VOL. II

TECHNICAL SPECIFICATIONS

LOT 2 AND 3: 66 kV SUB TRANSMISSION LINE TO GALANA KULALU

RFX No:1000001030

WORKS REQUIREMENTS AND TECHNICAL PARTICULAR SPECIFICATIONS

A GENERAL INFORMATION

A.1 Technical specifications describe the basic requirements for goods. Technical documentation shall be in English language and with the specific items on offer clearly marked for the products Tenderers intend to supply.

A.2 All the dimensions and capacities of the equipment and materials to be supplied shall not deviate significantly from those required in these specifications.

A.3 Deviations from the basic requirements, if any, shall be explained in detail in writing with the offer, with supporting data such as calculation sheets, detailed drawings, certified test reports etc. The procuring entity reserves the right to reject the products if such deviations shall be found critical to the use and operation of the products.

A.4 To facilitate efficient evaluation and comparison of bids, Tenderer shall submit a clause by clause statement of compliance with the specifications together with copies of the manufacturer's catalogues, brochures, technical data, drawings, test reports and test certificates clearly marked to support each clause. The manufacturer's type reference /designation of the item offered shall be indicated. In submitting the clause by clause statement of compliance, manufactures should provide cross references to the documents submitted.

The statement of compliance shall be in table form and shall cover in details all clauses of the specification.

A.5 Copies of relevant Type Test Certificates certified by an international testing/ standards body or the National Testing /Standards Authority of the country of manufacture or its accredited test laboratory shall be submitted with the offer for evaluation. A copy of the accreditation certificate of the testing laboratory shall also be submitted. These certificates & reports shall have been obtained at least six (6) months prior to the date of tender issue and they shall be subject to authentication by the procuring entity. Detailed contact information (Title, E-mail, Fax, etc.) of the testing and standards body used shall be provided.

Where a tender allows participation of non-manufacturers, a valid manufacturers letter of authority shall be submitted with the tender documents.

Detailed requirement shall be as specified in the specific technical specification documents.

1A.7 The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including valid ISO 9001: 2001 shall be submitted for evaluation. For locally manufactured goods this requirement is not mandatory but ALL Test Reports and certificates shall be certified by the Kenya Bureau of Standards or it's appointed Agents in which case a letter of Accreditation will be required.

1A.8 A detailed list of previous customers for similar items on tender and their contact addresses shall be submitted with the offer for the purpose of reference, or for evaluation where the technical specification so dictates.

1A.9 In the case of Tender award, technical details and design drawings for the items to be supplied shall be submitted to the procuring entity for approval before manufacture.

1A.10 Prior to the manufacture of the items on order, the procuring entity reserves the right to inspect the manufacturing facility and the quality management system at no extra cost. Upon completion of manufacturing process, the procuring entity shall send Engineers to inspect the items on order at the place of manufacture where inspection and all acceptance tests (routine and sample tests) shall be carried out in their presence. Routine and sample tests shall be done in accordance with the test standard given in the Technical Specification of the item(s) on order. All the costs of inspection and witnessing of tests (including accommodation and air travel of the engineers to) shall be borne by the contractor.

1A.11 Routine and Sample Test Reports shall be completed for all the items on order and made available for approval before packaging and shipment of the materials. No material or equipment shall be shipped/ delivered without written approval from the procuring entity.
REREC requires an advance notice of four (4) weeks before the commencement of Factory Tests & Inspection to enable engineers make the necessary arrangement to witness the tests.

1A.12 In all cases where the level of galvanising and painting is not specifically stated in the detailed Technical Specifications attached, the general requirement shall be for a uniform coating of thickness not less than 110 microns.

1A.13 Detailed Technical Specifications for each item is attached to the Tender Document.

1. GENERAL SPECIFICATIONS

1.1 SCOPE OF WORKS:

The contract covers route survey, design, pegging, supplying, testing before shipment, painting, packing for transport, insuring, shipping, delivering to the port of Kenya, landing, customs clearing, transporting from the port to the site, erecting, constructing, installing, site pre-commissioning testing and commissioning of the works as generally described below.
Subsequent paragraphs will give detailed descriptions and requirements as to the works specified herein.

Route Survey

- Identify proposed power line routes, raise route profiles and acquire updated cadastral maps of scale 1:2500 from relevant lands office.
- Pick all premises and other physical features along the proposed power lines and mark them on updated cadastral maps.
- Mark all the proposed 66kV routes, numbering all the profile pegs and angle points on the cadastral maps. Specify all the angles in degrees on the route profile.
- Peg all the proposed poles and stays positions as per design prior to construction of power lines.
- Provide both hard copies and soft copies in AutoCAD of both the profile and the cadastral.

Design

- Mark and design all the proposed lines, poles, stays, and steel towers using route profiles and cadastral maps of scale 1:2500.
- Raise pole schedules for 66kV line.

66kV overhead lines

- Poles or other line support structures and associated materials
- Steel towers and associated civil works.
- Conductors and accessories
- Insulators, Isolators, Air break switches and fittings
- Stays and stay blocks

66kV line tee off

- 66kV line as per construction standards.

Switchgears and Control Equipment.

- 66kV Disconnectors complete with structure, protection, control and isolation associated facilities.

1.2 STANDARDS

Ratings, characteristics, tests and test procedures, etc. for the electrical equipment encompassed by this Specification shall comply with the provisions and requirements of the standards of the International Electro-technical Commission (IEC), and or KPLC operational standards unless otherwise expressly stated in Particular Technical Specifications. Where the IEC standards do not fully cover all provisions and requirements for the design, construction, testing, etc. and for equipment and components that are not covered by IEC Recommendations recognized national standards shall be applied.

The latest revision or edition in effect at the time of Bid Invitation shall apply. Where references are given to numbers in the old numbering scheme from IEC it shall be taken as to be the equivalent number in the new five-digit number scheme. The Bidder shall specifically state the Precise Standard, complete with identification number, to which the various equipment and materials are manufactured. The Bid Documents do not contain a full list of standards to be used, as they only are referred to where useful for clarification of the text.

1.4 UNIT OF MEASUREMENT AND LANGUAGE

In all correspondence, in all technical schedules and on all drawings prepared by the Contractor, the metric units of measurement shall be used. On drawings or printed pamphlets where other units have been used, the equivalent metric measurements shall be added. All documents, correspondence, drawings, reports, schedules instructions, and nameplate readings of the equipment shall be in the language stated in the Bid Data sheet.

1.5 SERVICE CONDITIONS

From the geographical condition, the project area is categorized into tropical climate zone. In choosing materials their finishes, due regard shall be given to the humid tropical conditions under which the plant shall be called upon to work. The contractor shall submit details of his usual practice which have proven satisfactory and which he recommends for application to the parts of the work, which may be affected by tropical conditions. The materials and finishes used

shall be approved by the Employer. All switchgear and control cubicles shall also be rodent and vermin proof.

1.5.1 Environment

Unless otherwise specifically stated in Particular Technical Specifications or Scope of Works, any equipment, component and assembly shall be designed for the following service conditions:

Parameter	**Max**	**Min**
Ambient air temperature		
Outdoor	+40°C	-1°C
Indoor	+40°C	-1°C
24 hour average maximum	+30°C	-1°C
Ambient temperature for cables in the ground	+40 °C	-1°C
Relative humidity	90%	
Height above sea level	135 - 350 m	
EMC Class (IEC 61000)	Industrial environments	
Wind pressure on project area of conductors and cylindrical objects	400 N/m²	
Maximum wind pressure on steel members on 1.5 times projected area	820 N/m²	
Rainfall conditions		
Average	0-1000 mm/year	

Wherever any of these maximum or 24-hour average temperatures exceed the normal service condition temperatures of the IEC Recommendations for the relevant equipment, or of such other standard which is approved to be applied, the permissible temperature rises of the IEC Recommendations or the standard shall be reduced by the same amount as the difference between the above figures and the normal service condition temperatures. The Contractor shall guarantee these reduced temperature rises.

All air-cooled equipment shall be cooled with convection (i.e. without fans) provided other cooling methods are not explicitly allowed for in the specifications.

1.5.2 Acoustics, Noise measurement

The equipment shall as far as possible not generate undue vibrations or bothersome noise. Provided nothing else is specified the following requirements shall not be exceeded:

Area of equipment location	Maximum noise level dB(A)
Machine hall, workshop etc. (one meter from the machine)	85
Office, control room, day room etc	55
Emergency diesel generator (7 meter from engine room)	85

1.5.3 Tropicalization

a) All equipment must be designed for operations in the severe equatorial coastal climate conditions and fully comply with climatic aging tests as per IEC 60932-class 2.

b) In choosing materials and their finishes, due regard shall be given to the humid equatorial coastal conditions under which the plant will be called upon to work. Where it is not specifically called for, the contractor shall submit details of his usual practice which have proven satisfactory and which he recommends for application to the parts of the work, which may be affected by proposed sit climatic conditions. The materials and finishes used shall be approved by the Employer. All switchgear and control cubicles shall also be rodent and vermin proof.

Enhanced description.

(i) Metals:
Iron and Steel are generally to be painted or galvanized as appropriate. Indoor parts may alternatively have chromium or copper-nickel plates or other approved protective finish.
Small iron and steel parts (other than rustless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms shall be treated in an appropriate manner to prevent rusting.

(ii) Screws, Nuts, Springs, Etc.
The use of Iron and steels shall be avoided in instruments and electrical relays wherever possible. Steel screws shall be zinc, cadmium or chromium plated or where plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze.
Springs shall be of non-rusting material, e.g., phosphor-bronze or nickel silver, as far as possible.

(iii) Rubbers:
Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets, sealing rings, diaphragms, etc.

TROPICALIZATION TO BE IN COMPLIANCE WITH

- CLIMATE GRAPH NO. 8 OF THE IEC 721-2-1,
- TEST B: DRY HEAT IEC 68-2-2
- TEST Bd; DAMP HEAT, CYCLIC IEC 68-2-30.

1.5.3 Security

The project area is a wildlife corridor and the tenderer shall make appropriate arrangement to work safely and protect wildlife at all times. Any cost incurred shall be borne by the contractor.

1.6 WORKING STRESS AND EQUIPMENT/APPARATUS DESIGN

1.6.1 General

a) The design, dimensions and materials of all parts shall be such that they will not suffer damage under the most adverse conditions nor result in deflections and vibrations, which might adversely affect the operation of the equipment. Mechanisms shall be constructed to avoid sticking due to rust or corrosion.

b) The equipment and apparatus shall be designed and manufactured in the best and most substantial and workmanlike manner with materials best suited to their respective purpose and generally in accordance with up-to-date recognized standards of good practice.

c) All parts which will or might have to be dismantled for the purpose of serving or replacement shall be assembled with anti-corrosive fasteners. The type, material and size of all fasteners shall be selected to safely withstand the maximum superimposed direct, alternating, kinetic and all loads induced by workmen when installing or removing the fasteners during the life of the equipment.

d) Suitable structural steel bases or frames shall be provided where necessary to transmit to the concrete foundations all loads imposed by the various parts of the equipment. Such bases or frames shall be supplied complete with suitable anchor bolts and shall be so proportioned that the bearing loads imposed on the concrete foundations as specified in the technical specifications of the steel towers.

e) The equipment shall be designed to cope with 0.15G acceleration of seismology on the centres of gravity.

f) Whenever possible, all similar parts, including spare parts, shall be made interchangeable. Such parts shall be of the same materials and workmanship and shall be constructed to such tolerances as to enable substitution or replacement by spare parts easily and quickly.

g) All equipment shall be designed to minimize the risk of fire and consequential damage, to prevent ingress of vermin, dust and dirt, and accidental contact with electrically energized or moving parts. The plant shall be capable of continuous operation with minimum attention and maintenance in the exceptionally severe conditions likely to be obtained in a tropical climate.

h) Upon request by the Employer complete information regarding the design assumptions, loading and operating conditions, deflections and unit stresses used in the design shall be provided by the Contractor.

i) The Contractor shall be deemed to have examined the specification and drawings herewith, and unless stated specifically to the contrary in the schedule of proposed conditions and /or deviations from the specification to have concurred with the design and layout of the applicable project features as being sufficient to insure reliability and safety in operation, freedom from undue stresses, adequate drainage and other essentials for a satisfactory working plant.

