TECHNICAL REQUIREMENTS AND SPECIFICATIONS FOR BAMBURI CEMENT 132KV METERING WORKS

PART 2A

TECHNICAL REQUIREMENTS AND SPECIFICATIONS FOR 132 KV METERING SUBSTATION

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TECHNICAL SPECIFICATIONS, SCHEDULES & DRAWINGS

SCOPE OF WORKS:

This section covers the manufacturing, 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 testing and commissioning of the plant as generally described below.

Bamburi cement is located at Bamburi, Mombasa County 200m from Mombasa- Malindi highway at Bamburi turn off.

A.Bamburi 132/33 kV Substation Take off bay

Bamburi 132kv substation is located at Ngutatu area 3km from kiembeni shopping centre. The scope of works consists of the following;

Establish a 132kVtake off bay at existing substation,

The following will be required:

- One (1No.) 132kV circuit breakers- single pole operated
- Two (2No.) 132kV line isolator assembly with an integral earth switch
- One set (3 No.) of 132kV current transformers
- One set (3No.) of 132kV Line surge arrester
- One sets (3No.) 132kV Capacitive Voltage Transformer
- 2nos. 132kv post insulators
- Extension of the existing bus bar including bus bar support structures
- Take off gantry for new 132kv line
- Bus bar protection with low impedance differential numeric relay
- Line differential protection using OPGW, for the 132kV lines two (1) no.
- Line distance protection relays for the 132kV lines, two (1 no.)
- Line back up protection, over current & earth fault, over voltage 132 kV lines, two (1 no).
- Circuit breaker fail protection
- Line metering cubicle with meters of Cl.0.2 accuracy for the 1 no.132kV lines.
- Substation and equipment earthing – one lot
- Cabling : One Lot
- Structures and Civil Works including
    - Cable trenches, trays, covers , extension and linkage
    - R.C.C Foundation plinths for the above equipment
    - Galvanized Steel structures to match existing formation
    - Making good disturbed areas

One Lot

- Substation Illumination System- One Lot
- Safety Appliances

B. Bamburi 132/33 kV metering at Factory premise

The following works will be undertaken at the customer premise within the factory .a plot with dimensions 33m x 30m will be availed by the customer

To establish a 132kVmetering substation,

The following will be required:

- One (1No.) 132kV circuit breakers- Gang 3- pole
- Two (2No.) 132kV line isolator assembly with an integral earth switch
- One set (3 No.) of 132kV current transformers
- One set (3No.) of 132kV Line surge arrester
- One sets (3No.) 132kV Inductive Voltage Transformer
- Two (2)no lightening masts with security light
- 2nos. 132kv post insulators
- Incoming gantry for new 132kv line
- Bus bar protection with low impedance differential numeric relay
- Line differential protection using OPGW, for the 132kV lines one (1) no.
- Line distance protection relays for the 132kV lines, one (1 no.)
- Line back up protection, over current & earth fault, over voltage 132 kV lines, one (1 no).
- Circuit breaker fail protection
- Line metering cubicle with meters of Cl.0.2 accuracy for the 1 no.132kV lines.
- Substation and equipment earthing – one lot
- Cabling : One Lot
- Structures and Civil Works including
    - Cable trenches, trays, covers , extension and linkage
    - R.C.C Foundation plinths for the above equipment
    - Control building not less than 50sm floor area
    - Switchyard rehabilitation with inert material compaction, polythene sheet laying herbicide treatment and ballasting.
    - Access road in concrete block paving, drainage and chain link and gate.
    - Galvanized Steel structures to support equipment
    - Making good disturbed areas

One Lot

- Substation Illumination System- One Lot
- Safety Appliances

C.132KV Single circuit transmission line 7km

This will involve the Design supply, installation and commissioning of a 132 kv line in 175mm lynx conductor to take off at the gantry at Bamburi 32kv substation to terminate at the gantry at the proposed 132kv metering at the factory premise.
The line will be 7km long with lattice towers with acquisition of way leaves being under kplc scope.

1.1 DETAILED DESCRIPTION

BAMBURI 132/33KV METERING WORKS

a.)Protection and Control

The following equipment shall be provided and installed for the purposes of protection, control and monitoring.

- Line differential protection using OPGW as first main. Each protection relay to match remote relay at both ends
- Distance protection on new line
- Over current relays as backup protection and independent of the distance relays.
- Low impedance bus bar protection covering the 1 new 132kV line bays and the existing 2 no. 132 kV transformer bays, with spare inputs for future additional bays
- Circuit Breaker fail protection for the new Bamburi line circuit breaker, and the two existing transformer bays circuit breaker
- Annunciator relay (with audible alarm) for new bay
- Auto reclose with synch-check for the 132 kV lines. Selection for single pole auto-recloser, delayed auto reclose to be implemented on the panel using a selector switch.

b.) 132kV protection panel

Two 132kV protection panels each shall include but not limited to:

- Line differential protection
- Line distance
- Overcurrent
- Over voltage
- Other accessories to ensure full protection functionality

c.) 132 kV Metering and control equipment panel.

Two 132kV Metering and Control Panels. These shall accommodate the controls for 132kV lines, mimic diagram (with approved colour codes) and shall also incorporate the following but not limited to:

- Line Annunciator relay
- 1 Ammeter per phase
- MW and MVAR Meters
- Tariff Energy meter
- Trip/close control discrepancy switch
- Circuit Breaker ON/OFF indication
- Voltage meter with selector switch.
- Transducer for MW and MVAR to be interfaced with SCADA.
- Other accessories to ensure full functionality

d.) 132 kV Circuit Breaker Panels

Two circuit breaker panels shall include but not limited to:

- Breaker fail protection relay

- Pole discrepancy
- Auto reclose relay
- Sychro check
- Trip circuit supervision (both trip coils)
- Tripping relay with visible flag
- Annunciation relay for breaker functions(gas pressure alarm, block, breaker fail, pole discrepancy, dc supply failure)
- Other accessories to ensure full protection functionality

e.) Busbar differential Protection Panel

- Busbar protection relay

f.)Communications and SCADA

- SCADA data shall be collected and transmitted to the RCC and NCC via IEC 60870-5-104 protocol. The offered solution to operate seamlessly with existing system.

2. GENERAL SPECIFICATIONS

2.1 ELECTRICAL CONTROLS AND AUXILIARIES

(1) 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.

(2) Operation and control.
The operations, control procedures, monitoring and protective devices for the plants are described in Equipment Technical Specifications.
The Contractor shall take all measures and furnish all requirements necessary for effecting the intended method of operation and control.

The functional control shall be possible in a hierarchic structure as follows:

- Supervisory Control from a Supervisory Control and Data Acquisition (SCADA) System. This will be connected to Regional Control Centre (RCCs) in RABAI and NCC in Nairobi. The RCCs are subordinate to the National Control Centre (NCC). 132 kV stations shall also be under direct Supervisory Control from NCC in the way that control of the 132 kV part and the MV transformer breakers shall be from NCC whereas MV line breakers shall be controlled from RCC. Indications shall be available both in NCC and RCC.

- Local Control from the local relay and protection panels or from the instrument sections on MV switchboards.

- Direct Control/Emergency Control from the apparatus itself.

The stations shall function without interruptions even if connection to higher levels fails. A local/remote switch shall be accommodated on each control position blocking remote operation but not indication. The position of this switch shall be indicated in the higher levels of operation.
The control shall include operation of all circuit breakers and motorised disconnectors.

Status indication shall be available in the supervisory system for all HV breakers in the system as well as busbar voltages, line load in MVA, MW and amps. Relay trips and other relevant alarms shall also be transferred.

Direct control of all station switchgear at the respective switchyards/panels shall be possible.

Interlocking devices and automatic change-over systems shall be incorporated in the control circuits in the quantity needed to guarantee non-interruption and correct sequence of operation of the equipment. Protective devices shall be supplied in accordance with the Particular Technical Specifications, and the particular needs of such equipment furnished with the aim of ensuring a safe and reliable operation of the plants in the event of electrical and mechanical disturbances or in case of mal-operation by the plant personnel shall be taken into consideration.

The signals and command to be transmitted are given in Particular Technical Specifications

All equipment, instruments and devices in the substation necessary for supervisory, remote and local control as well as for protection, signaling and indication shall be included in the Bid and hence the Contract, it being understood so that the enumeration found in Scope of Works, in this respect is indicative but not limiting.

Interlocking devices shall be incorporated in the control circuit to ensure proper sequence and correct operation of the equipment (breaker, isolator and earth switch).

2.2. DESIGN DATA FOR LOW VOLTAGE EQUIPMENT

Low voltage installation shall be in accordance with EMC directives. The rating and design criteria for low voltage equipment shall be as follows:

2.2.1 AC system

	Parameter	**Value**
1	Rated voltage between phase	415V 3ph 4wire
2	Rated voltage between phase to earth	240V
3	Grounding system	PME
4	Frequency	50hz
5	Voltage variation	+/-6%
6	Frequency variation	+/-5%
7	Power frequency Test Voltage 1 min	3 KV
8	Thermal rating of conductors	120 % of load
9	Max short-circuit Current	31.5 kA

The three-phase supply shall be used for power circuit and the single-phase supply for lighting, indication, motor controls and similar small power circuits. The single phase supply within cubicles and panels shall be transformed down to 110 Volt AC if necessary.

Unless otherwise specified, the equipment provided under this contract is to be capable of reliable operation at voltages as low as 85% of the rated voltage, and to withstand continuously up to 110% supply voltage above the rated value of 240V or 415V AC**.**

AC LV equipment can, after the Project Manager's approval, be rated for lower short-circuit current if calculation demonstrates that lower values are applicable at the place of installation. DC equipment shall be adapted to the actual values at sites as shown in calculations.

2.2.2. DC system

	Parameter	**Value**
1	Rated voltage between phase	110V DC- 2 wire
2	Voltage variation	+/-6%
3	Thermal rating of conductors	120 % of load
4	Max short-circuit Current	31.5 kA

DC equipment shall be adapted to the actual values at sites as shown in calculations.

The 110V, 2-wire will be used for essential controls, indication, alarm, protection relays, emergency lighting, circuit breaker tripping and closing circuit.

All equipment and apparatus except the electrical protective relays and electronic equipment shall be capable of satisfactory operation at 80% to 125% of the rated supply voltage. The electrical protective relays and electronic equipment shall be capable of satisfactory operation of 85% to 120% of the rated supply voltage. All devices on DC operating circuit for the circuit breakers shall also be capable of satisfactory operation even at 130% of the rated working voltage, considering equalizing charge of storage battery.

DC loads to be supplied from battery and/or battery charger shall be calculated by the contractor and lists of those loads shall be submitted

1.3 DESIGN DATA FOR HIGH VOLTAGE EQUIPMENT

The rating and design criteria for the HV plant and equipment shall be as follows:

Item	Parameters	SYSTEM PARAMETER
		132 kV
1	System description	50 Hz, 3 phase, 3 wire
2	Neutral point earthing	Solid earthed
3	Nominal voltage of networks	132 kV
4	Highest system voltage as defined by IEC-60038***1***	145 kV
5	Short circuit and earth fault current, symmetrical r.m.s value (min breaking current) not less than 1 sec***2***	31.5 kA
6	Thermal short-circuit current, not less than 1 second	31.5 kA
7	Dynamic peak current (min making current) not less than	80 kA
8	Rated current of busbar, if not given in Scope of Works	2, 000 A
9	Minimum rated current of isolating switches and circuit breakers if not given in Scope of Works	1, 250 A
10	Insulation level according IEC 60071: ***3***	
10a	Switching surge withstand voltage	
	Phase-to-earth	N/A
	Longitudinal impulse component of combined test	N/A
10b	Lightning impulse withstand voltage (1.2/50 µs kV_{peak})	650 kV
10c	Test voltage at power frequency 1 min dry and wet. To earth and between phases	275 kV
11	For the design and erection of the conductors in the switchyard the following minimum clearances shall be observed:	
11a	Phase to earth [mm]	1 270
11b	Phase to phase [mm]	1 475
11c	Bus bars phase to phase [mm]	3 000 *1*
11e	Height to live parts above ground[mm]	5 000
11f	Lowest part of insulators above ground [mm]	3 500
12	Maximum temperature rise of conductors above ambient temperature (40 ºC)	40 ºC
13	Maximum wind pressure on conductors and cylindrical objects	430 N/m^2
14	Maximum wind pressure on flat surfaces	820 N/m^2

Item	Parameters	SYSTEM PARAMETER
		132 kV
15	Minimum nominal creepage distance as defined in IEC 60815, Table II	31mm/kV

Note *1)
Ref IEC 60038)

Note *2)
For all current carrying parts the permissible short circuit duration shall be at least 1 second. Indoor equipment shall be arc tested in accordance with IEC 60298 amendments 2. The dynamic or momentary short circuit current on which the equipment design shall be based shall be computed by multiplying the r.m.s value of the symmetrical short circuit current by the factor 1.8 x 2^0.5

Note *3)
Ref IEC 60071)

2.4 CLIMATIC CONDITIONS

Unless otherwise specifically stated in Equipment 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	+35°C	-1°C
Ambient temperature for cables in the ground	+40 °C	-1°C
Relative humidity	90%	65%
Height above sea level	140 m	100M
Cooling water temperature	N/A	N/A
EMC Class (IEC 61000)	Industrial environments	
Seismic coefficient	0.16	
Wind pressure on project area of conductors and cylindrical objects , N/m²	430	383
Maximum wind pressure on steel members on 1.5 times projected area	820 N/m²	
Rainfall conditions		
Average, mm/year	1100-1600	
Maximum, mm in 24 Hrs	160	
Annual mean isokeraunic level	Max 180 days	
Environmental Pollution	Medium to High	
Maximum Wind Velocity	120 km/hr (33.3 m/s)	

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.

2.5SEISMIC COEFFICIENT

The seismic coefficient shall be taken as 0.16

2.6 TROPICALIZATION

In choosing materials finishes, due regard shall be given to the humid tropical conditions under which the plant will 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.

2.7 EARTHING

The earthing grid comprising earthing bus and stub under the outdoor switchgear and the control building shall be installed by the contractor. The depth shall be 600mm.

Wiring for earthing and connections from the equipment, including for all ancillary equipment, control boards, steel structures, etc shall be installed under this contract.
Conductor size used for main earthing network will be 95mm^2 copper. Main equipment shall be connected with 95mm^2 copper wire. Auxiliary equipment shall be connected with at least 35mm^2 copper wire main to main earthing network.

2.8 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.

2.9 WORKING STRESS AND DESIGN

(1) General

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.

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.

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.

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 will not exceed 50kg per square centimetre.

The equipment should be designed to cope with 0.16 G acceleration of seismology on the centres of gravity.

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.

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.

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.

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.

(2) Strength and quality

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

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

2.10 MATERIALS AND WORKMANSHIP

Materials shall be new; the best 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.

Workmanship shall be of the highest class throughout to ensure reliable and vibration-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.

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.

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) 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 Electro technical Commission (IEC) or equivalent national standards. The Contractor shall include a statement of the standards, intended to be used.

(2) 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.

(3) Casting
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.

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 will 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.

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.

(4) Forging

The ingots from which the forgings are made shall be cast in metal moulds. The workmanship shall be first-class in every respect 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.

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.

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.

(5) Welding

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.

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.

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.

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.

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.

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.

(6) Galvanizing

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.

The minimum quantities of zinc coating shall be 350 gram/m^2 for bolts and nuts and 550 gram/m^2 for all other parts except steel wires, unless otherwise specified in the Contract Documents. The uniformity of zinc coating, tested by dipping surface shall not be exposed until the surface has been dipped four times for bolts and nuts, and six times for all parts.

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

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.

(7) Colour Standard

Each item of equipment shall be painted in accordance with the Clause 5.21. The final colour of each item shall be decided by the employer after contract.

(8) Nameplate

To facilitate operation and maintenance it is very important that all equipment, 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 mal-operation in operation or maintenance.

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

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

(9) Cabling and Wiring

The conductor used in substation and switching station shall be continuous between outlets, and no junction shall be made except within outlets or

junction boxes. The conductor shall be drawn through ducts or conduits after they have been cleaned. Oil or grease shall not be used as a lubricant for the drawing operation, but an approved compound may be used for this purpose. Joints in wiring shall be compressed and insulated with PVC tape or approved connectors may be used.

(10) Conduits

Rigid steel conduit shall be galvanized inside and outside, or enameled inside. It shall be of a minimum thickness of 2.3mm and have a minimum inside diameter of 16mm.

(11) Conduits Installation

Conduits shall be concealed within the walls, ceilings and floors where possible. Exposed runs of conduit shall be supported within a space of not more than 150cm. It shall be installed perpendicular to walls, structural members and ceilings.

Only threaded joints shall be used. Conduit, which were crushed or deformed, shall not be used in the works.

Conduit shall be installed in such a manner as to ensure that the inside remains in a dry condition. Conduit shall be securely fastened to all sheet-steel outlets, junction and pull boxes with galvanized locknuts and bushings.

Exposed conduits shall be finished with the same colour paints as the finished colour of the wall or ceiling against which the conduits are placed.

All joints and terminations shall comply with the weather-proof or explosion proof requirements as applicable.

2.11 BASIC REQUIREMENTS FOR ELECTRICAL EQUIPMENT

(1) Corona and radio interference

Switchgear shall electrically be designed to avoid local corona formation and discharge likely to cause radio interference, and shall be designed to mechanically endure short-circuit current without thermal and mechanical failure for one (1) second.

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.

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.

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

(2) Insulators and Fittings

All porcelain insulators and bushings for outdoor equipment shall be brown grazed. The resin insulators for indoor equipment may be of the inherent colour of the resin. All fittings shall be malleable iron hot-dipped galvanized alloy.

All the insulators and bushings shall have impressed thereon, before firing the glaze, the name, initial or trade mark of the manufacturer, the year of manufacture and the mechanical strength.

(3) Enclosure

The enclosures for switchgear, control and relaying equipment shall be dead-front, floor-standing or wall-mounting, rigid welded steel frames, completely enclosed by metal sheets and suitable for indoor or outdoor installation.

The completed sections shall have provisions for lifting and ample strength to withstand all stresses incidental to shipping, installation and operation without distortion or other damage.

The floor-standing type enclosure shall be bolted at the bottom to suitable steel channel and shall be of vermin-proof construction.

Suitable terminal blocks shall be provided for all outgoing power and control cables. All cable terminals shall generally be located for bottom entry and connections.

The enclosure shall be painted in conformity with the requirements specified in Clause 1.13.

The degree of protection of the enclosures shall be IP 41 for indoor switchgear, IP 54 for outdoor switchgear and IP 51 for indoor control and relaying equipment conforming to IEC 529 and IEC 144.

Interior illumination lamps operated by door switches shall be provided for each enclosure as much as applicable. At least one 240V convenience outlet of Kenya use shall be provided for each enclosure at convenient location.

Space heaters for 240-volt A.C. shall be provided inside the enclosures to prevent moisture condensation. A manual switch to control the heaters shall be provided in the enclosures.

(4) Measuring Instruments

All measuring instruments shall be of flush-mounted, back-connected, dust-proof and heavy-duty switchboard type. Each measuring instrument shall have a removable cover, either transparent or with a transparent window. Each instrument shall be suitable for operation with the instrument transformers shown on the drawing under both normal and short-circuit conditions.

For analog type instruments, scale plates shall be of a permanent white circular or rectangular finish with black pointer and markings. The scale range shall be determined from the current transformer and voltage transformer ratios.

All measuring instruments of analog type shall be approximately 110mm^2 enclosures and shall be provided with clearly readable long scale, approximately 240 degrees. The maximum error shall be not more than one and a half (1.5) percent of full-scale range.

(5) Indicating Lamp Assemblies

Indicating lamp assemblies for the enclosures shall be of the switchboard type, insulated for 110-volt D.C. service, with appropriately coloured lens and integrally mounted resistors for 110-volt service. The lens shall be made of a material, which will not be softened by the heat from the lamps.

Red indicating lamps shall be used for "ON" position and green lamps for "OFF" position.

(6) Nameplates and Escutcheon Plates

Each cubicle, panel, meter, switch and device shall be provided with a nameplate or escutcheon plate for identification. Each equipment shall be provided with a rating plate containing the necessary information specified in the relevant IEC standards.

The plates shall be made of weather-proof and corrosion-proof materials and shall not be deformed under the service conditions at the site. The entries on the plates shall be indelibly marked by engraving to black letter on a white background. The language of all plates shall be English.

(7) Wiring

(a) General

All wiring inside the switchboards shall be done with PVC insulated wire, not less than 2.5mm^2 except for electronics devices. A suitable wiring duct system shall be installed for all inter-panel and front-to-rear panel wiring which will provide easy access for inspection and replacement. As far as possible all wiring shall be installed in wiring ducts.

All wiring from hinged door panels to the fixed panels shall be done with flexible conductor of equivalent size.

All multicore cables shall be steel armoured.

Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable. **Wire runs shall be neatly trucked or clamped.**

Exposed wiring shall be kept to a minimum, but where used shall be formed into compact groups suitably bound together and properly supported.

Instrument transformer secondary circuits shall be grounded only at the first panel entered, and shall not be grounded at any point or outside of the enclosures.

Cable supports and clamp type terminal lugs shall be provided for all incoming and outgoing power wiring terminated at each panel. All wire shall be marked near each terminal end with circuit or wire designation. These markers shall be of an approved type and permanently attached to the conductor insulation.

(b) Phase arrangement

The standard phase arrangement when facing the front of the panel shall be R-S-T-N, and R-N-S from the left to right, from top to bottom, and front to back for A.C three-phase and single-phase circuits and N-P from left to right, P-N from top to bottom and front to back for D.C polarity. All relays, instruments, other devices, buses and equipment involving three-phase circuit shall be arranged and connected in accordance with the standard phase arrangement where possible.

(c) Wiring colour code

All wires shall have ferrules at all terminations to distinguish each terminal.

(d) Phase and polarity colour code

Following coloured ferrules shall be provided on each wire in order to identify phase and polarity.

Phase and Polarity		**Colour**
A.C., three-phase,	First phase	Red
	Second phase	Yellow
	Third phase	Blue
A.C., single-phase,	First line	Red
	Second line	Yellow
	Neutral	Black
	Grounded	Green with yellow stripe
Auxiliary Supply	Positive	Red
	Negative	Black

Ferruling system must be submitted to the Employer for approval before commencing the works.

(8) Terminal blocks

Terminal blocks for control wiring shall be rated not less than 600-volt with cover and be of the moulded type with barriers.

White or other light-coloured marking strips, fastened by screws to the moulded sections at each block, shall be provided for circuit designation.

Each connected terminal of each block shall have the circuit designation placed on the marking strip with permanent marking fluid. Terminal blocks for current and voltage transformers shall be separated and specially marked. They shall be equipped with a sliding splice for separation and “banana” sockets on both sides for testing. The splices shall be so arranger that they fall into closed position when loose. Where appropriate, other terminal blocks shall be equipped with facilities for testing, such as short-circuiting, separating splices, plugs, etc. All such device shall be accessible even when paralleling strips are used.

Terminal blocks shall be located at least 300mm from the bottom of the panel and shall be easily accessible. Terminal blocks for different voltages shall not be mixed between one another. All conductors in a multi-core cable shall be terminated on the same terminal block. The blocks shall be grouped for each voltage and they shall be clearly marked for easy identification of the system voltage. There shall be at least 20 % spare terminals on each block.

(9) Cable Laying and Routing

The final routing of HV and LV cables in indoor and outdoor installations shall be determined by the Contractor from the directives given in Particular Specifications, and the principles shown in the layouts on the drawings. All cable routing and arrangement shall be subject to the Project Manager's approval and must adapt to obstacles as tubes and ventilation channels. All penetrations of fire zone separations shall have the same fire classification as the separation itself.

Cables shall be laid on corrosion resistant (aluminium or hot dipped galvanised) cable trays and racks and by raising cables fixed to cable ladders. The trays shall be dimensioned and fixed so that it allows one man to climb on it in addition to the cable load. Each tray shall have at least 15 % spare capacity. The distance between each tray shall at least be 300 mm. For exposed outdoor installations cables shall be laid in covered cable trenches, plastic or steel ducts, depending on the available space.

Branch offs to individual equipment shall be fixed and supported all the way to the connection box. Cables and cable supports shall be properly fixed and secured against movement under short-circuit and strain caused by erection work. Particular attention shall be given to termination in confined areas where personnel may climb under erection and maintenance. Flexible tubes of “spiral type” shall not be used whereas tubes of “plica” type can.

