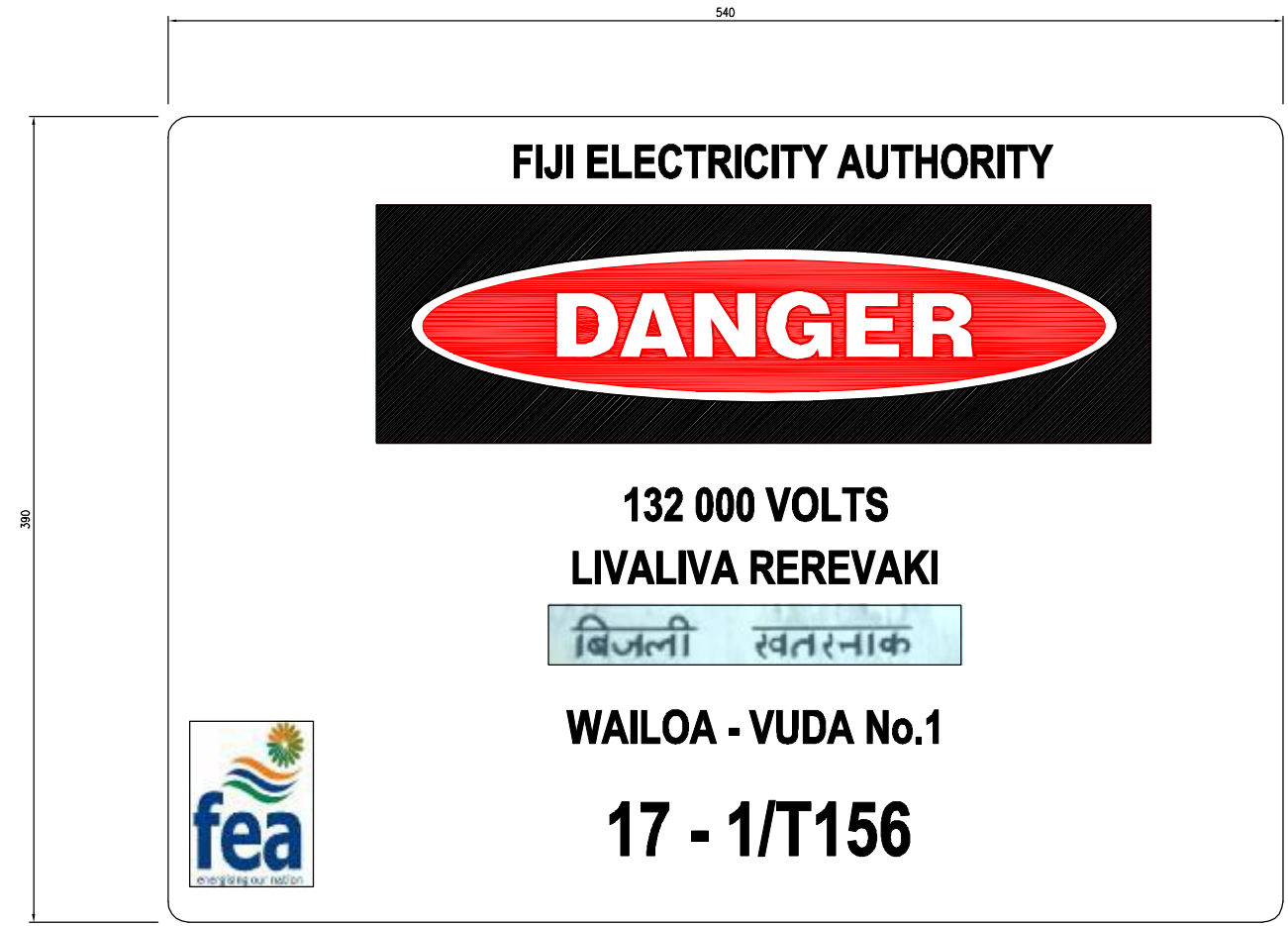
for LineTech, Wellington, NZ

LAYTON DRAUGHTING SERVICES
Draughting, Drawing & Data Management
93 Awatoto Rd,Greenmeadows, NAPIER
P.O.Box 327,NAPIER
Phone 06 8448982, layton.da@xtra.co.nz