1.6.2 Strength and quality

a) All steel castings and weldings and all site weldings shall be stress-relieved by heat treatment before machining, and castings shall be stress-relieved again after repair by welding.

b) Liberal factors of safety shall be used throughout, especially in the design of all parts subject to alternating stresses or shocks.

1.7 BASIC REQUIREMENTS FOR ELECTRICAL EQUIPMENT

All materials supplied under this Contract shall be new and of the best quality and of the class most suitable for working under the conditions specified. They shall withstand the variations of temperature and atmospheric conditions arising under working conditions (including start and stop) without distortion deterioration or undue stresses in any parts and also without affecting the

suitability of the various parts of the Works for which they were designed. The Plant shall be designed for a lifetime of 40 years. Equipment with a shorter life cycle shall be identified and so arranged that they are easy to replace.

1.7.1 Electrical controls, auxiliaries and power supplies

a) Responsibility for electrical control and auxiliaries.
The contractor shall provide all control, indication, alarm and protection devices and all auxiliary equipment with wiring and interconnecting cable which are integral parts of or are directly associated with or mounted on the equipment to be supplied under this contract.

b) Operation and control.
Interlocking devices shall be incorporated in the control circuit to ensure proper sequence and correct operation of the equipment.

1.7.2 Corona and radio interference

a) Switchgear shall electrically be designed to avoid local corona formation and discharge likely to cause radio interference.

b) The design of all line conductor fittings, vibration dampers, insulator fittings, etc. shall avoid sharp corners or projections which would produce high electrical stress in normal operation.

c) The design of adjacent metal parts and melting surfaces shall be such as to prevent corrosion of the contact surfaces and to maintain good electrical contact under service conditions.

d) Particular care shall be taken during manufacture of conductors and fittings and during subsequent handling to insure smooth surface free from abrasion.

1.8 EARTHING SYSTEMS, ELECTRODES AND CONNECTIONS

1.8.1 GENERAL

The earthing for all equipment and the provision of earthing systems, electrodes and connection shall be in accordance with the recommendations in the "Guide for safety in substation grounding" ANSI/IEEE No. 80 – 1986 and the requirements of British Standards BS 6651, BS 7430 and this Section.

1.8.2 EXTENT OF WORK

The work under this section comprises the design, supply and installation of earthing systems and connection to all electrical apparatus supplied under this contract. Also included is the provision of portable earthing devices.

The contractor will be required to prepare installation drawings and schedules of material to be provided. These drawings and schedules shall be submitted to the Employer for approval together with calculations of step, touch and mesh potentials.

1.8.9 66kV OVERHEAD LINE EARTHING

On 66kV lines an OPGW (Optical ground wire) cable shall be installed, metalwork on every pole is to be bonded and connected to the earthing wire of the OPGW. The earthwire shall be connected to earth at every 4th span. The resistance of the aerial earthwire with earth shall not exceed 0.2 ohm per kV of line voltage.

1.9 MATERIALS AND WORKMANSHIP

1.9.1 General

a) Materials shall be new; the best quality of their respective kinds and such as are usual and suitable for work of like character. All materials shall comply with the latest issues of the specified standard unless otherwise specified or permitted by the Employer.

b) Workmanship shall be of the highest class throughout to ensure reliable and vibrations free Operations. The design, dimensions and materials of all parts shall be such that the stresses to which they may be subjected shall not cause distortion, undue wear, or damage under the most severe conditions encountered in service.

c) All parts shall conform to the dimensions shown on and shall be built in accordance with approved drawings. All joints, datum surfaces and meeting components shall be machined and all castings shall be spot faced for nuts. All machined finished shall be shown on the drawings. All screw, bolts, studs and nuts and threads for pipe shall conform to the latest standards of the International Organization for Standardization covering these components and shall all conform to the standards for metric sizes. The Contractor shall never incorporate any standards or size system by his own account, regardless of that accepted and incorporated in this Contract.

d) All materials and works that have cracks, flaws or other defects or inferior workmanship will be rejected by the Employer. All defective materials shall be promptly removed from the site by the Contractor, and inferior workmanship shall be cut out and replaced.

1.9.2 Standard Specifications

The design, materials, manufacture, testing, inspection and performance shall, unless otherwise specified in the Special requirements of these Specifications, conform to the authorized standards of the International Electrotechnical Commission (IEC) or equivalent national standards in additional to KPLC Operational procedures. The Contractor shall include a statement of the standards, intended to be used.

1.9.3 Assembly

Necessary items of equipment shall be assembled in the factory prior to shipment and type tests shall be performed by the contractor as may be required to demonstrate to the satisfaction of the Employer the adequacy of equipment and its component parts. All tests should simulate normal operating conditions as closely as possible. All dismantled parts shall be properly match marked and doweled to ensure correct assembly in the field.

1.9.4 Casting

a) Casting shall be true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects, shall be satisfactorily cleaned for their intended purpose.

b) Major defect on castings shall not be repaired, plugged, or welded without permission of the Employer. Such permission will be given only when the defects are small and do not adversely affect the Strength, use or merchantability of the castings. The Contractor shall give the distinction between major and minor defects. Excessive segregation of impurities or alloys at critical points in a casting will be a cause for its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All castings shall be stress-relieved before machining and again after repair by welding.

c) Plates to be joined by welding shall be accurately cut to size and rolled by pressure to the proper curvature, which shall be continuous from the edges. Flattening in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be jointed shall be such as to allow thorough fusion and complete penetration, and the edges of plates shall be properly formed to accommodate the various welding conditions.

1.9.5 Forging

a) The ingots from which the forgings are made shall be cast in metal moulds. The workmanship shall be first-class in every respects and the forgings shall be free from all defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive non-metallic inclusions and segregations.

b) The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forgings shall be smooth and free from tool marks.

c) The forging shall be clearly stamped with the heat number in such locations to be readily observed when the forging is assembled in a completed unit.

1.9.6 Welding

a) Wherever welding is specified or permitted, a welding process, including stress relieve treatment as required if necessary, conforming to an appropriate and widely recognized professional standard shall be used. All welders and welding operators shall be fully qualified by such a standard.

b) After the welding process has been approved by the Employer, the Contractor shall record it on a special drawing, which shall thereupon become one of the drawings of the Contract.

c) Radiograph inspection shall be carried out by the Contractor when required by the standards, Specifications, or the design criteria employed. All welds which, in the opinion of the Employer, may be subject to the full stress induced in the adjacent plate, or which in the opinion of the Employer, do not appear to conform to the welding standard shall be radiographed when required.

d) All defects in welds shall be chipped out to sound metal and such areas shall be magnetically or ultrasonically tested to ensure that the defect has been completely removed before repair welding.

e) Plates to be joined by welding shall be accurately cut to size and rolled by pressure to the proper curvature, which shall be continuous from the edge. Flattening in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be jointed shall be such as to allow through fusion and complete penetration, and the edges of plates shall be properly formed to accommodate the various welding conditions.

f) The surfaces of the plates adjacent to the edges to be welded shall be thoroughly cleaned of all rust, grease and scale to bright metal. All-important welding shall be stress-relieved by heat treatment before machining.

1.9.7 Galvanizing

a) Unless specifically mentioned to the contrary, iron and steel shall be galvanized in the factory after fabrication. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. Galvanizing shall be applied by the hot dip process for all parts other than steel wires. All steel wires shall be galvanized by a recognized trade standard.

b) The minimum quantities of zinc coating shall be 760gram/sq. metre for bolts and nuts and 855 gram/sq. Metre for all other parts except steel wires, unless otherwise specified in the Contract Documents. The uniformity of zinc coating, tested by dipping surface shall be exposed until the surface has been dipped four times for bolts and nuts, and six times for all parts.

c) The preparation for galvanizing and the galvanizing itself shall not distort or adversely affect the mechanical properties of the materials.

d) Special treatment during galvanizing to prevent the formation of "White rust" during shipment or storage is required. The Tenderer shall state in his Tender the treatment to be used.

1.9.8 Colour standard

The final colour of each item shall be as described under the respective specifications and standards provided.

1.9.9 Nameplate

a) To facilitate operation and maintenance it is very important that all equipment e.g, valves, instruments, switches, pipeline, etc., shall be clearly identified by nameplates showing the function and proper use of each item. Such identification shall be in English and must be intelligently and carefully designed to minimize errors and to avoid maloperation in operation or maintenance.

b) The nameplates shall be permanently legible, clearly worded, weather proof when outdoors and securely mounted in conspicuous and logical locations.

c) A table showing materials, dimensions, location, mounting and wording shall be submitted to the Employer for approval.

1.10 SAFETY PRECAUTIONS

a) Prior to any of the work being energized, the Contractor shall be responsible for supplying and fixing in prominent positions near to each item of the work concerned, large temporary signs giving clear warning of danger in areas which might previously have been regard as safe.

b) During erection and tests the Contractor shall provide all temporary scaffolding ladders, platforms with toe boards and handrails as required for safe and convenient access of workmen, inspectors and other authorized persons. All dangerous opening or holes shall be provided with handrails or covers. Measures shall be taken to protect workmen from falling. The maximum possible safety shall be afforded to personnel directly engaged on this Contract or to those who frequent the working area or to those who in the normal course of their occupation find it necessary to utilize temporary works erected by the Contractor.

c) The Contractor shall demonstrate that he has facilities and personnel for conducting a safety programme commensurate with the works on the site. He shall submit in writing a proposed comprehensive safety programme to the Employer for approval prior to the start of construction operation on the site. The Contractor shall designate a competent safety officer to carry out his safety programme as per Vol 1 on personnel.

1.11 PROTECTION, CLEANING AND PAINTING

1.11.1 Embedded steelwork

All parts to ultimately be buried in concrete shall be cleaned and protected before leaving the manufacturer's plant by cement wash or other approved method. Before being installed they shall be thoroughly desiccated and cleared of all rust and adherent matter, or be treated according to a method approved by the Employer. Such cleaning or treatment shall not detrimentally affect the strength or final operation and function of the equipment.

1.11.2 Steel exposed to atmosphere

a) All machined parts or bearing surfaces shall be cleaned and protected from corrosion before leaving the manufacturer's plant by the application of an approved rust preventive coating, or a peelable plastic film. Where the latter is impracticable, such parts shall be heavily covered with high melting point grease. After erection such parts shall be cleaned with solvent and lapped or polished bright.

b) All parts, other than machined parts, which will be exposed after erection shall be thoroughly cleaned and galvanized or given with two coats of best quality approved primer and one coat of best quality approved finish paint before leaving the manufacturer's plant and a further one coat of paint of an approved quality and colour after erection and touching up on the site, expect such apparatus as panels and instruments which shall be finished painted under approved procedures.

c) All outside panel surfaces shall be primed, filed where necessary, and given not less than two coats of synthetic undercoat. The finishing coat for the outdoor and indoor installations shall be a gloss paint.

d) Primer shall be applied to surfaces prepared in accordance with the plant manufacturer's instructions. The surface shall be wiped clean immediately prior to applying the paint. The primer and finish coats of paint shall be applied using the methods and equipment recommended by the manufacturer.

e) The internal surface of all pipelines shall be cleaned out by the approved methods before installation and again prior to commissioning, to ensure freedom from dirt, rust, scale, welding slag, etc. all exposed pipes shall be painted with an identifying colour after erection is completed. The colour code system shall be approved by the Employer.

f) All steel surfaces, which are in permanent contact with oil, shall be given three coats of approved oil resistant.

g) No painting or protection is required for finished or unfinished stainless-steel parts.

h) The final colour of all equipments, frames for meters and relays, and switch handle shall be as described under each particular item.

i) The humid and tropical conditions shall be taken into account on selection of the paints and painting procedure.

