SECTION V

4.1.4 PARTICULAR TECHNICAL SPECIFICATIONS

FOR

SUBSTATION CIVIL WORKS

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4.1.4 PARTICULAR SPECIFICATION – SUBSTATION CIVIL WORKS

4.1.4.1 General

4.1.4.1.1 Summary and Location of the Works

The works to be constructed include the following:

4.1.4.1.1.1 33/11KV Substations with 2.5MVA to 7.5MVA Transformers

a. Site clearance and disposal of spoil from site.
b. Earthworks (cut, back fill, compaction, area grading and ballasting) of entire plot.
c. Transformer plinth shall be designed for 7.5 MVA transformer complete with a transformer oil interceptor pit and burnt oil separator.
d. Steel support structure for 2.5 MVa transformer to achieve min ground clearance
e. Equipment foundations in reinforced concrete.
f. Erection of substation equipment steel support structures and bay gantries
g. Control building with a minimum floor area of 120 sqm meters
h. Internal and external access roads (acceleration and deceleration lanes) with paving blocks
i. Reinforced concrete cable trenches and ducts at crossings
j. parking lot and offloading bay (2 lorries and 5 vehicles)
k. Rainwater harvesting and storage system (5,000 liters elevated and 10,000-liter ground mounted water tank with connection to nearby county water supply system with metering
l. Drainage (storm water and foul water/sewerage drainage including septic tank)
m. Ballasting layer of 100 mm thickness
n. Site restoration and landscaping work
o. Masonry boundary wall for the entire plot.
p. Demarcated guardhouse with washroom facilities and furniture floor mounted storage facility for PPEs (shall have a locking facility).
q. Lightning protection and earthing system
r. Switchyard lighting
s. Fire protection system
t. Equipment erection and commissioning

Any other works necessary for full completeness of the facility civil works scope.

4.1.4.1.1.2 33KV Switching Stations

a. Site clearance and disposal of spoil from site.
b. Earthworks (cut, back fill, compaction, area grading and ballasting) of entire plot.
c. Equipment support structures and bay gantries.
d. Prefabricated or Control building adequate for the facilities
e. Access roads
f. Reinforced concrete cable trenches and ducts
g. Area drainage
h. Ballasting layer of 100 mm thickness
i. Site restoration and landscaping work
j. Chain-link fence for the entire plot
k. Lightning protection and Earthing system
l. Switchyard lighting
m. Equipment erection and commissioning

Any other works necessary for full completeness of the facility civil works scope

4.1.4.1.1.3 Control Building

The switchgear building shall contain the following rooms:

I. 132/66/33/11 KV Substations with 10 MVA and above Transformers

The control room building shall contain the following rooms:

a) Control and protection panel room with space for future expansion (One transformer bay and two line bays).
b) Battery room (to accommodate both protection and communication batteries)
c) AC and DC distribution boards and battery charger room
d) Office room with furniture (document storage cabinets, chairs, key rack, and office tables) minimum
e) Kitchen with cabinets, dish rack, oven cooktop and sink
f) Communication equipment room
g) 2 no. washrooms with Gender Separation and showers
h) Store room for spares
i) Electrical system, Plumbing, air conditioning system and Fire protection system
j) Appropriately placed emergency doors
k) Sloped roof with fire retardant ceiling, insulation and water harvesting system
l) Fireproof doors and tempered burglar proof windows

All the rooms shall be pressurized to avoid dust.
Appropriately place emergency doors for fire escape

II. 33KV Substations with 2.5MVA to 7.5MVA Transformers

The control room building shall contain the following rooms:

a) Control and protection panel room with space for future expansion (One transformer bay and two line bays).
b) Battery room (to accommodate both protection and communication batteries)
c) AC and DC distribution boards and battery chargers room
d) Office room with furniture (document storage cabinets, chairs, key rack, and office table) minimum
e) Kitchen with cabinets, dish rack, oven cooktop and sink
f) Communication equipment room
g) 2 no. washrooms with Gender Separation and showers
h) Store room for spares
i) Electrical system, plumbing, air conditioning system and Fire protection system
j) Appropriately placed emergency doors
k) Sloped roof with fire retardant ceiling, insulation and water harvesting system
l) Fireproof doors and tempered burglar proof windows
m) Electrical, plumbing, water Supply, foul water Management, AC system and fire detection and suppression system.

All the rooms shall be pressurized to avoid dust.
Appropriately place emergency doors for fire escape

4.1.4.1.2 Sequence of Construction

The Contractor must complete all the civil works in time to provide a clean and complete site for the mechanical and electrical erection.

The Contractor shall be responsible for timely delivery of materials to site and for compliance with the specified or agreed construction programme.
The contractor shall prepare a civil worksite methodology before commencement of works. An updated works program to be always availed on site

4.1.4.1.3 Construction stages

The following shall guide:

- Preliminary Design (Topographical Survey, Geotechnical Investigations, Statutory Approvals, Civil Works Methodology, Standard Operating Procedures, Quality Management Plan, Safety, Health and Environment Plan, Organogram)

- Design Stage (Relevant Standards and Specifications, Drawings and Designs, Revision of Drawings, Statutory Approvals/Requirement)

- Construction Stage (Mandatory inspections, Routine inspection, Factory and site acceptance tests, Hold points, Works Program, Communication plan, quality assurance)

- Closure (As-built drawings, Water Supply and Electricity Supply account transfer to KPLC.)

An updated works program to be always available on site.

4.1.4.1.4 Documentation, Drawings and Designs

Any drawings issued with these documents are for tendering purposes only. The Contractor's obligations with regard to preparation and submission of drawings, calculations, samples, patterns, models etc. are stated in the Conditions of Contract. The Contractor shall prepare and submit to the Project Manager for approval dimensioned general and detailed design drawings and other pertinent information of all the Civil works specified in the Bid Documents accompanied by relevant design calculations. Designs shall be carried out in accordance with standards and specifications applicable in Kenya, including but not limited to British Standards, Eurocodes, ASTM, The National Building Code 2024, Kenya Roads Design Manual etc.

Drawings shall be submitted in soft and hard copies as per Conditions of Contract. A laminated hard copy of approved designs shall be displayed in the site office for access by the Project Manager. The Contractor shall also provide relevant design software with a laptop to the Project Manager for Civil works design.

On completion of the project, As-built documents shall be submitted for filing and to allow Operations and Maintenance and shall at least contain the following information as described under "Final Documentation" of GCC:

- Detailed description of the civil works, the individual components, relevant clearances, tolerances, allowable temperatures, settings, sizes etc.
- Descriptions of main civil works including earthworks, subsurface structures, terrestrial structures, drainage, cabling, road layouts, lightning protection, substation lighting, fire protection systems etc.
- Operational instruction. These shall illustrate the operational sequences in a clear and concise way.
- Test reports

4.1.4.1.5 Use of Site

The Contractor will restrict his activities to within the Sites. Access for others to work on the site concurrently with this Contract shall be maintained as far as possible. Where it is necessary for persons on foot or in vehicles, including other Contractors, to cross the site whilst work is in progress, the Contractor shall provide warning signs on either side of the Work and flagmen if necessary to guide such persons safely across the Site. The cost of maintaining access for others and assisting the passage of others across the Site shall be deemed to be covered by and included in the rates entered by the Contractor in the Price Schedules.

4.1.4.1.6 Plan of Operations and Temporary Works

The Contractor shall, in accordance with Conditions of Contract and before commencing work on Site, submit to the Project Manager a fully detailed programme showing the order of procedure and method by which he proposes to carry out the construction and completion of the Civil Engineering works, and particulars of the organization and staff proposed to direct and administer the performance of the Works.
The information to be supplied to the Project Manager shall include Drawings showing the general arrangements of his temporary offices, camps, storage sheds, buildings and access roads, and details of Constructional Plant and Temporary Works proposed.

The contractor shall provide a design for a Works signboard for review by the Project Manager.

4.1.4.1.7 Site Office

The contractor shall provide a suitable temporary office, with a room capable of holding meetings, a Project Managers office (furnished with desk, cabinet, phone, printer), and clean toilet facilities. Drinking water, site instruction book, visitors book, weather chart and safety occurrence/ toolbox minutes book, and PPEs shall be provided on site for access to Project manager within all working hours. Approved working drawings shall be laminated and displayed on site.

4.1.4.1.8 Contractor's Office and Accommodation, etc.

The Contractor shall be responsible for his offices, accommodation, storage and workshops. The Contractor may fence this area for his own security for the duration of the Contract but any such fence erected together with all buildings, plant and materials shall be removed, all holes filled in and the site left in a tidy and level condition upon completion of the Contract.

4.1.4.1.9 Dealing with Water

The Contractor shall keep the whole of the Works free from water and he will be deemed to have included in his rates in the Price Schedules for all pumping, shoring, temporary drains, sumps and other measures and provisions necessary for such purposes and for clearing away and making good to the satisfaction of the Project Manager damage caused thereby.
The Contractor shall keep all existing drainage channels clear and shall not obstruct the passage of water to or away from any such drainage channels.

4.1.4.1.10 Liaison with Police and Other Officials

Contractor shall cooperate closely with the Police and other officials of the area concerned regarding their requirements in the control of workmen, movement of traffic, or other matter.

4.1.4.1.11 Explosives and Blasting

The Contractor shall use explosives for blasting in connection with the work only at such times and places and in such a manner as the Project Manager may approve, but such approval shall not relieve the Contractor from his responsibility for injury, loss, inconvenience and annoyance to persons, the Work and adjoining structures, roads, places and things and injury or damage to animals and property consequent on the use of such explosives. The Contractor shall be entirely liable for any accident that shall occur and shall save the Project Manager harmless and indemnified from all claims arising from such use of explosives.