FIJI ELECTRICITY AUTHORITY

TOWER SIGN
SIGN DETAILS
VERSION 2

SCALE	FOLDER
DRAWING NUMBER: FJW-S4	REV
CAD FILE NAME	



REV	DESCRIPTION	NAME	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE

DESIGNED	K.M.	4.06
DRAWN	M.LAYTON	4.06
CHECKED		
APPROVED		

for LineTech, Wellington, NZ

LAYTON DRAUGHTING SERVICES
Draughting, Drawing & Data Management
93 Auckland Rd,Greenmeadows, NAPIER
P.O.Box 3271,NAPIER
Phone 06 8449882, layton.dls@xtra.co.nz

FIJI ELECTRICITY AUTHORITY

TOWER SIGN
SIGN DETAILS
VERSION 3

SCALE

FOLDER

DRAWING NUMBER
FJIJ-S5

REV

CAD FILE NAME

J) – CONDUCTOR AND OPGW SPECIFICATIONS

The following pages contain a sample of the signage requirements for the structures. The actual numbering is yet to be advised by FEA.

SPEC No.: 09-9855

REVISION: 1.1

TECHNICAL SPECIFICATION

FOR

Aluminum Conductor Steel Reinforced (ACSR)

Designer	Approver
袁俊俊	
Engineer of ZTT Overseas Department	Technical Director of ZTT Overseas Department

1. SCOPE

This specification covers the general requirements and performance of conductor which ZTT offered including electrical characteristics, mechanical characteristics, packing information etc.

2. REFERENCES

The conductor which ZTT offered shall be designed, manufactured and tested according to international standards as follows:

Quality Control Standard

ISO 9001	Quality Management Systems
ISO 14001	Environmental Management Systems

Component Wire Standard

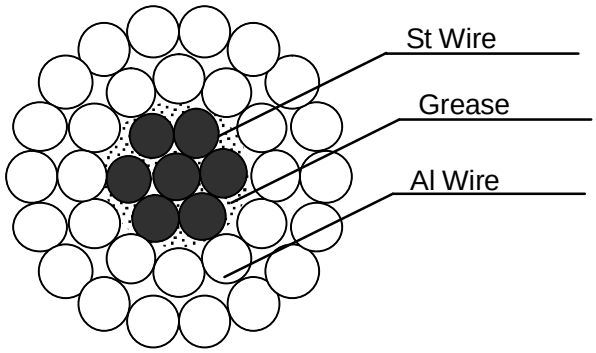
IEC 60888	Zinc-coated steel wires for stranded conductors.
IEC 61232	Aluminum-clad steel wires for electrical purposes
IEC 60104	Aluminum-magnesium-silicon alloy wire for overhead line conductors
IEC 60889	Hard-drawn aluminum wire for overhead line conductors.
ASTM B 502	Standard Specification for Aluminum-Clad Steel Core Wire for Aluminum Conductors, Aluminum-Clad Steel Reinforced
ASTM B 524	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201)
ASTM B 498	Standard specification for Zinc-coated (Galvanized) steel core wire for Aluminum Conductors, steel Reinforced (ACSR)
ASTM B 230	Standard specification for aluminum 1350-H19 wire for electrical purposes
ASTM B 398	Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes
ASTM B 415	Standard Specification for Hard-Drawn Aluminum-Clad Steel Wire

Conductor Standard

IEC 61089	Round wire concentric lay overhead electrical stranded conductors
ASTM B 399	Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM B 231	Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B 232	Standard specification for concentric-lay-stranded aluminum conductors, coated steel reinforced (ACSR)
ASTM B 416	Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors
ASTM B549	Standard Specification for Concentric-lay-Stranded Aluminum Conductors, Aluminum Clad Steel Reinforced (ACSR/AW)