Low power cables, i.e. cables for control, metering, etc. shall not be run in close parallel to high power cables or earth wires, but shall be run at the greatest possible separating distance. The minimum distances are:

- High and medium voltage versus control and measuring cables 800 mm
- Low voltage power cables versus control and measuring cables 400 mm

Necessary EMC consideration shall be taken in accordance with EMC standards.

Additionally, cables for extra low power, i.e. mA and mV circuits and cables connected to low power solid state electronic circuits, shall be laid in separate sheet steel trays with covers. The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection to the greatest extent possible.

Single-phase power cables shall be run in trefoil configuration, single-phase DC power cables shall be run in parallel. Special care shall be taken so that closed magnetic circuits do not form around single phase cables.

Cables below 25 mm^2 cross section shall be copper. Larger cross sections may be aluminium. Minimum cross sections shall be as follows:

- Measuring cables for current 4.0 mm^2
- Control and other measuring cables 2.5 mm^2
- Power cables according 120 % max load current

All cross section must be checked against max load current, allowable burden on measuring transformers, short circuit values, voltage drop, protection requirements and selectivity.

The cables shall be marked with item designation in both ends as well as by entrances in enclosures. The cable marking shall be fire proof.

Cables shall be laid in full runs and not spliced unless approved by Project Manager. Termination of multi-stranded conductor ends shall be with a suitable crimped thimble as specified above. All other cable lugs or similar shall be of crimped type adapted to the cable type and cross-section used. The tools used should be special approved for the lugs and cable type used.

The cable supplier's instructions regarding handling and bending radius shall be followed.

Fibre optic cables shall not contain metallic material and be so laid that they have proper mechanical protection, i.e. cables not constructed for embedding shall be laid in protective tubes.

2.12 SAFETY PRECAUTIONS

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.
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.

The Contractor shall demonstrate that he has facilities 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 supervisory employee to carry out his safety programme.

2.13 PROTECTION, CLEANING AND PAINTING

(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.

(2) Steel exposed to atmosphere

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.

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, except such apparatus as panels and instruments which shall be finished painted under approved procedures.

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 installations shall be gloss paint and for the indoor installations shall be a semi-gloss paint.

The inside surface of the enclosures shall have two prime coats and one finishing coat of light cream colour.

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.

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.

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

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

The final colour of all equipment, frames for meters and relays, and switch handle shall be approved by the Employer but the Contractor shall propose a colour scheme for the equipment and devices and shall submit colour chips or paint samples. A

colour chip shall be included with the approved colour schedule for each type of finish to be applied at the site.

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

2.14 EMBEDDED METAL WORK, OPENING, ETC

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.

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.

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.

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

2.15 SPARE PARTS

The Contractor shall furnish spare parts as listed in the Price Schedule.

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.

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 reprotected 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.

2.16 PACKING

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

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.

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.

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.

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.

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

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.

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

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

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

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

The following information must be clearly stencilled or printed on each packing case, crate, cask, drum, bundle or loose piece, care being taken that the number and other particulars on each package agree with those entered in the packing list accompanying the Invoice:

- Employer's Identity
- Supplier's Identity
- Destination
- Contract No.
- Package No.
- Item Code
- Weight, dimensions
- Sub-Project (Plant Identity).

The marking shall be durable. The marking shall be upon the body of the package. Marking upon a batten fastened on the case, etc. shall not be used.

2.17 DELIVERY

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.

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.

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

2.18 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 condition. 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.

2.19 PROGRAMME AND PROGRESS

Within one month after the Date of Commencement, the Contractor shall prepare his construction programme in a software form covering the design, 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 hard copy shall be submitted to the Employer for approval.

Upon approval of the programme by the Employer, it should thereafter be referred to as the approved Construction Programme and shall become a part of the Contract.

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.

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

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. If required by the Employer, responsible representatives of the Contractor shall attend such meetings at his own expense.

In executing the Approved Construction Programme 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.

The Progress Plans shall at least contain the following milestones:

- Essential information delivered from Employer
- Documentation for approval from Contractor to Employer
- Release of factory documentation
- Factory Tests
- Shipment
- Site ready for erection
- Start erection
- Ready for pre-commissioning
- Ready for commissioning
- Test run
- Taking over
- Submittal of final documentation

2.20 DRAWINGS AND DATA TO BE SUPPLIED BY THE CONTRACTOR

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 2 weeks before the commencement of the manufacturing process.

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.

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 six weeks should 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.

After approval of drawings by the Employer, the Contractor shall supply the approved drawings to the Employer according to the table given below.

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

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

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

The following number of drawings to be submitted to the Employer shall be as follows:
To the Employer, during the work

Drawing for approval	5 copies
Approved drawings	3 copies

After completion of the work (final drawings)

AutoCAD (latest version)	2 Cds
Complete set of bound prints (as built)	6 sets

All Protection and Control drawings shall be done on A4 paper. The function of each drawing shall be clearly indicated. Related drawings shall be arranged sequentially, have the same drawing number but different sheet numbers. The drawings shall include the following;

-AC Schematics
-DC Schematics
-Functional Drawings
-Layout Drawings
-Panel equipment wiring and cable terminations and schedules.
-Relays and accessories list.

Protection and Control Software drawings shall be done in the latest AutoCAD release edition.

Additional copies of particular drawings are to be provided if required, at the Contractor's expense.

2.21 OPERATING AND MAINTENANCE INSTRUCTIONS

The Contractor shall submit to the Employer for approval, general instructions concerning the correct manner of assembling, operating and maintaining the work. This instruction manual shall be submitted immediately following final approval of the drawings.

When finally approved, six (6) copies of the instruction manual shall be furnished to the Employer. The contractor shall ensure that his erection supervisor has a copy in his office at the Site.

The instruction manual shall describe in detail the erection procedure and use of all erection equipment and measurement devices. The method for assembling, adjusting, operating and dismantling of each device, system and machine shall be described and illustrated. The maintenance details of each component shall also be described, including the frequency of inspections and lubrication.

The instruction manual shall include a separate and complete section describing the normal and emergency operating procedures for the control of the switching equipment, and shall include explanatory diagrammatic drawings of equipment to facilities understanding the description.

The Contractor shall, in preparing the instruction manual, take into account the lack of experience and familiarity of the operators with this type of equipment.

The manual shall give specific information as to oil, grease, or any other materials needed for maintenance operations. This information shall include brand names and manufacturer's numbers or designations, for at least two brands available in Kenya, preferably manufactured in Kenya.

The manual shall include a complete list of all drawings prepared for the Contract, spare parts list, and a parts list for each component of the equipment. The parts list shall apply only to the equipment supplied and shall not include general reference or description of similar equipment which is of the same model but different only in detail. The manual shall be prepared on the English language.

2.22 TEST PROCEDURE INSTRUCTIONS

2.22.1 Electrical equipment:

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

2. 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. Tenderers should note that this requirement is mandatory.

3. Upon completion of the manufacturing process, routine tests shall be carried out as per the specified standard for each equipment. In addition to these tests, Impulse, temperature rise and short-circuit tests (where applicable) shall be

carried out and the results endorsed by the NSTA of the country of manufacture.

4. Routine test reports shall be completed for equipment and made available before the inspection by KPLC representatives.

5. A detailed list & contact addresses of previous customers shall be submitted with the tender. The manufacturer shall indicate the monthly & annual production capacity and experience in the production of the type and size of equipment he is offering. List of workshop tools and equipment shall also be appended.

6. 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.

7. The Contractor shall submit to the Employer for approval, during or immediately following the submission of drawings, testing programmes describing each test to be performed during commissioning and performance tests. The programme 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 programme shall also contain performance guarantees, design values, technical particulars, or other criteria and distributed in the same manner as the drawings.

8. A file containing a list of all the Commissioning Tests carried out and the results obtained for all the 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 by the Employer's representative.

9. Three copies of the Commissioning Report shall be submitted to the Employer.

2.22.2 ATTENDANCE OF EMPLOYER'S REPRESENTATIVE AT FACTORY TEST AND TRAINING

The Contractor shall arrange for three Employer's staff members to witness tests of major items of equipment listed below in the manufacturer's plant. All routine tests shall be carried out in the presence of the Employer's representatives. The representatives shall approve shipment of the equipment if they are satisfied that the requirements of the specification are fully met.

The Engineers shall witness the tests on each of the equipment's below for duration of at least 5 days (excluding the days of arrival and departure).

(1) 132 kV circuit breakers
(2) 132 kV outdoor isolators and earth switches
(3) Control and Protection panels

(4) 132 kV Current transformers
(5) 132 kV Capacitive Voltage Transformers
(6) 132Kv tower tests-destructive –for 2 types VH and suspension
(7) Communication terminal equipment.

During the attendance, the Contractor shall give the Employer's persons a brief explanation on design, manufacture, operation and maintenance of the materials and equipment. Protection Schemes philosophy and settings shall be explained.

2.22.3 TRAINING

(1) High voltage switchgear equipment
(2) Control and protection equipment
(3) Telecommunication Equipment

The training on the operation of the high voltage switchgear equipment, control, protection and communication equipment shall be conducted for three Employer's staff for duration of not less than 5 days.

2.23PHOTOGRAPHS

The Contractor shall keep photographic records of the progress of each phase of the work. Upon completion of the work, the Contractor shall submit three sets of colour photographs with explanatory description adequately edited in book form to the Employer's satisfaction.

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.

3. TECHNICAL SPECIFICATIONS FOR SUBSTATIONS

3.1 SWITCHGEAR AND CONTROL EQUIPMENT

SCOPE

This subsection covers the design, manufacture, testing before shipment, delivery to site, erection and testing at the site of the following:

3.2 132kV CIRCUIT BREAKERS:

3.2.1 SCOPE

This specification is for single pole operated outdoor 132kV circuit breaker together with controls and ancillary equipment.

3.2.2 REFERENCES

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

IEC 56: High – Voltage alternating current circuit breakers.

IEC 144: Degree of protection of enclosures for low – voltage switchgear and control gear.

BS 5311: Specification for A.C circuit breakers of rated voltage above 1 kV.

3.2.3 CONSTRUCTION

3.2.3.1 The circuit breakers shall be single pole operated, out-door type, SF_6 gas insulated and shall comply with the requirements of IEC 56 and/or BS 5311.

3.2.3.2 The circuit breaker shall be live tank type.

3.2.3.3 All the three poles of circuit breakers shall be operated by local electrical and Remote/electrical from the mechanism in the housing.

3.2.3.4 The circuit breaker shall have SF_6 gas for electrical interrupting medium.

3.2.3.5 The SF_6 gas shall comply with the requirement of IEC 376 and be suitable for use in the circuit breaker when it is operated under the service and system conditions.

3.2.3.6 Sufficient gas shall be provided for filling the circuit breaker at installation with additional 20% for any losses.

3.2.3.7 When the circuit breaker is in closed position a rapid fall in the SF_6 gas pressure, to a Level below that at which safe operation is possible shall not result in tripping the circuit breaker. A remote alarm indication to signal this condition shall be provided. A second stage drop in gas shall block closing and tripping of the circuit breaker.

3.2.3.8 Insulation creep age distance shall not be less than 25mm per kV of highest rated Voltage between phases.

3.2.4 OPERATING MECHANISM

The operating mechanism shall be suitable for mounting at the circuit breaker supporting structure, and below the circuit breaker in a weather-proof, dust-proof, vermin-proof and well ventilated housing.

The degree of protection shall be class IP 54 as per the requirement of IEC 144.

Operating duty shall be standard and operating mechanism shall be trip free during the entire closing sequence.

Operating mechanism shall be provided with either motor wound spring or pressure actuated mechanism with provision for hand charge.

Motor operating voltage shall be 110 Volts D.C.

A set of at least ten normally closed and ten normally open spare potential free contacts shall be provided for remote electrical indication as well as electrical interlocking and shall be wired to a terminal block in the housing.

Potential free contacts shall be provided for alarming spring charge failure.
Potential free contacts shall be provided for alarms for SF_6 gas low and SF_6 trip block.

A minimum of twenty (20) spare terminals blocks shall be provided for connection to the current and voltage transformers.

The circuit breaker shall be provided with local/remote selector switch. The selection of local operation shall inhibit the operation of the circuit breaker from any remote source and selection of remote inhibits operation from local operation.

The circuit breaker shall be provided with a local switch for Open/Neutral/Close Operation.

Mechanically operated indication to show the status of the circuit breaker operations (open/close and springs charged/discharged) shall be provided.

The circuit breaker shall be provided with suitable terminals for connecting clamps for up to 3” outside diameter copper tubes.

The circuit breaker shall be provided with means to prevent contact pumping while the closing circuit remains energized, should be circuit breaker either fail to latch or be tripped during closing due to operation of the protective relays.

Mechanical interlock key arrangement shall be provided on the mechanism such that it will not be possible to withdraw the interlock key with circuit breaker in closed position.

For the two 132 kV line circuit breakers, the mechanical interlock keys from each pole shall be such that they will be closed in a block of 4 keys so that the 4th key only come out when the other three are on in the block . That 4th key will be used to inter lock the 2 separately.

Circuit breaker shall be provided with duplicate trip coils in order to facilitate duplication of protection tripping.

The circuit breaker shall have separate operating mechanism for each pole.

From local position (only on middle phase) the operation of all the 3 poles should be possible with CLOSE/NEUTRAL/TRIP Switch.

3.2.5 RATINGS

	Parameter	**Value**
1	Nominal Voltage	132 kV
2	Highest Voltage	145 kV
3	Frequency	50 Hz
4	Normal current	2000 Amps
5	Rated short circuit current	31.5 kA
6	Duration of short circuit	1 Sec.
7	Rated short circuit making current	80 kA
8	First pole to clear factor	1.5
9	Operating sequence	0-0.3 sec – CO – 3 min – CO
10	Auxiliary D.C Voltage for closing & tripping coils	110 V d.c.
11	Auxiliary A.C Voltage	415/240 V, 50 Hz
12	Impulse withstand voltage	685kV peak
13	One minute power frequency withstand voltage	290kV r.m.s.
14	Minimum creepage distance of insulator	3988 mm
15	Minimum clearance between phases	1475 mm
16	Minimum clearance to earth	1270 mm

3.2.6 TESTS

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

Type and routine tests shall be carried out as per the requirement of IEC 56.

Test certificates issued by a recognized short-circuit testing station, certifying the operation of the circuit breaker at duties corresponding to the rated breaking capacities of the circuit breaker shall be submitted.

Tender documents shall be accompanied by copies of Type test and Routine test certificates for similar rated equipment. These certificates shall be certified by the National Testing or the National Standards Institute of the country of origin.

A detailed list & contact addresses of previous customers shall be submitted with the tender. The manufacturer shall indicate the monthly & annual production capacity and experience in the production of the equipment he is offering.

3.2.7 DRAWING AND MANUALS

Two sets of operational manuals and drawing detailing dimensions, panel layout, wiring and schematic shall be provided.

3.2.8 PACKING AND INFORMATION

The circuit breaker and associated components shall be packed in a manner as to protect it from any damage in transportation and repeated handling.

Each assembly and package of items associated with the circuit breaker shall be suitably marked.

Where an item includes a number of components to form a complete assembly, all component parts shall be included in one composite package which shall be firmly strapped and bound together.

Draft design and construction drawings shall be submitted to KPLC before the manufacturing of circuit breakers commence. KPLC undertake to submit their comments or approval for the drawings within three weeks of receiving the draft copies.

Sufficient relevant technical details and drawings shall be submitted for the purpose of Tender Evaluation. Tenders which do not meet this requirement will be considered non-responsive.

To facilitate comprehensive technical evaluation of the tenders, a clause by clause statement of compliance with the specification shall be submitted with relevant manufacturer's specification sheets, catalogues and brochure.

3.2.9 TECHNICAL SCHEDULES

The appropriate Technical guarantees in appropriate Volume II Technical schedule section shall be completely filled

3.3 132 KV THREE POLE DISCONNECTORS:

3.3.1 SCOPE

This specification is for 132kV, 1600 Amps Isolator for use on line disconnection, isolation of substation apparatus.

This specification covers both the 132 kV isolators with and without earth switch.

3.3.2 REFERENCES

The following documents were referred to during the preparation of this specification, and may be referred to in case of conflict; the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

IEC 129: Alternating current disconnections (isolators) and earthing switches.

IEC 144: Degree of protection of enclosures for low - voltage switchgear and control gear

IEC 60273: Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V

BS 729: Hot dip galvanized coating on iron and steel articles.

3.3.3 CONSTRUCTION

3.3.3.1 The isolator shall be horizontal side opening, double side break rotating post type for use on a 132kV, 50 Hz, 3 - phase system.

3.3.3.2 The isolator shall be complete with supporting base, phase coupling details, operating rod, unions and guides.

3.3.3.3 The operating mechanism shall be provided with a universal joint to allow for a reasonable degree of out-of alignment of the operating rod.

3.3.3.4 The isolator shall be motorised and also fitted with manual operation facility. There should be a remote selection to allow for operation of the isolator from the control room. The remote selection should block any local electrical or manual operation.

3.3.3.5 The supporting under-base shall be hot dip galvanized steel as per the requirement of BS 729. The under-base shall be suitable for mounting on a steel structure.

3.3.3.6 All the three switches shall be arranged so that the phase units are mounted independently and then finally interconnected with coupling tubes so as to ensure simultaneous operation of all switches by drive rods and operating handle for both manual and motor operation.

3.3.3.7 The operating mechanism shall be fixed at the base frame, in a weather proof, vermin proof and dust proof housing. The degree of protection shall be class IP 54 as per IEC 144.

3.3.3.8 Auxiliary dry contacts, five normally open and five normally closed shall be provided for electrical interlocks such that the isolator and associated 132 kV circuit breaker can be interlocked with each other. The contacts shall be rated to continuously carry at least 10Amps at voltages up to 500V dc/ac

3.3.3.9 Each phase shall be mounted on a spiral type solid core post insulator conforming to IEC 60273, and shall be fitted with clamp connector for the suitable conductor/connector.

3.3.3.10 The isolator shall be designed such that in fully open position, it shall provide adequate electrical isolation between the contacts on all the three switches.

3.3.3.11 All current carrying parts shall be made of electrolytic hard drawn copper with switch contacts silver plated.

3.3.3.12 The earth switch shall consist of a hinged type earthing switch fixed at the base frame. The earth switch shall have the same rating as the isolator.

3.3.3.13 The isolator shall be provided with both mechanical and electrical interlocking devices between the isolator and earth switch so that during operations, it is only possible to operate the earth switch with the isolator in the open position and the isolator with the earth switches in the open position.

3.3.3.14 Ten normally open and ten normally closed auxiliary contacts shall be provided on the switch for future use.

3.3.3.15 Five normally open and five normally closed auxiliary contacts shall be provided on the earth switch for future use.

3.3.3.16 The isolator and earth switch shall be provided with a padlocking facility such that the mechanism can be locked in OPEN or CLOSED position.

3.3.4 RATING

The ratings of the isolator, including its operating devices and auxiliary equipments shall be as indicated below.

	Parameter	**Value**
1	Highest system voltage	145 kV
2	Nominal voltage	132 kV
3	Rated lightening impulse withstand voltage	685 kV
4	Rated Power frequency withstand voltage	290kV
5	Rated frequency	50 Hz
6	Rated normal current	1600 Amps

	Parameter	Value
7	Rated short time withstand current for 1 seconds	31.5 kA
8	Minimum creepage distance of Insulators	3988mm
9	Motor operating voltage	110Vdc

3.3.5 TESTS

3.3.5.1 The isolator shall be inspected and routine tested in accordance with the requirement of IEC 129.

3.3.5.2 Certified type test certificates issued by the relevant National Testing Authority confirming compliance of the isolators on offer with the specifications shall be submitted.

3.3.6 TECHNICAL SCHEDULES

The appropriate Technical guarantees in appropriate Volume II Technical schedule section shall be completely filled

3.4 132kV CAPACITOR VOLTAGE TRANSFORMERS (CVTs):

3.4.1 SCOPE

3.4.1.1 This specification is for voltage transformers for use with electrical instruments and electrical protective devices on system with maximum operating voltage up to 145kV.

3.4.2 SYSTEM CHARACTERISTICS

3.4.2.1 The voltage transformers will be connected to overhead system operating at a nominal voltage of 132kV and a maximum voltage of 145kV which are generally of earthed construction.

3.4.2.2 The voltage transformer will be connected between line and earth of a 3-phase 3-wire system with the neutral point solidly earthed.

3.4.3 CONSTRUCTION

3.4.3.1 The voltage transformer shall be out-door oil-immersed capacitor type and shall comply with the requirement of IEC 186.

3.4.3.2 The voltage transformer shall be suitable for installation on steel structure. The voltage transformer shall be fitted with lugs.

3.4.3.3 The porcelain portion of the voltage transformer shall be made of high-grade brown glazed porcelain. All other external parts shall be either inherently resistant to atmospheric corrosion or hot-dip galvanised.

3.4.3.4 The voltage transformer shall have primary, secondary and earth terminals.

3.4.3.5 The primary terminal shall be tin-plated, suitable for both copper and aluminium connectors. The secondary terminal shall be brought out to a separate terminal box, complete with protection mcb. The mcb should have auxiliary contacts for indication, alarm and distance relay input.

3.4.4 RATINGS

The voltage transformer shall be capable of continuously carrying 50% burden above the rated capacity without damage.

The rating of the voltage transformer shall be as indicated herein:-

	Parameter	**Values**
1	Rated primary voltage	132000/√3 volts
2	Rated secondary voltage	110/√3 volts
3	Rated frequency	50 Hz
4	Minimum creepage distance of insulator	3988 mm
5	Lightning impulse withstand voltage	685kV at 1500m above sea level
6	Power frequency withstand voltage	290kV
7	Rated burden	100 VA
a	Rated voltage factor	1.5 for 30 seconds (1.2 continuous)
b	Accuracy class	1.0
c	No. of secondary out put	2 (metering, protection)

3.4.5 MARKING

The voltage transformer shall be fitted with a rating plate indicating the following:-

- The manufacturer's name or identification mark.
- The voltage transformer serial number or designation.
- The rated primary and secondary voltage.
- The rated frequency.
- The burden and accuracy class of each secondary output.
- The highest system voltage (e.g. 145kV).
- The insulation level.
- The rated voltage factor and corresponding rated time.

The terminals shall be marked clearly and indelibly.

The marking shall be in accordance with IEC 186.

3.4.6 TEST

Type and routine tests shall be carried out as per the requirement of IEC 186.

3.4.7 REFERENCES

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

IEC 186:	Voltage transformers.
BS 3941:	Specification for voltage transformers.

3.4.8 TECHNICAL GUARANTEES

The appropriate Technical guarantees in appropriate Volume II Technical schedule section shall be completely filled

3.5132 KV CURRENT TRANSFORMERS:

3.5.1 SCOPE

This specification is for current transformers for use with electrical instruments and electrical protective devices on systems with maximum operating voltage of 145kV.

3.5.2 SYSTEM CHARACTERISTICS

The current transformer will be connected to overhead system operating at a nominal voltage of 132 kV and maximum voltage of 145kV (with aerial earth wire) construction.

3.5.3 CONSTRUCTION

The current transformer shall be outdoor, oil-filled, hermetically sealed and shall comply with the requirement of IEC 185.The current transformer shall be suitable for vertical installation on steel structure.

3.5.3.1 The porcelain portion of the current transformer shall be made of high-grade brown-glazed porcelain. All external ferrous portions shall be hot-dip galvanized.

3.5.3.2 The current transformer shall have primary, secondary and earth terminals.

The primary terminal shall be tin-plated, suitable for both copper and aluminium connectors.

The secondary terminal shall be covered with removable plate. The terminal box shall be capable of accommodating up to 12 secondary terminals suitable for conductor of up to 4.0mm^2.

3.5.3.3 The current transformer shall have four cores. The protection cores shall be suitable for conventional over current requirements and for true transformation of the fully asymmetrical fault currents.

Measuring cores shall have high accuracy (low loss) and low saturation levels.

3.5.4 RATINGS

The short circuit rating of the current transformers shall be 31.5kA.

The current transformers shall be capable of passing rated primary current without damage with the secondary open circuited.

The rating of the current transformers shall be as indicated herein:-

	Parameter	**Values**
1	Rated primary current (Amps)	600/400/200
2	Rated secondary current	1 AMP
3	Rated frequency	50Hz
4	Minimum Creepage distance of insulator	3988 mm
5	Lightning impulse withstand voltage	685kV
6	Power frequency withstand voltage	290kV
7	Rated burden and accuracy class	
	Core No. 1	20VA, 5P20
	Core No. 2	20VA, 0.2
	Core No. 3	20VA, 5P20
	Core No. 4	20VA, 5P20

The knee point voltage shall not be less than 250 volts at 8mA.