The Contractor shall keep in his office at the Site copies of Laws applying to the transport, storage and use of explosives and shall also submit to the Project Manager a copy of any instructions or notices which the Contractor may issue to his staff or workmen or post about the site in compliance with such Laws.

The Contractor shall submit to the Project Manager details of the explosives, which he proposes to use, and of his proposals for the transport and storage of explosives.

4.1.4.1.12 Works Executed by the Project Manager or by Other Contractors

The Project Manager reserves the right to execute on the site, works not included under this Contract and to employ for this purpose either his own employees or other contractors.

The Contractor shall ensure that neither his own operations nor trespass by his own employees shall interfere with the operations of the Project Manager or his Contractors employed on such works and the same obligations shall be imposed on the Project Manager or his contractors in respect of work being executed under the Contract.

The Contractor shall provide unhindered access to all parts of the site to the Project Manager, authorised representatives of the Project Manager and of public bodies and corporations, and to contractors employed by the Project Manager, and he shall make available to such authorised persons the use of all temporary access tracks in or about the site.

Where works are being carried out concurrently in one area careful co-ordination of operations will be required so that interference can be minimised. The Project Manager shall have the power to regulate and rearrange the order of execution of the Works under this Contract to achieve the best co-ordination practicable. The Contractor's programme shall take into consideration all information on co-ordination available at the time of its preparation and it shall be flexible enough to allow for subsequent changes that may become necessary. The rates tendered for the Works shall include the costs of complying with the requirements of this Clause.

4.1.4.1.13 Water Supplies for the Works

The Contractor shall make his own arrangements for the supply of palatable water for his staff on site, the Project Management Team and water for the Works.

The Contractor must make all arrangements including the supply of pumps and motors, labour and the like to abstract water and must pay royalty to the owners. These costs shall be included in his prices.

If the Contractor fails to obtain permission to utilise existing water sources, he may have to drill boreholes near the sites at suitable locations.

The Contractor shall obtain the Employer's or the Project Manager's prior approval before utilizing any water source for the Works. The contractor shall connect the site to main water supply on completion of works..

4.1.4.1.14 Employer's Approval of Finished Works

The Contractor shall obtain the approval of the Project Manager for each section and each stage of construction. Approval of any section of any stage will not be given, and the Contractor shall not proceed with any subsequent stage, until all tests required by the Project Manager have been carried out, and the results have shown that the section complies with the Specification. Any works rejected by the Project Manager as not complying with the Specification shall be replaced by the Contractor at his own expense.

4.1.4.1.15 Preservation of Trees

No tree shall be removed without prior permission of the Project Manager who will limit the removal of trees to the minimum necessary to accommodate the permanent Works.

4.1.4.1.16 Survey Beacons

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way any permanent beacons or survey beacons. Should the Contractor consider that any survey beacon will be interfered with by the Works, he will notify the Project Manager, who, if he considers necessary, will make arrangements for the removal and replacement of the beacon.

If the Contractor removes or disturbs a beacon without the prior permission of the Project Manager he shall be liable for the full cost of its replacement together with the full cost of re-establishing the data relevant to it. The contractor shall establish the beacons once handed over the site.

4.1.4.1.17 Basic Survey and Setting Out

The Contractor shall appoint a suitably qualified Surveyor to set out the Works from the beacons and shall plot cross sections at 10 m intervals and submit to the Project Manager for approval. The Contractor will survey the sites provided in detail, and the exact locations shall be agreed with the Project Manager. The details of beacons and benchmarks shall be provided in the site survey drawings.

4.1.4.1.18 Design life and Service Conditions

The Contractor is required to design and construct the works so that they are fit for the purpose specified by the Employer to satisfy a level of durability and functionality that extends over a minimum of 50 years or as specified by the design life of the station transformer or relevant critical equipment. Design and calculations shall be governed by the design criteria given in the Bid Documents, standards and normal design practice and shall comply to Local and Regional codes of practice. Necessary safety factors shall be included. The service conditions shall be as per the conditions of contract

4.1.4.1.19 Spare parts and Tools for operations and maintenance

The Contractor shall provide mandatory civil spares as per the Employer’s requirement

4.1.4.1.20 Facility Handover to the employer.

The contractor shall submit water and electricity accounts documents closure or transfer to the employer project manager during facility handover or before issuance of completion certificate.

4.1.4.2 CIVIL CONSTRUCTION MATERIALS FOR THE WORKS

4.1.4.2.1 General

All materials shall comply with appropriate local or regional standards unless otherwise required hereinafter. Such standards shall be to the approval of the Project Manager.

The Contractor shall before placing any order for materials or manufactured articles for incorporation in the Civil Works, submit details of the manufacturers or suppliers for the approval of the Project Manager. The manufacturer or supplier shall submit samples, technical data sheets, type tests or all necessary details for approval as required by the Project Manager.

4.1.4.2.2 Preliminary Survey

4.1.4.2.2.1 Topographical survey

The contractor shall carry out a detailed land survey to demonstrate the shape, elevation and features of the site, including both natural and man-made elements. The contractor shall collect data on the spatial locations, coordinates and elevations of relevant features within the site plot and the surrounding area. Important information to include neighbouring plots, data for terminal drainage points, nearest main road and capture all existing services (overhead, terrestrial and underground).

4.1.4.2.2.2 Geotechnical survey investigation

The contractor shall collect all data he deems necessary for preparation of his bid. The Contractor shall include in his prices the price of rock if encountered.

The contractor shall carry out a detailed examination of the site's surface and subsurface soil and rock conditions to assess its suitability for construction. This survey shall involve collection and analysis of material samples, and assessment of groundwater levels to guide earthworks, drainage and foundation designs. The contractor shall submit a method statement for the investigations, procedures, depths, analysis methods, tools and equipment and identifying locations for sample collection and tests. This shall be reviewed by the Project Manager before commencement of works.

The sub-soil tests shall be carried out by any method as stated hereafter under the supervision of a qualified person, who shall be subject to approval of the Project Manager. Any boulder rocks encountered shall be removed completely.

4.1.4.3 EARTHWORKS

4.1.4.3.1 Bush Clearing

The areas of the platform and borrow pit shall be cleared of all trees, vegetation and roots. These shall be neatly stockpiled within 3 km of the site at locations agreed with the Project Manager and shall remain the property of the land owner.
Any structures on site to be demolished and removed by the contractor and to be included in the price schedule.

4.1.4.3.2 Removal of Top Soil

The top soil within the areas of platform and shall be stripped to an approximate depth of 200 mm and stockpiled at locations agreed with the Project Manager for later use on embankment slopes. Any top soil that shall not be reused shall be dumped at the designated local authority dump sites. Overburden in the borrow pit shall also be stripped to a depth specified by the Project Manager and stockpiled for later use in rehabilitation.

4.1.4.3.3 Classification of Materials

Earthworks shall be under the contractors' scope and considered fully priced by the contractor. The contractor shall familiarize with site conditions before tendering.

4.1.4.3.4 Order of Work

The construction of cuttings, side drains and embankments shall proceed in a methodical and orderly manner. It shall be solely the Contractor's responsibility to arrange his methods and programme of work so as to ensure that the earthworks are carried out by the most efficient and economical method possible with the type of plant employed on the Works.

All trimming of cuttings, and embankments, drains and shoulders to the specified slopes and shapes, shall be carried out concurrently with the earthworks that are being carried out at that particular site and level.

4.1.4.3.5 Fill Material

"Fill-material" shall mean material deposited in accordance with these specifications from any of the classes specified in order to build up an earthworks construction to formation level as shown on the Drawings or as ordered by the Project Manager. The Contractor shall obtain the fill material from a source approved by the Project Manager.

Fill materials will generally be obtained from cuttings. If the material obtained from this source is insufficient or unsuitable extra material shall be obtained from borrow areas. All fill material (other than rock fill in lower layers) shall pass 75mm BS sieve size.

The following materials are generally unsuitable for construction of fills.

- All materials containing more than 5% by weight of organic matter (such as top soil, materials from swamps, plants and vegetable matter)
- All expansive soils such as black cotton soils with swells of more than 3% as measured in the CBR test.
- All clay soils with plasticity index exceeding 50.
- All materials having a moisture content of 105% of the optimum moisture content (standard compaction)

Rock fill can be used provided that boulders greater than 0.2 m3 in volume or 600 mm in size are not used and that this material is not placed within the top 600 mm to formation level. The best materials from cuttings or borrow areas should be reserved for the upper layers of the fill.

4.1.4.3.5.1 Compaction of fill

Materials other than rock fill shall be placed in layers of compacted thickness not exceeding 300 mm. Thicker layers can only be permitted where very heavy compacting equipment is available and trial sections have proved that the required compaction will be readily achieved over the layer depth. The minimum layer thickness shall be twice the maximum particle size of the compacted material.

Fill material shall be compacted throughout to a dry density of at least 95% MDD at OMC (standard Compaction AASHTOT99) except the top 300 mm of the fill which shall be compacted to 100% MDD (AASHTO T99).

Where rock fill is used it should be placed in the bottom of the embankment. The largest sizes shall be placed in layers of 1.0 meter thick. The interstices shall then be filled with smaller rocks and approved filler material. The whole layer shall then be compacted until the interstices are completely filled or until the required settlement is obtained. Heavy vibratory rollers are generally the most suitable machines for compacting rock fill.

The specified compaction shall be achieved over the full width of the embankment. Any area inaccessible to the roller shall be consolidated and compacted using approved mechanical tampers.

4.1.4.3.5.2 Compaction of in situ Sub grades

After removing the top soil and/or 600 mm minimum thickness (or as determined by geotechnical report) of unsuitable /expansive soils and before placing fill, improved sub grade or gravel wearing course, the upper 300 mm of in situ sub grade will be compacted to 100% MDD standard compaction. Compaction in cuts without improved sub grade will likewise be compacted to 100% MDD standard compaction

4.1.4.3.6 Spoil Material

"Spoil-material" shall mean material excavated in accordance with these specifications from any of the classes specified, and which, being obtained from the excavation of side drains, cuttings or below the road embankment is unsuitable for the requirements of the Works. Spoil material shall be removed from the Site to a spoil tip which should be to a site acceptable by respective local authorities and shall be approved by the Project Manager.