3. CONSTRUCTURE AND SPECIFICATIONS FOR ACSR

3.1. Conductor Structure



3.2. Conductor Technical Structure

Parameter		Unit	Value
Structure	Center: Steel wire	pcs/mm	1/2.50
	Layer 1: Steel wire		6/2.50
	Layer 2: Aluminum wire		12/2.50
	Layer 3: Aluminum wire		18/2.50
Stranding direction of outer layer		Direction	Right
Conductor diameter		mm	17.5
Cross section		mm^2	181.6
Conductor weight with core grease		kg/km	683
Rated tensile strength		kN	63.5
Modulus of Elasticity (E-Modulus)		kN/mm^2	80.5
Thermal Elongation Coefficient		$10^{-6}/℃$	17.9
DC Resistance at 20℃		ohms/km	0.196
Conductor Max. Working Temperature		℃	90

3.3. Component Wire Characteristics (before stranding)

Parameter	Unit	Value	
		Al wire	St wire
Diameter & Deviation	mm	2.50±0.03	2.50 +0.08/-0.05
Calculated cross section	mm^2	4.91	4.91
Weight	kg/km	13.25	38.29
Tensile strength	N/mm^2	175	1310
DC Resistivity at 20℃	$\Omega \cdot mm^2/m$	0.0283	N/A

Note: All Sizes and Values are Nominal Values

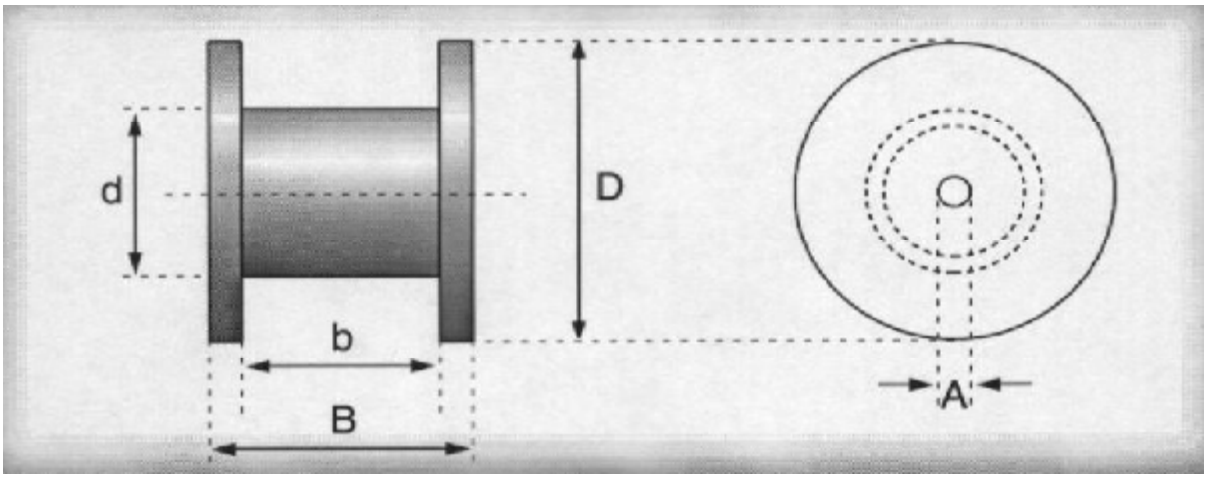
4. TEST REQUIREMENTS FOR ACSR

ACSR shall be accordance with applicable standard of ACSR and requirements of customer. The following test items shall be carried out according to corresponding reference.

No	Item	Reference
Tests of Steel wire		
1	Tension at 1% elongation	AS 3607
2	Tension Strength test	AS 3607
3	Elongation at break	AS 3607
4	Torsion test	AS 3607
Tests of Al wire		
1	Tensile strength test	AS 3607
2	Wrapping test	AS 3607
3	Resistivity test	AS 3607
Tests for finished Conductor		
1	Strain-stress test (Type test)	AS 3607
2	Breaking load (Type test)	AS 3607

5. PACKING AND DRUM FOR CONDUCTOR

Conductors shall be wound on a non-returnable iron-wooden drum or metal drum. Both ends of conductors shall be securely fastened to drum and sealed with a shrinkable cap. The required marking shall be printed with a weather-proof material on the outsides of drum according to customer's requirement.