3.5.5 MARKING

The current transformers shall be fitted with a rating plate indicating the following:-

- The manufacturer's name or identification mark.
- The current transformer serial number or designation.
- The primary and secondary currents.

- The insulation level.
- The highest system voltage (e.g. 145kV).
- The output and accuracy class of the cores.
- The rated frequency.

The terminals shall be marked clearly and indelibly.

The marking shall consist of letters followed by numbers.

The letters shall be in block capitals.

3.5.6 TESTS

Type and routine tests shall be carried out as per the requirement of IEC 185.

3.5.7 REFERENCES

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

IEC 185:	Current Transformers.
BS 3938:	Specification for current transformers.

3.5.8 TECHNICAL GUARANTEES

The appropriate Technical guarantees in appropriate Volume II Technical schedule section shall be completely filled

3.6 132 KV SURGE ARRESTERS:

3.6.1 SCOPE

This specification is for 132kV metal-oxide type surge arresters without spark gaps for a.c. system.

3.6.2 CONSTRUCTION

3.6.2.1 The surge arrester shall be metal-oxide type without spark gaps and constructed as per the requirement of IEC 99-4.

3.6.2.2.The metal-oxide used shall be of quality to ensure thermal stability under service duty of the surge arrester.

3.6.2.3 The completed surge arrester shall be housed in a silicone rubber. The silicone rubber insulator shall be dimensioned to provide a leak free interface with the end caps. The housing shall withstand the lighting impulse voltage of the arrester.

3.6.2.4 The surge arrester shall be sealed (end caps) with a controlled permanent seal to ensure no moisture absorption or deterioration of the metal-oxide element for the surge arrester.

3.6.2.5 The surge arrester shall be supplied with fixing accessories and fitted with pad type clamp connectors suitable for both copper and aluminium tubes of up to 76.2mm diameter.

The steel plates or straps shall be galvanized as per the requirement of BS 729.

The mounting brackets shall be suitable for both horizontal and vertical mounting on a steel channel.

3.6.3 RATING

The rating of the surge arrester shall be as indicated herein:-

	Parameter	**Rating**
1	Rated Voltage…….	108 kV
2	Nominal discharge current……..	10 kA
3	Long duration discharge class…….	3
4	Creepage distance of insulator……	3630 mm
5	Continuous operating voltage…….	84 kV
6	Rated frequency……..	50 Hz

3.6.4 MARKING

The surge arrester shall be fitted with a rating plate indicating the following:-

- The manufacturer’s name or identification mark.
- The surge arrester serial number or designation.
- The nominal discharge current.
- The insulation level.
- The continuous operating voltage
- The rated voltage
- The rated frequency.

3.6.5 TESTS

Type, routine and acceptance tests shall be carried out as per the requirement of IEC 99-4.

3.6.6 REFERENCES

The following documents were referred to during the preparation of this specification. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

IEC 99:	Surge Arrester. Part 4: Metal-oxide surge arresters without gaps for a.c. systems.
IEEE Std.:	C62.22 – 1991 IEEE Guide for application of metal-oxide surge arresters for alternating – current systems.

3.7 CONTROL, MEASURING AND PROTECTIVE RELAYING EQUIPMENT

3.7.1 SCOPE

This subsection covers the design, detailing, manufacture testing before shipments, packing, transport to site, erection and tests at the site of the following equipment:

Set of Protective relays, controls and accessories for 132kV switchgear

3.7.2 Requirements for Design

The equipment for the control system shall be highly reliable, durable and suitable for continuous operation.

The equipment shall be designed to be fail – safe for the possible failure of any major circuit during the operation and shall provide a safe guard against possible surges, fail – safe against disrupted surges and against disrupted signals due to outside interference that would normally be associated with the cable communication lines and any other provisions necessary for the efficient operation of the equipment.

All instrument scales, coils, relay contacts and other features shall be suitable for the apparatus controlled or the purpose intended.

The control and relay panels provided under this subsection shall be located in the control rooms of the substation.

It shall be the contractor’s responsibility to properly design the electrical control, protective relaying, alarm and indication schemes related to all equipment to beprovided under this contract and to co-ordinate with the existing control and relaying system.

The Contractor shall prepare arrangement and detailed drawings, equipment lists and wiring diagrams based on the requirements for meters, relays, control switches, indicating lamps and other devices including those to be supplied under other subsections.

3.7.3 Protection and Alarm

General
Protection against electrical faults and abnormal conditions on 132kV switchgear shall be conducted by the protective relays and switches.

3.8 ELECTRICAL PROTECTIVE RELAYS AND PANELS

3.8.1 General

The electrical Measuring protective relays for the 132 kV line shall be of Numeric Design type suitable for operation with the current transformer secondary of 1A and the voltage transformer secondary of 110V, as shown on the single line diagrams.

Auxiliary relays of Static or electromechanical design is acceptable.

The protective relays and their auxiliary relays shall operate successfully for any value of the DC supply voltage between 85% and 120% of the rated voltage of 110V without exceeding the temperature rise limits for the operating coils.
The protective relays and necessary auxiliaries shall be housed in the metal – enclosed cubicle.

Each protective relay shall be of the flush mounted, back connected, dustproof switch board type with rectangular case. Each relay shall have a removable transparent cover or cover with a transparent window, with provision for sealing. It is preferred that each measuring relay shall be of a withdrawable type from the front of the panel with sliding contacts, without opening the current transformer secondary circuits, disturbing external circuits or requiring disconnection of leads on the rear of the panels. Each protective relay shall be equipped with a red operation indicator and contacts for operation on 110volt DC for each phase, and external, front operated, manual-resetting device.

Each protective relay shall be equipped with adequate electrically independent contacts of adequate rating for trip and alarm functions. Test facilities shall be provided as an integral part of each protective Switchgear relay panel for testing of current and voltage transformer secondary circuits and trip circuit using secondary injection test equipment.

3.9 DETAILED SPECIFICATIONS FOR RELAYS, ENERGY METER, TRIP BATTERY & CHARGER.

These specifications indicate the required performance characteristics.

3.9.1 PROTECTION RELAYS.

These must satisfy the requirements for distance, Three Phase Overcurrent and Earth Fault Relay, Sensitive Earth Fault Relay and Auto reclose Relay facilities.

NB: See detailed specifications for each of the above protection functions, below.

Three phase Overcurrent and earth fault relay

Shall incorporate the following Features;

- Relay must be of Numerical Type
- Current setting range for overcurrent relay 0.5In-2.4In
- Current setting range for earth fault relay 0.05In-0.8In
- I.D.M.T characteristics according to BS142 or IEC255 i.e. SI, VI, EI, LTI, including definite time for the high-set Elements.
- Time setting multiplier 0.05 - 1.0
- Broken conductor protection feature
- Negative sequence Protection Feature
- High set Element for both overcurrent and earth fault
- Protection, with a setting range of 1-3012In.
- Thermal Protection
- Dedicated Breaker Fail Protection.
- Circuit Breaker Maintenance
- Fault records, Event Records and disturbance records.
- Configurable output relays with ability to output starting elements to control Tripping of other upstream Protection relays.
- Drop off /pickup ratio >90%
- Low transient overreach < 10%

Earth Fault Relay.

Shall incorporate the following Features;

- Relay must be of Numerical Type
- Current setting range 0.05In-0.8In
- I.D.M.T characteristics according to BS142 or IEC255 i.e. SI,VI,EI,LTI, including definite time for the high-set Elements.
- Time setting multiplier 0.05 - 1.0
- High set Element with a setting range of 1-30In.
- Circuit Breaker Maintenance
- Fault records, Event Records and disturbance records.
- Configurable output relays with ability to output starting elements to control Tripping of other upstream Protection relays.
- Drop off /pickup ratio >90%
- Low transient overreach < 10%

Sensitive Earth Fault Relay.

Shall incorporate the following Features;

- Relay must be of Numerical Type
- Current setting range for earth fault relay 0.005In-0.8In
- Definite time delay characteristic; setting range, 0- 30 Seconds.
- Circuit Breaker Maintenance

- Fault records, Event Records and disturbance records.
- Drop off /pickup ratio >90%
- Low transient overreach < 10%

Trip relay

- High burden tripping relay, immune to capacitance discharge currents and leakage currents
- At least 8 pairs of outputs contacts two of which should be normally closed (NC) contacts
- Instantaneous operation, t <12ms
- Flag or target should be a red L.E.D or bulb and should be electrically reset

Trip circuit supervision Relay

- The relay should have the following features
- Continuous supervision of trip circuit for circuit breaker in both OPEN& CLOSE position
- Trip circuit fail - Red L.E.D
- Trip Circuit Healthy – Green L.E.D
- Contacts should be available to be wired for annunciation and SCADA
- Two normally closed and three normally open output contacts
- *NB: The relay L.E.Ds should be visible from the front of the panel without opening the panel door(s).*

Annunciator unit

- Shall have Silence, Accept and Reset
- Accommodate 18 alarm Elements
- Relay output for audible alarm and self-supervision
- Integrated event register to provide analysis of the latest five (5) events

Discrepancy switch for circuit breaker control

- At least 2 pairs of contacts for CB closing
- At least 2 pairs of contacts for CB tripping
- For operation up to 110 V dc

Semaphore for isolator and earth switch position indication

- Preferably with Red L.E.D for ON indication and Green L.E.D for OFF Indication.

Autoreclose relay

For 132 kV Line

- Selectable 1 - 3 autoreclose shots
- Independent set dead time for each shot
- Autoreclose inhibit after manual close
- Separate input for overcurrent high set element and I.D.M.T element
- Autoreclose inhibition for over current high set element.
- Synchro-check facility and single pole autoreclose and delayed autoreclose facility.

Transducers:

- MW Transducer:
- Connection shall be 3-Phase 3or 4-Wire
- Inputs 110V AC and 1Amp
- Output shall be 0 - +/- 20 mA
- Auxiliary power supply shall be 110 V AC, separately connected.

- MVAr Transducer:
- Connection shall be 3-Phase 3 or 4-Wire
- Inputs 110V AC and 1Amp
- Output shall be 0 - +/- 20 mA
- Auxiliary power supply shall be 110 V AC, separately connected.

- Current Transducer:
- Input 0- 1Amp
- Output 0 – 20 mA
- Auxiliary power supply shall be 110 V AC

- iv)Voltage Transducer:
- Input 0- 110 Volts
- Output 0 – 20 mA
  Auxiliary power supply shall be 110 V AC, separately connected.

Distance Protection Relay (132kV line)

- Ratings: AC Inputs: 110v, 1 Amp (three phase) Power Supply Voltage range 80-260 VDC.
- The relays shall be of Numeric Design
- Under Impedance Starting criteria.
- Three zones phase – phase protection Mho/Quadrilateral characteristics.
- Three zones phase – earth protection, Mho/Quadrilateral characteristics with residual current compensation.
- Additional Zone 4 Protection
- Automatic Zone 4 protection
- Permissive under-reach and permissive overreach tele-protection features.
- Automatic switch on to Fault Feature.
- Independent settings for each zone.
- Distance to fault measurement, with the display on the Relay LCD Screen, where the distance can be read/seen by the system Operator.
- Display of Fault details on the LCD such as Fault Loop or Faulty phases, the Zone, and the Relay Operate time.
- Power Swing detection Feature which can optionally be enabled or blocked.
- Scheme communication logic with Permissive and Blocking Inter-tripping Schemes.
- Back up IDMT Three phase/overcurrent & Earth fault Protection
- Fuse failure supervision Logic
- Auto-reclose logic 1 and/or 3 phases
- Voltage Memory Feature

- Disturbance and event records including software for disturbance analysis.
- Event and Trip record should be incorporated.
- At least six (6) Binary inputs.
- Mho/Quadrilateral characteristics.
- Stability against switching inrush currents and reverse faults.
- Clear faulted phase indication.
- Clear fault identification even for boundary conditions.
- Software for Programming the configuration and Relay Settings and also downloading and analyzing the Relay Data.
- Three sets of Installation, Commissioning, Operation and Maintenance manuals shall be provided.

Line Differential Relay

- Ratings: AC Inputs: 110v, 1 Amp (three phase) Power Supply Voltage range 80-260 VDC.
- The relays shall be of Numeric Design
- Distance to fault measurement, with the display on the Relay LCD Screen, where the distance can be read/seen by the system Operator.
- Display of Fault details on the LCD such as Fault Loop or Faulty phases, the Zone, and the Relay Operate time.
- Back up IDMT Three phase/overcurrent & Earth fault Protection
- Disturbance and event records including software for disturbance analysis.
- Event and Trip record should be incorporated.
- At least six (6) Binary inputs.
- Stability against switching inrush currents and reverse faults.
- Clear faulted phase indication.
- Software for Programming the configuration and Relay Settings and also downloading and analysing the Relay Data.
- Three sets of Installation, Commissioning, Operation and Maintenance manuals shall be provided.

Breaker Failure Protection Relay

The breaker fail protection relay should have the following features:

- Numeric design
- Circuit –breaker failure protection, single or three pole with or without current
- Three phase overcurrent detectors.
- Earth fault detector.
- 2 out of 4 check of current detectors
- Independently settable delay times for operation with and without current
- “No current” condition control using the circuit-breaker auxiliary contacts
- Two stage delay, hence two stages of operation
- Trip command input.
- Necessary logic to determine breaker fail condition.
- Operator keypad with display
- Display of line measured current values
- Serial Interface
- Annunciation and storage of previous events.
- Self-monitoring

- Pole discrepancy
- Flush mounting
- LEDs to show phase and stage of operation.

Busbar Differential protection Relay

- Ratings: AC Inputs: 110v, 1 Amp (three phase) Power Supply Voltage range 80-260 VDC.
- The relays shall be of Numeric Design
- Display of Fault details on the LCD such as Fault Loop or Faulty phases, the Zone, and the Relay Operate time.
- Disturbance and event records including software for disturbance analysis.
- Event and Trip record should be incorporated.
- At least six (6) Binary inputs.
- Stability against switching inrush currents and reverse faults.
- Clear faulted phase indication.
- Software for Programming the configuration and Relay Settings and also downloading and analyzing the Relay Data.
- Three sets of Installation, Commissioning, Operation and Maintenance manuals shall be provided.

Other specifications

i) *TESTING FACILITIES*

Separate Test facilities for each AC current, voltage and voltage transformer secondary circuit so as to give access for testing of each protective relay and its associated circuits. This may consist of either test terminals blocks for the front of the panel mounting with automatic short circuiting of the current secondary by means of movement of links from their normal operating position, or a relay test block mounted adjacent to each or any other suitable testing arrangement.

Each current transformer circuit shall be earthed through a removable link at one point only. The common Protection trip and Alarm circuit for each Panel shall be provided with an isolation link to facilitate Testing and Breakdown Maintenance.

ii) *RELAYS*

All measurement relays must be of Numeric design.

Electromechanical relays are acceptable only for use as Auxiliary relays and contactors, NOT as Measuring Relays.

Relays contacts shall be suitable for making and breaking the maximum currents, which they may be required to control in normal service. Where contacts of the protective relays are unable to deal directly with the tripping currents, Auxiliary Trip relays shall be provided.

Relays contacts shall make firmly without bounce and the whole of the relay mechanism shall be as far as possible unaffected by vibration or external magnetic fields.

Relays shall be provided with clearly inscribed labels describing their application and to include the (IEC) Device Function number. To minimize the effects of electrolysis, relay coils operating on DC shall be so connected that the coils are not continuously connected from the positive pole of the battery. Relays shall be suitable for operating on the station 110V DC supply without the use of dropping resistors or diodes.

The relay thermal rating should be such that the fault current clearance times on any combination of current and time multiplier setting shall not exceed the thermal withstand capability of the relay (Maximum Fault current=25 kA)

The relays must be IEC 60255 and EMC 89/336/EEC compliant.

iii) RELAY PROGRAMMING SOFTWARE AND CONNECTION CABLES:

Software must be provided for Programming and downloading Data for all Numerical Relays supplied. The software Users Guide shall also be supplied. **The Numerical Relays will be equipped with an RS232 Communication Port or USB port or Ethernet port on the front to facilitate connection to a Laptop. There shall be two extra ports on the back for communication to regional control and National control independently**. The relevant communication cable, between the Relay and the Laptop shall also be provided (3 cables). Also communication facilities shall be provided on each Numerical Relay for Remote Interrogation and Programming of the Numerical Relays. The Relays will also have an MMI to facilitate manual Relay programming and Data access. Relay Operation due to system fault, shall be indicated by a Red L.E.D. and the fault details (flags) shall be displayed on the MMI. Both the Relay Fault flags and Red L.E.D will be reset without opening the Relay Cover.

3.9.2 CONTROL STATIONS

Distributed Control Units

Outdoor switchgear shall have a control and relay panel in the control room with facilities for Local Control. The local control for indoor breakers can be located in the instrument cabinet. The protection and control functions can also be combined in one unit. Signals from protection equipment can alternatively be hardwired to bay control unit.

The bay control unit shall handle position indications from circuit breakers, disconnectors and earthing switches. It shall control closing and opening of circuit breakers and receive time tag, store and display alarms and measurements.

The alarm handling capacity must be sufficient to handle all normal alarms from the switchgear, the protection.

All commands from the remote and supervisory control can be given to bay control unit, which execute the commands. Conventional interlocks should be retained.

All microprocessor based control equipment such as bay control units shall be galvanically isolated from the environments outside panels, using opto couplers or interposing relays for signals, galvanic isolated measuring transducers for measurements and relays or contactors for commands.

All data and parameters specified to the individual distributed control units, shall be stored in a non-volatile memory so no local logic or information will be lost due to power supply failure.

Editing and input of local data and parameters shall be performed locally by suitable programming equipment to be included in the supply. Preferably it should also be possible to edit any such local data at higher control level and download this information.

Interface with Supervisory Control and Data Facilities

In order to interface and achieve the desired functionality of the SCADA/EMS system, it should be noted that data concentrators in substations shall be based on standard IEC 60870-5-101 protocol. It should be noted that the following SCADA facilities shall be available from the substation.

- Supervisory control of all circuit breakers and motorized line and bus bar isolators.
- Status Indications of all circuit breakers, isolators, positions of on-load tap changers and 'local/remote', 'Automatic/ Manual', Main/Follower mode of automatic voltage regulators where applicable. These shall be reported by exception, but system shall allow scan by demand.
- Alarms; Bay alarms, Bus bar alarms, station alarms and warning shall be collected by the SCADA.
- Measurements; bus bar voltages, frequency active & reactive power, 48 & 110 V DC voltages and line currents.
- Energy measurements, this shall be at interconnection points and feeders.

Communication

All communication between bay units and between bay units and station controller/workstation shall be on a bus structure, preferably by fibre optic cable.

Indicating and Metering Instruments and Metering Transducers (if used)

Remote indication of measurands shall take place on the station controller's VDU. Local instruments are used they shall be of the dial type which is easily legible, with black graduations and numerals on a white background. The instruments shall have a dimension of 96 x 96 mm. The error of the instruments shall be maximum 1.5% reckoned on the total length of the scale. All instruments shall be of a narrow frame type.

Preferably the measurements shall be performed directly in the SCS or in the protection relays. However, if needed, the metering transducers (converters) shall be installed in the boards and shall be suitable for connection to the potential and current transformers. The cases shall be hermetically sealed against moisture and dust. Transducer output shall be an impressed DC current of 0-10 mA output. The maximum meter reading at the receiving end shall be equivalent to 30% overload of the source value. The permitted resistive load shall be at least 1000 ohms. The accuracy class shall be minimum 1%. The auxiliary voltage, if required (preferably not) shall be 110 V or 30 V DC.

The Watt and VAr measurements shall be of the three-element (three-wattmeter) type when connected to primary systems with grounded neutral. Watt and VAr measurements for transmission lines shall be such that the direction of the power flow is indicated by negative

direction towards the substation and positive direction out of the substation. The voltage shall be measured phase-phase voltage, one reading is sufficient.

The scale on the different types of instruments shall be proposed by the Contractor and be subject to approval by the Project Manager.

Programming and Fault Finding
Editing and input of local data and parameters shall be performed locally by suitable programming equipment to be included in the supply. Preferably it should also be possible to edit any such local data at higher control level and download this information.

The programming equipment shall also be suitable for fault diagnostic.

3.9.3 THE ENERGY METER

SPECIFICATIONS FOR CLASS 0.2S ELECTRONIC ENERGY METERS

1. The meters shall conform fully to IEC 687 for class 0.2S Energy Meters and any other relevant specifications.

2. The meters shall be programmable and relevant software and connection cable to laptop shall be provided. Meters complying with IEC 61334-4-4-1(DLMS Standard protocol) shall be preferred.

3. The meters shall have memory and be capable of storage of at least 12 months load profile and other data.

4. The meters shall be capable of bi-directional metering so as to record faithfully, both export and import quantities. The accuracy shall be as per IEC 687 in both directions.

5. The quantities to be displayed shall be determined by the user through use of software that shall be provided. The meters shall be configurable for use in three phase 3 /4-wire networks systems as follows:-

   3x240/415 V, 10 (100) A
   3x240/415 V, /5 (1) A
   3x /110V, /5 (1) A

6. The meters shall be usable on phase voltages of magnitudes ranging from 100V to 500V, 50 Hz. Meters shall be with voltage-surge protection that meets IEC 687 specifications.

7. The meters shall be for flush panel mounting.

8. The meters shall have a non-volatile memory so as to ensure no loss of data during power failures. Security passwords and switches shall be provided to prevent unauthorized programming of the meter.

9. The meters shall be suitable for operation in any part of the Republic of Kenya where the climate varies largely from temperatures between -5 and 40 Degrees Celsius and relative

humidity reaching 95% in some parts. Operating altitudes ranging from sea level to 2200 metres above sea level.

10. The meters shall support multi-tariff metering.

11. The Meters shall incorporate instrumentation for the following measurands:
    MW, MVAR, MVA, p.f., Phase Currents, Phase voltages and the angle between individual Phase Voltage and corresponding phase current. This measurands shall be visible on the Meter display.

12. The meters MUST have a capability of freezing billing readings on any selected date of the month.

13. The meters will measure maximum demand for MW, MVAR and MVA and these will be accessible on the Meter display. The Demand integration period will be programmable.

14. The CT and VT ratios shall be programmable.

15. The meters shall have an accurate internal quartz controlled clock. It should be possible to reset the clock without loss of billing data.

16. The supplier shall show proof of ISO 9000 and ISO 14000 standards compliance.

17. The meters shall be provided with adequate sealing facilities to prevent tampering.

18. The nameplate and meter details shall be clearly marked using materials and colours that are durable and indelible.

19. In addition to requirements of IEC 687 the name-plate shall carry the following particulars :

    (a) The inscription "The property of K.P.L.Co. LTD."
    (b) Owner's serial numbers as directed with a minimum 5mm figure height.
    (c) Year of manufacture.

20. The meter base cover shall be of non-metallic, non-hygroscopic, flame retardant, polished material having high impact-resilience and low dirt absorption properties.
    The front cover may be of translucent material with a clear transparent front.

21. The meter shall have a minimum of three sealing - provisions for the meter body, terminal cover and front cover (where applicable).

22. The meter terminal cover shall be the normal short length with provisions of easy bottom breakage for cable entry. The terminals shall be of bottom entry, and the arrangement shall be:-
    L1 L 1: L2 L2: L3 L3: N or
    I1 V1 I1: I2 V2 I2: I3 V3 I3: N

23. The accuracy shall be Class 0.2

25 The meter errors shall comply with the requirement IEC 687 and shall be adjusted at the manufacturer's works to be within 0.2% between low and high load and shall exhibit good stability.

26 The meter shall have a warranty against any defects, which may develop due to faulty material, calibration, transportation or workmanship for a period of not less than eighteen months from the date of delivery. All defective meters shall be replaced at the supplier's cost.

27 The following drawings and information shall be required with the tender:
(a) Meter drawing giving all the relevant dimensions.
(b) Wiring diagrams.
(c) Description leaflet including details of programming of the meters
(d) User's and service manuals.

3.10 TELECOMMUNICATION EQUIPMENT

3.10.1 COMMUNICATION EQUIPMENT AND SCADA REQUIREMENTS

The Scope will include Supply and Installation of cards for communications and tele-protection and integration of the new bays into existing SCADA equipment for the efficient supervision, control, operation and maintenance of the transmission system.

3.10.2 SCOPE OF WORK

The Scope will include integration of the 2 bays into existing substation SCADA, Installation of communications for tele-protection and SCADA equipment for the efficient supervision, control, operation and maintenance of the transmission system. At Bamburi the signals shall be integrated into the existing communication System to the National Control Center.