4.1.4.3.7 Expansive Material

When expansive material is encountered, it shall be removed to a minimum depth 600 mm (or as determined by geotechnical report) below the formation or the existing ground level, whichever is greater. Material removed shall be stockpiled for later use in slope protection or spoiled to a tip as instructed by the Project Manager.

4.1.4.3.8 Surplus Material

"Surplus-material" shall mean material excavated in accordance with these specifications from any of the classes specified and which is temporarily surplus to the fill requirements and shall be carted to a designated stockpile for re-use later elsewhere in the Works, or to an approved spoil tip.

4.1.4.3.9 Side Drains

Where side drains are required excavating the lines, slopes and widths as designed by the Contractor and approved by the Project Manager shall shape them. The side drains shall be finished off so that the formation levels and camber or super elevation of the formation, level and cross fall of the shoulders, and shape and invert levels of the side drains are everywhere in accordance with the Drawings.

Any excess depth or width excavated from the side drains shall be backfilled and made good to the satisfaction of the Project Manager at the Contractor's expense.

All other types of drains are specified separately in this Specification.

4.1.4.3.10 Excavation in "Rock"

a) Excavation Level

Unless otherwise directed, the formation of the platform can be founded on rock. However, rock shall be excavated to an average level 150 mm below the formation and in no place less than 100 mm below the formation. Any boulder rocks encountered shall be removed and disposed of.

b) Backfilling for Surfaces

Any excess excavation in rock below the formation shall be backfilled and compacted using approved fill material. Excess excavation in the invert of drains shall not be backfilled, but the rock surfaces shall be trimmed, and all loose particles removed, to allow laying of drainage blocks or as may be required.

c) Excess Excavation of Slopes

Where side slopes are over-excavated no backfilling will be required but the slopes shall be trimmed to a neat shape and safe angle as is acceptable to the Project Manager. The sloping sides of all cuttings shall be cleared of all rock fragments, which move when pressed with a crowbar.

d) Hard Material

The provisions of this Clause do not apply to hard and common materials, which materials shall be excavated to the lines and levels shown on the Drawings or as instructed, within the permitted tolerances.

4.1.4.3.11 Setting Out and Preparation for Earthworks

The Contractor shall set out the earthworks and the tops of cuttings and toes of embankments at intervals 10m. Reference pegs shall be provided clear of the earthworks and at right angles to the centre lines, from which the centre lines and levels can be re-established at any time.

Before the construction of any earthworks in the fills, the levels of the existing ground shall be agreed between the Contractor and the Project Manager. If the Contractor fails to take the requisite levels then the ground levels determined by the Project Manager shall be taken as correct.

4.1.4.3.12 Construction of Earthworks to Formation

All earthworks up to formation shall be formed and completed to the correct lines, slopes, widths and levels shown on the Drawings and with the sub grade parallel to and at the correct depth below the profile, camber, cross fall or super elevation shown for the finished level, unless otherwise directed by the Project Manager.

Embankments and fills shall be constructed only of suitable material obtained from the excavation of cuttings. If the Contractor encounters material which he considers unsuitable for earthworks, then he shall forthwith inform the Project Manager, who shall instruct the method of use or disposal of such material. If insufficient material can be obtained from the cuttings, additional material may be borrowed from approved borrow pits.

The Project Manager may direct that certain soils be excluded from certain layers and other soils set apart or obtained from borrow and used only for these layers, in which case the Contractor shall comply with the Employer's or the Project Manager's directions and shall allow in his price for such selection of materials.

4.1.4.3.13 Unsuitable Material Information

Where, in the opinion of the Project Manager, unsuitable material occurs in cuttings, the Contractor shall excavate it to the depths and widths directed and replace it with selected fill material to form an improved formation.

4.1.4.3.14 Spreading and Compaction of Embankment and Fills

Embankments and fills shall be laid out and compacted to achieve a stable platform with sufficient bearing capacity and stability. Tests shall be carried out as per local regulations and standards for compaction design.

4.1.4.3.15 Drainage of Works

All cuttings, embankments and borrow pits shall be kept free of standing water and drained during the whole of the construction.
Should water accumulate on any part of the earthworks, either during construction or after construction, until the end of the maintenance period, giving rise to soaking or eroding conditions in the earthworks, the Project Manager may order the Contractor to remove and replace at the Contractor's expense any material which has been so affected.
All drains shall be maintained throughout the Contract in proper working order.
The Contractor must allow in his price for draining the earthworks satisfactorily at all stages during the construction and arrange his methods and order of working accordingly. The entire platform shall be adequately drained and all cable trenches including those in switchgear building should be well drained. The minimum slope of drain channels shall be 1:200.

4.1.4.3.16 Tolerances

The following tolerances will be permitted in the finish of the formation to roads and platform:
a) The level of the formation should be within +/- 100 mm of that specified.
b) On the final trimmed slope of earthworks, a variation of + or - one fifth of the specified slope will be allowed.
c) The tolerances permitted in the overall width of the bottom of cuttings shall be plus or minus 150 mm in the distance between center lines and the toe of cuttings slopes, and plus 150 mm in the case of embankments.

4.1.4.3.17 Protection of Embankment Slopes

The top soil and expansive material removed from the Works shall be placed on embankment slopes as directed by the Project Manager. The slopes shall be trimmed to form a gradient not less than 1 on 5 unless otherwise directed.

4.1.4.3.18 Grassing of Slopes /Slope Protection/Stone Pitching

The surface of embankment slopes, after placing of top soil, shall be planted with grass or best suited method as per Project Manager’s approval. Unless instructed otherwise by the Project Manager, the type of grass shall be indigenous. While planting, the area shall be irrigated for as long as necessary to ensure that the grass is properly established and has completely covered the ground. Grass should only be planted in the rainy season. Slope protection and Stone pitching shall be provided as per the designs.

4.1.4.3.19 Borrow Pits

Where it is necessary to borrow material for construction, suitable pits shall be provided by the Contractor to the approval of the Project Manager. All borrow pits must be carefully cross sectioned before and after excavation in order to determine the quality of earth excavated.

After removal of material for use, the area must be rehabilitated by the Contractor so that it will not prove a hazard to man or beast or a source of erosion. The sides of the excavation must first be sloped and then any previously stockpiled top soil spread as far as possible.
At some borrow pit locations, further cleaning and fencing etc., may be required.

4.1.4.3.20 Soil Sterilization

In order to stop the growth of vegetation and incidence of pests, the Contractor shall apply an approved herbicide and pesticides over the platform area. A damp-proof membrane shall be applied to the entire switch yard before placement of ballast. Long term pesticides shall be used around control building and any other required area.

4.1.4.3.21 Earth Electrode

The Contractor shall install Earthing electrodes in trenches as outlined in the Specifications for earthing in Particular specifications.

4.1.4.3.22 Platform Areas

The substation platform areas shall be at least 1.5 times the area required by the facility developed area.

4.1.4.4 DRAINAGE

The Contractor shall design for area drainage of the works in compliance with local or regional standards and codes of practice to the approval of the Project Manager (BS 8301, BS 6031, CP 2005, etc). The Contractor shall be responsible for carrying out data collection for design calculations working with relevant Local Authorities. The designs shall be sufficient for a 50-year design life and shall incorporate surface and subsurface drainage mechanisms.

The contractor shall obtain approvals from relevant authorities to connect exit channels or pipes to the public systems. The Employer's Safety Health and Environment policy shall apply to the quality of effluent released from the site. The Drainage designs shall consider potential future substation additions and shall avoid discharging excessive water into existing drainage areas.

4.1.4.4.1 Stormwater Drainage

The Contractor shall carry out stormwater drainage design focusing on collecting and managing rainwater runoff to prevent flooding and water damage. It shall involve a system of pipes, channels, and other infrastructure designed to handle the volume of water expected from rainfall events. The design process shall include calculating runoff rates, sizing drainage components, and ensuring the system can safely convey water away from the area. The Site shall remain self-draining once construction is complete.

The Contractor shall determine levels of the terminal point outside of the site where site stormwater shall drain. The terminal point shall be the lowest point in the geographical area and site levels shall be established with respect to this reference level.

A surface and subsurface water drainage system covering the entire substation shall be installed. The system shall typically involve a network of drains, channels and attenuation basins to collect and discharge water safely. The Contractor shall provide cleanout and outlet structures, accessible for maintenance and inspection.

The number of runs and outfalls and pipe sizing must be sufficient to cope with the severest precipitation (based on hydrological factors and meteorological data), with a factor of safety of 1:2 within the substation site and other areas in which maintenance will be carried out. The drainage must allow uninterrupted access. Open drains shall be avoided at the switchyard.

Materials used in the drainage system such as pipes, trenches and filters shall meet relevant standards and specifications, shall be non-metallic and with adequate strength for purpose.

To maintain flow, the finished floor level of the buildings shall be a minimum of 600mm above the external finished ground level. The top of equipment foundations shall be a minimum of 200mm above finished ground level. The top of cable trench walls to be minimum 150mm above finished ground level. The finished ground level to be graded such that no flooding can occur and shall be to project manager's approval. For below ground levels, the top of internal cable trench finished floor shall be minimum 300mm above the top of external cable trench finished floor with a sloped transition at building junctions.
All levels shall remain above the external terminal drain point. The level and location of the burnt oil separator tank shall allow natural drainage from the Transformer oil interceptor sump.