1.12 EMBEDDED METAL WORK, OPENING, ETC

a) The Contractor shall supply and install all enters, fasteners, embedded metalwork's, piping, conduit and sleeves associated with and required for the equipment being provided and installed under this Contract, except as otherwise provided in the specifications.

b) The Contractor shall indicate the location and details of foundations, openings, block-out and all embedded components on his drawings and shall be responsible for the completeness and accuracy of his drawings and the information supplied to others. The Contractor shall be responsible for the adequacy and accuracy of location of all embedded components supplied by him.

c) The foundation bolts, embedded steel parts, anchors, braces, posts, supports, shims, etc., and all metal works as may be required for temporary or final support of anchorage of the equipment shall be provided and installed by the Contractor as part of this contract.

a) Any metal work, which is to be built into the concrete foundations, shall not be painted nor coated unless otherwise approved.

1.13 SPARE PARTS

a) The Contractor shall furnish spare parts as listed under each particular item. Other mandatory spares shall be provided as listed in the price schedules.

b) The spare parts supplied shall be packed or treated in such a manner as to be suitable for storage under the climate conditions at the Site for a period of not less than two years, and each part shall

be clearly marked with the description and purpose on the outside of the package. The manner of storage shall be recommended by the Contractor.

c) Spare parts so provided shall be delivered into such stores as may be designated by the Employer. Delivery of spare parts will not be deemed to be complete until the packages have been opened by the Contractor, their contents checked by a representative of the Employer and the articles re-protected and repacked by the Contractor to the satisfaction of the Employer, or assembled into units at the employer's option. The method of package and package materials shall be suitable for the satisfactory re-package.

1.14 PACKING

a) Each item shall be packed properly or protected for shipment from the place of manufacture to the site.

b) Each crate of package shall contain a packing list in a waterproof envelope and a copy in triplicate shall be forwarded to the Employer prior to dispatch. All items of material shall be clearly marked for easy identification against the packing list.

c) All cases, packages, etc, shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

d) Cases, which cannot be marked as above, shall have metal tags with the necessary marking on them. The metal tags shall be securely attached to the package with strong steel wire or equivalent.

e) Long pieces of steel angles shall be packed in bundles and properly tied together by an approved method and care taken to ensure that they are robust and not of excessive length and weight for handling in transit.

f) Short pieces of steel angles and steel plates shall be bolted or wired together through holes and packed in stout timber cases.

g) Bolts, nuts, washers and fillers shall be bagged in sealed vinyl and packed in steel cans. The cans shall bear the contents and be crated together.

h) Packing together of components of dissimilar metals shall not be acceptable.

i) Conductors and overhead earthwire shall be packed on drums stoutly constructed of good quality wood. Drums shall be securely battened around the perimeter to give maximum protection to the conductor and the earthwire and correct direction of rolling indicated with an arrow in a manner not easily removable.

j) The first layer of conductors or earthwire on drums shall be secured to the hub in manner avoiding damage to subsequent layers.

k) All drums shall be protected from deterioration on site by termite or fungus attack by an approved impregnation treatment at the works before dispatch.

l) The Employer shall reserve the right to inspect and approve the equipment and the packing before the items are dispatched. The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor from responsibility for any loss or damage due to faulty packing.

m) It shall be the responsibility of the Contractor to improve and to reinforce the road facilities when the weight and dimension of the cargo exceed the above specification.

All packing materials shall remain the property of the Contractor and shall be removed from the Site at the earliest opportunity and disposed off to the satisfaction of the Employer.

(a) Consignee: MINISTRY OF ENERGY C/O REREC.

(b) Name of Project: GALANA KULALU ELECTRIFICATION PROJECT

(c) Contract No.:

(d) Port of destination: NAIROBI/MOMBASA

(e) Item Number, if applicable,
Package number in sequence,
and quantity per package: …….

(f) Description of Contents: ……
Net and gross weight, cubic measure: ……

The shipping mark is finally subject to the Employer's approval.

1.15 DELIVERY

a) The Contractor shall deliver all materials and equipment including Contractor's equipment supplied under the Contract to the site in adequate time for its preparation and erection according to the Schedule.

b) Each notification shall include a complete shipping list of the contents of each package to be delivered and shall indicate the anticipated date of delivery and the serial number for each component to be used for identification and evidence of the insurance cost arranged for it.

c) The Contractor shall be responsible for the reception on Site of all deliveries for the purpose of the Contract.

1.16 CLEANING AND MATERIAL DISPOSAL

The Contractor shall at all times during the course of the work prevent the accumulation on the premises of debris caused by the Works. Whenever it is necessary, in the opinion of the Employer and in all events upon completion of the Works, the Contractor shall remove from the premises all temporary buildings and facilities, tools, scaffolding, surplus materials, debris and all work and materials condemned by the Employer and shall leave the premises in a clean, safe and sanitary

conditions. The Contractor shall prevent at any time unnecessary accumulation and scattering of debris, materials, tools and equipment around the premises, and shall conduct the work in an orderly manner. In case the Contractor fails to comply with the above provision, or in case of dispute, the employer shall have the RIGHT to order removal by others of debris, materials, tools or equipment, and to charge the cost of such removal and/or repairs to the Contractor. All Cable drums, replaced poles and oil Drums shall be returned to REREC stores.

1.17 PROGRAMME AND PROGRESS

a) Within one month after the Date of Commencement or contract signing, the Contractor shall prepare his construction program in a Software form covering manufacture, delivery, erection testing and commissioning of the Works, in sufficient detail to define the various sections of the Works, including parts to be supplied by the Contractor. A soft and hard copy shall be submitted to the Employer for approval.

b) Upon approval of the program by the Employer, it should thereafter be referred to as the approved Construction Program and shall become a part of the Contract.

c) Monthly progress reports shall be provided by the Contractor, indicating the actual state of progress of all items during the course of manufacture and work at the Site, in the form given by the Employer.

d) A brief weekly report on the construction work at the Site shall also be submitted by the Contractor to the Employer.

e) From time to time during the execution of Contract, the Employer is empowered to call meetings, either in his home office or at the manufacturer's offices or Employer's Nairobi office or at the Site, as he deems necessary, for the purpose of co-ordination and control. The employer is required to call regular meetings in addition to the monthly meetings. If required by the Employer, responsible representatives of the Contractor shall attend such meetings at his own expense.

f) In executing the Approved Construction Program of this Contract, the Contractor shall co-operate with the Employer and other contractors on the Site in order to effect the timely completion of the Project as a whole.

1.18 DRAWINGS AND DATA TO BE SUPPLIED BY THE CONTRACTOR

a) Before starting manufacture of the equipment, dimensioned drawings and data showing all significant details of the equipment and materials to be used shall be submitted to the Employer for approval, at least 3 weeks before the commencement of the manufacturing process, this shall include the bill of materials for the entire works.

b) These drawings shall be submitted within the times mentioned hereunder, measured in calendar month from the Date of commencement. The drawings shall be modified as necessary if requested by the Employer, and resubmitted for final approval.

c) When the Contractor prepares his construction schedule, as required herein, he shall make allowance for the drawing approval time and indicate it on the schedule. A period of at least

two weeks shall be allowed for such approval after receipt by the Employer. Claims or extensions of time will not be approved if they are related to the late submission of drawings to the Employer or if they involve delays caused by drawings not being approved by the Employer.

d) After approval of drawings by the Employer, the Contractor shall supply the approved drawings to the Employer according to item **h** below.

e) If after the said 2 weeks the employer has not approved the drawings, the Contractor will notify the employer and proceed with the manufacturing process.

f) It is to be understood, however, that approval of the drawings will not relieve the Contractor of any responsibility in connection with the work.

g) All drawings submitted for approval or sent to the Employer for any other reason shall be sent by courier.

h) After items of the work have been manufactured and erected, complete sets of prints of the finally corrected drawings shall be furnished according to the following table.

	To the Employer
<u>During the work</u>	
Drawing for approval:	3 hard copies and one soft copy
Approved drawings:	3 hard copies and one soft copy
Bill of Materials	3 hard copies and one soft copy
<u>After completion of the work (final drawings)</u>	
AutoCAD georeferenced and digitized (latest version):	2 USB memory disks
Complete set of bound prints (as built)	3 sets

1.20 TEST PROCEDURES AND INSTRUCTIONS

a) The Contractor shall prepare and execute a testing program which will establish that specified requirements have been met and that the items furnished and installed will perform as specified and required.

b) The Contractor shall submit to the Employer for approval, during or immediately following the submission of drawings, testing program describing each test to be performed during commissioning and performance tests. The program shall establish the sequence of the test, the equipment preparation and operation procedures to be followed and the detailed procedure for conducting each test. The program shall also contain performance guarantees, design values, technical particulars, or other criteria and distributed in the same manner as the drawings.

c) A file containing a list of all the Pre-commissioning Tests carried out on all the equipment and Protection and Control schemes and the primary equipment, including system balanced and unbalanced fault analysis for relay coordination and scheme settings shall be submitted to the

Employer prior to the commissioning of the project. It is mandatory that these group tests shall be witnessed and signed by the Employer's representative.

d) Three copies of the Pre-Commissioning Report shall be submitted to the Employer.

1.21 EQUIPMENT TESTING AT PLACE OF MANUFACTURE

a) The manufacturers shall be responsible for performing or for having performed all the required tests specified under the specification for all the equipment. Tenderers shall confirm the manufacturer's capabilities in this regard when submitting tenders. Any limitations shall be clearly specified.

b) Tender documents shall be accompanied by copies of Type test and Routine test reports & certificates for similar rated equipment for the purpose of tender evaluation. Type test reports & certificates shall be certified by the National Standards and Testing Authority (NSTA) of the country of origin. **Where a body other than NSTA is used to certify the type-test reports, a copy of the certificate of accreditation shall be attached**. Current contact information of the testing and certification authority shall be provided.

c) Upon completion of the manufacturing process, routine tests shall be carried out as per the respective standards of each equipment and the results endorsed by the NSTA of the country of manufacture.

d) The Contractor shall arrange for the Employer's staff members to witness tests of major items of equipment in the manufacturer's plant as follows:

(1) Disconnectors
(2) Poles
(3) Conductors and cables
(4) Fittings and accessories
(5) OPGW cables

e) The equipment mentioned above shall be subjected to inspection by REREC Engineers or her representative at place of manufacture for all equipment and all routine tests and other tests specified under each specification carried out in their presence. REREC representatives shall approve shipment of the equipment if they are satisfied that the requirements of the specification are fully met. The supplier shall quote separately as in Vol 1 for these inspections. The full cost of the visit, including air tickets, and accommodation shall be borne by the contractor.

1.22 PHOTOGRAPHS

a) The Contractor shall keep photographic records of the progress of each phase of the work. The determination of each particular phase shall be agreed upon between the contractor and the employer after contract signing. Upon completion of the work, the Contractor shall submit three sets of colour photographs or a CD with explanatory description adequately edited in book form to the Employer's satisfaction.

b) The Contractor shall provide himself with necessary access to the work and temporary facilities to photograph his part of the work at any stage of construction or manufacture.

SITE TESTS

After the power line and ancillary equipment have been erected and connected up on site, the Contractor shall carry out to the satisfaction of REREC such tests as may be required to prove compliance with the specification, independently of any tests carried out at the manufacturers' works.

Not less than thirteen weeks before any section of the line is required to enter commercial service, the Contractor shall submit, for the approval of REREC, his detailed site test proposals for that section of the line, together with details of the test equipment and methods that he proposes to use. Subject to approval of the tests, these will be written by REREC into an overall programme of tests, which will be issued to all directly concerned prior to the starting date for the tests.

REREC shall have the right to witness all tests, and the results must be available to them as the tests proceed. They may recommend waiving of some tests, or may add further tests if considered necessary to prove compliance with the Specification.

Clear records of all tests necessary before the line can be regarded as ready to be first connected to REREC's system shall be maintained by the Contractor and submitted to REREC in duplicate. REREC/KPLC requires this information before the plant will be accepted for initial energising.

Initial energising and all subsequent 'live' tests will be directed by REREC/KPLC, and carried out jointly by REREC, KPLC and the Contractor. They will be subject to REREC's standard safety procedures, and all operational switching will be carried out by REREC/KPLC according to a detailed programme, which REREC will prepare and which will be agreed in advance between ALL parties.