Detailed requirements are as follows:-

System design – The system design and preparation of contractor's drawings to approval of the Engineer

Supply and installation of lead in cables to the equipment terminals

Supply and installation of fibre optic terminal and multiplexing

Supply and installation of supervisory management system and cabling to the relevant distribution frame(s)

Testing and commissioning of the systems up to the terminal equipment and integration to existing SCADA system. The OLTEs shall be incorporated in the existing network management system.

Multiplexed signals for permissive and direct inter-trips for the 132 circuits

The following signals shall be collected via SCADA

Control of circuit breakers and isolators

- Supervisory control of the two 132 kV Circuit Breakers (CBs)
- Supervisory control of 4 no. 132 kV motorized line and busbar isolators.

Status Indications:

- Status indication of the 2 no. 132 circuit breakers .For acquisition of 132 kV CB status indications the auxiliary contacts of only one pole shall be wired for CB closed position and for open position.
- Status indication of all 132 kV line and busbar isolators

Alarms:

Bay Alarms: For each bay, the following protection signals shall be acquired individually if available:

- "Main Protection 1 Trip" (MP1)
- "Main Protection 2 Trip" (MP2)
- "Backup Protection Trip" (BPT)
- "Permissive Trip Signal A Send" (PAS)
- "Permissive Trip Signal A Received" (PAR)
- "Permissive Trip Signal B Send" (PBS)
- "Permissive Trip Signal B Received" (PBR)
- "Blocking Signal Send" (BSS)
- "Blocking Signal Received" (BSR)
- "Direct Transfer Trip Send" (DTS)
- "Direct Transfer Trip Received" (DTR)
- "PT Fail A" (PTA)
- "PT Fail B" (PTB)
- "Trip Circuit Faulty" (TCF)
- "Protection A Faulty" (PAF)
- "Protection B Faulty" (PBF)
- "SF6 Low 1st Step (SF1)
- "SF6 Low 2nd Step (SF2)
- "CB Failure Protection Operated" (FPO)
- "CB Spring Charging Failure" (SCF)
- "Autorecloser Operated" (ARO)
- "Local Control Position of Selector Switch" (LCP)
- "CB Pole discrepancy protection" (CBD)

Depending on the type of bay (line, bus coupler), the voltage level and the respective protection philosophy, the Main and Back-up Protection Alarms may be a "Distance Protection 1 trip", "Distance Protection 2 trip", "Differential Protection trip", "Overcurrent Protection trip", "Overload protection trip", "Directional earth fault protection trip" etc.

Other alarms generated for the individual bays or circuit breakers shall be grouped at the station level and then transmitted to the respective Control Centre

- "Circuit Breaker Faulty" (CBF) as one common (grouped) alarm for other failures that do affect the operation of the circuit breaker and need immediate attention / repair.
- "Bay faulty" (BFY) as one common (grouped) alarm for all other failures that do not affect the operation of the circuit breaker.

Busbar Alarms:
- Busbar differential protection trip (BDT)
- Busbar voltage status (BVS)
- Busbar supervision operated

3.10.3 FUNCTIONAL REQUIREMENTS FOR ADAPTATION WORKS

This Section is dealing with the interfacing equipment and works to be performed at substations and power stations.

Analogue and digital input data to RTU

Power system analogue and digital input data shall be collected from the substation field instrumentation and provided to the RTUs. Interfacing shall be designed to minimize electromagnetic and electrostatic interference.

Analogue Measurements
The interfacing shall consist of analogue transducers, isolating/test devices, wiring, cabling and terminations to the secondary PT/CT circuit in the control or relay cabinets. The output signal from the analogue transducer shall be transmitted to the appropriate input at the RTU. This refers i.e. to MW/MVAr, Current and Voltage measurements.

Status Indications
The interfacing shall use spare potential free contacts where available or auxiliary paralleling relays to be provided under the Contract, (one independent contact / relay for each position) actuated by the switchgear equipment, isolating and test devices, wiring, cabling and terminations to the digital input point at the RTU.

Alarms
Input wiring to the RTU from alarm points shall use spare contacts available on the actuating device wherever possible. Where spare contacts are unavailable, auxiliary "contact multiplying" relays shall be supplied and wired to provide the required digital input signal to the RTU.

Pulse Accumulations

The pulse accumulation interfacing shall utilize potential-free pulse contacts or pulse outputs of electronic meters if available, isolation and test devices, wiring, cabling and terminations to the RTU. Where potential free pulse contacts or pulse outputs are not available, new meters shall be provided under the Contract.

Supervisory control interface

The substation adaptation works for device control will be required to take an output signal from the RTU, actuate an auxiliary control relay, and have a contact from the control relay to initiate a control action such as breaker trip/close, etc. on the substation equipment by the appropriate connections to the substations equipment control circuits.

The supervisory control interface shall consist of outputs from the RTU, interposing relays, isolating/test devices, and wiring, cabling and terminations to the appropriate control circuits and control relays and switches in control cabinets.

Each RTU control output shall drive an auxiliary control relay, which shall be located in the control panel or locally. The interposing relay shall be normally de-energized during normal operation. A normally open contact of these interposing control relays shall actuate a breaker tripping/closing coil. In no cases shall the relay contacts supplied in the RTU directly control any equipment.

The circuit breaker close command in stations where separated networks / generation could be switched shall pass through synchro-check relays to prevent CB closing under none-synchronous conditions. Installation of Synchro-check relays under this contract is part of the project tasks under the Contractors responsibility.

In no case shall the closing commands for circuit breakers by-pass any station internal interlocking.

A key type selector switch shall be installed for each feeder equipped for remote control from the corresponding Control centre. The switch shall allow selection of control from the Control centre or from the substation and its position shall be indicated at the corresponding Control centre.

The Contractor shall provide and install suitable test switches or isolating devices for all control points, to allow for proper control isolation, testing, safety procedures.

Digital inputs

The digital inputs shall be opto-isolated, signal voltage 48 V DC. Other voltages shall also be possible by changing the matching resistor in the input circuit.

Contact bouncing of the interposing relays shall be filtered. The bounce filtering time shall be 7 ms. Input circuits with selectable bounce filtering time setting are preferred.

The indications shall preserve the chronological order of events inside the RTU.

Analogue inputs

In analogue measurements, the information to the analog input modules of the RTU is given in the form of analog current supplied by the output of measuring transducers. Measuring transducers shall normally be installed in the switch/control gear.

In analog input modules, the following current input ranges shall be available:

- unipolar 0-5 mA, 0-10 mA, 4-20 mA
- bipolar +/- 5 mA. +/-10 mA, 4-20 mA.

It shall be possible to change the input range for each individual input, preferably by software means, instead of changing the input resistor.

The analog input circuit shall have a precise DC impedance less than 200 ohms for current inputs. This impedance must not vary more than half of the accuracy of the Analog to Digital Converter (ADC) with influence values such as temperature, etc.

In the input circuit galvanic isolation shall be provided from mechanical earth and electrical earth, and, preferably, between different inputs.

The circuits of the analog input module shall be protected against disturbances caused by switching transients and against disturbances from power and radio frequencies present at outstations.

The scanning of each input shall not introduce any error on the analog information.

For each input it must be possible, without disturbing the other inputs,

- to isolate the input from the ADC and close the analog circuit,
- to connect, on the ADC side, a test set for maintenance or adjustments,
- to measure the analog input value without disturbing the measurement (addition of an mA meter over a link which is then disconnected).

The analog information shall be converted into digital value by the ADC which can be common for all inputs. Analog measurements shall be transmitted to the master station with at least 11 bits plus sign bit.

The total accuracy must be better than 0.5% of the nominal range of a measurement calculated from RTU's analog input up to Control Centre. A calculation of the total accuracy in the wide sense as well as in the restricted sense as per IEC 870 - 4 shall be included in the Tender.

The input circuits must withstand a permanent overload of 30% without any damage.
In case of input overload the output message shall be either

- the exact value corresponding to the input or
- the maximum value that is possible to code (with the correct sign).

Pulse inputs

The counter register shall be 16 bit. The maximum input frequency shall be 25 Hz. In practice, the pulses will be dimensioned in a way that max. frequency is less than 5 Hz. Interposing relays will not be used.

3.10.7 TECHNICAL GUARANTEES

The appropriate Technical guarantees in appropriate Volume II Technical schedule section shall be completely filled

3.11 MISCELLANEOUS MATERIALS

3.11.1 SCOPE

This subsection covers the design, manufacture, testing before shipment, delivery to Site and erection and testing at Site of the following materials.
(a) Electrical conductors, cables and fittings
(b) Insulators and fittings
(c) Steel structures
(d) Earthing materials
(e) Other material
(f) Lighting facilities for outdoor switchyard.

3.11.2 CABLES

3.11.2.1 600V Cables

Low-tension motor circuit from AC distribution panel to each motor:
The sectional area of the 600V cables shall be ample for each motor capacity and shall be decided by the Contractor taking into account the voltage drop for starting current.

3.11.2.2 Control Cables

Control cables shall be copper conductor, of jacket type, 600V, polyvinyl chloride insulated PVC sheathed, r multi-cores copper. The cross-sectional area of core shall not be less than 2.5sq mm. and the cables shall be armoured.

The cross-sectional area of core for current transformer circuit control cables shall not be less than 4 sq mm and shall be armoured.

3.11.2.3 Insulated Wire

600V PVC insulated wire shall be considered stranded copper conductors and used for power and heater for indoor wirings.

3.11.2.4 Cables Drawn into Ducts

Unless otherwise specified, the Contractor shall provide ducts and pipes. Immediately before pulling the cables, the Contractor is to remove any loose material from the ducts and prove them by drawing through a material of slightly less diameter than the duct. The ducts shall be water and vermin proof sealed and for indoor installations fireproof.

3.11.2.5 Cables Installed in Concrete Trenches

In substations concrete trenches and cable ducts shall be provided and installed by the Contractor. These trenches shall not be filled with sand. All cable duct entries to buildings, whether or not for cables, shall be protected against entry of water, oil and vermin with a suitable filling material supplied and installed by the Contractor on the approval of the Employer.

All cable routes in concrete trenches shall be suitably supported by means of cleatsor racks and raised from the trench floor by means of suitable spacers. All cables shall be run in a neat and orderly manner and the crossing of cables within the trench shall be avoided as far as possible.

The Contractor shall be responsible for removing and replacing the trench covers free of charge during the execution of his work as directed by the Engineer.

3.11.2.6 Bus Conductors

The following conductors shall be provided as outdoor bus and jumper conductors:

For 132 kV bus bar and jumper

(i) Pipe bus: Copper pipe – 75mm (diameter) x 5mm (thickness)
(ii) Jumper and droppers: AAC.400 mm^2

3.11.2.7 Galvanized Steel Wires

Galvanized steel wires of 55 mm^2 (7/3.2 mm) shall be used for overhead ground wires, of which ultimate tensile strength shall be more than 90kg/sq.mm.

3.11.2.8 Fittings

Suitable compression clamps and spacers for conductors, suitable terminals for the equipment to conductor, and suitable clamps for galvanized steel wire shall be supplied and installed.

Connecting clamps shall be free from electrolytic corrosion and designed for bi-metal against the connection between aluminium and copper.

The following tests, as applicable, shall be carried out at the Contractor's plant:

(a) Construction test
(b) Tensile strength test

(c) Elongation test
(d) Resistance test
(e) Insulation resistance test
(f) Withstand voltage test
(g) Characteristics

3.11.3 INSULATORS AND FITTINGS

3.11.3.1 Substation Disc Insulator Units

Each suspension and strain insulator string shall be of 12 units for 132kV circuits without arcing horn. The insulator unit shall be standard 254 mm porcelain, with ball and socket, and have a spacing of 146mm between discs, complying with IEC publication 305-1974. The connection between units shall be such as to allow sufficient flexibility for freedom of movement, and to prevent the possibility of becoming separated accidentally either during or after the erection.

The interlocking sockets shall be designed to allow easy passage of the ball into the socket and retaining or locking devices required to keep in the socket under all service conditions.

The dimensions of socket and pin shall be in accordance with IEC. Recommendation 120, 16mm socket and pin.

The insulator units shall be brown glazed porcelain.
Each insulator unit shall have the following characteristics:

	Withstand voltage:
Power frequency, dry	70kV
Power frequency, wet	40kV
Impulse voltage	110kV
Puncture voltage	110kV
Minimum breaking load	70 kN
Minimum creepage per unit	295mm

Minimum creepage for insulator string shall be 3988mm
Minimum breaking load of insulator string with fittings shall be 70 kN.

3.11.3.2 Station Post Insulators

Station post insulators shall be provided for supporting the connecting lead wires of switchgear equipment to bus. The insulator shall be of brown coloured porcelain rated as follows:

System voltage	145kV
AC withstand voltage (wet, 1 min.)	290kV
Impulse withstand voltage	685kV

The station post insulator shall comply with IEC.273-1968, IEC 720.

3.11.3.3 Fittings

All fittings shall be malleable iron hot dip galvanized to BS 729.

Suspension and tension clamps shall be as light as possible and of approved types. All clamps shall be designed to avoid any possibility of deforming the stranded conductors and separating the individual strands. Tension clamps shall be bolted type, and shall not permit slipping off or damage to conductors or any part thereof. Suspension clamps shall be free to pivot in the vertical plane containing the conductor.

Clamps shall not exhibit excessive heating by magnetization or otherwise..

U-bolts, ball hooks, socket-eyes and other necessary fittings required for the above insulators and clamps shall be provided.

The following tests shall be carried out before shipment:
(a) With stand and flashover voltage
(b) Mechanical strength
(c) Dimensions of insulators and fittings
(d) Galvanizing

3.11.4 STEEL STRUCTURES

3.11.4.1 General

The Contractor shall furnish all steel structures required, including framework of outdoor equipment.

3.11.4.2 Details of Design

The steel structures shall be designed in accordance with the following requirements:

(a) Vertical loading
The weight of the conductors, ground wires, insulator strings, workers, the structures themselves and equipment to be supported, if any, shall be considered.

(b) Wind pressure:
(i) On conductors and earth wires: 385 N/m^2 on projected area
(ii) On insulators and all other circular: 385 N/m^2 on projected area section
(iii) On lattice structures or beam structure: 590 N/m^2 on projected area

(c) Working tensions of conductor and wire:

(i) Conductors for 132kV buses-700kg per conductor and for 132kV lines 700kg per conductor
(ii) Overhead ground wire- 500kg per wire

(d) Seismic co-efficient: 0.16

(e) Factor of safety: 2.5
The structures shall be designed so that no failure or permanent distortion shall occur when the load equivalent to 2.5 times the maximum simultaneous working loads are applied.

(f) Slenderness ratio:
The slenderness ratio shall not exceed 200 for main and web members and 250 for nominal members.

(g) Member size
No leg members less than 5mm in thickness and 60mm in width of flange for main, and 4mm in thickness and 45mm in width of flange for web and nominal members shall be used.

(h) Bolts and nuts
All the members shall be connected by bolts and nuts. The size of the connection bolts shall be not less than 16mm for leg member. The suitable anchor bolts shall be provided. The size of step bolts shall be 16mm.

The Contractor shall submit full details and drawings for the steel structures to the Employer for approval prior to commencing fabrication.

3.11.4.3 Foundation

The Contractor shall place the concrete foundation for steel structures and switchgear equipment on the switchyard.

The Contractor shall supply installations drawing giving erection particulars.
The foundation shall be anchor bolt type.

Such members as to be buried in the foundation concrete block shall not be provided. Size of block-out hole for anchor bolts shall be indicated on the drawing so that the concerning work can be performed prior to the erection of supports.

Safety factor of concrete for up lifting force shall not be less than 2.5. The allowable bearing strength of earth will be assumed to be 2.0 ton/m^2, however, it shall be confirmed by the Contractor. The weight of earth shall be assumed to be 1.6 ton/m^3 and weight of concrete to be 2.3 ton/m^3.

If required, pile foundation shall be provided, and the cost of piling shall be deemed to be included in the Bid Price.

The angle of repose will be reckoned as 10 degree.

3.11.4.4 Materials

All steel employed for the structures have high yield point and high ultimate tensile strength and shall be subject to the approval of the Employer.

Diameter of both holes shall not be more than 1.5mm larger than the diameter of the bolts.

All members shall be stamped or marked in an approved manner with numbers and/or letters corresponding to number and/or letters on drawings or material list approved by the Employer.

The erection marks shall be stamped before galvanizing and shall be clearly legible after galvanizing.

The following tests shall be carried out before delivery to site.

(a) Mechanical strength of materials
(b) Galvanized test
(c) Shop assembly

3.11.5 EARTHING MATERIALS

In addition to the conductors and fittings to be used for the works to be erected under the contract, the Contractor shall supply and install the following materials for the grounding system and complete the grounding system.

The Contractor shall submit full details and drawings for grounding systems to the Employer for approval. Grounding resistance shall be 1-ohm at the maximum or the value calculated and the Contractor shall be responsible for preparing the specified value.

(a) Bare annealed high conductivity copper stranded wire:
95sq.mm for main grounding mesh, local transformer, arresters, etc. and sq.mm and/or 35sq.mm for other equipment and materials.
(b) Copper plates of 3mm thick, 1 meter by 1 meter size, equipped with copper lead conductor 95sq mm 3 meter long
(c) Grounding rod of 25mm diameter, 3 meter long, copper clad steel rod equipped with copper led conductor, 35sq.mm, 3 meter long.
(d) Clamps needed for connecting each conductor shall be provided.

3.11.6 OTHER MATERIALS

All other miscellaneous materials, such as conduct pipes, steel plates, fabricated cable ducts, cables supporting brackets sand/or cable racks, pipe hangs, angle steels, channels steels, bolts and nuts and other items, required for putting into service the works to be covered under this Contract, shall be supplied and installed by the Contractor as required. These materials shall comply with the highest grade specified in the relevant standards.

Coloured phase mark plates and bus identification marks shall be fitted on each beam of steel structures of incoming feeders, outgoing feeders, main buses and transformers buses.

Colour of phase marks shall be red, yellow and blue.

3.11.7 LIGHTING SYSTEM

A complete lighting system for the switchyard extension shall be supplied and installed by the Contractor.

Station lighting components of approved type shall be supplied and installed. These shall include but not limited to:

(a) Lighting Fixtures

(i) Outdoor type mercury lighting fixtures for AC 240V shall be equipped with screwed base lamp holders, and shall be of high-power factor suitable for stable operation in tropical climate and weather proof type.
(ii) Outdoor type incandescent lighting fixtures for DC 110V for emergency use shall be complete with all fittings.
(iii) The type of lighting fixtures used should be available locally.

(a) Lighting supports
Lighting supports shall be steel poles painted with suitable colour, which will be instructed by the Employer. Ballast, cut out, and terminals shall be equipped in the pole and other attachments necessary for wiring and fixing of the lighting fixtures shall also be provided with the pole. The ground level shall be marked on the support for easy installation.
600-volt PVC insulated wires of 3.5 square millimetres in size shall be laid in the lighting pole for connection from the terminal box to the lighting fixtures.

(c) Cabling and wiring shall be of approved type as well as all required installation materials.

(d) Lighting panel for outdoor lighting system shall be extended in the station. The lighting panel shall be indoor metal enclosed, wall mounting type, dust and vermin proof construction and shall contain the following equipment.

- Identification name plate
- Twenty single pole moulded case circuit breakers 600 V, 30A
- Pole moulded case circuit breakers 600V, 100 A
- Magnet contactor for emergency lighting
- Internal wirings
- Neutral links
- Terminal boards

(e) Spare Parts

The following spares parts shall be supplied for the station- 3 sets of each type of complete lighting fixtures with all accessories.

Lighting for outdoor switchyard and access roads constructed under this contract shall also be provided by the Contractor.

The Contractor shall prepare and submit to the Employer for approval the calculation sheets, the facilities drawings, the installation drawings and wiring diagram.

The power shall be supplied from the low tension AC distribution panel in the control building.

The mean illumination level of each location for AC power shall be as follows:

- Outdoor operating area 30 lux
- Outdoor switchyard 5 lux
- Street lighting 10 lux

3.11.8 MARSHALLING BOXES

Marshalling boxes shall be used for outdoor switch bays and control building for the stations.

The boxes shall be of outdoor or indoor, metal enclosed, air insulated, self-standing type, dust and vermin-roof construction and containing the terminal blocks, internal wiring, space heater with thermostat for moisture protection, and other necessary equipment. Those for outdoor use shall be of weather-proof construction.

3.11.9 AC POWER OUTLETS

An AC power outlet shall be installed in the adjacent place of local service transformer. The AC power outlet shall be of outdoor, metal enclosed, air insulated, self-standing or structure mounted type and dust, vermin and weather proof construction and containing a 3 pole moulded case circuit breaker, 600V, 100A power plug cable gland, and other necessary accessories.

3.12 CIVIL ENGINEERING AND BULIDING WORKS

3.12.1 GENERAL

The works comprise the topographical survey of site, subsoil investigations, detailed design, production of working drawings, provision of labour, plant and materials, and construction of the civil engineering and building works.

The works include site clearance and earthworks; Cabro (Minimum 80mm or 49N/mm^2) paved Substation and access road, surfaced water drainage, switchgear and structures, Drained indoor/outdoor cable trenches etc. The framed structure extension of control buildings will be completed with control/relay room.

3.12.2 SITE SURVEY AND SUBSOIL INVESTIGATION

The Bidder shall visit the site to satisfy himself that information given in the Bid Document is accurate and also to collect additional data, which he may require for preparation of his bid.

(A) **Site Survey**

The Contractor shall survey the site of the switchyard associated with control building, to obtain the following:

(1) Accurate volume of ground to be cut and levelled.
(2) Accurate positions of switchgears, structures, ducts, drainage, buildings, fences, etc.
(3) Drainage pattern of the site

A site survey plan shall be prepared in the scale of 1:500 showing the survey results and proposed layout of the work.

(B) **Sub-soil Investigation**

The Contractor shall ascertain for himself the nature of the sub-soil conditions over the sites of the works for his design purposes, by means of sounding tester and trial excavations, etc. The following should be considered as a minimum requirement, but should be extended if many inconsistencies are encountered:

(1) Depth of sounding tests shall be less than 5 metres unless rock is encountered; in which case the thickness shall be proved to be greater than 1.5 metres on two boreholes. Where weak soils are encountered, the test shall be taken down to a load bearing stratum and adequate thickness.

(2) Test records shall describe and indicate level of all soils encountered and indicate the natural water table level. Rock core records should specify total core recovery, solid core recovery and quality of the rock cored.

(3) Electrical resistivity of the soil shall be verified on four samples, in accordance with approved practice. (e.g. British Standard Code of Practice CP 1013-1965):

3.12.3 DESIGN OF WORKS

(A) Design and Drawings

The Contractor shall design the civil engineering and building works and prepare design report complete with working drawings in size A3 as necessary for the construction of the works.
The Contractor is required to produce full design calculations for the foundations, building structures, etc. and detailed working drawings. He shall be responsible for the detailed designs, strength and safety of the structures, to meet the structural, acoustic and environmental requirements of the buildings and other works. He shall be responsible for ensuring that the design satisfies the requirements of all authorized local and natural bodies.

Design calculations and detailed drawings must be submitted to the Employer for approval before the relevant construction work is carried out. Design calculations shall be in accordance with an approved method of computation and should take into account the most unfavourable combination of dead load, live load and wind load.

(B) Detail Requirements for Design

(1) Calculations
Calculations shall clearly identify the subject of the calculations and shall include but not be limited to providing the following information:
(a) Assumption used for design purposes
(b) Codes or standards used
(c) Loading used
(d) Calculation
(e) Technical specification section and paragraph number

(2) Drawings
Drawings and data sheets prepared by the Contractor shall include complete construction details.
The drawings shall include but not be limited to the following information or detail as applicable: construction joints, reinforcement details and bar bending schedules, details for unusual or special items of architectural, form work, trenching, structural steel details, etc.

3.12.4 GENERAL SITE WORKS

A. Setting-out

The Contractor shall be responsible for all setting-out, irrespective of any checking by the Employer. The accuracy of all setting-out is to be better than ±1part in 3,000.
The Contractor shall advise the Employer within 24 hours whenever a new setting-out peg is established or an existing one destroyed, and shall regularly furnish the engineer with layout plans showing all current setting-out and survey stations.
The tolerances shown below shall rule on site unless otherwise agreed upon by the Employer and the Contractor.