4.1.4.4.1.1 Roof Drainage

For buildings, roof water gutters and downpipes shall be designed to meet the requirements of relevant standards and national building code and BS EN 12056-3. Materials and components for rainwater goods shall conform to the relevant BS or Eurocodes. Manufacturer Data sheets shall be submitted to the Project Manager for review and approval.

Gutters shall be adequately supported and not sag. Gutters and downpipes shall, unless otherwise shown on the drawings, be approved plastic coated steel or heavy gauge PVC of diameters 200mm and 150mm respectively. One downpipe shall be provided for approximately every 50sqm of roof area. Gutters and downpipes including supports shall be designed for a concentrated load of 100 kg. Screens or strainers shall be provided to prevent debris from clogging the down pipes. Joints shall be lapped 150 mm in the direction of the flow and soldered. Slip joints shall be provided to allow for expansion.

Stormwater from the switchgear building roof shall be drained to the main water reservoir tank and main drainage.

Surface water from roofs of buildings other than the switchgear building shall be drained to down pipes with catch pits, which shall be connected to a suitable underground drainage system. For buildings with air-conditioning, the external unit drains shall be extended to discharge away from the paved apron.

4.1.4.4.1.2 Paved areas Drainage

For paved areas, drains shall be provided adequately to ensure timely removal of accumulated water that could cause potential safety hazard or damage equipment. These shall include roads and parking areas, building aprons, tops of equipment foundations etc. whose tops shall have sufficient slope. There shall be no obstructions in the drains.

4.1.4.4.1.3 Cable trench Drainage

External cable trenches shall be sloped at a minimum of 1:250 slope and drain pipes or channels adequately placed to allow flow of water. Internal cable trenches shall be adequately sealed to prevent any backflow of water. The transition from building to yard in cable trenches shall be sloped away from the building to avoid backflow.

4.1.4.4.1.4 Area Drainage

The formation level of the site is to be formed with uniform cross-falls of minimum 1:300 in the same direction as the natural drainage path of the surrounding environment. Drainage channels minimum slope shall be 1 in 200 and subsurface drains installed where appropriate or necessary. All storm water to be drained outside of the station.

Embankments and cuttings are to have drainage facilities at their top or bottom. In areas where there is a risk of water runoff the substation shall be protected from failure by means of gabions, retaining walls, and stone pitching or otherwise to the employer's approval. Stone for pitching to drains, inlets and outlets of culverts, to embankments and around structures shall consist of sound un-decomposed rock. Precast concrete tiles may also be used.

The contractor shall install concrete culverts of minimum diameter 900mm for stormwater drainage (with 200mm thick concrete haunching) for the purpose of providing free flow of storm water at the substation entrances and or exits. The contractor shall also provide 200mm thick reinforced concrete plastered head walls. At the main gate, cut off drainage with grating may be provided to ensure external water does not flow into the Site.

4.1.4.4.1.5 Sub-surface Drains

The Contractor shall provide subsurface drains, especially within the switchyard where open drains are not applicable. These shall be designed with a minimum slope of 2% and diameter as per design data and guiding standards. These shall be laid in trenches of minimum depth 300mm from finished ground level. Perforations shall be provided on the drain pipe and Filter shall be provided in form of geotextile membrane used together with a filter layer. The filter backfill for Sub-soil Drains shall be graded crushed stone as for platform surfacing. Outlets and inlets shall be protected to prevent soil erosion and ensure proper drainage. Drain design shall be informed by data on specific site conditions, soil type, topography, groundwater levels, local building codes and historical hydrological data for the area.

4.1.4.4.2 Foul water Drainage

The Contractor shall carry out foul water drainage design leveraging on collecting and safely transporting wastewater from substation facilities to a treatment facility. It shall involve a system of pipes, channels, and other infrastructure designed to handle the volume of foul water and flowrate estimated from the use of facilities. The design shall consider site characteristics, wastewater volume and flow rates, pipe materials and size, sustainability and local regulations.

In areas where a public sewer system is unavailable, treatment plants (septic tank/biodigester) shall be installed to remove pollutants from wastewater before discharge.

4.1.4.4.3 Transformer Burnt Oil Drainage

The Contractor shall design an oil collection pit below the Transformer to trap burnt oil. The volume of this pit shall be 120% of transformer oil capacity. The Contractor shall use the specifications for the transformer plinth applicable. The pit shall be done

in reinforced concrete around the transformer plinth and shall have galvanized steel grating with inert crushed rock in a layer of minimum thickness of 200mm. The size of the gravel to be 60-120mm.

The Contractor shall design for minimum spec, galvanized steel pipes to be used from oil collection pits to the Burnt Oil separator tank. Design must also ensure that no oil is released to the environment, subject to Local Authority requirements. The design must allow for exit of water naturally without use of pumps

4.1.4.5 ROADS

Where necessary access roads to the substation sites shall be constructed to gravelling / murram standards. Substation land next to paved roads shall have access road and acceleration-deceleration lane to paved standard. All connections to main roads shall be approved by the relevant authority.

Roads shall be designed and constructed with regards to the relevant standards, specifications and codes of practice such as the Kenya Roads Design Manual, and design shall be informed by the expected traffic load

4.1.4.5.1 Earthworks and Road Subgrade

The Contractor shall design for roads earthworks to formation level as per the Kenya Roads Manual earthworks. Formation material layers shall be designed to achieve respective strength and dimensional requirements of the governing standards. The road layers shall conform to the requirement of the Kenya roads design manual and shall be subject to routine and mandatory tests approved by the Project Manager.

4.1.4.5.2 Geometry

The Contractor shall design roads with minimum width of five (5) meters with the alignments allowing for low loader trailers

4.1.4.5.3 Subgrade Materials

The Contractor shall design for substation road to be compacted to 100% MDD and OMC after grading and shall have final paving layer of minimum standard paving blocks to meet estimated load weight.

4.1.4.5.4 External Access Roads

The horizontal alignment and geometric design shall be to relevant road design manuals. The Contractor shall design access to the station from the main feeder road to the substation plot. All roads shall have road drainage respectively. The external access roads shall have provisions for acceleration and decorrelation.

4.1.4.5.5 Internal Access Roads

Internal substation road shall be compacted to 100% MDD after grading and shall have final paving layer of minimum standard paving blocks to meet estimated load weight. The paving blocks shall have minimum thickness of 80mm, with a minimum strength class of 49N/mm2.
The road shall also be lined with kerbs and channels, with adequate provisions for drainage of water and shall be constructed to a fall that will allow proper drainage of the road. All roads shall have road drainage respectively.

4.1.4.5.6 Parking and Offloading Lot

The contractor shall design for a parking lot area that shall also be used as the offloading bay. This area shall be adequate to accommodate the Employer's staff and maintenance vehicles, with sufficient room for turning of maintenance trucks.

4.1.4.5.7 Damage and making good

Any damage occasioned to the road network by whatsoever cause during construction shall be repaired accordingly and handed over defects free

4.1.4.6 GRAVEL WEARING COURSE ROADS

4.1.4.6.1 Materials Requirements

Gravel standard roads comprise of a single layer of selected granular material placed directly on the sub grade to serve as a pavement and as surface-wearing course. The gravel for the single layer should be of adequate quality to guarantee the following:

a) General

In general gravel wearing course materials should comply with the following:

- They should have sufficient cohesion to bind the particles together and prevent the surface from raveling and becoming corrugated in the dry season.
- The amount of fines and plasticity should be limited so as to avoid the occurrence of dusty and slippery conditions in dry during the dry and wet weather respectively.

b) Grading Requirements:

Grading curve of the gravel should be within the class 1 envelope (initial daily number of commercial vehicles less than 150) to guarantee good stability. The grading to consider is that obtained after processing and compaction.

Grading after Compaction		
Size (mm)	% passing by weight	
	Class 1	Class 2
37.5	-	100
28	100	95 – 100
20	95 – 100	85 – 100
14	80 – 100	65 – 100
10	65 – 100	55 – 100
5	45 – 85	35 – 92
2	30 – 68	23 – 77
1	25 – 56	18 – 62
0.425	18 – 44	14 - 50
0.075	12 - 32	10 - 50

c) Plasticity Requirements

Plasticity index of the gravel should not exceed 15 and shall not be less than 5 in wet areas (annual rainfall greater than 500 mm per year). In dry areas (annual rainfall less than 500 mm per year) maximum plasticity index shall be 30 but subject to a minimum of 10.

d) Bearing Strength Requirements

A minimum CBR (after 4 days soak) of 20% at 95% MDD and OMC (Modified AASTO T180) is required

e) Construction Procedures

Gravel materials are excessively coarse in their “as dug” state. Appropriate processing is therefore necessary to bring them to the required gradation.

This is normally done on the road by using grid, cleat or sheep’s foot rollers. Oversized particles which cannot be broken down to the required size shall be

removed. The minimum thickness of a compacted layer shall not be less than 125 mm.

f) Sub-grade Layer

During this process the sub grade layer shall be graded to level, parallel to the cross fall or chamber and profile shown on the approved design drawings or directed by the Project Manager and to agreed tolerance.

g) Tolerances

The following tolerances will be permitted in the finish of the formation to roads and platform:

a) The level of the formation should be within +/- 100 mm of that specified.
b) On the final trimmed slope of earthworks, a variation of + or - one fifth of the specified slope will be allowed.
c) The tolerances permitted in the overall width of the bottom of cuttings shall be plus or minus 150 mm in the distance between centre lines and the toe of cuttings slopes, and plus 150 mm in the case of embankments.

4.1.4.6.2 Pavement

The single gravel layer should consist of a minimum thickness necessary to avoid excessive compressive strain in the sub grade and to compensate for the expected gravel loss under traffic during the period between re-gravelling.
Where the top 300 mm layer of the formation level embankment or natural ground sub grade has a CBR greater than 5%, the following thicknesses shall be provided:

- Roads within the Switch Yard not subjected to heavy commercial vehicles– The minimum compacted thickness of 125mm.
- Access roads outside the Switch Yard and roads within the Switch Yard likely to be subjected to heavy commercial vehicles during construction and during periodic maintenance. – Provide a 250 mm thick compacted layer.