During these 'live' tests the Contractor shall remain responsible for the performance of the line A record of the results of the tests in this category will be made available to REREC.

REREC shall provide the tests to be performed on the line. However, the contractor is required to construct the line based on the REREC/KPLC distribution standards and REREC shall during construction, inspect/supervise the site works at all stages of implementation

PARTICULAR TECHNICAL SPECIFICATIONS

Particular technical specifications for the line materials are available in the enclosed folder

Technical specifications for the 66kV Towers for Galana River and Water canal crossing

SPECIFICATION FOR 66KV-132KV RIVER CROSSING STRUCTURE (DOUBLE CIRCUIT-VERTICAL CONFIGURATION)

1. SUPPLY AND INSTALL MATERIAL MANUAL

As soon as final support positions are approved, the Contractor shall provide the requisite copies of the A4 size Supply Install Material Manual (SIMM).

Each support position shall be represented by one of the manuals with the following information recorded:

a. Provisional and final support numbers.
b. Profile and record map reference drawing numbers.
c. Span
d. Wind span
e. Weight Span
f. Angle of deviation
g. Support type, leg and body extensions and General Arrangement (G.A.) drawingreference numbers
h. Foundation type and G.A. drawing reference number
i. Earthing details and G.A. drawing reference number
j. Insulator set details and G.A. drawing reference number
k. Sag adjustment setting and linkage requirements – (where appropriate)
l. Phase conductor jumper details including spacer and general arrangements drawing reference number – (where appropriate)
m. Earth wire set details and G.A. drawing reference number
n. Earth wire vibration damper G.A. drawing reference number
o. Aircraft navigator (obstruction aids) drawing reference number – (where appropriate)
p. Fibre optic junction boxes and cabling G.A. drawing reference number – (where appropriate)

In addition the following schedules shall be included:-

i. Phase conductor and OPGW (ground wire) sags and tension (erection and final)
ii. Suspension insulator sets off-sets
iii. Location and spacing of all phase conductor spacers dampers – (where appropriate)
iv. Location of all phase conductor and earth wire tension and non-tension joints
v. Location and spacing of all aircraft warning spheres (where appropriate)
vi. Location of all fibre optic joint boxes – (where appropriate)

The appropriate reference drawing numbers shall also be included. Preliminary copies of SIMMs shall be available prior to any site work commencing, together with materials summaries. This is Hold Point.

2. MAINTENANCE MANUAL

The Contractor shall provide at the specified period before the end of the construction period of the contract, a maintenance manual covering the following information:-

a) Type, code numbers and description of all plant erected, together with names andaddresses of manufacturers
b) Methods of assembly of all fittings
c) Method of replacing any part of the plant including the use of maintenance holesprovided on the support access provisions and where appropriate the application of "live – line' maintenance techniques.
d) Recommendations of preventive maintenance including frequency of inspection.
e) List of recommended maintenance equipment with a description of its use and limitations
f) Type and application of temporary Earthing equipment.
g) Personal safety equipment requirement and any risk assessment required.

The above information must be specified to this contract and entirely in the Englishlanguage. Drawings and diagrams shall be used where necessary to enable the Employer/Purchaser to properly maintain the whole of the works.
The manual shall be suitably bound within a hard cover and all materials used shall be reasonably hard wearing.

The manual shall be submitted to the Employer. This is Hold Point.

3. SAMPLES AND MODELS

If the nature of the works makes it desirable the Contractor/ supplier may be asked to submit or prepare for the Employer such samples, patterns and models as the Employer may reasonably require for the purpose of design approval at the expense of the Contractor/supplier.

4. PHOTOGRAPHS

The Contractor shall make all arrangements to provide progress photographs of all tests and such sections of the work in progress as directed by the Employer. Each photograph shall be of size 25cm x 20cm suitably entitled, in digital format. The photographs shall be the property of the Employer and no copies of the photographs shall be released without the authority of the Employer.

The Contractor will normally be required to provide every month at his own cost the specified number of sets of un-mounted progress photographs suitably inscribed of potionsof the work in progress throughout the period of construction. Any variation to thesequantities will only be with the permission of the Employer.

5. DAMAGE GENERAL

The Contractor shall take all reasonable precautions to avoid damage to land, property, roads, crops, fields drains, fences walls, hedges, gates, trees and the like and shall ensure that the work is adequately supervised so that any damage is reduced to the minimum. Save as otherwise provided, the Contractor will be liable for all damage arising by or in consequence of the works except unavoidable damage to crops and shall pay compensation or make good at the option of the Employer.

5.1Contractor's Responsibility

The Contractor's liability for loss or damage shall extend to any such loss or damage resulting from the employment of a Subcontractor. This does not relieve the Contractor of his liability for all actions of his Subcontractor.

5.2 Livestock

Adequate provision shall be made by the Contractor to prevent the straying of or injury to livestock during the execution of the work and until the permanent reinstatement of fences, wall, hedges, gates and the like is completed.

The Contractors shall be liable for any injury to or loss of livestock due to failure to comply with the above requirements.

6. GEOTECHNICAL INVESTIGATION

6.1 General

Geotechnical investigations shall be undertaken in accordance with the technical requirements detailed in the following clauses.

Where required by the Employer, the Contractor or his appointed geotechnical consultant shall undertake the specified slope stability analysis and design.
The Contractor shall give the Employer the requisite period of notice prior to commencing the geotechnical investigation. This is a Hold Point.

6.2 Level 1

Level 1 geotechnical investigations shall be based on a visual-tactile examination or disturbed soil samples for the determination of both soil classification and strength.

6.3 Level 2

Level 2 geotechnical investigations shall be based on in-situ testing for the determination of the soil strength and visual tactile examination of disturbed samples for the determination of soil classification

6.4 Level 3

Level 3 geotechnical investigations shall be based on in-situ testing (as level 2) for the determination of the soil strength and the recovery of disturbed soil samples for the subsequent laboratory testing.

Laboratory soil classification tests for non-cohesive soils shall be article size distribution, moisture content and relative density, whilst those for cohesive soils shall be moisture content and Atterberg limits.

6.5 Level 4

Level 4 geotechnical investigations shall be based on a combination of in-situ testing (as level 2) and the recovery of disturbed/undisturbed soil samples for the subsequent laboratory testing.

6.6 Soil and Ground Water Samples

W here specified, soil and ground water samples shall be obtained for determination of the chemical content i.e. organic matter, sulphate, pH and chloride content.

6.7 Geotechnical Investigation Criteria

Geotechnical investigation shall be undertaken to the following criteria:

a) Geotechnical investigation shall be undertaken as near as possible to the tower site. For test foundations the investigation shall be undertaken as near as possible to the test site, and shall take account of the theoretical failure surface of the foundation. ;

b) Time lapses between the investigation and foundation installation shall take into account any noticeable effect on the geotechnical properties due to rainfall or seasonal variations in the groundwater level;

c) Depth of investigation shall be:

i. For trial pits 2m; or

ii. the foundation depth plus 1.5 times the maximum base width dimension forconcrete pad and chimney or steel grillage foundations; or

iii. 3m or 5 times shaft diameters (whichever is greater) below the foundation depth for drilled shaft, piled foundations; or

iv. at least 2m into rock or hard dense stratum ($N_{SPT} > 50$) if this occurs before the recommended depth; or

v. for uplift or lateral foundation tests not less than 1m below the base of the test foundation.

d) SPTs (standard penetration tests) should be undertaken at the top of each stratum and then at 1m intervals in soil or weak rock;

e) PMTs (Pressure meter tests) should be undertaken in each stratum or as required;

f) CPTs (Cone Penetration Tests) should be taken continuously over depth of investigation

g) VSTs (Vane Shear Tests) should be undertaken at top of each stratum and then at 1m intervals;

h) Soil/rock description should be based on disturbed samples taken in each stratum and thereafter at 1m intervals.

i) Highest ground water level and variation in water level

7. QUALITY CONTROL OPGW

Types of Tests

Type, sample and routine tests shall be undertaken on the OPGW, their associated fittings, non-metallic underground fibre optic cable and optical fibres in accordance with the requirements of specification, CCITT G652, IEC 793 and IEC 794 as appropriate.

OPGW Tests

a) Fatigue

The Contractor shall submit documentary evidence to show the fatigue life of the OPGW including that ofthe optical sub-unit compared to that of a conventional conductor of similar characteristics. e.g. diameter, mass, stranding etc.

b) Stress-Strain

A sample of OPGW not less that 10m length, complete with the proposed end fittings shall be subject to astress-strain test. The test shall be undertaken in accordance with IEC 1089 Annex B and the measuring techniques in accordance with IEC 794-1-E1.

c) Tensile performance

The test shall be undertaken in accordance with the load conditions specified in IEC 1089 Annex B and the measuring techniques in accordance with IEC 794-1-E1.

d) Crush and Impact

The test shall be undertaken in accordance with the recommendations of IEC 7941-1-E3 and IEC –794-1- E4.

The crush test shall be undertaken by applying a 10kN load for 1 minute to the OPGW via two 50mm x50 mm flat plates.

The impact test shall be undertaken by dropping a 4 kg weight from a height of 150 mm onto the end of a 20mm diameter steel mandrel places on the OPGW. These should be done 20 times.

e) Temperature cycling

The optical performance under temperature cycling shall be tested in accordance with IEC 794-1-F1 with specified temperature ranges for a duration of 4 hours. The test should be undertaken twice.

f) Water Ingress

The optical sub-unit shall be tested for water ingress in accordance with IEC 794-1-F5

g) Fault Current

A sample of OPGW not less than 2 metres in length shall be subjected to a fault current pulse. The test shall be performed twice with an interval of 30 minutes between tests. After the second impulse the OPGW shall be dismantled and the optical cable examined throughout its length for any signs ofdeterioration.

h) Lightning Strike

Tests shall be carried out to verify the effectiveness of the OPGW to withstand the effects of a lightning strike. The test shall consider both an initial stroke and a follow through. The test shall be carried out on a sample of OPGW not less than 2 metres long. The acceptable criteria shall be that earthwires calculated residual strength is not less than 90 percent of the original stated ultimate strength.

Optical Fibres

Optical fibres shall be tested in accordance with the requirements of IEC 793.

Optical joint Boxes

Optical joint boxes shall be visually inspected to ensure they meet the specified requirements.

Non- metallic underground Fibre Optic cable

Non-metallic underground fibre optic cable and the optical fibres shall be tested in accordance with the requirements of IEC 793 and IEC 794 as appropriate.

Fibre Optic cable

All fibre optic cables shall be tested prior to dispatch using an OTDR on each fibre and other tests detailed in this document.

Test Certificates

Test records, covering type and sample tests shall be provided.

Test equipment

The following test equipment if specified in the price schedules shall be supplied and shall remain the property of the Employer after the completion of the site installation. The equipment shall be delivered to the Employer's site depot complete with suitable packaging after completion of the installation tests.

h) One-Portable Optical Time Domain Reflectometer (OTDR) with 1300 and 1550 nm modules. Storage and printing capabilities of traces shall be provided;
i) Two- Portable Optical Power meters for 1300 and 1550nm;

j) Two- Portable High Stability Laser Sources for optical power measurements at 1300 and 1550 nm wavelengths:

k) An optical fibre fusion splicing machine which shall be of the automatic type, designed to carry out fibre core alignment, pre-cleaning and fusion splicing as a fully integrated and properly co-ordinated sequence of functions. It shall only be necessary for the operator to correctly prepare the fibre ends and carry out preliminary alignment prior to initiating the slicing sequence. Optical devices and light sources that are utilised in the fibre system shall form an integral part of the fusion splicing machine and the alignment process. Devices that rely on the use of remotely mounted light sources will not be acceptable. The fusion splicing machine shall be capable of producing splices with an averageattenuation value of less than 0.05dB.