Block work

(1)	**Position in plan**	
	Fair-faced or specified side from the designed position	±15mm
(2)	**Length**	
	Up to and including 5m	±15mm
	Over 5m up to and including 10m	±20mm
	Over 10m	±25mm
(3)	**Height**	
	Up to and including 3m	±15mm
	Over 5m up to and including 6m	±20mm
	Over 6m	±25mm

(4) Thickness

More than one block	±15mm

(5) Level of bed joints

Length up to but not exceeding 5m	±10mm
Over 5m but not exceeding 10m	±15mm
Over 10m but not exceeding 20m	±20mm
Add for every 5m	±5mm

(6) Straightness

In any 5m (not cumulative)	±10mm max

(7) Verticality

In any 3m	±15mm

Permissible Deviation on In-site Concrete

(1) Plant and other foundations

(a) Position of centre line on plan from nearest building grid line	±10mm
(b) Dimensions on plan	-5mm + 20mm
(c) Formation level	±25mm
(d) Surface level	-5mm + 0mm
(e) Sleeved bolt location	±15mm
(f) Sleeved bolt vertically	1 in 100
(g) Cast-in bolt location	±2mm
(h) Cast-in bolt vertically	1 in 300
(i) Bolt levels	0mm + 20mm

NB: Where tolerances (e) and (f) conflict with (g) and (h) the latter shall govern.

(2) **Components above foundation (excepting items in (c) below)**

(a) Position of centre line on plan from Nearest building grid line	±19mm
(b) Verticality: Plumbers in height of up to 0.5m	±5mm
Over 1.5m to 1.5m inclusive	±10mm
Over 1.5m to 3m inclusive	±15mm
Over 3m to 30m inclusive	±20mm

(c)Cross section and linear dimensions of beams, slabs, columns and walls.

Up to 300mm	±5mm
Over 300 to 600mm	±10mm
Over 600mm to 1.5m	±15mm
Over 1.5mm to 3m	±20mm
Over 3m	±30mm

(d) Level of specified surface relative to the nearest Bench Mark	±10mm

(3) Overall dimensions of a concrete framed building

(a) Length and width measured at external ground level

For dimensions up to and including 15m	±15mm
For dimensions over 15m up to 30m	±50mm
For each subsequent 30m	±20mm

(b) Height of structural roof level with reference to the transferred Bench mark ±40mm

The Employer may at his discretion alter or specify new tolerances as necessary.
The Contractor shall submit for the Employer's approval, his proposed finished site levels, road levels and building floor levels. Following approval by the Employer the Contractor shall level the sites to suit.

B. **Drainage**

Drainage shall be designed in accordance with relevant Codes for Practice published by authoritative Standards Organization such as the British Institution, e.g. BS 8301, BS 6031 and CP 2005.

A surface water drainage system covering the switchyard shall be installed. The number of runs and outfalls and pipe sizing must be sufficient to cope with the severest precipitation, with a factor of safety of 1.2. Within switchyard and other areas in which maintenance will be carried out the drainage must allow uninterrupted access.

Embankments and cuttings are to have drainage facilities at their top or bottom. The formation level of switchyard areas is to be formed with uniform cross-falls of about 1 in 300 in the same direction as the natural drainage path of the surrounding country.

Surface water from roofs of buildings shall be drained to down pipes, which connect with the site drainage system.

C. Cable Ducts and Trenches

The Contractor is responsible for all civil engineering works required for the cable runs between switchgear and buildings, in concrete cable trenches. Cable entries into buildings shall be through ducts or in concrete cable trenches. Trench covers outside buildings shall be of reinforced concrete, designed for the maximum likely imposed loads appropriate to their location. Concrete cable trenches shall be adequately drained to underground infiltration tanks of adequate capacity.

Power cables and control cables shall be laid on suitable cable racks in trenches.
Cable entries into buildings shall be sealed to prevent the entry of dust, vermin, etc., using suitable materials.

D. Station Building

The reinforced concrete framed structure control buildings will be completed with control and relay room. Walls and partitions shall be dressed stone masonry with minimum compressive strength of $12N/mm^2$. Control building floor layout shall be approved by the employer before detailed drawings production. The buildings shall have prefabricated steel roof, with walls of concrete block-work, rendered outside and plastered inside. All walls and roofs shall be fully insulated, to produce maximum thermal transmittance (U.)

values of 1.14 (watts/m^2.) for walls and 0.57 for roofs. Architectural treatment of the buildings shall be in accordance with the Employer's usual standard or preference.
The buildings will have been designed with ease of operation and maintenance as a major factor. Materials, workmanship and finish must be of an appropriately high standard. In considering the various materials, details, and construction methods, Contractors must investigate the availability, delivery and transportation to the sites of all materials, plant, and labour, to enable the programme to be maintained.

The equipment areas shall have screened floors finished with a surface hardener. All finishes shall be fireproof or flame retarding. Floor finished shall be sand-cement screed throughout. Room heights shall be governed by the criteria that there should be 1-meter clearance between the top of cubicles or panels and ceilings.
Particularly, attention must be given in the design of the buildings to fire prevention and safety of the personnel at all times. Access doors and escape doors shall be provided and fitted with panic bolts where necessary, so that operating and maintenance staff can always exit safely from the buildings in fire emergencies of any nature or location.

All windows shall be dustproof. A number of opening lights shall be provided in all rooms, including air-conditioned rooms. External doors shall be made of steel as appropriate.

E. Site Clearance and Excavation

The Contractor shall clear from all areas required for the works all unwanted materials, debris, etc., but shall take all reasonable precautions to prevent damage to existing road construction and to existing surfaces, buildings and other facilities in the area which do not need to be demolished.

The whole of the excavations shall be carried out to the widths, lengths and depths shown on the approved drawings. No unlicensed or indiscriminate digging will be permitted.
The Contractor may excavate by any method he considers suitable, subject to the Employer's approval, and shall allow for the use of types of plant most suited for excavation at any time.

The Contractor shall allow for risk of meeting and having to excavate through any sort of material, which may be encountered, including rock.

Materials from the excavation may, if approved by the Employer, be used by the Contractor in the construction of the Works. Other excavated material shall be backfilled where required or deposited where directed anywhere on site. Surplus materials shall be removed from the site by the Contractor to the approved place. Backfill material shall not be borrowed from the site, site deterioration due to backfill borrowing on site shall be restored to Employer satisfaction with no additional cost. Whereas Employer plot might be bigger than Substation site requirement, the Contractor shall only use the Substation site as will be in the approved Substation layout drawing, use of land outside this area will require Employer approval.

The Contractor shall at all times keep the site free from all surplus materials, rubbish and offensive matter.

In excavations for foundations, a bottom layer of excavation 150mm in thickness shall be left undisturbed and subsequently removed only when the concrete is about to be placed in order that softening or deterioration of the surfaces of the bottom of the excavated area by exposure may be avoided as far possible.

The bottom of all excavated areas shall be trimmed, levelled and well rammed. Concrete shall not be deposited thereon until the bottom has been inspected and approved by the Employer.

All excavation works are to be kept dry and clean, in order that work is not affected or interfered with by water entering the excavations.

The arrangements made for dealing with water in excavations must be approved by the Employer, and they must ensure that the de-watering of excavations can continue during the placing of concrete or the execution of any other works that could be affected by water in excavations. Adequate precautions must be taken against washing out of cement and concrete or to prevent the work being disturbed in any way. No concrete, masonry, brickwork or other materials shall be placed or built until the surfaces are properly drained.

G. Filling and reinstatement

Filling for trenches, excavations and levelling for the Site shall be deposited in layers not exceeding 250mm uncompacted thickness. Where excavations, whether in rock or other material, are made to a greater depth than detailed, the intervening space shall be brought up to the proper level in plain concrete.

The Contractor shall be responsible for the stability of the embankments where formed either by cutting or filling, and precautions taken to protect the earthworks from deterioration under adverse weather conditions. Wherever applicable the recommendations contained in the following codes of practice shall be followed in calculations, detailing and performance of the earthworks and drainage:

(1) Earthworks – British Standard Code of Practice BS 6031 – 1981
(2) Civil Engineering Code of Practice No.2 on Earth Retaining Structures, Issued by institute of Structural Engineers, U.K.
(3) Soils - British Code for Civil Engineering Soils BS 1377.

Embankments shall not be formed over inclined ground surfaces without previously forming the founding surface, on which the fill material will be placed, to a benched profile.

All earthwork top surfaces shall be finished off level and regular and the sides of cuttings and embankments shall be properly trimmed to the detailed slopes as they become consolidated.

The Contractor is to allow for embankments and cutting slopes to be well forked, raked and stabilized as protection from erosion.

3.12.5 CONCRETING WORK SPECIFICATIONS

GENERAL

Authoritative Standards and Codes Practice

The following authoritative standards are referred to hereinafter:

	B. S.	Date	Title
A	12	1989	Portland Cement (Ordinary and rapid hardening) .
B	812		Methods for sampling and testing of mineral aggregates, sand and fillers
C	882	1983	Aggregates from natural source for concrete (including granolithic)
D	1881		Methods of testing concrete
E	5328	1981	Method of specifying concrete
F	2499	1973	Hot applied joint sealants for concrete pavements
G	3148	1980	Tests for making concrete
H	3921	1985	Clay bricks
A	4251	1974 (1980)	Trunk type concrete mixers
B	4449	1988	Carbon steel bars for the reinforcement of concrete
C	4466	1981	Bending dimensions and scheduling of bars for the reinforcement of concrete (old edition)
D	4483	1985	Steel fabric for the reinforcement of concrete
E	5075		Concrete Admixture
F	6073:Pt.1	1981	Precast concrete blocks
G	8810.Pt. 1&2	1985	The structural use of concrete
H	5950		The use of structural steel in buildings
I	KS 95	2003	Specification for Natural Aggregates for use in Concrete
J	8007	1987	The structural use of concrete for retaining aqueous liquids
K	3110	1972	Safe use of cranes (cranes, tower cranes and derrick cranes)

MATERIALS AND SPECIFICATIONS

(a) Concrete for concrete foundation and pile shall have the minimum required breaking strengths as specified in the technical schedules.

(b) Cement used shall be Portland or other approved composition obtained from an approved maker. Portland cement shall conform in all respects o 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 40mm square, subject to KS 95:2003. Where specially approved in writing by the Employer, coarse aggregate of uniform size not larger than will pass a 25mm mesh may be used throughout. Fine aggregate shall be coarse, sharp, clean and free 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 a well-graded mixture of coarse and fine grains from 5-mm gauge downwards.

(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.

(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 a laboratory approved.

Neither the mix proportions nor the source of supply of materials shall be altered without the prior approval of the Employer except that the Contractor shall adjust the proportions of 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) Concrete cubes are to be taken and tested to verify the concrete strength during the concreting works. The Contractor shall provide the cube moulds at site for the purpose, accordingly. The test specimens shall be 150mm cube and the 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) Concrete strength

Grade '35', '30', '25', and '20' concrete shall have the minimum strengths as given by Works Cubes Tests shown below. The grade of concrete stated is concrete characteristic strength below which not more than 5% of the test results may fall, Concrete target mean strength $F_{cu.o}$= Grade in N/mm^2+ 1.645σ where σ = standard deviation of the strength tests, 1.645 is the probability factor and 1.645σ is the design margin. Target mean strength shall exceed required characteristic strength by the design margin value, and ***concrete production shall aim to attain this mean,***

	Minimum Crushing Strengths			
	Grade 35	Grade 30	Grade 25	Grade 20
7 Days	23.5 N/ sq. mm	20.0 N/ sq. mm	16.5 N/ sq. mm	13.5 N/ sq. mm
28 days	35.0 N/ sq. mm	30.0 N/ sq. mm	25.0 N/ sq. mm	20.0 N/sq. mm

The average strength obtained from cube tests shall be 10 per cent higher than the Strength shown above. Subject to design the minimum grade for structural

concrete shall be Grade 25, Grade 15 will be allowed for blinding concrete, precast concrete minimum grade shall be Grade 30.

(h) Tests required and Sampling

⇒ Sampling of materials

- Approved sources, graded aggregates, sampling and testing to BS 812,

⇒ Workability

- Fresh concrete slump test. Slump range 25 – 50mm,
- mechanical vibration and maximum 1.5m fall method of placing.

⇒ Strength/durability

- Compression/cube (150mm) test, three after seven days and three at twenty-eight days. Test to BS 1881.

Works cubes are to be made at intervals as required by the Employer. The cubes shall provide a continuous record of concrete work. The cubes shall be made in approved 150mm moulds in strict accordance with code of practice.
Three cubes shall be made on each occasion from different batches, the concrete being taken from the point of deposit. Each cube shall provide a distinguishing number (numbers to run consecutively and the date, and a record shall be kept on site, giving the following particulars :-

(I) Cube number
(II) Date made
(III) Location in work
(IV) 7 –day Test
Date; ……
Strength ……
28 –day Test……..
Strength……

Cubes shall be forwarded, carriage paid for, to an approved Testing Authority in time to be tested two at 7 days and one at 28 days and the remaining one at the discretion of the Employer. No cube shall be dispatched within 3 days of casting. Copies of all work Cube Test results shall be forwarded to the Employer within one week after test and one shall be retained on site office file.

If the strength required above are not attained, and maintained throughout the carrying out of the contract, the contractor will be required to increase the proportion of cement and/or substitute better aggregate so as to give concrete which does comply with the requirements of the contract .The contractor may be required to remove and replace at his own cost any concrete which fails to attain the required strength as ascertained by Work Cube Tests.

The contractor must allow in his rates for concrete test cubes for all expenses in connection with the preparation and conveyance to the Testing Laboratory and of test cubes and no claim in respect of his failure to do so will be entertained.

Piling and Other Special works.

Piling 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 Employer on the basis of the final agreed design data; and payment made for departures form the assumed tender design quantities on the basis of the difference of quantities times the schedule variation rates. Tender Prices shall include for all necessary casings, pumping, depreciation of piling machines, materials, transportation 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 basis of schedule rates where applicable. To this extent the schedule variation rates for concrete, steel and excavations shall apply throughout irrespective of special conditions.

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

Following special requirement shall additionally be considered:

(A) **Construction Joints**

Construction joints shall be permitted only at the position predetermined on the Drawings or as instructed on the site by the Employer. In general they shall be perpendicular to the lines of principal stresses and shall be located at points of minimum shear, viz. vertically at, or near, mid-span of slabs, ribs and beams.

Suspended concrete slabs are generally to be cast using alternate bay construction in bays not exceeding 15.000M in length. No two adjacent bays are to be cast within a minimum period of 48 hours of each other. The joints between adjacent bays are to positions agreed with the Employer.

Joints shall be water tight and use of water bars and appropriate sealant shall be specified in all cases.

(B) **Construction Bays**

The Contractor shall agree with the Employer, prior to the commencement of concreting, upon the sequence of placing concrete and the positions of vertical and horizontal joints, whether shown or not on the drawings.

In general, slabs in excess of 6 meters in length and/or width and walls exceeding 6 meters in length shall not be poured in one operation and subsequent adjacent shall not be concreted within 7 days. The maximum are of any pour shall be 100-sq mm.

In the light of experience the Employer may consider the above pour size limits to be excessive and will have the authority to reduce them.
Expansion joints shall be fully detailed on construction drawings for approval.

Expansion joints shall be filled with bitumen-impregnated fiberboard to full depth and width. The infilling will be permitted to be used as permanent formwork only for the

second casting. Where the fibreboard is exposed it shall be cutback for a depth of at least 2cm from the chambered edge, filled and pointed with a resilient liquid polysulfide polymer sealant to the manufactures instructions.

Where dowel bars are indicated on the Drawings forming part of a joint, they shall be held securely horizontal and perpendicular to the joint during concreting.

(C) **Formwork**

All, "forms, false work or shuttering" shall include all temporary moulds forming the concrete to the required shape and size together with any special lining that may be required to produce the concrete finish specified.

A. All timber for formwork, false work and centering shall be sound wood, well seasoned and free from lose knots, shakes, large cracks, warping and other defects. Before use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked prior to the placing of concrete shall be rejected.

B. If the contractor proposes to use steel shuttering, he shall submit to the Employer dimensioned drawings of all the component parts, and give details of the manner in which he proposes to assemble or use them. Steel shuttering will only be permitted if it is sturdy in construction and if the manner of its use is approved by the Employer.

C. Struts and props shall, where required by the Employer, be fitted with double hardwood wedges or other approved devices so that the moulds may be adjusted as required and eased gradually when required. Wedges shall be spiked in to position and any adjusting devices locked before the concrete is cast.

D. All forms shall be wood and shall be built grout- tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidents to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the timber.

E. All formwork shall be approved by the Employer before concrete is placed within it. The contractor shall if required by the Employer provide the latter with copies of his calculations of strength and stability of the formwork or false work but not withstanding the Employer's approval of these calculations, nothing shall relieve the contractor of his responsibilities for the safety or adequacy of the formwork.

Form of construction joints

F. Where permanent or temporary joints are to be made in horizontal or inclined members, stout stopping off boards shall be securely fixed across the mould to form a grouting joint. The form of the permanent construction joints shall be as shown on the Drawings.

G. Where reinforcement or water stops pass through the face of construction joint the stopping off boards shall be drilled so that the bars or water stop can pass through or the board shall be made in section with a half round indentation in the joint faces for each bar so that when placed, the board is neat and accurate fit and not grout leaks from the stops.

H. The forms shall be restrained and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed.

I. All sharp edges inside the forms shall be provided with 25mm triangular fillets, unless otherwise shown on the drawings or directed by the Employer.

J. Openings for the inspection and cleaning of the inside of shuttering for walls, piers and columns shall be formed in such a way that they can be closed conveniently before commencing.

K. When concrete is to be deposited to a steeper slope than 45 deg. to the horizontal, top forms shall be used to enable the concrete to be properly compacted.

L. Form, clamps, tie bolts and anchors shall be used to fasten forms. The use of wire ties to hold forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete.

M. The cavities shall be filled with grout mortar and the surface left sound, smooth, even and uniform in colour, All forms form for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

N. The shapes, strength, rigidity, water tightness, and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged timber must be replaced. Forms, which are unsatisfactory in any respect, shall not be re-used.

O. All forms shall be treated with approved mould or similar oil or be soaked with water immediately before placing concrete to prevent adherence of concrete. Any materials which adhere to or discolour concrete shall not be used.

P. All forms shall be set and maintained true to the line designed until the concrete is sufficiently hardened. Forms shall remain in place for periods which shall be as specified hereinafter. When forms appears to be unsatisfactory in any way, either before or during the placing of concrete, the Employer shall order the work stopped until the defect have been corrected.

Release Agent

Q. Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2% will be permitted. Water-soluble emulsion and oils without surfactant shall not be used. Oil based release agents shall be applied at a ratio of $7m^2$/litre, 24 hours in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer's recommendations.

R. The greatest care must be taken that all sawdust shavings, ships and debris is removed from the formwork before concrete is placed in position and the necessary arrangements

must be made by leaving out a board in the bottom of the formwork or otherwise required.

S. The erection, easing, striking and removal of all formwork must be done under the personal supervision of a competent foreman, and any damage occurring through fault formwork or its incorrect removal shall be made good by the contractor at his own expense.

T. All projecting fins on the concrete surfaces after removal of formwork shall be chipped off, and any voids or honey combing to any surface made good to the requirements of the Employer.

U. No patching of the concrete is to be done before inspection of the concrete surfaces as stripped.

V. Traffic or loading must not be allowed on the concrete until the concrete is sufficiently matured and in no case shall traffic or loading be of such magnitude as to cause deflection or other movement in the formwork or damage to the concrete members. Where directed by the Employer props may be required to be left in position under slabs and other members for greater period than those specified hereinafter.

W. It shall be the Contractor's responsibility that no distortion, damage overloading or undue deflection is caused to the structure by the striking of formwork, but the Employer reserves the right to delay the time of striking in the interest of the work. Formwork shall not be struck until the concrete has sufficiently hardened. Approval of the Employer shall not relieve the Contractor of his liability to make good any concrete damage by premature removal or collapse of forms. In no circumstances shall forms be struck until the concrete reaches cube strength of at least twice the stress to which the concrete may be subjected at the time of striking. The following times given in days (24 hours) are the absolute minimum that will permitted:-

Striking Times

Forms	Ordinary Portland Cement	Rapid Hardening Cement
Walls, Columns (unloaded Beam sides	2	2
Slabs – props left under	7	2
Beams soffits – props left under	14	5
Slabs – props	14	5
Beams – props	18	8

The time for removal of forms as set out shall not apply to slabs and beams spanning more than 10 metres. For such spans appropriate times shall be recommended or advised by the Employer.

The periods given above are based on the removal of all props and formwork using ordinary Portland Cement under average weather conditions. Adverse weather conditions or different cement may cause the above periods to be increased. Should the contractor wish to make use

of reduced striking time then he must satisfy the Employer that the strength of the concrete at such time and the structural system is adequate to withstand the dead and imposed loads applied to it. Before making use of reduces striking times the Employer's agreement must be obtained in writing.

Finishes

Saw finish- The shuttering shall consist of saw boards, sheet metal or other materials to give a support to the concrete. Appearance is not of primary importance for this class of formwork. It shall be used for surface against which backfill or further concrete is to be placed. The treatment of the shuttering or concrete to provide a bond for the further surface treatment of the concrete shall be directed or approval by the Employer. Masonry or similar material used for facing concrete shall only be used as shuttering where directed by the Employer.

The Employer's approval shall be obtained to the use of blocks or slabs when used as permanent forms in foundation and other similar location.

A. Wrought finish.
   The shuttering shall be wrought with boards arranged in a uniform pattern. Alternatively, plywood, metal panels or other approved materials may be used, subject to the Employer's approval. Joints between boards or panel shall be horizontal or vertical unless otherwise directed. This shuttering shall give a good finish to the concrete and will normally be used for all faces where a high-class finish is not necessary.

B. Fair-faced finishing.
   Standard steel panels, hardboard and boarding will not be permitted for the face of this shuttering. The shuttering shall be faced with resin-bonded plywood, faced with matt finished plastic or equivalent material in large sheets, which shall be arranged in an approved uniform pattern. Whenever possible, joints between sheets shall be arranged to coincide with features such as stills, jambs or changed in direction or the surface areas of formwork between features in walls, between beams in horizontal surface or other similar arrangement, shall where possible, be divided into panels of uniform dimensions, without the use of make-up pieces. All joint between panels on vertical or inclined surfaces shall be vertical or horizontal unless otherwise directed by the Architect; those on horizontal surfaces shall be at right angles and wherever possible they shall be parallel to walls and beams. The shuttering shall give a high class finish to the concrete with no lips, fins, or irregularities, and shall give a completely true and even surface, which will be prominently exposed to view where good alignment is of special importance. It is for use in both in-situ and pre-cast concrete.

C. Texture finish.
   This is an all-over finish of high quality as may be directed by the Employer. Sample panels may be constructed on site prior to commencement of the works, to compare different textures. The shuttering shall be such that the concrete finish give a surface that will be prominently exposed to view a good appearance and alignment are of special importance.

D. Where other finishes, apart from the above are specified, the contractor shall provide a sample panel at least 2.4m x 1.2m in vertical surface area including a typical horizontal

and vertical joint in the shuttering. The sample panel shall be construction techniques that the contractor proposes for the actual works. This sample when approved will form the standard for the entire works. All unsuccessful samples shall be removed from the site.

Floor Finish

E. Where "tamped finish" is specified it will be obtained by an edge board to the Employer's approval. Board works are so be made to a true pattern and will generally be at right angles to the traffic flow. Haphazard or diagonal tamping will not be accepted.

3.12.6 STRUCTURAL STEEL

QUALITY OF MATERIALS AND WORKMANSHIP

(A) The quality of all materials and workmanship used in the execution of this contract shall comply with the requirements of the most recent issues of the following British Standards and code of practice, including all amendments.

B.S 4 (part 1)	Hot Rolled Sections
B.S 4 (part 2)	Hot Rolled Hollow Sections
B.S 449	The use of Structural Steel in Buildings
B.S 638	Arc welding plant equipment and accessories
B.S 639	Covered Electrodes for manual Metal Arch Welding of Mild Steel and Medium tensile steel
B.S 916	Black Bolts, Screws and Nuts
B.S 1449	Steel plate, sheet and strip
B.S 1775	Steel Tubes for mechanical, structural and General Engineering Purposes
B.S 2994	Cold rolled Steel Sections
B.S 4190	ISO metric black hexagon bolts, screws and nuts
B.S 4320	Metal washers for general engineering purposes
B.S 4360	Weldable structural steel
B.S 4848	Hot rolled structural steel sections
B.S 4872	Approved testing of welds when welding Procedures approval is not required
B.S 5135	General requirements for the Metal Arc Welding of Structural steel
B.S 5493	Protection of iron and steel structures from Corrosion
BS 729	Specification for hot dip galvanized coatings on iron and steel.