In addition to the above, where the in-situ sub grade or the embankment material has CBR strength of less than 5% then:

- Top 300 mm layer of the fill / embankment shall be made with selected imported material with CBR (after 4 days soak) of between 7 and 13%.
- Where in situ sub grade an improved sub grade 300 mm thick of imported materials with CBR (4 days Soak) of between 7 and 13% shall be laid.

The above thickness shall extend to cover the shoulders to a minimum of 1m. A cross fall of 4% shall be provided. Compaction will be in layers not thicker than 200 mm and will achieve compacted densities of 95% MDD (Modified AASHTO T180) at compaction moisture contents of between 80% and 105% OMC.

4.1.4.6.3 Drainage

The Contractor's design shall provide for adequate and timely removal of stormwater. The drainage system shall comprise a network of trenches, pipes, culverts etc.

4.1.4.6.4 Road marking and Furniture

The contractor shall use thermoplastic road marking paint on the road kerbs to the Employer's approval. The Contractor shall also demarcate the parking area as per the designs approved by the Project Manager. The Contractor shall provide well marked safety balustrades, road signs and all relevant road furniture for the Works. Paint to be used for shall be black and yellow meeting employer's corporate color scheme. It shall have a minimum life span of two years in adverse weather conditions.
6.2.5.8.5 Existing Bitumen Standard Access and Internal Roads
All shall be reinstated to their original standard of materials and construction.

4.1.4.6.5 Quality Control

The Contractor's Quality Management Plan shall describe in detail all the tests and procedures to be carried out on materials and works. These shall adhere to relevant standards, Codes of practice and local regulations and shall be carried out by approved accredited laboratories. These tests shall be witnessed by the Project Manager and results shall be submitted routinely and periodically.

4.1.4.7 FENCING

4.1.4.7.1 Boundary Establishment

The Contractor shall construct fencing along the perimeter of the land/plot handed over. The fence shall include gates and shall comply with the requirements of the following clauses.
The perimeter fence shall be constructed to ensure boundary establishment from beacon to beacon. No part of the structure shall breach the boundary. The height of the perimeter wall shall maintain a minimum height of 2700mm from FGL. The perimeter wall shall be built of weatherproof materials and protected from the elements.

4.1.4.7.2 Masonry wall

The contractor shall design substation fence in masonry with adequate structural integrity to meet the design life of the substation. The masonry shall be dressed Natural stone of 10N/mm2 minimum compressive strength as per British standards. The wall shall have a structural framework of reinforced concrete beams and columns at minimum 3m spacing. The contractor shall provide a reinforced concrete beam at finished ground levels.

Structural designs shall be carried out for the wall, and shall be informed by the geotechnical and topographical surveys.

The fencing shall be mounted with an electric fence and razor wire. The electric fence shall be designed to have minimum 8 Strands separated at 50-100mm spacing. The strands shall be minimum 2mm diameter made from galvanized high tensile steel wires or zinc and Aluminum coated, with tensile strength of minimum 1200N/mm2. Posts for the electric fence shall be galvanized steel anchored minimum 350mm within the reinforced concrete columns. The electric fence energizer shall adhere to IEC 60335-2-76.

The top of the wall shall have coping to protect the stonework. The contractor shall provide razor wire of minimum 450mm diameter placed together with the electric fence. Expansion joints shall be provided at every 30m with adherence to local regulations.

4.1.4.7.3 Masonry Wall Gates

The minimum width of the gate from post to post shall be a minimum of 6m to allow for heavy vehicles. The gate shall have two leaves on the main road for vehicular traffic, and a separate pedestrian access gate for pedestrian traffic. The design of the leaves shall allow opening in either direction and shall have adequate hinges to carry the weight of the gates. The gates shall be provided with wall passes and anchored on RC columns designed for the purpose.
The gate shall conform to the Employer's standards including but not limited to:
i. Material specifications such as leaf materials, paint, joinery, structural support etc.: to match the substation design life
ii. Colour to match the Employer's Corporate colours

4.1.4.7.4 Chain-link fence

Where the plot covers more than 1-acre, chain-link fence shall be used to demarcate the switchyard area. Chain-link fence shall be used to demarcate the guardhouse from the switchyard. The chain link shall be constructed on concrete posts subject to project manager approval. The binding wire to be used shall be flexible aluminium wire of steel galvanized wire of right gauge.

Dimensions

i. Height of chain link fabric:
- 2 000 mm if within substation,
- 2700mm for perimeter

ii. Barbed wire:
- 3 wires above fabric, height of 300 mm, on supporting arms facing outwards from Site at 45^0 angles.

iii. Maximum distance between posts or columns:
- 3000 mm, except where interrupted by gate.

iv. Terminal posts: including end, corner and straining posts;
- 89 mm outside diameter
- 114 mm outside diameter at gates.

v. Embedment lengths of terminal posts:
- Corner and straining posts 1100 mm
- End posts 1200 mm
- Gate posts 1400 mm

vi. Tension bars and bands:
- locate at terminal posts to fix fabric, bottom wire and barbed wire.

vii. Top rail: "extra-strong" pipe, 43 mm outside diameter.

viii. Braces: "extra-strong" pipe, 43 mm outside diameter for attaching end and gate posts to adjoining posts. Use two braces at corner and restraining posts.

4.1.4.8 Gates

4.1.4.8.1 Chain link fence gate

Gate width: free distance between 2 gate posts, 1500 mm for single gate, 5000 mm double gates. Separate pedestrian gate to be provided.

Double gates: one leaf for normal traffic, another leaf to remain closed by means of drop bolt locking into center rest, inoperable from exterior.

Gates: able to open in either direction to 1800. Gates to be hinged on a kingpost and not directly hinged on the concrete column.
Gate hardware: three hinges, latch with padlock accessible from either side of gate, latch catch. Gates to be of solid panel, gauge 16 and designed to Project Manager's approval.

Top of posts and uprights: weatherproof tops.

4.1.4.8.2 Materials

Fabric: ASTM A 392, 2 000 mm high, 3.8 mm diameter (No. 9 gauge) steel wire, 50 mm diamond pattern, twisted and barbed finish at top, knuckled wires at bottom, zinc coated.

Pipes: ASTM A 120, steel pile, hot-dipped zinc coated after welding, diameter and weight size as shown on drawings, unthreaded ends, free from burrs.

Fence fittings: ASTM F626, hot-dipped zinc coated according to ASTM A123.

Barbed wire: ASTM A121, 2.51 mm diameter wire in strand (No.12-1/2 gauge), 2 strands with 4-point barbs spaced at 125 mm, Class 3 zinc coating.
Bottom wires: 5 mm (No. 6 gauge) steel wire, 500 g/m2 zinc coating. This shall be surrounded by a concrete beam (C20) as shown on the drawings.

Fence fittings: ASTM F 626, steel tension bars and bands, nuts and bolts, weather proof tops of commercial aluminium alloy, malleable cast iron, or rolled or pressed steel, cast iron and steel fittings hot-dipped galvanised with 500 g/m2 according to ASTM A123.
Concrete: 25MPa at 28 days

4.1.4.8.3 Installation

Install fencing and gates according to ASTM F 567 unless otherwise indicated, and to drawings and this Specification.
Level ground surface so that space between finished ground surface elevation and bottom of fabric does not exceed 50 mm.
Plumb and align posts to within 10 mm.

Install posts of a gate at same elevation regardless of difference in ground level.

Set posts in concrete footings in form of truncated cone, according to ASTM F 567, and as follows:

FOUNDATIONS	ORDINARY SOIL		SOLID ROCK	
(Dimensions)	Line Posts	Terminal Posts	Line Posts	Terminal Posts
Depth	1000 mm	1600 mm	300 mm	500 mm
Diameter at top	250 mm	300 mm	150 mm	150 mm
Diameter at bottom	350 mm	400 mm	150 mm	150 mm

Make joints in fabric at terminal posts. Fasten as follows:
a) Every 450 mm along top rail, braces and bottom wire;
b) Every 300 mm on line posts.
Secure barbed wire to terminal and gate posts with tension bands, and to gate uprights with hooks. Install bottom wire in middle of last line of mesh.

4.1.4.9 SWITCHYARD

4.1.4.9.1 Site Setting Out

The Contractor shall carry out setting of the site before commencement of works. He shall ensure application of current technology to ensure accuracy to establish control points, transfer design coordinates and mark out key features. The contractor shall keep detailed records of these setting out activities and copies shall be submitted to the Project Manager.

4.1.4.9.2 Site Layout

The Contractor shall prepare the arrangement of elements in the site to ensure flow of construction activities, proper and safe placement of routes and facilities, reduction of clutter and compliance to local regulations. The layout shall also allow safe maintenance of facilities and shall provide for future expansion. The layout shall consider the site topography, traffic flow, space allocation, stakeholder coordination and environmental impact. The Contractor shall submit a site layout with temporary facilities indicated to the Project Manager before commencement of works.

4.1.4.9.3 Area Grading

The substation shall be levelled and shaped to ensure a stable and safe uniform surface suitable for equipment placement, earthing systems and access to equipment. The area shall remain well drained with no pooling of water.

4.1.4.9.4 Stone for Platform Surfacing

The stone shall be hard and durable crushed rock with a maximum particle size of 40-60 mm and not more than 15% shall pass a 9.5 mm sieve. The stone layer to be spread uniformly over the finished surface of the platform shall have a thickness of 100 mm.