4.2 MINIMUM CLEARANCES

Minimum Clearance of Live Parts to Towers is provided in Appendix 9.A.2

APPENDIX 9.A1

SPECIFICATIONS FOR THE COMPOSITE INSULATORS

No	Specifications	Suspension	Tension
1	Maximum System Voltage (kV)	145	145
2	Pollution Category	Heavy Pollution	Heavy pollution
3	Dielectric	Silicon rubber	Silicon rubber
4	One-minute power frequency withstand voltage, 50 Hz, wet. (kV)	275	275
5	Lighting impulse withstand voltage, 1,2/50 pos. (kV)	650	650
6	Power arc current	25 kA, 0.5 sec	
7	Minimum creepage distance (mm)	3700	3700
8	Specified mechanical load, tension (kN)	70	100
9	Minimum Arc Gap (mm)	1250	1250
10	Material fittings	Steel h.d.g	Steel h.d.g
11	Material of rod	E- CR Glass	E- CR Glass
12	Material of housing and sheds	HTV- Silicone	HTV Silicone
13	Socket	IEC 60120/16	IEC 60120/16
14	Ball	IEC 60120/16	IEC 60120/16
15	Arcing Rings material	Steel h.d.g	Steel h.d.g
16	Arcing rings	IEC 61284	IEC 61284

APPENDIX 9.A2

Minimum Clearances

Minimum clearance of live parts to towers

The minimum electrical clearances of live parts to earthed structures for the project shall be as follows:

Minimum clearances		
a) In still air (Vertical position)	:	1350mm
b) Under 20^0 swing of suspension insulator set or jumper conductors	:	1350mm
c) Under 40^0 swing of suspension insulator set or jumper conductors	:	1140mm
d) Under 60^0 swing of suspension insulator set or jumper conductors	:	830mm

Minimum Ground clearances of conductors

Above general terrain	7.5m
Above main roads	8.5m
Above other Power lines	3.2m
Above other Telephone lines	3.2m
Above railways, SGR	8.5m, 15m

Note: i. *Actual minimum clearance to apply is in the design scope of the contractor considering the altitude, Climatic condition, loading, loading conditions and best engineering practices*

ii. Minimum Phase to Phase, horizontal, Vertical and inclination distance to be considered for tower design is in the scope of contractor.

iii. Minimum sag difference between phase conductors and OPGW and Mid-span clearance between conductor and OPGW from a towers to another is in the scope of contractor.

iv. The Sag Error, Leg Extension requirement for tower design and Muff height between concrete and ground level are in the design scope of contractor considering the altitude, Climatic condition, loading, loading conditions and best engineering practices

v. Contractor shall take to consideration the altitude correction factor as per IEC standards.

5. TOWERS

5.1 TYPE OF TOWER

Towers shall be self-supporting and broad base galvanised steel lattice type with body and hillside extensions. The hillside extensions shall be applied for tower legs on the slope so that legs are suited to the original slope of tower site and also that excessive land cutting around foundations and land collapse is prevented.

The following tower types shall be designed for the project in order to meet various tower positions and loadings economically.

(a) Type-S : Use at tangential positions or angle points up to 2 degrees of horizontal deviation, provided with suspension type insulator sets.

(b) Type-L : Use at positions of light angle up to 15 degrees of horizontal Angle deviation with tension type insulator sets.

(c) Type-M : Use at positions of medium angle up to 30 degrees of horizontal angle deviation with tension insulator sets.

(d) Type-H : Use at positions of heavy angle up to 60 degrees of horizontal angle deviation with tension insulator sets.

(e) Type-HS : Use at positions of specifically heavy angle up to 75 degrees of horizontal angle deviation with tension type insulator sets.

(f) Type-T : Use at positions of line termination (Dead end) or up to 90 degrees of horizontal angle deviation with tension type insulator sets.

5.2 TOWER DESIGN GENERAL ARRANGEMENT

Towers shall have the general arrangements and configurations shown in the drawings included with the specification. They shall be designed to resist the specified ultimate system loading. Clearances between live parts and supporting steelwork and between the phase conductors and ground or other obstacles shall be as specified.

All tower designs shall be such as to facilitate inspection, painting, maintenance, repairs and operation with the continuity of supply being the prime consideration.

The design shall be such that the number of different parts shall be as few as possible to facilitate transport, erection and inspection. The maximum weight of the heaviest single member shouldbe limited to that within the normal lifting capability of the proposed erection equipment.
Main leg members of lattice steel towers shall be formed of the maximum single lengthsappropriate to the body or leg extensions and shall not without the Employer's approval incorporate additional spliced sections.

For lattice steel towers a fully triangulated system of bracings shall preferably be adopted. If full triangulation is not adopted, the overall stability and secondary bending stresses must be considered in the design.

Where fabrication processes employed adversely affect the material properties, or introduce zones of high stress concentration the overall design of the structures shall take such factors into account.

Cross-arms shall be so arranged that they can be disconnected in the plane of the longitudinal face of the support without disturbing any members forming part of the support body.

The cross-arms should be designed to take and be compatible with the AB CHANCE Live Line maintenance tools and equipment.

Appropriate bird guard protective devises shall be installed to keep away birds from roosting directly over the insulator units.

10.2.1 Height of Towers

Height of towers shall be determined in the under-mentioned way:H = Gc + Sg + Li

+ Hc + Hg

Where,

H	=	total height of tower
Gc	=	Necessary ground clearance of power conductors above ground orother objectives.
Sg	=	Maximum conductor sag for DC line
Li	=	Length of a suspension insulator set for DC line, but nil for a tension type towers.
Hc	=	Vertical spacing of upper conductor cross -arm spacing
Hg	=	Vertical spacing between upper conductor cross-arm and overhead earthwire.

Towers shall be provided with body extensions in a 3m step to a standard height for maintaining necessary conductor ground clearance mentioned in Appendix *9.A2* on various ground profiles. The maximum body extension will be 6m. In addition in the body extensions, each leg will have hillside extensions in a 1m step to suit for the original ground slope. Standard tower structures are shown in typical lattice tower drawing no.03 as well as insulation clearance diagram of conductors.

10.2.2 Design Span

The design of all towers shall provide for the following basic, wind and weight spans:

Type of Tower	S	L	M	H	HS	T
Basic span (m)	300	300	300	300	300	300
Wind span (m)	350	350	350	350	350	350
Weight span (m)	600	1,200	1,200	1,200	1,200	1,200
Uplift Weight (m)	0	-300	-300	-300	-300	-300

The term basic span means the horizontal distance between centres of adjacent supports on the level ground which the height of standard towers is derived with the specified conductor clearances to ground in still air at maximum temperature.

The term wind span means half the sum of adjacent horizontal span lengths supported on any one tower.

The term uplift weight means the weights of conductors and overhead earthwire supported upwards at any one tower for reinforcing strength of cross arms.

10.2.3 Design Loads

Structural loading shall refer, ASCE Manual and Report on Engineering Practice No.74 "guidelines for electrical transmission line structural loading".
The following minimum loads shall be applied in the design of towers, actual site environmental loads (wind) with appropriate factors of safety will be used for detailed design:

(a) Wind Loads
- on power conductors and overhead earthwire : 385N/m^2 (on the projected area of conductor or wire)
- On tower structures : 690N/ m^2 (on the projected area of structure members)
- On insulator sets : 385N/ m^2

(b) Maximum working Tensions of Conductor and Earthwire
- Power conductor Lynx : 22,500 N
- Overhead OPGW : 14,100 N

(c) Vertical Loads
- tower structures : actual weights of tower structures including accessories
- Power conductors : Weight of conductors of specified weight span with accessories

- Overhead OPGW : weight of specified weight span with accessories

- Erection Loads : such loads as workers' weights on tower members, reaction of temporarily backstays during stringing operation, etc

(d) Horizontal Angle Effect

-Power conductors and overhead earthwire : horizontal component of maximum working tension of conductors and earthwire due to the specified horizontal angle deviation.

The towers shall be designed for the following wind and weight spars.

TYPE OF TOWER	S	L	M	H	HS	T
Wind Span [m]						
- Normal working condition [m]	350	350	350	350	350	350
- Broken wire condition [m]	260	260	260	260	260	260
Weight Span [m]						
- Normal working condition [m]	700	1200	1200	1200	1200	1200
-Broken wire condition [m]	500	900	900	900	900	900
Uplift weight for cross arms	-	300	300	300	300	300

10.2.4 Design Conditions

a) Assumed Normal Loading Condition:

The assumed maximum simultaneous working loading on towers shall be as follows:

(i) Vertical loads : as above-mentioned.

(ii) Transverse loads : wind loads horizontal angle deviation effects

(iii) Longitudinal loads : wind loads and erection loads but together with maximum working tensions of power conductors and overhead earthwire for their termination for Type-T tower.

(b) Assumed Broken-Wire Condition:

Under the condition, any one power conductor or an earthwire is assumed to be broken at their maximum working tensions in addition to the loads under the normal condition. In the case of Type-S tower, the pull will be assumed to be reduced to 70% of the specified maximum working tensions.

(c) Factor of Safety:

The following factors of safety for tower structures shall be applied in the design.

(i) More than 2.5 for the synthetic maximum load under the normal loadingcondition.
(ii) More than 1.25 for the synthetic maximum load under the broken-wire condition.

Those factors of safety shall be proved under tower loading tests on the proto-type towers in the manufacturer's testing station, and there should be no failure or permanent distortion during the tests.

Note: The given data are for guidance, maximum working tension data shall be obtained from design from design calculations considering the loading and conditions provided.

(d) Shield angle
The design shield angle for the OPGW shall be 30 degree, subject to contractor design confirmation. Parallel factors to be considered for the towers and Pilot insulator Swing angleshall be determined by the contractor considering the loads and loading conditions provided.

10.2.5 Design of Towers.

Latticed steel structures shall be designed with geometric configurations based on structural strength, electrical, economic, and safety requirements. Member forces caused by the design factored loads shall be determined by established principles of structural analysis.

Each type of towers shall be designed so that no failure or permanent distortion shall occur when tested with applied force equivalent to 2.5 times the maximum simultaneous working loadings specified in the Clause 10.2.4 [Normal Working Loading] and also equivalent to 1.25 times the maximum simultaneous working loadings resulting from the assumed broken wire condition.

Design loads shall consider:

a) Minimum legislated levels
b) Client specifications including factors of safety,
c) Expected climatic conditions,
d) Line security provisions,
e) Design life of not less than 50 years,
f) Construction and maintenance operations.

The ultimate design stress, obtained from the working stress multiplied by the factor of safety of 2.5 under the normal condition and 1.5 under the broken wire condition, in tension members shall not exceed the yield point of materials. The ultimate design stress, obtained from the working stress multiplied by the above mentioned factor of safety, in compression members shallnot exceed a figure obtained from an approved formula to be entered in Tender based on the yield point of materials. Alternately, formulas in the American Society of Civil Engineersstandard for the design of self-supporting latticed steel transmission structures ASCE 10- 97. Structural loading shall refer, ASCE Manual, BS 8100: Lattice Towers/masts Code of practice and Report on Engineering Practice No. 74 guidelines for electrical transmission line structural loading.

Tower design report shall consist of full structural analysis report showing correctness of dimensional detail calculations, tower profile/layout drawings, shop detail drawings, erection

drawings and bills of materials. Shop detail drawings shall be approved by the producing utility Engineer of Record (EOR) regarding compliance with the purchaser's specifications and the strength requirements of the design.

Designed tower full size prototype proof test to BS EN 60652:2004 "loading tests on overhead line structures "shall be conducted and approved before tower materials shop production and delivery to site.

Note: The Prototype tower Proof test shall be carried on one complete assembled tower of each type of the towers to be supplied in this project.

10.2.6 Materials and Fabrication.

The towers shall be fabricated from high tensile strength steel of the finest quality of which mechanical properties shall comply with Grade Fe 430 and Fe 510 as specified in ISO 630-1980 or Fe 510B/S355JR or equivalent the meets BS, IEC and ASTM standards.

No member of the tower shall be less than 6mm in thickness and 50mm in width of flange for leg members of towers and main members of the cross-arm, and 5mm and 45mm for the web and nominal members respectively.

The slenderness ratio shall not exceed 150 for the leg and arm members, 200 for the web members and 250 for the nominal members as compression member and 350 for tension only member.