TOLERANCES

All members shall be fabricated with a tolerance in length of + 0mm and -3 mm, all shall not deviate from straightness by more than 1 in 400.

The allowance for angular twist shall be (3 + 0.6L) in the length of the member under consideration in metres. Twist shall be measured by placing the member as fabricated against a flat surface measuring the differences between the two corners of the opposite end.

The above tolerances shall be adhered to unless otherwise specified on the Engineer's drawing.

(A) **Materials**

All metals and metal work components whether fabricated on or offsite shall conform to the requirements of the relevant British Standards and other standards to the approval by the Employer.
Metalwork articles shall have a first class finish, and be free from scale, rust, damage or other defects.

Components shall be properly assembled and joined in a neat and functional manner. Welded connections shall be ground off as necessary to present a clean smooth finish without detriment to the strength of the connection.

Particular attention shall be given to the protection of metalwork from degradation caused by the environment in which it is to be used. This shall be accomplished by galvanizing, surface coating or such other treatment suitable for the metalwork under consideration.

(1) Mild Steel
Mild steel shall comply with the relevant standard and shall be galvanized for parts, which are not accessible, or in open air, or come in contact with moisture. All other parts, except reinforcement to concrete, shall be primed as described under the Clause for painting.

(2) Copper
Copper and copper alloys shall comply with the British Standards and approved standards and approved standards relevant to the form and use for which the material is intended.
Copper components shall be placed so that in no case shall they come in direct contact with aluminium nor shall it be possible for water or condensation to pass off copper on to aluminium.

(3) Zinc
Zinc sheet shall be of good colour, free from cracks, dross, overlaps, scales and any other defects, which might be detrimental to its working properties. All zinc shall be at least 0.8 mm thick. No iron or copper shall be used in contact with zinc.

(4) Aluminium Sheeting
Aluminium for profiled roof sheeting and flashing shall be manufactured from alloy in hard temper conforming to BS 1470 Ns3 Specification not less than 0.7 mm thickness and with a colour coasted surface finish. Profiled sheeting shall conform to BS CP 5427.

Fastenings shall be by means of aluminium hook bolts or other approved fixes in accordance with BS CP 143 Part 1 and recommendations of the manufacturer.
Laps shall be sealed as necessary.

(5) Galvanizing

Where steel members are specified to be galvanized they shall be so treated after all cutting, drilling, punching and removal of burrs has been carried out.
Galvanizing shall be applied by the hot dip process and shall consist of a coating of zinc weighing not less than 610 g/sq .m of surface. The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanizing itself shall not adversely affect the mechanical properties of the steel.

The testing of the zinc coating on galvanized articles shall be carried out in accordance with BS 729.

(B) **Steel External Doors**

Steel external doors shall be fabricated from steel sheet covering a framework of steel angles and galvanized after fabrication. Door frames shall also be galvanized steel. All external doors shall be insulated and fitted with panic latches, which are lockable from outside.

External doors shall be effectively sealed to reduce the ingress of dust as far as practicable, using heavy duty seals which shall be guaranteed for a minimum period of five years from date of commissioning. Doors and seals shall be designed so that replacement of worn seals can be achieved easily on site.

(C) **Workmanship**

All plates and sections shall be true to form, free from twist and straightened before any fabrication work is started on them. Each piece of work shall be distinctly marked before dispatch in accordance with a marking diagram to be provided by the Contractor.

3.12.7 BLOCK WORK

A) Materials

(1) Cement

Cement shall be Sulphate–resisting and of a quality as described in the section for concrete. The clause in that section referring to cement storage shall also apply.

(2) Sands an aggregates

Fine and course aggregates for forming blocks shall be aggregates from natural sources of hard, durable material or other approved, free from deleterious substances. Sand shall be graded 2 mm down and coarse aggregate shall be as specified for concrete.

(3) Lime

Lime for mortar shall be hydrated gray-stone lime in accordance with BS 890 for hydrated calcium limes. Magnesia lime shall both be used in mortar for brickwork below the damp-proof course.

The Contractor shall forward copies of Manufacturers certificates to the Employer, which in addition to certifying compliance with BS 890 shall give details of the type of lime. If lime is delivered as lime putty, the certificate shall state whether quicklime or hydrated lime was used in its manufacture.

All lime shall be efficiently protected against deterioration during transport and whilst stored on site. Different type or brands of lime shall be stored separately in dry conditions in a manner that allows it to be used in the order of delivery.

When lime putty is to be used the Contractor shall obtain the approval of the Employer of his arrangement for transport handling and storage. Precautions shall be taken to prevent contamination and drying out of lime putty stored on site. Lime putty made from quicklime should mature for at least 14 days before being used. Where it is made from hydrated lime (powder), lime putty should stand for at least sixteen hours before use.

(4) Concrete Blocks

Concrete blocks shall be solid or hollow blocks to comply with the relevant standard as previously mentioned and shall be solid hard, true to size and shape and sharp arises in accordance with Ministry of Works Standard Specification for Metric sized concrete block for building dated September, 1972.

They shall be obtained from an approved manufacturer or manufactured on site in approved block making machines. The mix used shall be less than (1:9) by volume and maximum size of aggregate shall be 12mm size. The blocks on removal from the machine shall be laid on edge or racks under sheds erected by the Contractor and left for 3 days during which period they shall be kept constantly wet.

After this initial period they shall be placed on edge in the open racks and protected by sacking or other approved covering and kept wet for further 5 days.
Thereafter the blocks shall be left in the same position without wetting for a further 20 days. No blocks shall be used in the works until 28 days old and until samples have been tested approved by the Employer.

The Contractor shall ensure that the blocks are stocked separately in their respective categories in the structure in the position shown on the drawings.

Any stone for walling shall be good hard local stone equal in standard and quality. Stone shall be squared, dressed and joints chisel dressed on the face. Stone to receive render, shall be so dressed to reduce dubbing-out to a minimum.

The coursed stone shall both be less than 150mm deep and 305 mm long. All stone shall be laid on their natural or quarry bed lines.

Block Laying

All blocks shall be kept completely filled with mortar. The thickness of the horizontal mortar joints shall not exceed 40mm to every four joints. Where block work is to be plastered or rendered, joints shall be struck off and left rough to provide a key.

Movement joints shall be provided where required. They shall incorporate a joint filling strip and sealant Gaps in movement joints shall be left free from debris and shall not be pointed with mortar.
Block work shall be built with three courses to 600 mm in a uniform manner, in truly level courses and truly vertical or battered. Corners and other advanced work shall be racked back and not raised above the general level more than one meter. Toothing shall be used only where provision has to be made for a future extension. Both leaves of cavity

shall be built up simultaneously. Galvanized flat twist wall ties of an approved pattern shall be bedded with a slight fall towards the outer face and shall be provided in alternate courses at intervals of 900mm and staggered horizontally. Additional ties shall be used near the sides of all openings at the rate of one for each 300mm of opening height. The cavity shall be kept clear of mortar droppings and rubbish, and the inside mortar joints shall be finished flush as the work proceeds. Cavities shall be 50-75 mm in width.

Both holes shall be built into the external skin of cavity walls in the form of sand filled vertical joints at 1m centres and are to be racked out on completion. Weep holes shall be laced over all lintels.

Walls shall be constructed with an approved metal reinforcement every second course. Additional horizontal reinforcement shall be provided in bed joints in walls for each 2 courses above and below all openings greater than 300mm wide. The reinforcement shall extend a minimum of 900mm beyond the opening on both sides.

Below ground level and at the jambs of all openings, the hollow concrete blocks shall be filled with weak concrete, well taped down and carried from base slab to top of such openings. Cavities shall be kept clear of mortar droppings or other debris, by the use of lifting batters or other suitable means.

Where external block work abuts concrete surfaces and where indicated elsewhere, the blocks shall be tied to the concrete every second course with adjustable galvanized steel ties fixed in slots cast into the concrete.

Concrete abutting external block work shall be coated with two coats of bitumen paint. Holes and chases shall be cut out or left in the walls as required and provision shall be made for making good to the satisfaction of the Employer.

On completion, all block work shall be cleaned down and mortar dropping and other marks removed. Defective blocks or workmanship shall be made good.

(5) Reinforcement

When required, vertical reinforcement for hollow concrete blocks shall be high yield deformed steel conforming to BS 4449 requirements. The minimum to be provided shall be 10mm diameter bars at 150mm centres.

Lap lengths for vertical reinforcement shall be a minimum of 50 diameters.

Horizontal bed joint reinforcement shall be made from hard drawn steel wire to BS4482 consisting of two wires with diameter a minimum of 5 mm and separated by cross wires welded at 304-mm centers. The main wires shall be at 50 mm centers and 160mm centers for 100 and 200mm block work respectively. Alternatively, approved expanded mesh reinforcement may be used.

(6)Lintels

The block work over all openings in walls shall be supported on reinforced concrete grade 25 lintels.

All lintels shall be the same width as the block work into which they are being built.

Building in Frames
Openings in masonry for doors, widows, air conditioning units' ventilators and fans etc. shall be properly marked out and built in as the work proceeds with approved anchors. The fittings shall be propped and strutted where required.

The back surface of steel and galvanized fittings shall be coated with a bituminous paint before fixing.

All fittings shall be bedded in 1:3 sand cement mortar 12mm thick.

Precautions during Inclement Weather
Newly laid masonry work shall be protected from the harmful effects of sunshine, rain, drying wind, running or surface water and shocks. Any work that may be damaged shall be taken out and pointed as directed by the Employer. Any costs incurred in carrying out such remedial work shall be borne by the Contractor.

Damp Proof Course (DPC)
A damp proof course shall be laid in walls, above ground level so as to exclude rising moisture.

Damp-proof courses shall be from one of the following materials:

(1) Lead and copper DPC complying with the requirements of BS 743.
(2) Asbestos base bitumen DPC complying with the requirement of BS 743 Type C.
(3) Asbestos base lead cored bitumen DPC complying with requirements of BS 743 Type F.

Damp-Proof Membrane
An approved bitumen/PVC waterproof membrane shall be placed on the blinding under concrete floor slabs, to exclude rising moisture. The membrane shall be taken up walls and lapped with the wall DPC.

All floor finishes shall be protected from damage by following trades and other causes and any damage, howsoever caused, shall be made good by the Contractor at his own expense to the satisfaction of the Employer.

3.12.8 FLOOR LAYING

(A) Screeded Beds

Concrete floors, which are required to be surfaced with screed, shall have a roughened surface, produced by hacking and wire brushing. The roughened concrete floor shall be cleaned, wetted preferably overnight, the surplus water removed and 1:1 cement/sand grout brushed into the surface, keeping just ahead of the screeded bed. The screeded bed shall be 40mm thick and shall be well compacted and leveled with a screeding board and steel trowelled smooth. If the screed is the finished surface, it should be treated with an approved silicate of soda solution hardener to prevent dusting. The screed shall be mixed in the proportions of 1:2:4 (cement, sand, and 10mm-pea shingle) by volume with the minimum quantity of water necessary to give a good hard smooth, steel trowelled finish. The section hereof concerning concrete applies, but the sand shall satisfy the requirements of BS 1199.

Rigid screed battens shall be fixed on continuous beds of mortar to prevent movement when screeds are being laid and compacted. The screed batten shall be fixed to true lines and levels.

The bay sizes shall not exceed 15 square meters and the length of any one bay shall be limited to 1.5 times the width. The bays shall be laid alternately, ie. in chequerboard fashion, a minimum of 24 hours being allowed to elapse between the laying of adjacent bays.

The bays shall be separated by strips of hard plastic or other suitable material.
Screeded beds shall be cured for at least seven days, using polythene sheeting or other approved method.
Floor finish shall be terrazzo, granito tiles and ceramic tiles mixture as approved

3.12.9 CABLE DUCTS AND DRAINAGE

(A) Cable Ducts

Cable ducts may be constructed of in-situ concrete or pre-cast concrete duct. In each case, the material shall be in accordance with relevant sections of this Specification.
All cable ducts shall be laid in straight lines and regular gradients between cable pits, as directed. All ducts shall be kept clear from earth, debris and other obstructions during and after laying.

(B) Drainage

All drainage shall be designed for common use with cable ducts, in accordance with approved standards and Codes of Practice.

All drains shall be laid in straight lines and regular gradients as described or directed.
Great care shall be exercised in setting out and determining the level of the drains. All drains shall be kept clear from earth, debris, superfluous cement and other obstructions during and after laying.
Underground drains shall be provided with inspection well at appropriate sections and connected to common underground infiltration tank.

3.12.10 PAINTING AND DECORATING

Paints for priming, undercoat and finishing shall be ready mixed paints of the best quality for the intended use and comply with BS 6150. Paint for use on concrete or block work shall be of a type specially prepared for this purpose.

All work shall be properly cleaned and rubbed won between each coat in a way, and using materials, recommended by the manufacturers of the paints concerned. No coat shall be commenced until the Employer has passed the previous coat dry, hard and satisfactory. Each coat shall be of a distinct colour from the preceding one and all colours shall be approved by the Employer. Spray painting will not be permitted except for internal faces of walls and ceiling. All other paint shall be thoroughly brushed into and completely cover the surface.

All timber required to be built into bedded or fixed against brickwork, masonry or concrete shall be given two priming coats and one undercoat on the concealed surfaces.

All woodwork shall have knots treated with two coats of a knotting solution and then painted with aluminium priming paint prior to priming the complete surface. The wood shall then be primed, stopped and painted with two undercoats and one high gloss-finishing coat.

Hard wood, which is not required to be painted, shall be made perfectly smooth, prepared and oiled twice with linseed oil. Alternatively, it shall be stained and wash-polished, or treated with two coats of an approved varnish.

Bitumastic painted surfaces and coated pipes shall be thoroughly cleaned to remove grease, dirt or other deleterious matter, and then painted with one coat of sealer, one coat of leafing aluminium, one coat of undercoating paint and one coat of high gloss finish.

When so described or directed, internal surfaces of fair-faced block work, plastered walls and the soffits of concrete roofs shall be prepared and painted with one coat of antisuction primer, followed by one undercoat and two finishing coat of PVA based plastic emulsion paint.

Exterior surfaces for fair faced block work walls and concrete columns at the new buildings shall be prepared and painted with two coats of an approved stone paint.

At the completion of all works, the Contractor shall clean down the premises; wash paving and steps; wash and leather down wall tiling, etc. Clean all sanitary fittings; touch up paint work; examine all roofs and leave watertight; clean out all pipes and leave the whole of the premises in a clean, sound and perfect condition ready for immediate occupation.

3.12.11 ANCILLARY CIVIL ENGINEERING AND BUILDING WORKS

General

The ancillary civil engineering and building works for the Project are classified as follows:-

(1) Air conditioning and ventilating works.
(2) Fire safety facilities
(3) Control room

(1) Air Conditioning and Ventilating services

Air Conditioning
Control room, Library shall be air-conditioned.
Air conditioning shall be provided in the form of self-contained air conditioning units, in a designed capacity for proper operation and maintenance of communications equipment proposed by the Contract.

The air conditioning units shall be individually thermostatically controlled to maintain internal conditions at 20 to 22 degrees centigrade.

Design

All air conditioning and ventilation systems shall be designed for continuous operation. Plant shall be arranged to facilitate maintenance and future replacement of equipment.

The Contractor shall calculate heat gains and losses under the local conditions, taking into account solar radiation, thermal transmittance through roofs, walls, floors and windows, fresh air requirements, heat emission from installed electrical equipment and lighting, personnel, infiltration and any other sources.

The Contractor shall be responsible for determining the heat transfer coefficients for all materials used in building construction. In the event of any change in materials, design or method of building construction, the Contractor shall at all times be responsible for rechecking the design of all system to ensure that they are capable of meeting the specified design requirements.

Self-contained room air conditioners shall be of the through-the-wall pattern and complete with adjustable grilles, heavy gauze zinc coated stove enamelled sheet steel casing with single or two colour decorative finish.

The casing and position shall be such as to protrude not more than 250mm into the conditioned space and not external projection beyond the building line will be permitted other than the fixing of the condenser cooling air grille.

Compressors shall be of the fully hermetic type, fitted with resilient mountings and complete with thermal overload protection and starting relays.

Evaporators shall be manufactured of copper tube with copper or aluminium fins mechanically bonded. The evaporator fan shall be of double inlet double width type and complete with continuously rated totally enclosed electric motor.

Filters shall be of the washable type, suitably positioned for easy access for cleaning.
Automatic control by means of an integral thermostat shall be provided together with the safety controls to prevent excessive cooling.

(2) Fire Safety Facilities

Portable fire extinguishers shall be provided under this Contract. Portable, wall mounted, hand held extinguishers shall be 5.5kg pressurized control discharge BCF units.

The body of the extinguisher shall be seamless, welded and brazed as appropriate.
The extinguisher shall be capable of being released by means of a lever-operated valve provided with a safety pin.

Extinguishers shall be capable of controlled partial discharge.

The type shall be of that recharge unit that is locally available.

The extinguishers shall be wall mounted and attached in a manner affording quick release from the supporting bracket. They shall be installed so that the top of the extinguisher is not more than 1.5meters above the floor. In no case shall the clearance between the bottom of the extinguisher and the floor be less than 0.1 meter. The extinguishers shall be positioned so that the instructions for operation face outwards.

Automatic control by means of an integral thermostat shall be provided together with the safety controls to prevent excessive cooling.

(3) Control rooms

Extension to BAMBURI Substation Control/Relay Room

At the BAMBURI Substation, the control room shall house the following;

- Circuit breaker control and protection relay panels room

3.13 TESTS AT THE SITE

During the construction and after the installation of each item of equipment under the Section 2, tests shall be performed, as specified herein, to establish the accuracy of the assembly and to prove the adequacy of the materials and the workmanship. All tests and tests procedures shall be approved by the Employer.

The Contractor shall perform the following tests of each subsection, for all items where applicable, to ensure that the equipment has been correctly installed, all necessary adjustments and settings made, and that the item is in sound condition to run under load.

(A) Inspection during erection of equipment

(a) Appearance check of all equipment
(b) Calibration of pressure gauges
(c) Protective relay check
(d) Gas leakage tests
(e) Measurement of the resistance of the main circuit

(B) Test after the installation of equipment

1. Substation Switchgear.

a. Circuit breakers

i. Closing and opening operation test
ii. Trip-free operation test
iii. Manual operation test
iv. Remote operation test
v. Main Contact resistance test
vi. Breaker timing (closing time and opening time)
vii. Measurement of insulation resistance

b. Disconnecting switches

i. Operation test (manual and remote)
ii. Check of interlock mechanism
iii. Measurement of insulation resistance
iv. Main Contact resistance

c. Lightning arresters

i. Measurement of insulation resistance

d. Current transformers

i. Measurement of insulation resistance
ii. Ratio test
iii. Polarity check
iv. Magnetisation curve to confirm knee point

e Voltage transformers

i. Measurement of insulation resistance
ii. Ratio and Polarity check.

2. Control, measuring and protective equipment

a. Control and measuring equipment

i. Relay tests
ii. Measurement of insulation resistance
iii. Sequential operation check
iv. Calibration of meters

b. Protective relaying equipment

i. Individual relay calibration and Functional tests
ii. Residual voltage (current) measurement
iii. Measurement of burden
iv. Current and voltage transformer circuits grounding point check
v. Sequential operation test at each station by primary and secondary injection to check sensitivity and stability
vi. Station to station operation performance tests (transmission line protective relaying equipment only).
vii. Test on Trip and alarm circuits
viii. Test of Autoreclose schemes
ix. Calibration Tests on all Instruments
x. Calibration Test on Energy meter

(3) Miscellaneous materials

a. Outdoor bus

i. Measurement of insulation resistance

b. Power cables

i. High voltage test
ii. Insulation resistance measurement

c. Control cables

i. Insulation resistance measurement

(C) ENVIRONMENTAL REQUIREMENTS

The Contractor shall undertake to complete all works in accordance with statutory requirements including those of:

i) The Kenya Agricultural Act - Concerning protection against soil erosion.
ii) Public Health Act – Concerning with noise, water and air quality as they relate to human health.
iii) Chief Authority Act – Concerning the regulation of timber cutting and wasteful destruction of trees and avoidance of damage to the public road or other community facilities.
iv) The Local Government Act – Section 145 for preservation or protection of wildlife and Section 163 regarding noise disturbance controls.
v) Environment Management and Coordination Act - EMCA"99, Kenya Environmental Law and accompanying gazetted regulations.
vi) Energy Act 2007 Environmental provisions.
vii) Forest and Wildlife Act
viii) Clearance and disturbance of natural vegetation shall be kept to a minimum to prevent habitat loss and to keep soil erosion in check.

3.14 SITE VISIT

In practising due diligence, the contractor is specifically advised to inspect the site & terrain and be well acquainted with the actual working and other prevalent conditions, facilities available, position of material and labour. The bidder is advised to visit and examine the site where the plant is to be installed and its surroundings and obtain for itself on its own responsibility all the information that may be necessary for preparing the bid. The bidders shall ask for necessary clarifications required for clearly understanding the scope & technical /commercial requirements of the tender from KPLC before submitting their offer.

SECTION VI

TECHNICAL SCHEDULES

TECHNICAL SCHEDULES

PREAMBLE

1.1 The Technical Schedules shall be filled in and completed by the Bidder, and submitted with the Bid.

1.2 All documentation necessary to evaluate whether the equipment offered is in accordance with this Specification shall be submitted with the Bid.

1.3 All data entered in the Schedules of Technical Guarantees are guaranteed values by the Bidder and cannot be departed from whatsoever.

1.4 All data entered in the Schedules of Informative. Data are also guaranteed values by the Bidder. These data may only be altered following the Engineer's written consent.