4.1.4.9.5 Water Harvesting and Reticulation

The design of the substation shall allow for rainwater harvesting, a storage and reticulation system. The design shall provide for collection of rooftop rainwater to meet the station needs. The Employer's minimum specifications include provision of gutters on buildings, with downpipes leading to a ground mounted water storage tank of minimum volume 10,000litres. The water shall then be pumped to elevated storage of minimum 5,000 litres to enable reticulation to all wet areas including but not limited to Kitchen, washrooms, battery room, guardhouse and an external tap.

The design shall incorporate alternative supply where available. The contractor shall seek approval and apply for an account if supply is available nearby which shall be transferred to the Employer's name upon completion of works.

4.1.4.9.6 Lightning Protection

The substation shall be designed for lightning protection, and the contractor shall provide structural designs for lightning protection structures/ lightning arrestors. All steel support structures shall be grounded to the earthing system (refer to electrical specification).

4.1.4.9.7 Switchyard Lighting

The Contractor's designs shall include designs for illumination of the perimeter wall and the switchyard. (refer to electrical specification)

4.1.4.10 STRUCTURES

4.1.4.10.1 Excavations

The Contractor shall carry out excavations for reinforced concrete foundations in accordance with the approved designs and to the approval of the Project Manager and to fit in with the programme of construction. The contractor shall also prepare a Works Methodology for excavation.

4.1.4.10.2 Shoring and Timbering of Excavation

The Contractor shall be entirely responsible for the safety of all excavations, for the prevention of injury to workmen and for the stability of the faces of the excavation. The adjacent road surfaces must remain trafficable, and cracking or cave-ins must be avoided.

All shoring and timbering shall be done to the approval of the Project Manager, who may order such shoring or timbering to be strengthened or altered if he considers this necessary in the interests of the work or to safeguard against accidents to workmen or cave-ins.

4.1.4.10.3 Bottom of Excavations

In no case shall broken stone for under drainage or concrete be placed in an excavation until the surface on which such materials are to be placed has been approved by the Project Manager. The Contractor shall advise the Project Manager whenever the bottom of any excavation is ready for inspection or whenever it is necessary to cover up the work. In default of such notice the foundation shall on the order of the Project Manager be uncovered by the Contractor and reinstated without extra charge.

4.1.4.10.4 Dewatering

The whole Works shall be constructed in dry and the Contractor shall be held responsible for keeping all excavations free from water, whatever the source or cause may be, and shall properly deal with and dispose of water by use of sufficient temporary works, plant and appliances so as to ensure that the whole Works is executed in a satisfactory dry and safe manner, and costs for all dewatering operations shall be included in the price for civil works.

4.1.4.10.5 Disposal of Excavated Material

All material excavated under this Contract shall be disposed of in accordance with the instructions issued by the Project Manager. Selected material required for back-filling shall be removed to a tip found by the Contractor and the Contractor shall be responsible for ensuring that the required amount of spoil is set aside.

4.1.4.10.6 Other Services

Where trenches pass near or across other services, the Contractor shall take every precaution against damaging such services. These services shall be properly supported in the trench until back-filling is complete and the back-filling shall be thoroughly compacted under and around such services.

4.1.4.10.7 Backfilling and Compaction

Back-filling shall be carried out either with selected spoil as set aside, or with imported selected spoil, or other material to the approval of the Project Manager. No back-filling shall be done until all the formwork has been removed together with pieces of timber, cement bags, vegetation and or other rubbish.

All back-filling shall be compacted in layers not exceeding 150 mm thick and shall be sprayed with water to bring the moisture content to the optimum to achieve designed values of compaction according to the designs, standards and codes of practice.

4.1.4.10.8 Depth of Concrete Structures

The contractor shall design for all concrete structures with reference to site geotechnical report. These include foundations to Transformers, equipment pedestals, boundary wall and building works. The depth of these foundations shall be designed at a depth not less than 1200 mm from the existing ground level. All equipment foundations shall be designed as the base and pedestal type.

The transformer pedestal shall cover the entire mounting of the transformer base. Its foundation shall allow for oil collection pit draining to an oil separator. The depth of the oil separator shall allow for self-draining of water.
Where necessary, Firewalls shall be introduced and shall be made of reinforced concrete as guided by the electrical designs.

4.1.4.10.9 Material Specifications for Concrete works

- Aggregates

a) Shall conform to BS 882 requirements.
b) Shall be stored in separate heaps on hard, self-draining surfaces.

- Water

Shall be fit to drink/ potable and inert.

- Reinforcement

Shall conform to BS 4449.

- Reinforced Concrete

Shall conform to BS 8110 and BS 8004

- Steel

Shall conform to BS 5950

- Cement

Shall conform to BS 12

Shall be determined based on purpose and application area, with minimum of 42.5N as the standard. Special cements shall be only be used subject to the Project Manager's approval. For example, in coastal environments, cement shall be sulphate resistant.

Cement shall be used within 6 weeks of manufacture, and the Contractor shall make storage arrangements to ensure use of earliest consignment. It shall be stored in a moisture free environment. Different types of cement or different manufacturer cement shall not be mixed in a single cast or for a single element.

Additives shall not be used in this project.

4.1.4.10.10 Concrete work

4.1.4.10.10.1 Work Method Statement

The Contractor shall provide a detailed work statements with specific procedures and quality management plan for all concrete works specific to the site.

4.1.4.10.10.2 Formwork

Formwork shall be sufficient to achieve smooth finish free of projections, voids, etc. This shall be specified on drawings and be within the tolerances specified in the following table as well as to provide an acceptable surface for applied finishes, where required.

- Line and Level1mm per metre not exceeding 5mm
- Pockets, Sleeves etc. +/- 5 mm
- Bases +/- 50 mm

The type of ties to be used shall be such that the required finish is achieved and does not become marred by subsequent corrosion. Ties to be set out to definite pattern to the Project Manager's approval. Rubbing down is allowed only after the Employer's or the Project Manager's approval of the surface to be treated.

All concrete works including foundation bases must have formwork. No casting shall be done direct to earth sides.

4.1.4.10.10.3 Reinforcement

Reinforcement shall not be heated or re-bent for this project. It shall be of strength specified in BS 8110 and of ribbed type only. It shall be free from any material likely to impair bond or initiate corrosion. It shall be bent and fixed according to the bending schedules as per BS 8110 detailing. Reinforcement shall be tied with soft iron wire to Project Manager’s approval and shall be supported to maintain the following minimum cover as per BS 8110.

The Contractor shall inform the Project Manager in good time to allow inspection before concreting.

NOTE: Holding down bolts shall be supplied under the civil works part or by the main contractor if he so decides, and in any case be included in the turnkey price.

4.1.4.10.10.4 Design Mix

Not less than 2 weeks before the start of concrete work, the Contractor shall submit to the Project Manager for his approval a statement of proposed mix proportions for the various grades required in the project. (Note: the grade is the characteristic strength or the cube strength below which not more than 5% of the result may be expected to fall when tested at 28 days).

The statement shall include proportions of cement, fine and coarse aggregate, and water, the maximum and minimum slump and the target strength for each grade. A certificate from an accredited laboratory that the proposed mix will meet the requirements must accompany the statement.

The proportions stated and the materials used may not later be altered without the written approval of the Project Manager. Cost of mix designs to be borne by the Contractor.

4.1.4.10.10.5 Batching

Shall:

a) Be by mass in accurately calibrated scales or by volume in soundly constructed gauge boxes making due allowance for bulking of the fine aggregate.
b) Be in proportion to whole sacks of cement.

4.1.4.10.10.6 Mixing

Shall:

i. Be done mechanically in a machine (concrete mixer) in good condition, large enough to carry the whole mix, controlled by a competent experienced operator.

ii. Carry on for sufficient time to ensure complete mixing of the ingredients.

4.1.4.10.10.7 Placing

Shall:

a. Be under the control of a competent, experienced overseer.
b. Be in a manner to prevent separation of the ingredients.
c. Be a continuous process until the pour is complete.
d. Be complete within the time stipulated in BS 8110

4.1.4.10.10.8 Compaction

i. Shall be done by immersion (poker) vibrator in the hands of experienced operators.
ii. Concrete shall not be moved by vibrator.
iii. Shall be sufficient to remove all air pockets and honey-combing and to ensure complete dense concrete cover to all reinforcement
iv. Shall comply to BS 8110

4.1.4.10.10.9 Sampling and Tests

The Contractor shall prepare concrete cubes as per BS 8110 for No of samples, size of samples and procedure. The Contractor shall then cure the concrete cubes in the environment stipulated in BS 8110 and arrange for transport of cubes to approved testing laboratories. The results of these tests shall be submitted to the Project Manager routinely and in a timely fashion.

4.1.4.10.10.10 Curing

a) Shall commence early on the morning following the placing of the concrete.
b) Shall be affected by keeping the concrete in a permanently wet state.
c) Membranes shall not be used.
d) Shall continue for a minimum of seven (7) days or such longer time as may be required by the Project Manager.
e) Water used shall meet requirement of BS 8110

4.1.4.10.10.11 Stripping of formwork

i. To soffits shall not be struck until 7 days after placing of concrete (but see below for (props).

ii. To vertical faces shall not be struck until 14 days after placing concrete.

iii. Props to soffits shall not be struck until 14 days after placing concrete.

iv. Shall not be stripped without the Employer's or the Project Manager's approval who may vary the above item in special circumstances.

4.1.4.10.10.12 Patching

i. To defective work shall not be undertaken before the item has been shown to the Project Manager.

ii. Is a sign of poor work-Manship. The Project Manager shall have the right to reject the complete element if an unreasonable amount of patching has to be done, or if patching will spoil the appearance of the finished concrete.

4.1.4.10.10.13 Records

Shall be kept by the Contractor, showing date and time of each concrete pour, the weather conditions, the temperature, the number of the cubes which represent the concrete, the slump and any other items which the Contractor and/or the Project Manager consider relevant. These records are to be made available for the Project Manager inspection when required.