All the connection shall be made by mild and/or high tensile steel bolts and nuts. No bolt shall be less than 12mm in diameter. All bolts and nuts shall be provided with approved spring washers. Antitheft bolts shall be used from ground level to the tower anti-climb level.

Bolt holes shall not be more than 1.5mm larger in diameter than the corresponding diameter of bolts. Holes shall be drilled for the members not less than 13 mm in thickness. For the membershaving thickness below 13 mm, holes may be drilled or punched, but the former is preferred.

All the steel members should have clearly identifiable part numbers which enable quick identification of similar parts. The letters '***KPLC'*** should also be inscribed on each bracing- by punching or any other suitable method, with more than one inscription for parts of length greater than 0.5m.

All burs shall be removed completely by reaming and smoothing before hot-deep galvanising.

10.3 TOWER ACCESSORIES

The following accessories shall be provided for every tower.

(i) **Anti-climbing device and climbing steps**: All towers will be provided with the anti-climb device on each leg at the height of 3 m to 5 m above the highest ground level atall tower locations. The device installed on the step-bolted legs shall be provided on

all towers. Gates shall be designed to open upwards only and shall be secured with galvanised bolts and nuts. No padlocks are required.

Each tower shall be provided with step-bolts of an approved type on diagonal sides of the tower at a spacing no more than 380mm, starting immediately above the anti-climbing device and continuing to the earth wires.

Step and anchor bolt shall be made of high strength steel grade 8.8 as per ISO 898-1:1999, BS 3692:2000, with minimum diameter: 5/8 inch (16mm) and Length: 8-9/16 inch.

Holes for removal step-bolts below the anti-climbing guards shall be provided at not more than 380mm centres on the step legs.

Where the line is passing through forests inhabited by baboons as indicated in the ESMP document, the towers shall be provided with Racer and Barbed wires ofapproved type by the employer in addition to anti-climbing devices. These racer wiresare made to deter the primates from climbing the towers and accessing the live conductors. The Racer and Barbed wires shall be installed at least 5m above the ground level.

The step-bolts shall also be installed on this towers as required in all the towers

(ii) **Danger, Number and Helicopter patrol plates**: Danger plate which shows warning sign for tower climbing of other people than maintenance crew will be provided on all towers.

Number plates which show tower number set serially from Narok to Bomet will also be installed on every tower.

On the top of every section tower, and every 10^{th} tower, additional number plates willbe provided to aid helicopter patrol over the transmission line. Lettering and size of plates shall be to the Employer's requirements, and should be both sides of the number plate for clear identification when patrolling from either end.

All plates shall be of anti-corrosive material. If enamelled iron plates are used, the whole surface of each plate including the back and edges shall be properly covered and resistant to corrosion. On all plates the colours shall be permanent and free from fading. With enamelled plates, washers or fibre or other approved material shall be provided back and front of the securing bolts.

(iii) **Tower Earthing**: No separate earth conductor from top to bottom of towers isrequired and earthing continuity will therefore depend on surface contact between bolted members.

All structures shall be provided with means for connecting earthing devices at or around nominal ground level, on each leg and for connecting earthwire bonds to each top crossarm or earthwire peak.

Each leg of towers will have an earthing rod underneath its foundation to act as basic grounding required by good transmission line Engineering. Basic grounding shall be constructed in such a way that isolation from the tower and concrete foundation is possible to allow earthing survey if required during line service life.

Maximum earthing resistance of a tower is targeted on 10 Ohms, and in case of higher resistance than 10 ohms, additional horizontal counterpoise earthing system will be added in the ground longitudinally to the line route with more than 50 cm depth. The rate entered in the schedule of prices shall include for all necessary fittings and shall be adjusted at the variation rate for increased or reduced fittings.

(iv) **Aircraft Warning Devices**: Due to the activity of aircraft in the vicinity of certain parts of the transmission line, it shall be necessary to mount warning spheres on earthwires at some locations. Aircraft warning spheres shall be capable of being clamped securely to overhead earthwire. The sphere itself shall be of plastic or fibreglass construction of at least 0.5m in diameter and coloured orange or yellow as required by local regulations. The Contractor is to enter rates against appropriate item in the schedule of prices for the above and he will be advised early in the contract of actual requirements.

(v) **Bolts:** Where appropriate all metal parts hall be secured with bolts and nuts with single spring washers. When in position the bolts shall project through the corresponding nuts by at least three threads, but such projections shall not exceed 10mm. No screwed threads shall form part of a shearing plane between members.

In order to safeguard the tower members from theft; special anti-theft bolts shall be applied from ground level up to 1 metre above the anti-climbing device. The bolts shall be approved by the Employer. The bolts are of the type that shears once the fulltorque has been applied.

The nuts of all bolts attaching phase conductor insulator set, earthwire sets, maintenance brackets/plates shall be locked in an approved manner preferably by locknuts.

The bolts of any one diameter in a tower shall be one grade of steel. Leg members shall be joined in such a way that electrical continuity is maintained to ground.

Bolts and Nuts shall be made of High tensile strength grade 8.8 or higher steel, and diameter shall be not less than 16mm as per BS3692:2000, ISO 898-1:1999

(vi) Rectangular and Auxiliary Cross Arm

The type H, HS and T towers may be provided with rectangular arms where horizontal angle exceeds 45 degree.

The prices of the rectangular arm set shall be included in the prices for the towers.

(vii) Spare Towers

Five sets of 132kV section towers of emergency restoration type shall be provided for line possible collapse emergency repairs. Emergency towers will be pure aluminium modules of maximum length 3m with an articulated 360^0 base. Spare web bracings shall also be provided, sufficient for five (5) standard suspension towers up to the anti-climbing device level.

10.4 MATERIALS

All steel shall comply with BS EN 10025 or BS EN 10210 as appropriate, unless otherwise specified and shall be suitable for all the usual fabrication processes, including hot and cold working within the specified ranges.

The quality of finished steel shall be in accordance with BS EN 10163. All steel shall be free from blisters, scale, laminations, segregations and other defects. There shall be no rolling laps at toes of angles or rolled-in mill scale.

Unless specified to the contrary the following grades of steel shall be applicable:

a) Mild steel shall be either grade S235JRG2 or S275JR.
b) High tensile steel shall be grade S355JR for sections less than 20mm thick and S355JOfor sections greater or equal to 20mm thick, except for plates which shall be greater or equal to 40mm thick.

10.5 WORKMANSHIP

All steel lattice members shall be cut to jig and all holes in steelwork shall be drilled or punched to jig. All steel parts shall be carefully cut and holes located so that when the members are in position the holes will be opposite each other before being bolted up. The drilling, cutting, punching 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 structures on site. High tensile steel members shall be bent hot. Care shall be taken not to punch holes too close to the edge of members.

Means shall be provided to enable the Employer to carry out such checking of members, as he may consider necessary. Built-up sections, when finished, shall be true and free from all kinks, twists and open joints and the materials shall not be strained in any way.

In order to check the workmanship, not less than 1per cent, of the members corresponding to each type of tower or cross arm shall be selected at random and assembled to form complete latticed supports or cross-arms in the presence of the Employer representative at the manufacturer's works.

6. CIVIL WORKS

6.1CONCRETE FOUNDATIONSGeneral

Concrete pad/Block and chimney type foundations will be applied to most of the towers, the design of the concrete foundations of the towers shall be performed based on the requirements and assumptions set out below, and the details of the design and drawings for each type of foundations shall be submitted with the Tender.

The foundation design shall be depended on tower design, geotechnical survey, soil investigationto be done by the contractor and other design factors given in the subsequent clauses

Such design of foundations for the towers are subject to modifications to suit the site conditions as indicated in writing by the Engineer during execution of the Contract without any price adjustment of the items of the foundation stubs.

6.2 CONCRETE FOUNDATIONS: - PAD AND CHIMNEY

The types of the concrete foundations and natures of earth to be considered shall be as follows:-

Types of concrete foundation Assumed natures of earth Yield bearing capacity		L	M	H
- Vertical	[ton/m^2]	60	40	20
- Lateral	[ton/m^2]	30	20	10
Mass	[kg/m^3]	1,600	1,500	1,400
Angle of frustum	[degree]	30	20	10

All Structural Concrete shall be reinforced with steel bars to structural design details. Deformed steel bars are preferable for the reinforcement.

The depth of the foundations, concrete and steel grade is depended on each type of tower design and geotechnical investigations data obtained by contractor.

The abbreviations L, M and H of the concrete foundation types shall mean as follows:-L : Light concrete foundation

M : Medium concrete foundationH : Heavy concrete foundation

The angle of frustum of earth shall mean the angle vertical of earth frustum to resist the uplift force.

The concrete to be considered shall conform to class C20/25 with a minimum strength of 25N/mm^2 at 28 days:-

Assumed natures of concrete

Following is the assumed nature of concrete to be considered;Allowable strength:

-Compressive	[kg/m^2]	60
-Tensile	[kg/m^2]	6.0
-Shearing	[kg/m^2]	6.0

Mass:

-Concrete without reinforcement	[kg/m^3]	2,300	
-Concrete with reinforcement	[kg/m^3]	2,400	Allowable

strength on:

-Galvanized steel action	[kg/m^2]	3.6
-Round reinforcing bars	[kg/m^2]	7.2
-Deformed reinforcing bars	[kg/m^2]	12.0

Each type of foundation shall be designed based on the following formula:

[1] Against compression load

$$\frac{q}{F} \geq \frac{C+G+Ws}{A}$$

Where, q : Yield bearing capacity of earth [ton/m^2]
F : Factor of safety
C : Compressive load [ton]
G : Weight of concrete [ton]
Ws : Weight of earth above foundation pad [ton]
A : Area of foundation pad [m^2]

[2] Against uplift load

$$\frac{W}{S} \geq$$

Where, T : Uplift load [ton]
Ws' : Weight of earth in frustum [ton]
F : Factor of safety

[3] Against lateral load

$$\frac{q' \times A'}{F} \geq Q$$

Where, Q : Horizontal load [t]
q' : Yield lateral bearing capacity of earth [ton/m^2]
A' : Projected area of foundation chimney and pad[m^2]

The factor of safety shall not less than 2.5 under the normal working conditions and 1.25 under the broken wire conditions.

The upper surfaces of the foundation pads shall be reinforced and sloped within 45 degrees to the horizontal. The minimum thickness of the edges of base pad shall be not less than 300mm.
The frustum shall be assumed to start from the top edges of the pad. Where frustums overlap each other, allowance shall be made for loss of uplift resistance.

Concrete shall cover any part of the top steelwork by at least 100mm and shall extend above the ground for the minimum height of 350mm. Additional 500mm minimum chimney extension shall be provided to foot on lower side in sloping areas. The upper surface of chimney shall be sloped to ensure drainage of water.

The cleats shall be attached by bolting at the base of each stub to assist in transfer of leg load to the foundation pad as shown on drawing *Appendix 1.A3 (Anti-Climbing device and Grounding system)*. Minimum portion of stub loads in the design of cleats shall be assumed at 50 per cent.

6.3 SPECIAL FOUNDATIONS

Besides the mentioned above concrete foundations, special foundations such as raft type foundation, rock anchor, piled foundation or others may be required. Final type of foundation to be applied for each tower shall be determined in accordance with results of soil investigation performed by the Contractor during execution of the Contract.

For the purpose of tendering, basic designs shall be submitted with the tender under the following assumptions, and prices for the special foundations shall be quoted based on thedesign.

[a] Raft type foundation

The foundation shall be designed with the following specifications: ultimate bearing capacity of 10ton/m^2, soil weight of 1.4 ton/m^3 and no angle of frustum of soil. Weights of reinforced concrete and soil shall be taken as entirely submerged. Other design conditions specified in this subsection will be applied. Contractor shall determine the applicable concrete density for submerged condition.

[b] Piled foundation

Piles used for the foundation shall be either pre-casted concrete pile with circular or square cross section or in-situ concrete pile.