SCHEDULE VI-1a TECHNICAL GUARANTEES, OUTDOOR SWITCHGEAR

OUTDOOR SWITCHGEAR			132kV	
Item	Particulars	Unit	Guar. Fig	Tolerance
A1	**Circuit Breakers** (Type _____)			
	Breaking Medium	SF_6/Vacuum		
	Manufacturer			
	- Rated voltage	kV		
	- Maximum service voltage	kV		
	- Rated frequency	Hz		
	- Rated continuous current	A		
	- One minute power frequency withstand voltage, dry and wet			
	- to earth	kVrms		
	- across open breaker pole	kVrms		
	- Impulse withstand voltage 1.2/50 ms			
	- to earth	kV peak		
	- across open breaker			
	- Breaking capacity at rated voltage			
	- symmetrical	kA rms		
	- asymmetrical	kA rms		
	- Making capacity	kA peak		
	- Breaking capacity of capacitive current	A		

SCHEDULE VI-1a TECHNICAL GUARANTEES, OUTDOOR SWITCHGEAR **Sheet 2 of 3**

OUTDOOR SWITCHGEAR			132 kV	
Item	Particulars	Unit	Guar. Fig	Tolerance
	Circuit breakers continued			
	- Overvoltage factor for disconnection of unloaded transformers (without voltage limitation by lightning arresters)			
	- Rated inductive current switching capacity	A		
	- Permissible 1 second short-time current	kA rms		
	- Dynamic short-time current	kA peak		
	- Opening time, interval of time between the instant of application of tripping impulse to the instant when the main contacts have separated in all poles	m.sec.		
	- Make time, interval of time between the initiation of closing operation and the instant when the current begins to flow in the main circuit	m.sec.		
	- Total break time, interval of time between the instant of application of tripping impulse to the instant of final arc extinction in all poles			
	- at 100% breaking capacity	m.sec.		
	- under phase opposition	m.sec.		
	- Rate of rise of recovery voltage (RRRV) at 100% short circuit current			
	- 3-phase	kV/msec		
	- 1-phase			
	- RRRV out of phase duty	kV/msec		
	- Minimum temperature rise at rated current of main contact	°C		

SCHEDULE VI-1a TECHNICAL GUARANTEES, OUTDOOR SWITCHGEAR **Sheet 3 of 3**

OUTDOOR SWITCHGEAR			132 kV	
Item	Particulars	Unit	Guar. Fig	Tolerance
A2	Current Transformers Manufacturer - Rated voltage - Maximum service voltage - Rated frequency - One-minute power frequency test voltage of - primary winding - secondary winding - Lightning impulse withstand voltage - Rated primary currents - Rated secondary current - Short-time thermal rating - 1 second - Short-time dynamic rating - Burden and accuracy class of - measuring core - protection core - Instrument security factor of the measuring core - Accuracy limit factor of the - protection core	 kV kV Hz kV rms kV rms kV peak A A kA rms kA peak		
A3	**Voltage Transformers**, Type _____ Manufacturer - Rated voltage - Maximum service voltage - One-minute power frequency test voltage - primary winding - secondary winding - Lightning impulse withstand voltage - Burden and accuracy class of a. measuring winding protection winding - Ratio	 kV kV rms kV rms kV rms kV peak kV		
A4	**Country of Manufacture** - Cubicles - Circuit breakers - Current transformers - Voltage transformers			

SCHEDULE 1a: TECHNICAL GUARANTEES, OUTDOOR SWITCHGEAR

Sheet 1 of 2

OUTDOOR SWITCHGEAR			132 kV
Item	Particulars	Unit	Guar. Fig
A5	**Disconnector** (Type _____)		
	Manufacturer	(state)	
	Applicable Standards	(state)	
	Breaking Medium	Air	
	- Rated voltage	kV	
	- Maximum service voltage	kV	
	- Rated frequency	Hz	
	- Rated continuous current	Amps	
	- Contact Resistance	(state)	
	-Max temperature rise under rated voltage and current	(state)	
	-Rated Power Frequency Withstand Voltage		
	- to earth	kV	
	- across open contacts	kV	
	- Impulse withstand voltage 1.2/50 ms		
	- to earth	kV peak	
	- across open contacts		
	- Breaking capacity at rated voltage		
	- symmetrical	kA rms	
	Current density	kA rms	
	-Moving Blade	A/sq.mm	
	- Terminal pad	A/sq.mm	
	- Contacts	A/sq.mm	
	-Terminal connector	A/sq.mm	
	- Breaking capacity of capacitive current	(state)	
	- Rated inductive current switching capacity	(state)	
	- Permissible 1 second short-time current	kA rms	
	- Dynamic short-time current	kA peak	

SCHEDULE 1a:TECHNICAL GUARANTEES, OUTDOOR SWITCHGEAR Sheet 2 of 2

OUTDOOR SWITCHGEAR			132 kV
Item	Particulars	Unit	Guar. Fig
	- Auxiliary Supplies		
	- DC	V	110
	- AC	V	240/415
	- No. of spare auxiliary contacts		
	- disconnector		10
	- earthing switches		5
	- Auxiliary contacts' current rating	Amps	10
	- Motor rating	Amps	
	- Level of galvanisation		
	Padlocking facility in both open and closed position	(state)	
	- Tolerance (DC)	%	85 - 110
	- Degree of Protection for Control box		IP 54
	- Thickness of silver coating	µ	
	- Creepage distance	mm	4495
	- Operation		
	- Local (manual)		
	- Local (motorised)		
	- Remote (motorised)		
	- Interlocking with breaker (electrical/mechanical)	(state)	
	-Interlocking with earth switch (Mechanical)	(state)	
	- Position indication on control box	(state)	
	Clearances		
	-between phases	mm	
	-between phase and ground	mm	
	Type of break	(state)	
	Any special assembly tool	(state)	

SCHEDULE VI-1b INFORMATIVE DATA OUTDOOR SWITCHGEAR

Item	Particulars	Unit	Data	Tolerance
B1	Circuit Breakers			
	- Reference standard			
	- Type of breaker and designation			
	- Voltage drop across main contacts at rated current	mV		
	- Type of main contact	mm		
	- Type of arch control device	m/s		
	- Method of closing			
	- Method of tripping			
	- Max. percentage of recovery voltage across any break	%		
	- Minimum clearance between live parts and earth, in SF6 or vacuum	mm		
	- Min distances between phases			

SCHEDULE VI-1bINFORMATIVE DATA, OUTDOOR SWITCHGEAR Sheet 2 of 3

Item	Particulars	Unit	Data	Tolerance
	- Number of opening operations permissible before inspection and maintenance of contacts, gas treatment etc. - at rated current - at maximum short circuit current			
	For SF_6 breakers			
	- Normal gas density for SF6 circuit breaker (represented by gas pressure)			
	- at 20°C	Bar		
	- at 40°C	Bar		
	- Minimum gas density for safe operation			
	- at 20°C	Bar		
	- at 40°C	Bar		
	- Quantity of gas required per pole	kg		
	- Operating pressure of relief device	Bar		
	- Method of monitoring pressure and temperature compensation			
	- Max. permissible dew point temp.	°C		
	- Max. permissible acidity level			
	- Max. permissible leak rate	%/year		
	- Control voltage	V DC		
	- Type of operating device			
	- Motor voltage			
	- AC or DC			
	- Max. permissible service voltage	V		
	- Min. service voltage	V		
	- Starting current of motor			
	- Power consumption of motor			
	- When starting	W		
	- When running	W		
	- Power consumption of			
	- Closing coil	W		
	- Trip coil	W		
	- Heater	W		

SCHEDULE VI-1bINFORMATIVE DATA, OUTDOOR SWITCHGEAR **Sheet 3 of 3**

Item	Particulars	Unit	Data	Tolerance
	- Auxiliary switch - Rupturing current at 110 V DC - Number of free NO contacts - Number of free NC contacts - Test voltage 50Hz, 1 min. Manufacturers of: - Support insulators - Breaker insulators - Operating mechanism NOTE - In addition to the characteristics listed above, the following information shall be given for all switchgear: - Layout and overall dimensions drawings - descriptions	A V		
B2	Earthing Switches - Reference standard - Type of isolating switch - Min. creepage distance (live parts to earth) - Min. isolating distance (clearance between open contacts) - Material of contact surface - Total contact pressure - Type of operating device - weight of earthing switch	 mm mm		
B3	**Current Transformers** - Reference standard - Type designation - Overall dimensions - Total weight of one current transformer - Type of insulation	 kg		
B4	**Voltage transformers** - Reference standard - Type designation - Overall dimensions - Total weight of one current transformer - Type of insulation - Type of insulation	 kg		

SCHEDULE VI 4a TECHNICAL GUARANTEES, PROTECTION ETC.

CONTROL, PROTECTION, METERING, SIGNALLING				
Item	Particulars	Unit	Guar. Fig	Tolerance
a.1	**Indicating Instruments** - To be filled in for each AC Ampere meter and Voltmeter and for each Wattmeter, VAr-meter and other indicating instruments: - Instrument for: (A, V (AC), W, etc.) - Error - Max. admissible current - Max. admissible voltage	 % %.I_N %.I_N		
a.2	**Meters** - To be filled in for each meter - Meter for (MWh, MVArh): - Error with 5% load - Error with 10% load - Error with 20% load - Error with 100% load - Max. admissible current	 % % % % %.I_N		
a.3	**Metering Converters (Transducers)** - Converter for (MW, MVAr, A, etc.): - Error - Linearity - Max. admissible current for 0.5 seconds - Max. admissible current continuously - Max. admissible voltage for 0.5 seconds - Max. admissible voltage continuously	 % % %.I_N %.I_N %.I_N %.I_N		

SCHEDULE VI 4a TECHNICAL GUARANTEES, PROTECTION ETC. **Sheet 2 of 3**

CONTROL, PROTECTION, METERING, SIGNALLING				
Item	Particulars	Unit	Guar. Fig	Tolerance
a.4	**Protection Relays** - To be **copied** and filled in for each type of relay as applicable Relay for _____: - Accuracy of the adjustable tripping time - Min. possible tripping time - Drop out ratio - Directional sensitivity (dist. relay only) - Max. admissible current during 0.5 sec. - Max. admissible current continuously - Relation between tripping coil current and holding coil current (diff. relay only) - Limit value of the adjustable tripping current (Overcurrent Relay) - Limit value of the instantaneous tripping current (Overcurrent Relay) - Limit value of the adjustable tripping voltage (Overvoltage Relay.) - Limit value of the instantaneous tripping voltage (Overvoltage Relay.)	 sec. ms % %.U_N %.I_N %.I_N % %.I_N %.I_N %.V_N %.V_N		
a.4	**Protection Relays** - To be **copied** and filled in for each type of relay as applicable Relay for _____: - Accuracy of the adjustable tripping time - Min. possible tripping time - Drop out ratio - Directional sensitivity (dist. relay only) - Max. admissible current during 0.5 sec. - Max. admissible current continuously - Relation between tripping coil current and holding coil current (diff. relay only) - Limit value of the adjustable tripping current (Overcurrent Relay) - Limit value of the instantaneous tripping current (Overcurrent Relay) - Limit value of the adjustable tripping voltage (Overvoltage Relay.) - Limit value of the instantaneous tripping voltage (Overvoltage Relay.)	 sec. ms % %.U_N %.I_N %.I_N % %.I_N %.I_N %.V_N %.V_N		

SCHEDULE VI 4a TECHNICAL GUARANTEES, PROTECTION ETC. **Sheet 3 of 3**

CONTROL, PROTECTION, METERING, SIGNALLING				
Item	Particulars	Unit	Guar. Fig	Tolerance
a.5	**Auxiliary Circuit Breakers** - To be filled in for each type of AC and DC breaker: - Min. operating voltage - Max. operating voltage - Drop out voltage - Service life (min. number of contact operations)	 %.U_N %.U_N V		
a.6	**Manufacturer's Name** - Control room panel - Local relay panel - Protection relays - Auxiliary contactors			
a.7	**Country of Manufacture** - Control room panel - Local relay boards - Protection relays - Auxiliary contactors			

SCHEDULE VI 4b INFORMATIVE DATA, PROTECTION ETC.

CONTROL, PROTECTION, METERING, SIGNALLING				
Item	Particulars	Unit	Data	Tolerance
b.1	**Indicating Instruments** To be filled in for each type of instrument: - Reference standard - Type (moving coil, iron type, etc.) - Consumption of internal resistance - Size	 VA/ohm mm		
b.2	**Meters** To be filled in for each type of meter: - Reference standard - Type - Consumption of internal resistance - Size	 VA/ohm mm		
b.3	**Metering Converters** (Transducers) To be filled in for each type for converter: - Reference standard - Type - Consumption, current - Consumption, voltage - Time constant - Size	 VA VA ms mm		
b.4	**Alarm Annunciators** To be filled in for each annunciator panel: - Reference standard - Type - Number of annunciators - Size of each annunciator (area of the cap) - Total size of panel	 mm mm		
b.5	**Control Room Panel** - Height - Width - Length - Relay Panel - Height - Width - Length	 mm mm mm 		

SCHEDULE VI 4b INFORMATIVE DATA, PROTECTION ETC. **Sheet 2 of 2**

CONTROL, PROTECTION, METERING, SIGNALLING				
Item	Particulars	Unit	Data	Tolerance
b.6	**Protection Relays** To be **copied** and filled in for each relay with the applicable items of the data below: Relay for _____: - Reference standard - Consumption - Limit values of the adjustable tripping time - Limit values of the adjustable sensitivity - Limit values of the adjustable operating quantity (current, voltage, frequency, etc.) in % of normal - Limit values of the instantaneous operating quintet in % of nominal value - Size For distance relay only: - Starting impedance adjustable between - Earth fault tripping current adjustable between	 VA sec. % % % mm ohm/ph x.I_N		
b.6	**Protection Relays** To be filled in for each relay with the applicable items of the data below: Relay for _____: - Reference standard - Consumption - Limit values of the adjustable tripping time - Limit values of the adjustable sensitivity - Limit values of the adjustable operating quantity (current, voltage, frequency, etc.) in % of normal - Limit values of the instantaneous operating quintet in % of nominal value - Size For distance relay only: - Starting impedance adjustable between - Earth fault tripping current adjustable between	 VA sec. % % % mm ohm/ph x.I_N		

SCHEDULE VI 5b INFORMATIVE DATA, CABLES

POWER CABLES, CONTROL CABLES, CABLE RACKS				
Item	Particulars	Unit	Data	Tolerance
b.1	Low Voltage Cables - Conductor material - Insulation material - Armouring/screen - Protective coating - Overall diameter of cable of biggest cable - Weight of heaviest reel, including cable - Size of biggest reel, diameter/width	 mm kg mm/mm		
b.2	**Control and Measuring Cables** - Conductor material - Insulation material - Armouring/screen - Protective coating - Overall diameter of cable of biggest cable - Weight of heaviest reel, including cable - Size of biggest reel, diameter/width	 mm kg mm/mm		
b.3	**Special Cables** To be used for: - Relevant informative data			

SCHEDULE VI 6a TECHNICAL GUARANTEES, EARTHING

Sheet 1 of 1

EARTHING SYSTEM				
Item	Particulars	Unit	Guar. Fig	Tolerance
a.1	**Resistance to Earth of Earthing Electrode System** (for each substation)			
	- Under the control building max.	ohms		Nil
	- Under the switchyard max.	ohms		Nil
	- Complete earthing system	ohms		Nil

SCHEDULE VI 6b INFORMATIVE DATA, EARTHING

EARTHING SYSTEM				
Item	Particulars	Unit	Data	Tolerance
b.1	- Reference standard - Material of earth conductor - Max. temp of any earth conductor during 1 sec. rated phase - ground fault - Method of interconnecting earth grid conductors			

SECTION - VI

FORMS AND PROCEDURES

Forms and Procedures

Form of Completion Certificate

Date: _____
Loan/Credit Nº: _____
IFB Nº: _____

_____

To: _____

Dear Ladies and/or Gentlemen,

Pursuant to GC Clause 24 (Completion of the Facilities) of the General Conditions of the Contract entered into between yourselves and the Employer dated _____, relating to the _____, we hereby notify you that the following part(s) of the Facilities was (were) complete on the date specified below, and that, in accordance with the terms of the Contract, the Employer hereby takes over the said part(s) of the Facilities, together with the responsibility for care and custody and the risk of loss thereof on the date mentioned below.

1. Description of the Facilities or part thereof: _____

2. Date of Completion: _____

However, you are required to complete the outstanding items listed in the attachment hereto as soon as practicable.

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

_____
Title
(Project Manager)

Form of Operational Acceptance Certificate

Date: _____
Loan/Credit Nº: _____
IFB Nº: _____

_____

To: _____

Dear Ladies and/or Gentlemen,

Pursuant to GC Sub-Clause 25.3 (Operational Acceptance) of the General Conditions of the Contract entered into between yourselves and the Employer dated _____, relating to the _____, we hereby notify you that the Functional Guarantees of the following part(s) of the Facilities were satisfactorily attained on the date specified below.

1. Description of the Facilities or part thereof: _____

2. Date of Operational Acceptance: _____

This letter does not relieve you of your obligation to complete the execution of the Facilities in accordance with the Contract nor of your obligations during the Defect Liability Period.

Very truly yours,

_____
Title
(Project Manager)

Change Order Procedure and Forms

Date: _____
Loan/Credit Nº: _____
IFB Nº: _____

CONTENTS

ANNEXES

Change Order Procedure

1. General

This section provides samples of procedures and forms for implementing changes in the Facilities during the performance of the Contract in accordance with GC Clause 39 (Change in the Facilities) of the General Conditions.

2. Change Order Log

The Contractor shall keep an up-to-date Change Order Log to show the current status of Requests for Change and Changes authorized or pending, as Annex 8. Entries of the Changes in the Change Order Log shall be made to ensure that the log is up-to-date. The Contractor shall attach a copy of the current Change Order Log in the monthly progress report to be submitted to the Employer.

3. References for Changes

(1) Request for Change as referred to in GC Clause 39 shall be serially numbered CR-X-nnn.

(2) Estimate for Change Proposal as referred to in GC Clause 39 shall be serially numbered CN-X-nnn.

(3) Acceptance of Estimate as referred to in GC Clause 39 shall be serially numbered CA-X-nnn.

(4) Change Proposal as referred to in GC Clause 39 shall be serially numbered CP-X-nnn.

(5) Change Order as referred to in GC Clause 39 shall be serially numbered CO-X-nnn.

Note: (a) Requests for Change issued from the Employer's Home Office and the Site representatives of the Employer shall have the following respective references:

Home Office	CR-H-nnn
Site	CR-S-nnn

(b) The above number "nnn" is the same for Request for Change, Estimate for Change Proposal, Acceptance of Estimate, Change Proposal and Change Order.

Annex 1. Request for Change Proposal

(Employer's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

With reference to the captioned Contract, you are requested to prepare and submit a Change Proposal for the Change noted below in accordance with the following instructions within _____ days of the date of this letter _____.

1. Title of Change: _____

2. Change Request No. _____

3. Originator of Change: Employer: _____
Contractor (by Application for Change Proposal No. _____[1]:

4. Brief Description of Change:
_____

5. Facilities and/or Item No. of equipment related to the requested Change:
_____

6. Reference drawings and/or technical documents for the request of Change:

Drawing No./Document No. Description

7. Detailed conditions or special requirements on the requested Change:
_____

8. General Terms and Conditions:

(a) Please submit your estimate to us showing what effect the requested Change will have on the Contract Price.

(b) Your estimate shall include your claim for the additional time, if any, for completion of the requested Change.

_____

(c) If you have any opinion negative to the adoption of the requested Change in connection with the conformability to the other provisions of the Contract or the safety of the Plant or Facilities, please inform us of your opinion in your proposal of revised provisions.

(d) Any increase or decrease in the work of the Contractor relating to the services of its personnel shall be calculated.

(e) You shall not proceed with the execution of the work for the requested Change until we have accepted and confirmed the amount and nature in writing.

_____

(Employer's Name)

_____

(Signature)

_____

(Name of signatory)

_____

(Title of signatory)

Annex 2. Estimate for Change Proposal

(Contractor's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

With reference to your Request for Change Proposal, we are pleased to notify you of the approximate cost of preparing the below-referenced Change Proposal in accordance with GC Sub-Clause 39.2.1 of the General Conditions. We acknowledge that your agreement to the cost of preparing the Change Proposal, in accordance with GC Sub-Clause 39.2.2, is required before estimating the cost for change work.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Brief Description of Change: _____

4. Scheduled Impact of Change: _____

5. Cost for Preparation of Change Proposal: _____[2]

(a)		Engineering	(Amount)
(i)	Engineer	_____ hrs x ___ rate/hr =	_____
(ii)	Draftsperson	_____ hrs x ___ rate/hr =	_____
Sub-total	_____ hrs		_____
Total Engineering Cost			_____
(b)		Other Cost	_____
Total Cost (a) + (b)			_____

[2] Costs shall be in the currencies of the Contract.

(Contractor's Name)

_____

(Signature)

_____

(Name of signatory)

_____

(Title of signatory)

Annex 3. Acceptance of Estimate

(Employer's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

We hereby accept your Estimate for Change Proposal and agree that you should proceed with the preparation of the Change Proposal.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Estimate for Change Proposal No./Rev.: _____

4. Acceptance of Estimate No./Rev.: _____

5. Brief Description of Change: _____

6. Other Terms and Conditions: In the event that we decide not to order the Change accepted, you shall be entitled to compensation for the cost of preparation of Change Proposal described in your Estimate for Change Proposal mentioned in para. 3 above in accordance with GC Clause 39 of the General Conditions.

_____
(Employer's Name)

_____
(Signature)

_____
(Name and Title of signatory)

Annex 4. Change Proposal

(Contractor's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

In response to your Request for Change Proposal No. _____, we hereby submit our proposal as follows:

1. Title of Change: _____

2. Change Proposal No./Rev.: _____

3. Originator of Change: Employer: *[*_____
Contractor: _____

4. Brief Description of Change: _____

5. Reasons for Change: _____

6. Facilities and/or Item No. of Equipment related to the requested Change:
_____

7. Reference drawings and/or technical documents for the requested Change:

Drawing/Document No.	Description

8. Estimate of increase/decrease to the Contract Price resulting from Change Proposal:[3]

	(Amount)
(a) Direct material	_____
(b) Major construction equipment	_____
(c) Direct field labor (Total _____ hrs)	_____
(d) Subcontracts	_____

[3] Costs shall be in the currencies of the Contract.

(e) Indirect material and labor _____

(f) Site supervision _____

(g) Head office technical staff salaries

Process engineer	_____ hrs @ _____	rate/hr	_____
Project engineer	_____ hrs @ _____	rate/hr	_____
Equipment engineer	_____ hrs @ _____	rate/hr	_____
Procurement	_____ hrs @ _____	rate/hr	_____
Draftsperson	_____ hrs @ _____	rate/hr	_____
Total	_____ hrs		_____

(h) Extraordinary costs (computer, travel, etc.) _____

(i) Fee for general administration, _____ % of Items _____

(j) Taxes and customs duties _____

Total lump sum cost of Change Proposal _____
(Sum of items (a) to (j))

Cost to prepare Estimate for Change Proposal _____
(Amount payable if Change is not accepted)

9. Additional time for Completion required due to Change Proposal

10. Effect on the Functional Guarantees

11. Effect on the other terms and conditions of the Contract

12. Validity of this Proposal: within *[Number]* days after receipt of this Proposal by the Employer

13. Other terms and conditions of this Change Proposal:

(a) You are requested to notify us of your acceptance, comments or rejection of this detailed Change Proposal within _____ days from your receipt of this Proposal.

(b) The amount of any increase and/or decrease shall be taken into account in the adjustment of the Contract Price.

(c) Contractor's cost for preparation of this Change Proposal:[2]

_____
(Contractor's Name)

[2] Specify where necessary.

(Signature)

(Name of signatory)

(Title of signatory)

Annex 5. Change Order

(Employer's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

We approve the Change Order for the work specified in the Change Proposal (No. _____), and agree to adjust the Contract Price, Time for Completion and/or other conditions of the Contract in accordance with GC Clause 39 of the General Conditions.

1. Title of Change: _____

2. Change Request No./Rev.: _____

3. Change Order No./Rev.: _____

4. Originator of Change: Employer: _____
Contractor: _____

5. Authorized Price:

Ref. No.: _____ Date:
_____
Foreign currency portion _____ plus Local currency portion _____

6. Adjustment of Time for Completion

None Increase _____ days Decrease _____ days

7. Other effects, if any

Authorized by: _____ Date: _____
(Employer)

Accepted by: _____ Date: _____
(Contractor)

Annex 6. Pending Agreement Change Order

(Employer's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: *[*_____

Dear Ladies and/or Gentlemen:

We instruct you to carry out the work in the Change Order detailed below in accordance with GC Clause 39 of the General Conditions.

1. Title of Change: _____

2. Employer's Request for Change Proposal No./Rev.: _____ dated: _____

3. Contractor's Change Proposal No./Rev.: _____ dated: _____

4. Brief Description of Change: _____

5. Facilities and/or Item No. of equipment related to the requested Change: _____

6. Reference Drawings and/or technical documents for the requested Change:

Drawing/Document No.	Description

7. Adjustment of Time for Completion:

8. Other change in the Contract terms:

9. Other terms and conditions:

(Employer's Name)

(Signature)

(Name of signatory)

(Title of signatory)

Annex 7. Application for Change Proposal

(Contractor's Letterhead)

To: _____ Date: _____

Attention: _____

Contract Name: _____
Contract Number: _____

Dear Ladies and/or Gentlemen:

We hereby propose that the below-mentioned work be treated as a Change in the Facilities.

1. Title of Change: _____

2. Application for Change Proposal No./Rev.: _____ dated: _____

3. Brief Description of Change: _____

4. Reasons for Change:

5. Order of Magnitude Estimation (in the currencies of the Contract):

6. Scheduled Impact of Change:

7. Effect on Functional Guarantees, if any:

8. Appendix:

_____
(Contractor's Name)

_____
(Signature)

_____
(Name of signatory)

_____
(Title of signatory)

DRAWINGS REFERENCE

The following drawings shall be referenced for protection, metering & layout of the sub-station at BAMBURI 132kV and this drawing shall be read in conjunction with the "Technical Specifications"

SCOPE OF WORK - SUBSTATIONS

As required for effective and completeness of the works relating to installation, testing and commissioning of the transformer and associated switchgear

TABLE OF CONTENTS

4.2 SCOPE OF WORK - SUBSTATIONS

4.2.1 General

The Bidder shall examine the scope of works in this section in close connection with the other documents and particulars forming these Bidding Documents.

Special attention shall be paid to General Specifications and Particular Technical Specifications, in which the general technical requirements are specified. The drawings enclosed in are for bidding purposes only.

If the Specifications and/or Drawings do not contain particulars of materials or goods, which are necessary for the proper and safe completion, operation, and maintenance of the equipment in question, all such materials shall be deemed to be included in the supply.

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

In the event of any conflict between scaled dimensions and figures on the Drawings, the figures shall prevail.

Should the Bidder find discrepancies in or omissions from these Specifications or from the other Documents, or should he be in doubt as to their meaning, he should immediately contact the Project Manager for interpretation, clarification or correction thereof before submitting his Bid. Such action shall, however, in no case be considered as a cause for altering the closing date of the Bid.