4.1.4.10.10.14 Construction Joints

Shall be avoided, if possible, but if inevitable shall be pre-planned in consultation with the Project Manager and temporary stop ends inserted. Before placing of concrete against a construction joint, the formed face shall be hacked down to expose the coarse aggregate, kept continuously wet for 24 hours. Vertical faces should be covered with cement/water slurry and horizontal faces should be covered with 15 mm layer of cement/sand grout. New concrete should then be placed immediately.

4.1.4.10.10.15 Camber

To formwork shall not be at the expense of the overall depth of the concrete.

4.1.4.10.10.16 Weather conditions

Concrete shall not be placed if temperatures above 30 degrees Celsius or below 0 degrees Celsius are expected during concreting.

4.1.4.10.10.17 Cable Ducts and Trenches

The Contractor is responsible for all civil engineering works required for the cable runs between switchgear and buildings. The Contractor's design shall provide separate cable trenches for power and control cables to achieve separation as specified in Cable laying particular specifications. All cable trenches shall be designed in reinforced concrete with minimum thickness of 150mm.

The Contractor shall design for the trench dimensions depending on the type and size of cables, the load requirements, turning radii of cables and local regulations. Serviceable cable trenches shall allow access for installation and maintenance without pulling, and this shall be provided for by maintaining minimum width and depth of 800mm.

Power and control cables shall be laid on suitable hot dip zinc galvanized cable racks and perforated cable trays and in separate trenches. The anchorage of cable racks shall be adequately designed for to allow the weight of a person and the load from all cables.

The trench bottom shall be designed to allow free drainage by sloping a minimum of 1:200 and provision shall be made for a serviceable sump at the lowest level. The cable trench walls shall be raised a minimum of 150mm above the final ground level to prevent stormwater entry. Cable trenches shall be provided with exit drains and sumps as necessary. Concrete cable trenches shall be adequately drained to open drains, or where necessary soak pits of adequate capacity or shall be connected to the general drainage system such that they will remain as dry.

Cable trench entry points shall be sealed to prevent the entry of dust, vermin water, etc., using suitable materials. The transition between building and external trenches shall adequately slope away from the building. Cable entries into buildings and road crossings shall be through 150 mm diameter heavy gauge ducts or in reinforced concrete cable trenches Two (2) lines of 150 mm diameter heavy gauge of spare ducts shall be provided.

All road crossings shall require a reinforced concrete duct with provisions for spare ducts. The ducts shall be constructed in such way that they will be able to withstand the weight imposed on them at a minimum depth of 1.2m. Drainage shall be provided at duct terminal points.

The Contractor's design shall provide construction joints at 30m or less along the cable trench. These shall be adequately sealed to prevent ingress of moisture.
Cable trenches in the switchyard shall be covered using reinforced concrete covers, designed for the maximum likely imposed loads appropriate to their location. The trench covers shall have steel angle line protecting the edges. The trench covers will be constructed such as to allow easy access to the trench by means of handles or otherwise installed for every fourth cover. The top of cable trench walls shall be raised a minimum of 150mm above the finished ground level to prevent water from flowing in the trench covers will be fitted into grooved sides of the trench walls for a flush top of trench and covers.

Cable trench covers inside the building shall be designed with equivalent of 6mm thick metal chequer plates or higher specification material. This shall be reinforced with 25x25x4mm angle iron welded underneath along the edges and across in 'X" formation with allowance for easy handling on removal (provide drop-down handles for easy handling and non-trip safety). In areas where heavy traffic is expected, trench covers shall be recommended to be concrete finished with terrazzo to match the floor finish.

Cable Galleries
Where cable galleries are deemed necessary, anchorage of support brackets and clamps shall be adequately designed for.
Cable entries to be 150mm below the finished internal cable trench level.
6.2.7.8.16 Equipment Foundation Structures

The Contractor shall design equipment support structures to comply with relevant design manuals and local regulations. The equipment support structures shall be designed to endure substation loads and operational stresses. Their design shall also adhere to safety and testing requirements. The Steel support structures for the substation equipment shall be hot formed, hot dip galvanized, with a minimum zinc coating thickness > 110 microns and shall adhere to BS 5950. All steel support structures for equipment to be tubular, and for gantries to be in lattice angle channels.

Design calculations and shop drawings shall be submitted to the Project Manager for his approval prior to fabrication of members. Structural steelwork shall be shop-fabricated from structural shapes of steel in lengths suitable for easy transport and erection. All workmanship and fabrication shall be in accordance with the best practice and shall comply with the requirements of B.S. 5950.

The greatest accuracy shall be observed to ensure that all parts fit together correctly on erection within the tolerances stated in this section. Steelworks shall include all materials, bolts and attachments, cleats, brackets, gussets, etc. Steel structures shall be designed to anchor in the reinforced concrete foundations. The design for anchor bolts shall incorporate pull out strengths.

Other steel structures not made for equipment support (MKs and LV boards supports) shall have a coating > 100 microns. The Project Manager shall prefer bolts for joinery on site. Welding on site shall be minimized and cold galvanized. All steelwork shall be transported, handled, stored on site and erected so that members are not damaged or subjected to excessive stresses.

All steel support structures shall be grounded to the earthing system.

4.1.4.10.10.18 Equipment Steel Structures

The Contractor shall design Steel support structures for the outdoor substation equipment in hot formed galvanized steel to BS 5950. The equipment support structures shall be designed to endure equipment loads, wind and earthquake loads and operational stresses. Their design shall adhere to safety and testing requirements as per standards, specifications and codes of practice for substation equipment support structures.

The Project manager shall approve use of tubular or lattice angle channels steel structures for equipment support. Steel structures shall be designed to anchor in the reinforced concrete foundations. The design for anchor bolts shall incorporate pull out strengths.

The contractor shall incorporate in his design all elements that support equipment from steel support structures, their anchorage and concrete foundations. All steel support structures shall be grounded to the earthing system.

4.1.4.10.10.19 Erection and Commissioning of equipment support structures

The Contractor shall carry out erection of steel structures as per design and erection manual guide.

4.1.4.11 CONTROL BUILDING AND GUARDHOUSE

4.1.4.11.1 ARCHITECTURAL DESIGN

4.1.4.11.1.1 Substation Building Size

The Contractor shall design a Control Room Building to house control facilities and associated gear as per Scope of Works. The Contractor shall design room numbers and size as per the specific equipment, with consideration for operating conditions, access, safety and maintenance as well as provide spare room for future expansion.

Where applicable, the contractor shall also design a guardhouse for security personnel. The guardhouse design shall include washrooms with showers. The design for substation buildings shall conform to relevant building codes and local regulations.

4.1.4.11.1.2 Roof

The contractor shall incorporate in his design all elements that support the roof of the building. Fireproof and fire-resistant materials shall be preferred. Substation roof design shall prefer sloping roofs to prevent accumulation of water. The roof design shall compliment the overall building layout, ensuring adequate draining and sufficient space for maintenance and access too equipment. The roof shall be able to support any equipment that may be installed on top, including antennas and radios. Choice of materials shall comply with the local climate conditions.
The Contractor shall submit manufacturer and fabricator profiles to the Project Manager for review for all materials, accessories and fixings prior to procurement. The Project Manager

may conduct due diligence and may require samples of the materials for inspection and testing, these costs shall be borne by the contractor. The Contractor shall provide the methodology on roof assembly before construction.

Roof structure
The Contractor shall design roof trusses, purlins and accessories in steel. The design shall incorporate all loads guided by the location of the site and shall be weatherproof. The design shall consider worst case maximum load with regard to regional weather data. The design shall comply to BS 5950 and installation shall be carried out as per Structural steelworks guidelines in this document. The trusses shall be weatherproofed accordingly.

Insulation
Insulation sheeting will be laid before installation of roofing sheets. The Contractor shall submit manufacturer technical data sheets and specifications for approval by the Project Manager, and a minimum thickness of 10mm shall be preferred.

Roof Structure
Structural steelwork shall be shop-fabricated from structural shapes of steel in lengths suitable for easy transport and erection. The Project Manager shall prefer bolts for joinery on site. Welding on site shall be minimized and cold galvanized.

All workmanship and fabrication shall be in accordance with the best practice and shall comply with the requirements of B.S. 5950. The greatest accuracy shall be observed to ensure that all parts fit together correctly on erection within the tolerances stated in this section. Steelworks shall include all materials, bolts and attachments, cleats, brackets, gussets, etc. All steelwork shall be transported, handled, stored on Site and erected so that members are not damaged or subjected to excessive stresses. Fabrication and erection shall comply with B.S.5950 Part 2. Steel structures shall be designed to anchor in reinforced concrete. The design for anchor bolts shall incorporate pull out strengths.

Roof sheets
Roof sheeting shall be hot dip galvanised troughed mild steel sheeting of IT5 profile or similar approved by the Project Manager. They shall be of minimum thickness 0.5 mm. The sheeting shall have approved plastic coating on face side. Type and brand of such sheeting shall be proposed by the Contractor and supported by the technical data sheets and manufacturer specifications.

The Project Manager shall prefer that the sheets shall be laid with a minimum 200mm end laps and double corrugation side laps away from the prevailing wind. The sheets shall be fixed to purlins with galvanised coach screws and seating washers.

Holes for screws shall be carefully drilled in the ridges of the corrugations and J-bolts used. Great care shall be exercised to avoid damage and disfiguration to the surface coating of the sheets. At eaves and exposed edges, the corrugations shall be closed with purposely made corrugation closers.

The contractor shall provide eaves of minimum 1m on all four sides of the building, otherwise provide canopies above doors and windows on gable sides.

Switchgear building - ceiling
The Contractor shall design for the provision of ceilings consisting of fore-manufactured sheets, mounted on steel grids jointed to roof structures. The ceiling shall be designed to be fireproof. If gypsum, the boards shall be of minimum 12mm thickness and shall have cornices.