[i] Pile data

Pile diameter or dimension

- Circular cross section	-	Φ300 mm.
- Square cross section	-	300 x 300 mm
Pile depth below ground level	-	12 m Ratio or ultimate
bearing/uplift capacity of pile	-2.5: 1	

[ii] Uplift

The mass density of concrete below ground level shall be assumed as 1,600 kg/m^3 to allow for hydrostatic effects and similarly soil as 960 kg/m^3. Additional weight of concrete shall be included as necessary to provide the specified resistance to uplifting under any condition. Where bored or driven piles are proposed having no specially madebulb or enlarged concrete foot to provide positive uplift resistance but relying on skin friction alone, at least 75% of the networking uplift force, and 50% of the nett brokenwire uplift force shall be provided in dead weight of concrete, whichever is the greater.

The cost of such concrete shall be included in the piled foundation rate.

[iii] Compression

Mass density of concrete shall be assumed as 2,300 kg/m^3 on their technical acceptability and cast.

Contractors must justify assumptions of equal performance of their piling system with that proposed. No extra payment shall be made for access tracks necessary for heavy piling rigs.

Piles shall be embedded in a reinforced concrete cap of adequate dimensions and the caps tied with nominal reinforced concrete beams of a minimum size of 460 mm deep by 300 mm wide with at least eight 19 mm diameter main reinforcing bars per beam.

Piling shall be carried out using an approved procedure throughout. The actual length and numbers of piles required at any given location shall be approved by the Engineer on the basis of the final agreed design data.

[c] Other Foundations

Where special ground conditions exist which do not allow for any of the above designs in an original or modified, special types of foundations may be employed. They will be paid for on basis of submitted rates schedule for concrete, steel and excavations applying throughout, irrespective of special conditions.

Tower prices shall cover for all costs not covered by special scheduled rates where admissible including the provision of access tracks and standings for piling equipment or building of bund for the Contractor's convenience in paddy fields or other flooded areas.

6.4 FOUNDATION WORKS

11.4.1 Soil Investigation

The Contractor shall make tests of subsoil conditions at every tower site by means of an approved simple hand-operated borer [sampling] and sounding tool, and indicate results on the approved soil test sheets together with ground water levels and proposed foundation type to be applied at the tower position.

The Contractor shall obtain the Engineer's approval for the foundation type in advance of the foundation works at each tower site. Particular note is to be made where any poor ground is encountered likely to require special foundations. The test results shall show firm evidences to prove reasons why the proposed type of foundation is selected from the specified foundation types. The cost of the sub-soil tests is deemed included in the rate for foundation work.

The Engineer may request the Contractor additional sub-soil tests at the bottom of excavated pits, if the Engineer judges its necessity for further confirmation on the proposed foundation types. The sub-soil tests shall be done at the earliest stage of the filed works to the urgency of having tower stubs and templates on site in order that foundation works can proceed with a minimum of delay. BS5930, soil investigation code will apply as a technical guide for reference.

11.4.2 Excavation and Backfilling

Where angle towers are fitted with unequal length cross arms at each side of the tower, the tower centre shall be offset to ensure that conductors are located as near as possible equidistant either side of the route centreline in adjacent spans.

The Contractor shall ensure that excavations are made to the correct depth and width. If excavations are taken deeper that the designed dimension the excess depth shall be backfilled with concrete at the Contractor's expense. If excavations are made wider than the designed dimension, such modifications to the design as the Engineer may require shall be made at the Contractor's expense.

For uplift foundations, undercutting or other approved method shall be applied as far as possible for allowing upward bearing of the foundation pad against undisturbed soil for a minimum widthof 250mm all around. Alternatively the concrete pad shall be cast to the edge of the excavation for a minimum height of 250 mm in order to gain assistance by adhesion to the original ground. In cases where the concrete block is cast in undercutting, the earth frustum assumed to resist uplift shall be considered to start from the bottom of the vertical edges of the block. Otherwise, the frustum shall be assumed to start from the upper top of the block edges.

The backfill of all types of foundations shall be thoroughly rammed with mechanical rammers, and the ramming shall be carried out at intervals of not greater than 300 mm to ensure thorough consolidation of the backfill as the Engineer requires.

Foundation Concrete faces shall be painted with an approved bituminous paint to separatebackfill from concrete before backfilling.

In no circumstances shall peat, black Cotton soil or equivalent materials be used as backfill for foundations. Where excavations are made in peat ground, backfilling to be foundations shall be made with a suitable soil or hard-core from an approved source at the Contractor's expense. Backfill shall be finished in such that the original ground contours are restored as nearly as possible, any subsidence of backfill shall be made good before the issue of the Taking-Over Certificate.

11.4.3 Stub Setting

Stubs for tower foundations shall only be installed with the use of templates, probes or by use of the lower sections of the tower with the suitable temporary bracings to ensure correct spacing.

The stub setting templates shall be of approved type with sufficient rigidity to ensure correct setting of the stubs. The method selected shall be such that all four stubs are supported and interconnected by a rigid steel framework. The main members of the templates must be in the position by the template while the concrete is placed. The templates are not to be removed until at 48 hours after the foundations have been completed.

The templates shall be manufactured from mild steel angle or channel or a combination of both, of approved and adequate cross-section, and shall be equipped with central alignment notches or holes, corner braces, riser-braces, and stub angle bolting legs to permit the accurate setting of stubs in respect of the following requirements:

i) Longitudinal centreline
ii) Tower lateral centreline
iii) Stub elevations [with reference to datum]
iv) Stub levelling
v) Inclinations of stubs
vi) Stub hip bevels
vii) Spacing between stubs

No concrete shall be started before the stubs are confirmed to be in the design positions, setting details recorded in setting out form.

11.4.4 Concrete Works

[a] Concrete for concrete foundation and pile shall have the minimum required breakingstrengths as specified in the technical schedules. BS 5328 will refer when specifyingconcrete and BS 8110 in reference to structural use of concrete

[b] Cement used shall be Portland with minimum strength of 42.5 KN/m^2 or other approved composition obtained from an approved maker. Portland cement shall conform in all respects to BS-12.

[c] Aggregates shall be clean and free from dust, earthy or organic matter or salt. Coarse aggregate shall be approved grading to be retained on a mesh not less than 5mm square,and of a maximum size to pass a mesh not more than 40 mm square. Where specially approved in writing by the Engineer, coarse aggregate of uniform size which will pass a 25mm mesh may be used throughout. Fine aggregate shall be river sand and shall be coarse, sharp, clean and fee from dust, salt, clay, vegetable matter or other impurity and shall be screened through a mesh not more than 5mm in the clear. It shall be well graded mixture of coarse and fine grains from 5mm gauge downwards. Aggregates shall conform in all ways to BS812 and KS 95:2003.

[d] Water shall be clean and free from all earth, vegetable or organic matter, salt, soil, oil, acid and alkaline substances either in solution or in suspensions. Quality shall be confirmed by lab test as per BS 3148 (Mixing Water Specifications).

[e] At least four weeks before commencing any concreting work, the Contractor shall make trial mixes using samples of cement and fine and coarse aggregates.

The test specimens for the trial mixes shall be of cube type. Preliminary test specimens shall be taken from the proposed mixes as follows:

For each proposed mix a set of 6 specimens shall be made from each of 3 consecutive batches. Three from each set of six shall be tested at an age of seven [7] days and three [3] at an age of 28 days. The test shall be carried out in an approved laboratory.

Neither the mix proportions nor the source of supply of materials shall be altered without the prior approval of the Engineer except that the Contactor shall adjust the proportions of the mix as required, to take account of permitted variations in the materials, such approval shall be subject to the execution, to the Engineer's satisfaction, of trial mix procedures set out herein.

[f] Where directed by the Engineer concrete cubes are to be taken and tested to verify the concrete strength during site concreting works. The Contractor shall provide the cube moulds at site for this purpose accordingly. The test specimens shall be 150 mm cubed andthe mould shall be of metal with inner faces accurately machined in order that opposite sides of the specimen are plane and parallel. Each mould shall be provided with the metal base having a smooth machined surface. The interior surfaces of the mould and base should be lightly oiled before concrete is placed in the mould.

[g] The cost of concrete testing shall be deemed to be included in the Contractor's general schedule rates. Testing Lab shall be approved

[h] Requirements for testing concrete samples during construction are set out in Clause 11.8.

[i] The concrete shall thoroughly wetted before backfilling commences. When shutters are to be struck, backfilling of excavation is not to take place immediately, and the concrete shall be kept continuously moist to avoid rapid drying.

[j] In the event that the Contractor proposes to use ready mixed concrete for foundation work, approval must first be obtained from the Engineer, who will inspect the batching plant and cement, sand and gravel used for concrete. No ready mixed concrete shall be used in foundation work if it has been mixed in the lorry during its journey for more than 45 minutes. At the discretion of the Engineer, ready mixed concrete may be used in foundations in excess of 45 minutes journey, if the cement is added to the drum at site andis thoroughly mixed prior to placing, or alternatively if the ready mixing lorry carried its own drum during the lorry's journey and not mixed for more than 45 minutes prior to placing. The Engineer's decision to reject any of the above methods of supplying ready mixed concrete shall be final.

[k] Throughout the line route, the Contractor shall at regular intervals and at the time of survey, obtain samples of subsoil and ground water, which he shall have analysed to ascertain if any agents be present which may have an adverse effect on concrete made with normal Portland cement. The analyses shall be forwarded to the Engineer without delay together with any recommendations for the use of special cement. The Engineer's decision as to the type of cement to be used will be final. The cost of obtaining soil and ground

water samples is deemed to be included in the Contract Price. The cost of any special cement used will be paid at an appropriate rate to be agreed with the Engineer.

[l] Concrete shall be placed immediately after mixing. All concrete shall be thoroughly compacted by vibration during the operation of placing, and shall be free from honeycombing and other defects. The upper surface of the concrete for all types of foundations shall be finished smooth and sloped in an approved manner to prevent accumulation of water. A concrete additive of a type approved by the Engineer may be used.

11.4.5 Piling and Other Special Works

Pilling will be carried out using an approved procedure throughout. The actual length and numbers of piles required at any location will be approved by the Engineer on the basis of the final agreed design data and payment made for departures from the assumed tender design quantities on the basis of the difference of quantities times the Schedule variation rates. Piles shall be tested in accordance with Clause 11.8. Tender Prices shall include for all necessary casings, pumping, and depreciation of piling machines, materials, transportation, testing and others.

Where special ground conditions exist which do not allow for any of the designs in an original or modified form, special types of foundations may be employed which will be paid for on the basisof schedule rates submitted. To this extent the submitted schedule of rates for concrete, steel and excavations shall apply throughout irrespective of special conditions.

6.5 ERECTION OF TOWERS

Where tower members arrive on site with slight distortions due to handling in transit, they shall be straightened by the Contractor using approved means and offered to the Engineer for inspection and acceptance or rejection before erection commences.

In general, towers shall be assembled and erected with bolts finger tight only. Final tightening of bolts shall only take place when all members are in place. As far as practical, bolts shall be inserted with the nuts facing outwards or downwards.

Whenever wire slings or ropes are liable to abrade tower members, the members shall be suitably protected by heavy Hessian bags or strips, or by some other approved means.

The Contractor shall make use of temporary struts on panels prior to lifting, if in the opinion of the Engineer, there is likelihood of damage occurring to that panel during lifting. Where derricksare used for lifting panel they shall be securely guyed and shall be supported only at approved locations on the legs.

All towers shall be vertical under the stress set up by the completed overhead line to the satisfaction of the Engineer. The maximum acceptable deviation form vertical shall normally be 1%.

Proper precautions shall be taken to ensure that no parts of the towers or supports are unduly stressed or damaged in any way during erection. Drifting shall not be allowed.

Suitable ladders shall be used whenever necessary during erection, but such ladders and removal step bolts shall be removed when erection work is in progress.

Before assembly of members, joints shall be free of all earth, or any other substances which might prevent the correct alignment of members. After erection, all materials shall be cleaned of all foreign matter or surplus paint.

Spanners used during erection shall be well shaped and fit closely on the nut to avoid damaging nuts and bolt heads. Approved equipment shall be used for tightening the shear bolts which will be used from ground level up to one metre above the anti-climbing devices. After erection, the rest of the bolts up to the bottom cross arm shall have the threads smashed in an approved manner to prevent unauthorized removal.