Cable Type	Drum Length (m)	Drum Dimensions & Weights						material
		D mm	d mm	B mm	b mm	A mm	weight kg	
Grape	2800	1400	600	1080	900	95	2030	Iron-wooden

Note: The value "D" don't contain the dimension of seal.

6. HARDWARE AND ACCESSORIES

ZTT can also manufacture and supply corresponding tension clamp, suspension clamp, down-lead clamp, and vibration damper for conductors etc.

SPEC No.: 10-13264

REVISION: 1.1

TECHNICAL SPECIFICATION

FOR

Optical Fiber Overhead Ground Wire (OPGW)

Designer	Approver
王李峰	
Technical Manager of ZTT Global Market	Chief Technical Engineer of ZTT Global Market

1. SCOPE

This specification covers the general requirements and performance of OPGW offered by ZTT, including optical, electrical, mechanical and geometrical characteristics.

2. REFERENCES

The OPGW offered by ZTT shall be designed, manufactured and tested according to international standards as follows:

ISO 9001	Quality Management Systems
ISO 14001	Environmental Management Systems
IEEE Std 1138	IEEE standard construction of composite fiber optic overhead ground wires (OPGW) for use on electric utility power lines
IEC 60793-1	Optical fiber Part 1: Generic specifications
IEC 60793-2	Optical fiber Part 2: Product specifications
IEC 60794-4	Optical fiber cables – Part 4: Sectional specification – Aerial optical cables along electrical power lines
IEC 60104	Aluminum magnesium-silicon alloy wire for over-head line conductors
IEC 61232	Aluminum – clad steel wire for electrical purposes
IEC 60888	Zinc-coated wire for stranded conducts
IEC 60889	Hard-drawn aluminum wire for overhead line conductors
IEC 60114	Recommendation for heat-treated aluminum alloy bus bar material of the aluminum-magnesium-silicon type
IEC 61089	Round wire concentric lay overhead electrical stranded conductors
IEC 61395	Overhead electrical conductors – Creep test procedures for stranded conductors
IEC 61396	Electrical, mechanical and physical requirements and test methods of optical ground wire (OPGW)
EIA/TIA 598	Color code of fiber optic cables
ITU-T G.650	Definition and test methods for the relevant parameters of single-mode fibers
ITU-T G.652	Characteristics of a single-mode optical fiber cable
ITU-T G.655	Characteristics of a non-zero dispersion shifted single-mode optical fiber cable

3. OPTICAL FIBER: Type G. 652

The optical fiber shall be made of high pure silica and germanium doped silica. UV curable acrylate material is applied over fiber cladding as optical fiber primary protective coating. The detailed data of optical fiber performance are shown in the following table:

ZTT G.652D Fiber

Category	Description	Specifications	
		Before cabling	After cabling
Optical Specifications	Attenuation @1310 nm	≤0.34 dB/km (max.)	≤0.36 dB/km (max.)
	Attenuation @1383±3 nm	≤0.32 dB/km(max.)	≤0.35 dB/km(max.)
	Attenuation @1550 nm	≤0.20 dB/km (max.)	≤0.22dB/km (max.)
	Attenuation @1625 nm	≤0.23dB/km	≤0.25 dB/km
	Zero Dispersion Wavelength	1300~1324 nm	
	Zero Dispersion Slope	≤ 0.092 ps/nm^2·km	
	PMD Link value (M=20cables Q=0.01%) maximum PMD_Q	0.1 ps/√km	
	Cable Cutoff Wavelength (λ_{cc})	≤1260 nm	
	Macro bending Loss (100 turns; Φ50 mm) @1550 nm (100 turns; Φ50 mm) @1625 nm	 ≤ 0.05 dB ≤ 0.10 dB	
	Mode Field Diameter @1310 nm	9.2±0.4μm	
Dimensional Specifications	Cladding Diameter	125 ±0.7μm	
	Core/clad concentricity error	≤0.5μm	
	Cladding Non-Circularity	≤1.0%	
Mechanical Specifications	Proof stress	≥0.69Gpa	