The scope of work for equipment shall cover engineering design, manufacture, testing before shipment and packing sea worthy or otherwise as required, delivery CIP site, of all equipment as specified in the preceding chapters.

For substations contracted on turnkey basis the substation contractor shall be responsible for design, material supply, transport, erection, and installation and commissioning as well as having the full responsibility for civil works including design and construction of transformer foundations and control building.

The Contractor shall design and construct the transformer foundations with oil collection pit, oil trap and fire damper consisting of crushed stones laying on a galvanised steel grating.

Loose equipment for the Employer’s rehabilitation shall be complete with documentation and ancillaries like programs, licences and programming tools.

Equipment that is to be dismantled and removed from existing substations is to be recovered by the Contractor and deposited to sites within or in the immediate vicinity of each substation. Such sites are to be designated by the Employer. The recovered equipment is to be taken over by the Employer at these sites.

KPLC has a SCADA (Supervisory, Control & Data Acquisition) system that is controlled from the Regional Control Centres& the National Control Centre. The National Control Centre (NCC) is at Juja Rd and controls the entire transmission network & substations (ie some 66kV, all 132kV, all 220kV & soon to be introduced 400kV stations.)

There are 4 regional control centres in total. These are located in the following locations; Juja Rd (Nairobi region), Rabai (Coast region), Lessos (West Kenya region) &Kiganjo (Mt Kenya region). These Regional Control Centres monitor & control the 11KV, 33kV & 66kV Distribution networks &substations in their specific regions.

The Control Centres all run ABB's Network Manager WS500 which is the software used for monitoring & Control of all the incorporated substations. The Communication protocol currently supported by KPLCs front end servers is ABBs PCU 400, for data telegram exchange with Remote Terminal Units (RTUs). Whereas, the Station Control Management Systems (SCMS) in the substations in its SCADA system are **IEC 60870-5-101**&**IEC 60870-5-104**.

The interconnected KPLC's telecommunications system is based on a backbone of SDH STM1/4 terminal equipment, FOX 515 from ABB. A network management system (NMS) for the telecommunication system has been installed at NCC.

4.2.2 Standard Substation

This section defines the standard substation components. The actual quantities to be included in the price schedules are found for each substation in the subsequent sections.

4.2.3 132 kV Bay

4.2.3.1 Take off bay

1 (one) complete bay shall be equipped with:

(a) 1 (one) circuit breaker
(b) 2 (two) isolator with motor operation
(c) 1 (one) earthing switch
(d) 2 (Two) set of bus bars support
(e) 1 (one) complete set of three-phase line including clamps for the flying busbars and for connection between the gantries, and between the apparatus.
(f) 1 (one) set of current transformers
(g) 1 (one) set of surge diverters
(h) 1 (lot) of steel structures for support
(i) 1 (one) bay control unit with proper display, for measurements (V,I,MVAR,MW)
(j) 1 (one) multifunctional protection unit as per 4.1.2.4.2.2 Section VI Particular Technical specifications substations control, and Protection
(k) HV over current protection relay.
(l) 1 (one) lock-out trip relay with electrical/hand reset facilities
(m) 1 (one) lot of necessary interposing relays, MCB's, terminal blocks and wiring to form a complete operative bay control. The control scheme shall be prepared for SCADA operation.
(n) 1 (one) set of Voltage Capacitive transformers

4.2.3.1.1 Scope SCADA/SAS.

(a) For New substations: 1 (one) lot complete system (equipment and software), with communication gateway, data concentrator etc. for interface to a regional (RCC) SCADA system and to the national (NCC) SCADA system.
(b) For existing Substations with SAS/RTU in operation. One complete (lot) extension of the SAS/RTU to accommodate the additional switchgear. This shall include Hardware and software and necessary Engineering.

For a point-to-point communication link the IEC 60870-5-101 protocol shall be implemented. As part of the supply necessary engineering of the substation signal list (I/O list) shall be included. The engineering shall be carried out on the format prescribed to KPLC by the SCADA contractor.

4.2.3.2 Control and Measuring Cables

(a) All external cables, conventional or fibre optical, for control, protection, measuring, indication, etc., for the complete plant. Wiring between the switchyard apparatus, transformers, the board(s) and the control system in the control building and the interconnections between the various apparatus in the switchyard shall be included.

4.2.3.3 Telecommunications

a) In order for the SCADA data to be transferred to the Regional control centres, the bidder shall design and commission an appropriate communication system based on Fibre or PLC communication media for data and speech requirement.

   Equipment supplied shall be digital and latest technology and shall comply to the latest ITU-T, IEC, ITU-R, IEEE and ETSI standards.

   It is required that one remote subscriber be implemented in each substation.
   Interface for data transmission shall be according to ITU-T recommendation V.24 or V.35
   Bit error rates of $1x10^{-6}$ shall not be exceeded.

b) It is the responsibility of the contractor to interconnect with existing SCADA and Telecommunications system. However use and extension of existing infrastructure where possible shall be encouraged.
c) The Tenderer shall acquaint himself with all the sites and determine the requirements for towers or masts to suit his design. When a new tower or mast is necessary is necessary, the Tenderer shall supply drawings for the proposed installation. All towers shall be 36 m and self supporting. The tenderer shall provide details of loading and guy stresses for masts or towers to be erected on buildings. All antennae mounting components including wave-guides, cables, cable clamps and external cable connectors shall be specified.
d) Where PLCs are to used or where the T-offs affect existing PLC communication links, blocking line-traps including support structures shall be in scope of supply.
e) All communications equipment installed in the country must be type approved by the Communications Commission of Kenya (CCK). The Contractor will obtain the type approval.
   The CCK has to be consulted and give approval for each new project and an application has to be submitted stating the location of the sites and request for

the frequencies to be used. Unless otherwise stated this application for frequencies is normally done by KPLC.
The radio frequency plan shall be prepared by the Contractor and closely coordinated with KPLC during the project design stage. All path surveys shall be carried out by contractor.

f) The Contractor shall provide a list of recommended spares, the quantities and prices to last for a period of five (5) years after expiry of guarantee period.
g) The contractor shall offer training for four (4) technical appointees of the employer for 2 weeks at manufacturer's premises. Terms and conditions similar to 4.2.15
h) The contractor shall provide necessary configuration software pre-installed on a maintenance laptop with a one-time software license.

4.2.3.3.1 Scope of works - Telecommunication

The scope as described shall include detailed system design, manufacture, supply, installation, testing, commissioning, remedying of defects, and maintaining the works during the defects liability period and any incidental work necessary for the proper completion of the work in accordance with this contract. Scope shall include integration of STM-4, to the existing KPLC Network Management System. In some cases there shall be need to upgrade existing Telecommunication equipment in order to achieve data and speech routing to Regional and National control centres. Survey and necessary preparation works on existing systems, Equipment and substations to achieve specified functionality shall be in the scope of supply. Contractors shall be required to submit for approval detailed design of system before manufacture.
The STM 4 equipment shall include Tele-protection modules (4 Command), High Speed Ethernet modules and 1+1 protection.
Necessary upgrade of communication and SCADA Front Ends (PCUs) equipment at terminal stations and at Control centres shall achieve complete Data and Speech to RCC/NCC shall be included in scope.

In addition all substations (irrespective of whether SCADA functionality to control centre is established) shall be equipped with a Base Radio capable of communicating with the ASTRO trunking radio system for use during switching operations. Where OLTEs are the terminal equipment, additional Ethernet capability shall be established to cater for other corporate data. All stations shall be equipped with two (2N0.) telephone extensions originating from existing PAXes in Regional control centres.

All communication equipment supplied under this project shall be type approved by the regulator, Communication Commission of Kenya (CCK) and the Kenya Bureau of Standards (KBS) where applicable. It is the responsibility of the contractor to obtain these necessary approvals.

The type of required communication link shall be detailed in scope of supply for individual stations.

4.2.4 Auxiliary AC Supply Equipment

4.2.4.1 Main AC Distribution Board

1 (one) main distribution board designed for minimum 200 A with the necessary number of panels for:

(a) 1 (one) circuit breaker, manual operated, minimum 200 A, for the feeder from the station supply transformer.
(b) 2 (two) current transformers 200/1/1 A with two cores, one core for measuring and one for protection.
(c) 1 (one) constant time over current relay.
(d) 1 (one) earth fault relay.
(e) 1 (one) A-meter function with selector switch.
(f) 1 (one) V-meter function with selector switch.
(g) 1 (one) lot of feeder circuit breakers with electro-BAHnetic and thermal releases. The breaker ratings shall be chosen to suit the different consumers to be connected. 20% of the breakers of each size shall be spare and readily mounted.

4.2.4.2 Sub-distribution Boards and Panels

(a) 1 (one) lot of all necessary sub-distribution boards and panels (including the distribution panel for lighting and small power of the control building).

The boards shall be completely equipped with busbars, circuit breakers, miniature circuit breakers etc. Contactors, motor starters, instruments, operating switches, push buttons, indicating lamps, etc., shall be included whenever required. 20% of the breakers of each size shall be spare and readily mounted.

4.2.4.3 Cables

(a) 1 (one) lot of all necessary armoured power and control cables for supply to the main distribution board and to the sub-distribution boards, panels and equipment except for the cables for lighting and small power which are included in the civil Goods under separate contract.

4.2.5 DC Supply System

4.2.5.1 Battery

i. (1 (one) 110 V battery. Capacity at least 200 Ah/10h for substations with more than 10 MVA installation of transformer capacity

ii. The 48V batteries shall be included in the bid for communication equipment and the RTU. The battery shall be at least 100A/10Ah

The capacities to be recommended by the Bidder, based upon the calculated consumption considering a fully developed substation.
Batteries shall be installed in separate room with EX proof ventilation fan (for 110 V batteries only).

4.2.5.2 Charger

(a) 1 (one) DC charger for the 110 V battery.
(b) 1 (one) DC charger for the 48 V Battery.

The chargers shall be complete with instruments, breakers on AC and DC side, and protection.

4.2.5.3 Switchboard

1 (one) switchboard 110 V DC.

The board shall have:

(a) 1 (one) circuit breaker with BAHnetic and thermal release for the feeder from earache charger and battery.
(b) 1 (one) A-meter with shunt for each battery.
(c) 1 (one) V-meter with selector switch for the voltage between the poles and between poles and earth for each battery.
(d) 1 (one) set of contacts on the front for banana jacks for the battery voltage and earth.
(e) 1 (one) battery monitoring devices with alarm contacts.
(f) 1 (one) lot of all necessary circuit breakers and miniature circuit breakers for the outgoing feeders and circuits.

20% of the breakers of any size shall be spare and readily mounted.

4.2.5.4 Battery Conductors and Fuses

(a) 1 (one) set of conductors for the battery in the battery room.
(b) 2 (two) single pole fuse boxes with main fuses for the battery, placed on the wall outside of the battery room, and two fuses for the battery monitoring device.

4.2.5.5 Sub-distribution Boards and Panels

(a) 1 (one) lot of all necessary sub-distribution boards and panels.

The boards shall be completely equipped with busbars, miniature circuit breakers, fuses, etc. Contactors, motor starters, instruments, operating switches, push buttons, indicating lamps, under-voltage relays with alarm contact, etc., shall be included whenever needed.

4.2.5.6 Cables

(a) 1 (one) lot of all necessary DC power supply cables, including wiring to the apparatus in the switchyard.

4.2.6 Earthing System

An earthing network shall be installed comprising the following:

(a) 1 (one) lot of underground earthing system covering the platform and control building with risers
(b) 1 (one) complete set of "above-floor" earthing system for the control building, as applicable, with connections to the risers from the under-ground system.

4.2.7 Ancillary Equipment

4.2.7.1 Station Equipment

(a) 2 (two) self-contained, rechargeable, portable hand-held lights.
(b) 1 (one) audible alarm system with the necessary wiring.

4.2.7.2 Earthing Devices

(a) 1 (one) set of three phase portable earthing devices for outdoor 33kV with operating rods suitable for earthing of the bay conductors and busbars.
(b) 1 (one) set of voltage indicator for 33 kV and 11KV with audible and visual indication for voltage

4.2.7.3 Cable Accessories

(a) 1 (one) lot of all connecting material, cable boxes and material for fixing the cables.

Terminals and terminal labels to the extent that this is not included in other sections.

4.2.7.4 Racks, Conduits, Ducts, etc

(a) 1 (one) lot of all cables, racks and trays to the extent necessary for the proper distribution of cables.

All the conduits and protection tubes, wherever cables may deteriorate or where cable laying may otherwise present difficulties.

Civil Works

Platform works

Platform with fence roads and ditches shall be constructed as specified in particular specifications and in scope of work.

Switchgear buildings

Switchgear buildings shall be constructed as specified in particular specifications and in scope of work.
Control Panels and medium voltage indoor switchgears of different Voltage levels shall be installed in separate rooms

Transformer foundations

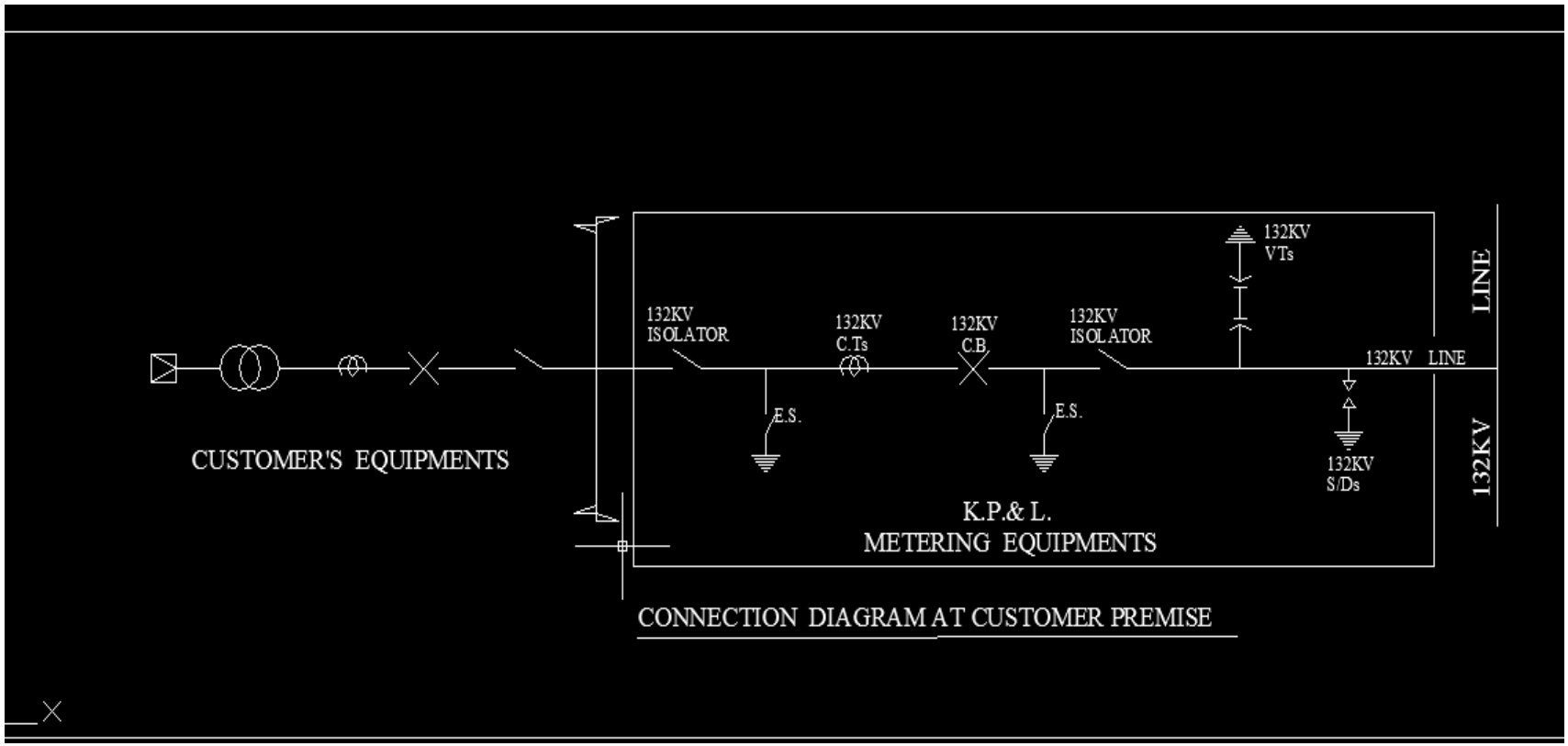
Transformer foundations shall be constructed as specified particular specifications and in scope of work.

Cable Trenches

Cable trenches shall be constructed as specified in particular specifications and in scope of work.

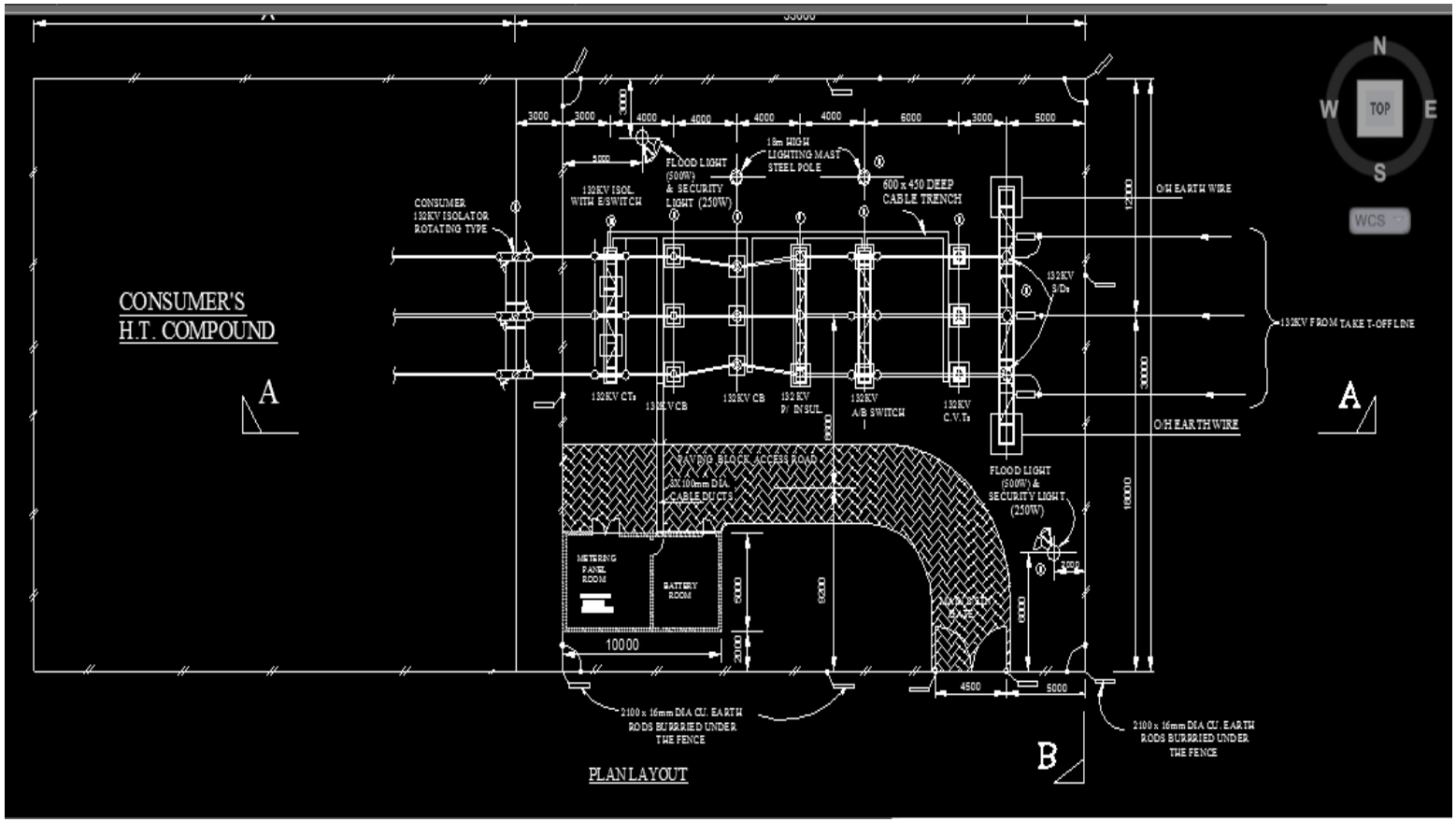
i. Single line diagram for BAMBURI 132kV METERING

Note: These drawings are a guideline. Plot dimensions -30mx33m



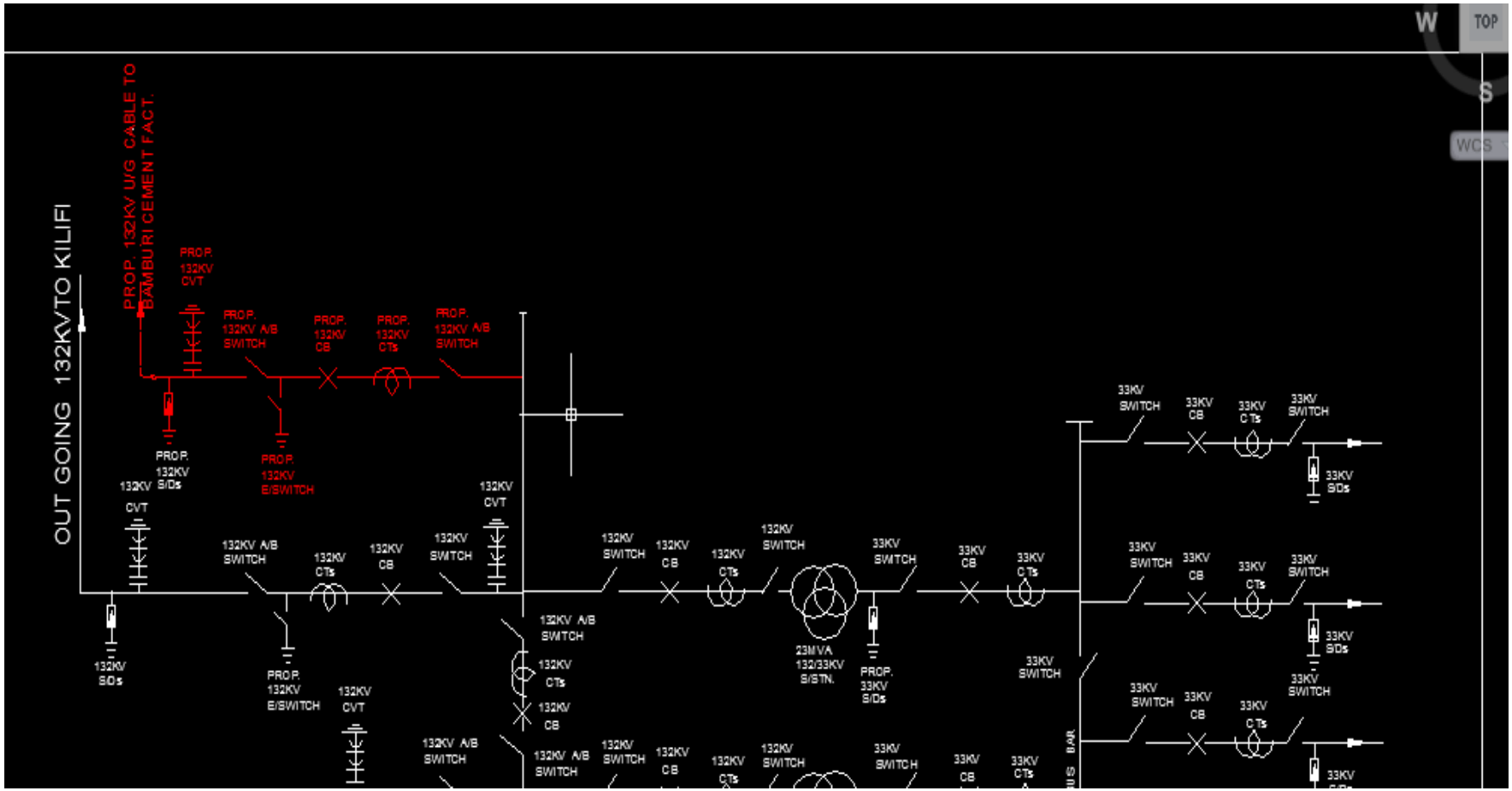
ii. General arrangement for BAMBURI 132kV METERING

Note: These drawings are a guideline. Plot dimensions -30mx33m



i. Single line diagram for BAMBURI 132kV Substation Bus Bar extension and Bay

Note: These drawings are a guideline. RED works as proposals



iii. General arrangement for BAMBURI 132kV METERING

Note: These drawings are a guideline. Proposals in RED