Damage to the galvanised surfaces of bolts, tower steelwork or smashed bolts shall be repaired using zinc rich paint or similar and the cost of such repair is deemed to be included in the appropriate rates.

The Contractor must ensure that tower erection, steel handling and operation of equipment shall be such as to ensure the maximum safety of all personnel associated with the project as well as the public.

Lower parts of towers erected in the submerged area during wet seasons shall be protected from corrosion with an approved paint as ordered by the Engineer. The cost for the paint shall be quoted in the Price Schedule.

6.6 GROUNDING OF TOWERS

Before placing foundation concrete, basic grounding earthing rods specified in Clause 11.8 shall be erected to each foundation cleats. Installation shall ensure that earthing can be isolated from the tower and concrete foundation to allow earthing survey. Measurement of footing resistances of all towers shall be carried out with an approved instrument before stringing of an overhead earthwire. A target value of the resistance is less than **10 Ohms**. The Contractor shall report the measured value in an approved form to the Engineer. The Engineer will instruct necessitate of installation of counterpoises to the Contractor who shall then provide the counterpoises asspecified in the Clause 11.8 to the instructed towers and measure the resistances for reporting theEngineer. In case the resistance is still high, the Engineer may order the Contractor to install additional counterpoises.

6.7 ERECTION OF CONDUCTOR AND OVERHEAD EARTHWIRE

a) The fullest possible use shall be made of the maximum conductor lengths in order to reduce the number of joints to the minimum. The number and location of conductor and overhead earthwire tension joints shall be approved. Tension joints shall not be less than 15m from thenearest clamp.

b) Unless the Engineer agrees to the contrary, mid span joints shall not be not used-

    (i) at locations which would allow less than 3 clear spans between mid-span joints on a given conductor and wire

(ii) in spans crossing power lines, telecommunications lines, public roads or buildings, and
(iii) in single span sections.

c) Conductor repair sleeves shall not be used without the permission of the Engineer, which willbe granted only in exceptional circumstances.

d) Conductor and earthwire stringing shall be carried out entirely by tension stringing methods and the Contractor shall submit for approval full details of the precise method of tension stringing and of the stringing equipment which he intends to use. Conductors shall be keptoff the ground at all times when the conductor is in motion. The method of tension stringing required to install all conductors and earthwire shall be continuously controlled.

e) The conductor and earthwire tension during stringing operation shall be kept as low as possible, consistent with keeping the conductor and earthwire clear of the ground whilst in motion. At no time will the tensions be allowed to exceed 75% of the final tension.

f) All stringing equipment shall be properly anchored and shall be positioned in such a way that structures, insulators and fittings will not be overloaded.

g) Conductor and earthwire drums shall be securely anchored during the stringing operation and drum jacks shall be of the self-braking type to prevent conductor over run.

h) Conductor an earthwire pulling shall be such as will ensure a continuously steady pull. Every precaution is to be taken to prevent damage to the conductor and earthwire. Clamps and other devices used for handling conductor and earthwire during erection shall allow no slippage or relative movement of strands or layers and shall not pinch or deform the conductor and earthwire. Grooves in sheaves and tensioners shall be lined with neoprene or rubber. Sheaves shall have an electrical conducting path between their suspension points and the conductor supported within them and shall run with minimum friction.

i) Conductor and earthwire shall be effectively earthed in an approved manner during running out and at all places where men are working on them.

j) At least three months before stringing commences, the Contractor shall give due to consideration to all the factors involved and submit to the Engineer for approval a fully detailed stringing schedule stating locations of conductor and earthwire drums, winch operation for stringing and the proposed positions of mid-span joints, together with temporary staying wires of towers and all other relevant information.

k) Conductor and earthwire drums shall be closely examined before conductor pulling commences and all nails and other things which could damage the conductors and earthwires shall be removed. During stringing, the conductor and earthwire drums are to be supervised at all times and the conductor and earthwire shall be inspected for defects while it is being pulled off the drums. Any damage caused to conductors or earthwires shall be reported to the Engineer whose decision to replace or repair will be final.

l) Conductors and earthwires shall be carefully regulated to the correct prestress and initial tensions by a measurement of sags. Ambient temperature shall be measured by a

thermometer suspended on the tower at the sag measurement position. Making for and application of anchor clamps shall follow regulation to initial tension without delay. Immediately after regulation and clamping has been completed in a section, the sag of conductors and earthwire shall not depart from the correct value by more than ±1.5%. Suspension insulator sets shall be installed so that clamps are within 20mm of their correct position on the conductor.

m) The insulators strings shall be cleaned and inspected before assembly. Any defective insulator be shall be removed from site forthwith. Insulators have the security clip, cotter pins and other locking devices fully in place and shall be erected in a manner avoiding damage to the sheds, fibre-glass rod or locking devices.

n) Where required by the Engineer, the Contractor shall check prior to the issue of the Taking-Over Certificate that the sags of conductors and earthwire in selected spans are within the specified tolerance, and shall make any adjustment necessary to ensure compliance.

o) Joints, clamps, etc. shall be applied using the approved tools and in such a manner that no bird-caging, over-tensioning of individual wires or layers or other deformation or damage to the conductor and earthwire occurs. Cutting of layers of conductors shall be carried out with tools designed to prevent damage to underlying strands.

p) Compression fittings shall be applied only by linemen approved by the Engineer, using approved methods. The outer surfaces of conductors and earthwires and the interiors of compression sleeves shall be scratched-brushed immediately before assembly.

q) After conductors have been made off and landed, stringing sheaves shall be removed and suspension clamps and vibration dampers shall be fitted with minimum delay. Suspension clamps shall be fitted with due regard to offsets where appropriate, and the conductor and earthwire shall be cleaned before the clamp is assembled.

r) The Conductor shall keep a record of all sagging showing details of the section, the sagging and checking spans, ambient temperature, pre-stress, initial and final sags, the date of sagging and clipping-in offset, etc. This record shall form part of the final records for the line and shall be handed over to the Engineer prior to the issue of taking-Over Certificate. The records shall be available for inspection at any time.

6.8 TESTS AT SITE

[1] General

Following investigations and tests shall be carried out by the Contractor, when ordered by the Engineer.

Those investigations and tests as mentioned in the Price schedule will be paid for at the rates entered. Other investigations and tests not scheduled in the Price Schedule shall be deemed to beincluded in the prices of the relative items of the works.

[2] Ground Prove Tests

Tests by means of an approved type of penetrometer or other approved means shall be carried out during the check survey as provided for in Clause 11.4. Results of these tests shall be submitted to the Engineer on an approved form giving a preliminary indication of the ground bearing properties and water levels, etc. Bore penetration shall be at least 9m below ground levelin poor ground.

[3] Laboratory Soil Tests

Where ordered by the Engineer, the Contractor shall obtain soil samples and submit these for tests to an approved laboratory to determine the necessary properties of the soils for the purpose of foundation designs. Such information shall be detailed in an approved manner and conclusionsgiven as to the recommended bearing pressures to be adopted. Tests shall be carried out generally in the manner described in BS-1377

[4] Ground Bearing Test

Where ordered by the Engineer, the Contractor shall carry out ground bearing tests to determine the ground bearing capacity, by means of loading a 300 mm square plate in an approved manner.Tests shall be carried out generally in the manner described in BS-5930.

[5] Pile Bearing and Uplift Tests

Where ordered by the Engineer, the contract shall carry out pile bearing and uplift tests for all types of pile generally in accordance with the method given in the BS CP-2004. Such tests shall be carried out to determine the ultimate uplift and bearing values.

[6] Foundation Loading Tests

Where ordered by the Engineer, foundation loading tests shall be carried out in full scaled individual footings.

[7] Records of Site Investigation Tests

All records of site investigation tests shall be detailed in an approved manner. Sample log sheets, charts, etc. shall be submitted to the Engineer for approval before any investigation commences. All site investigation data, charts, etc. shall be handed over to the Engineer in triplicate upon satisfactory conclusion of the tests, and before the issue of Taking-Over Certificate.
Where the Contractor carried out other tests at his own expense, not ordered by the Engineer, andto the contrary, where the Employer had independent tests made along the route of the line, such information shall be made available to the Contractor.

[8] Concrete Tests

The Contractor shall carry out tests on sample of concrete from the foundation works, as required by the Engineer as specified in Clause 11.4. The test specimens shall be stored at the site at a place free from vibration under damp sacks for 24 hours. They shall be then removed from the moulds, marked and stored in water at a temperature between 10^0 C and 21^0 C until the testing date. Specimens which are to be sent to a laboratory for testing shall be packed for transit in a

damp sand, or other suitable damp materials, and shall be brought in the laboratory at least 24 hours before test. On arrival at the laboratory, they shall be similarly stored in water until the time of the test.
The results shall be handed in triplicate to the Engineer, as soon as possible after testing, and not later than seven days.

[9] Support Footing Resistance

The resistance to earth of the complete foundation of individual structures shall be measured inan approved manner before the stringing operation of overhead earthwire, as specific in Clause
11.6. The placing of tests electrodes shall normally be along the centre line of the route in such direction as to ensure that the lowest resistance to earth is recorded, and a note shall be made of the direction in the time of the test.

[10] Additional Footing Resistance Test

If in the opinion of the Engineer, it is necessary to reduce the tower footing resistance by means of counterpoises, the Contractor shall make further measurement after the additional counterpoises have been carried out before the stringing operation of the overhead earthwire. Any further measurement shall be carried out as necessary without extra charge.

[11] Measurement of Galvanising Thickness

The Contractor shall have on site an instrument suitable for accurate checking of galvanizing thickness for the Engineer's use. The gauge shall be available from time of arrival of the first consignment of steel work until the issue of Taking-Over Certificate. The cost of the gauge and other operating expenses shall be deemed to be included in the contract price and the gauge shall remain the property of the Employer.

[12] Testing of Rock Anchors

Where rock anchor foundations are used in hard rock, as provided for by the Engineer's order, the Contractor shall test individual anchors by tensile test loading to failure for obtaining design data of the foundations. The test shall be considered satisfactory if the steel bar fails by yielding at or above its ultimate strength.
Anchor for the testing shall be installed away from permanent foundation anchors but in thesame rock. The frequency of the test shall depend upon the different types of hard rock encountered and the number of tests performed shall be such as to give confidence in the employment of rock anchor foundations and experience of the type of rock suitable for their use. The frequency of test shall, in the case of dispute, be reasonably determined by the Engineer. Tests shall be carried out generally in the manner described in BS-8081 on ground anchorages.
The cost rock test shall be included in the relevant schedule rates.

[13] Test on Completion

The line along the towers shall be energized at full working voltage before handing over, and the arrangement for this and such other test as the Employer/ Engineer shall desire to make on the completed line shall be assisted by the Contractor who shall provide such labour, transport and other assistance as required without extra charge.

Specifications for laptop-Minimum

OPERATING SYSTEM	Genuine Preinstalled: Windows 11 Pro, Version 21H2
PROCESSOR	11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80GHz 2.80 GHz
INTERNAL STORAGE	1TB 5400 rpm Hard Drive
MEMORY	12 GB DDR3L - 1 DIMM
REMOVABLE STORAGE	External Optical Disk Drive
DISPLAY	13.3-inch diagonal Full HD WLED-backlit IPS Display (1920x1080)
GRAPHICS	Intel® HD Graphics 5500
AUDIO/VISUAL	DTS Sound+, stereo speakers, integrated dual array microphone with 720p HD9 Webcam
WIRELESS SUPPORT	Broadcom 802.11 a/b/g/n, Realtek 802.11 b/g/n, Bluetooth v.4.0 combo
COMMUNICATIONS	NIC 10/100/1000 Ethernet Controller
PORTS	2 USB 3.0 ports 1 USB 2.0 port (power port 1 VGA I HDMI 1.4a, I Stereo microphone input, I Headphone line out, 45 (Ethernet), 1 power connector
WEIGHT	3.31 lb (1.50 kg)
POWER	3-cell 48WHr Lithium-ion Battery, 45 W AC power adapter
WARRANTY	1 year
CARRY CASE	Carry Case