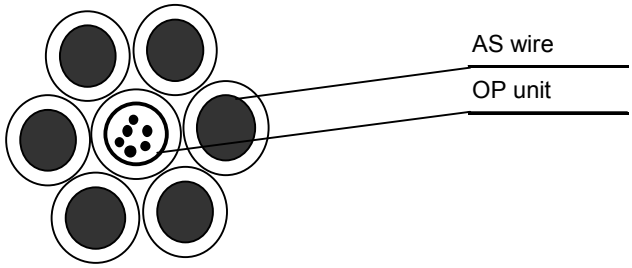
4. CONSTRUCTURE AND SPECIFICATIONS FOR OPGW

ZhongTian Hitachi		Serial No:	ZTT201013264
	OPGW Cable Specifications	Bid No:	OPGW

Cable Type: **OPGW - 1C 1/36B1 (0/50 -16.0)**

Industry standard: OPGW-36B1-50 [51.1;16.0]

Cross Section:



		Name	No	Name	No	Material Dia.	
Structure	Fiber	G.652	36	G.655	0		
	Center	SUS Tube	1	Fibers	36	Tube-Dia.	3.20 mm
	Layer1	27%ASwire	6	AA wire	0	Diameter	3.25 mm

Technical Data	according to IEC, IEEE standards			
	Stranded:core and layer1 greased stranding direction of outer layer is left hand(S-stranding)			
	Cable Diameter			9.70 mm
	Cable Weight			328 kg/km
	Supporting Cross Section			50 mm^2
	Section of AS Wire	49.77 mm^2		
	Section of AA Wire	0.00 mm^2		
	Rated Tensile Strength (RTS)			51.1 kN
	Modulus of Elasticity (E-Modulus)			140.0 kN/mm^2
	Thermal Elongation Coefficient			13.4 $\times 10^{-6}/℃$
	Permissible Maximum Working Stress (40% RTS)			410.4 N/mm^2
	Everyday Stress（EDS) (16%~25% RTS)		164.2	~256.5 N/mm^2
	Ultimate Exceptional Stress (70% RTS)			718.2 N/mm^2
	DC Resistance			1.301 Ω/km
	Short Time Current (1s, Initial 40℃)			4.0 kA
	Short Time Current Capacity I^2t			16.0 kA^2s
	Minimum Bending Radiu Installation：			194 mm
	Operating：			145 mm
	Ratio between Pull and Weight			15.9 km
Temperature Range:	Installation		-10℃ ~ +50℃	
	Transportation and Operation		-40℃ ~ +80℃	

Remarks: All Sizes and Values are Nominal Values

Rev. ZHC-TD 10-2008	Designer	*WangLF*	Authorized		2010-9-1

5. COLOR IDENTIFICATION OF FIBER IN OPGW

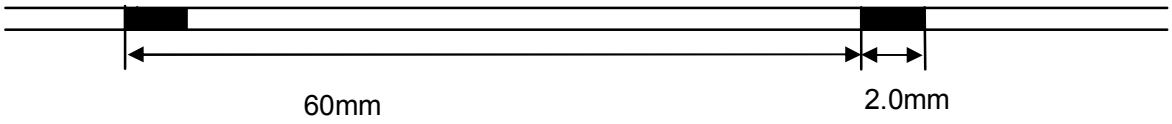
5.1 Color code of fiber in OPGW shall be identified referring to the following table:

Typical number of fiber: 36

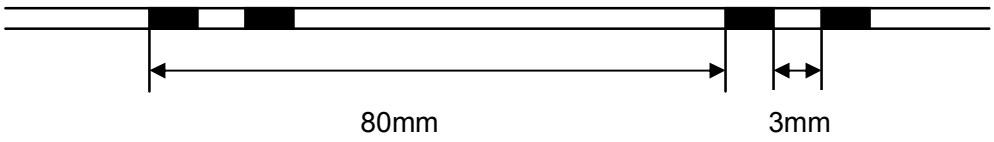
Remark	Fiber No. & Color					
Without Color Ring	**1**	**2**	**3**	**4**	**5**	**6**
	Blue	Orange	Green	Brown	Gray	White
	7	**8**	**9**	**10**	**11**	**12**
	Red	Nature	Yellow	Violet	Pink	Aqua
With S60 Color Ring	**13**	**14**	**15**	**16**	**17**	**18**
	Blue	Orange	Green	Brown	Gray	White
	19	**20**	**21**	**22**	**23**	**24**
	Red	Nature	Yellow	Violet	Pink	Aqua
With D80 Color Ring	**25**	**26**	**27**	**28**	**29**	**30**
	Blue	Orange	Green	Brown	Gray	White
	31	**32**	**33**	**34**	**35**	**36**
	Red	Nature	Yellow	Violet	Pink	Aqua
Remark: The black color with color ring is changed into nature color.						

Color ring method:

S60: Use single black color ring on the fiber surface with 60mm alternation:



D80: Use double black color ring on the fiber surface with 80mm alternation:



6. TEST REQUIREMENTS FOR OPGW

6.1 General

There are different test series to assure the quality of OPGW:

- Routine test (in–process testing according to internal quality plan)
- Factory acceptance test (FAT, witnessed by customer)
- Type test (only in case of a basic new design, repetition in exceptional cases)

OPGW tests shall be in accordance with applicable standards or agreements between purchaser and manufacturer.

Type test

Type test may be waived by submitting maker's certificate of the similar product performed in an internationally acknowledged independent test organization or laboratory. If type test should be performed, it will be carried out according to an extra type test procedure reached to an agreement between purchaser and manufacturer.

Routine test

The optical attenuation coefficient on all production cable lengths is measured according to IEC 60793-1-CIC (Back-scattering technique, OTDR). Standard single-mode fibers are measured at 1310nm and at 1550nm. Non-zero dispersion shifted single–mode (NZDS) fibers are measured at 1550nm.

Factory test

Factory acceptance test is carried out on two samples per order in the presence of the customer or his representative. The requirements for quality characteristics are determined by relevant standards and agreed quality plans.

6.2 Test items

The following table shows that the test items shall be carried out according to corresponding references.

Test on fibers

No	Item	Reference
1	Attenuation coefficient	IEC 60793-1-40
2	Chromatic dispersion	IEC 60793-1-42
3	Mode field diameter	IEC 60793-1-45
4	Cladding diameter	IEC 60793-1-20
5	Cladding non-circularity	IEC 60793-1-20
6	Core/clad concentricity error	IEC 60793-1-20
7	Cable cutoff wavelength	IEC 60793-1-44

Test on Aluminum clad steel wire before stranding

No	Item	Reference
1	Quality of appearance	IEC 61232
2	Diameter	IEC 61232
3	Tensile stress test	IEC 61232
4	Elongation test	IEC 61232
5	Torsion test	IEC 61232
6	Resistivity	IEC 61232
7	Minimum aluminum thickness	IEC 61232
8	Stress at 1% extension	IEC 61232

Test on finished OPGW

No	Item	Reference
1	Tensile Test	IEC-60794-4-10
2	Stress-strain test	IEC-60794-4-10
3	Crush test	IEC-60794-4-10
4	Impact test	IEC-60794-4-10
5	Temperature cycling test	IEC-60794-4-10
6	Water penetration test	IEC-60794-4-10
7	Drip test	IEC-60794-4-10
8	Sheave test	IEC-60794-4-10
9	**Short circuit test**	**IEC-60794-4-10**
10	**Lightning test**	**IEC-60794-4-10**
11	**Aeolian vibration test**	**IEC-60794-4-10**
12	**Galloping test**	**IEC-60794-4-10**
13	**Creep test**	**IEC-60794-4-10**

Note: the above-mentioned items 9-13 (bold font) which are considered as type tests will not be included in factory test report. Other items of completed OPGW can be tested and inspected in our factory.