The ceiling shall have an escape hatch in the office and in the washrooms. The contractor shall provide a ladder for maintenance within the Control Building. The external soffit shall be finished with T1G, light gauge steel or aluminum or any alternative material that shall guarantee service through the design life of the substation.

4.1.4.11.2 SUPERSTRUCTURE

4.1.4.11.2.1 Setting out Walling

The Contractor shall provide proper setting out rods and set out all work on the same for courses, openings, heights, etc. and shall build the walls and piers, etc. to the widths, depths and heights indicated on the drawings and as directed and approved by the Project Manager.

4.1.4.11.2.2 Materials

a) Cement
Cement shall be as described in concrete works in this document

b) Fine Aggregates
Fine aggregates for concrete blocks shall be as described for fine aggregate in Concrete Works.

c) Coarse Aggregate
Coarse aggregate for concrete blocks shall be good, hard, clean aggregates from an approved quarry. It shall be free from all de-composted materials and shall be graded up to 7 mm, and all as described for coarse aggregate, Concrete Works.

d) Machine cut stone
This shall be to BS 5628.
This shall be to approval of project manager and meet minimum required specifications. Minimum requirement is compressive strength of 7N/mm2.

e) Natural Dressed Stone This shall be to BS 5628.

f) Concrete Blocks
Concrete blocks for walling shall be provided by the Contractor complying with B.S. 6073 and made in approved block manufacturing machines. Minimum thickness of blocks in external walls shall be 150 mm, and in internal walls the thickness shall be minimum 100 mm.

Blocks in external walls shall be hollow type. The volume of the cavities shall be not more than 50 % of the gross volume, and the dimensions of the cavities arranged so that each cavity is vertically continuous when the blocks are bonded. Blocks in internal walls shall be of the solid type. Samples of the proposed block types shall be approved by the Project Manager before any walling work is commenced.

Blocks shall be cast under sheds in suitable block manufacturing machines either power driven or hand operated. The form shall be of steel, and accurately made to size to give the required shape and squareness of block. The concrete shall be vibrated during casting to achieve a dense and uniform concrete. The material shall contain only sufficient water to obtain full chemical reaction of the cement and to give proper workability of the constituents.

The ratio of combined aggregate to cement shall not exceed 3:1. The Contractor shall present his proposal for mix recipe supported by test results for the Project Manager's approval. Concrete shall have minimum 28 days strength of 20N/mm2 in accordance

with B.S. 1881. Mixing shall take place in mechanical mixers so as to thoroughly mix the constituents to a uniform consistency before casting.

On removal from the machine the blocks shall be carefully deposited on edge on boarding or a clean concrete floor under sheds so as to prevent drying out by the sun for 3 days. During this time blocks shall be kept constantly damp. The blocks may then be laid on edge in the open and kept damp by spraying or covering with wet hessian or by other means for a further 5 days. The blocks may then be stacked if required, but not more than one meter high, and in such a way as to prevent damage to the edges and corners.

No blocks may be used in building or be transported to site before having reached required 28 days strength criterion. All concrete blocks shall be of even texture and properly mixed ingredients and all portions of the block shall be properly set and hardened concrete.

Blocks shall be free from cracks or blemishes and shall be true to shape and size with clean sharp edges and corners and with corners truly square. Damaged blocks shall immediately be removed from the site. No dimension of a block shall deviate individually by more than 3 mm from the correct size. The average length, width and height of a sample of 15 blocks should neither be longer nor less than 2 mm than the correct size.

Dressed natural stone blocks at least 200mm width may be used as alternative to the concrete blocks.

4.1.4.11.2.3 Mortar

The cement mortar is to be mixed in the proportions of1 Cement: 4 Sand, and thoroughly incorporated with a sufficiency of water. Any cement mortar which has been left for more than one hour shall not be used in the Works.

4.1.4.11.2.4 Walling

All block work shall be laid in raking stretcher bond solidly bedded, jointed and flushed up in mortar. Where wall faces are to be plastered the joints shall be raked out to form a key. The blocks shall be thoroughly wetted for at least 24 hour before laying.

Walls shall be carried up evenly course by course. During laying an open joint not less than 15 mm wide shall be left between the ends of all concrete lintels, whether pre-cast or cast in-situ and the blocks adjacent to these ends. These open joints shall be left as long as possible during construction and not filled until plastering or other works render such filling necessary. All such joints shall be properly filled in before the completion of the work. External walls shall be reinforced with two 8 mm high yield steel bars in every third horizontal mortar joint. The building shall be designed as a framed structure.

Block work which is not to be rendered or plastered shall be finished with a fair face and the blocks shall be selected for even texture and unmarked faces, regular shape and square unbroken arrases. The block work shall be pointed as the work proceeds with a neat joint. Where block work is to be rendered or plastered the joint shall be raked out 10 mm deep as the work proceeds to form an adequate key.

Galvanized steel ties with fishtailed end cast into the concrete spaced at alternate courses and extending not less than 150 mm into the block joints. All mortar joints are not to exceed 15 mm or less than 12 mm.

4.1.4.11.2.5 Lintels

Concrete lintels shall be used for all openings and shall be reinforced with two 12 mm high yield steel bars. Lintels shall have a minimum bearing of 500 mm at the ends.

4.1.4.11.2.6 Doors

General

Metal doors shall be supplied by approved manufacturers.
All doors shall be painted as specified under Painting and Decorating. All locks shall be master-keyed with three master keys supplied in addition to three regular keys for each door or gate.
Doors shall be measured by the number of doors of specified dimensions. The Contractor's rate shall include all supplies, site works, painting and hardware.

Doors

Placement of doors shall be in accordance with the approved building drawing. The contractor shall submit manufacturer profile for approval by the Project Manager before procurement.

Door frames shall be pressed steel frames made from minimum 2 mm thick steel sheeting and reinforced where door closers are fixed. The main door shall have a latch provision to accommodate the Project Manager's Standard Padlock. Thresholds shall be made from rolled steel sheeting approximately 100 mm wide and 12 mm high.

Door shall be filled with mineral wool acoustic insulation and lined both sides with steel sheeting minimum 1.25 mm thick. Total thickness of door shall be minimum 45-55 mm. Door frames are to be complete with 100 mm, loose pin steel hinges welded in position and adjustable striking plate.

Internal door frames shall be built to walls truly vertical and square with six-ties per frame. External door frames shall be built in to walls truly vertical and square with eight/ten ties per frame.

Frames shall generally be built-in during construction of the walls and securely fixed. A gap shall be left between the top of the frame and the soffit of the lintel during construction. Frames shall be adequately strutted to prevent distortion and shall be protected from damage during other work.

Door frames and similar components shall be fixed with countersunk screws or bolts with heads set into the frames. Walls shall be built as close as possible to the frames and the gap filled solid with mortar at each course. Render shall be neatly brought up to the frame and well tamped into any remaining cavities. The junctions between window frames or external door frames and external finish or block work shall be caulked tight with approved mastic or mortar wherever required, and neatly pointed. Mastic so used shall have long-term resistance against weather, insects and ultra-violet light.

Doors wider than 800 mm shall have three 100 mm hinges. Other doors may have two hinges except where specified or detailed otherwise. Door stops shall be fitted by screwed fixings where necessary.
All doors shall have fire rating Class A30.

Entryways
Entry to rooms with panels and equipment shall be via ramps. These ramps and steps where necessary, shall be of reinforced concrete.

4.1.4.11.2.7 Windows

Placing of windows in accordance with Switchgear building drawings.

Unless otherwise indicated windows shall consist of aluminium sub-frame with clear glass of approved thickness. Windows shall be from an approved supplier and the details thereof shall be approved by the Project Manager. Windows shall be operable and provided with corrosion resistant metal insect screens or as directed by the Project Manager.

Frames shall generally be built-in during construction of the walls and securely fixed. Widows are to be built in to walls truly vertical square with six-ties per frame.

All aluminium or steel windows are to be from an approved manufacturer and illustrated in the Manufacturer's Catalogue. The aluminium window frames shall be KPLC blue and of minimum 2.5mm thickness. Window panes shall be of minimum thickness 6mm thickness which is shatterproof.

Windows are to be fitted complete with casement fastening, stays etc. All windows shall have approved burglar bars, and approved means of opening/locking.

4.1.4.11.2.8 Door and Window Furniture

Ironmongery shall be strongly made, well finished, good quality "stock pattern" articles. Ironmongery for windows and doors shall be galvanised or other approved manufacture for external use. Samples of all items shall be submitted to the Project Manager for approval before they are used for the Works.

All doors except emergency doors shall be lockable. External doors shall have approved security locks in the Employer’s standards. ironmongery shall be cleaned, oiled, adjusted and left in perfect working order.
Emergency doors shall be provided accordingly as per the safety requirements, complete with approved panic lock.

All ironmongery shall be of the best respective types required and no alternative articles will be accepted unless approved. Articles described as brass must be solid brass and not brass finish. Chromium plated articles must be plated satin finish on solid brass or other approved metal.

Where items for ironmongery are required to be fitted to steel door frames, etc., the Contractor must ensure that the Manufacture makes provisions for the correct fitting or lock striking plates, hinges, cleat holes, bolt keeps, etc.

Locks and Keys
Locks are to be two levers unless otherwise described. All locks are to be provided with three keys which must be handed over to the Owner on completion of the Works with identification labels attached.

Steel
Steelwork for general building construction is to be of approved manufacture complying generally with the appropriate British Standards and free from all defects, oil, dirt, loose rust, scale or other deleterious matter.

4.1.4.11.2.9 MV Switchgear Room

Openings for pressure release: In the MV switch-gear room it is necessary to arrange for openings for pressure release in case of explosion in one of the switch-gears. To avoid damage in the room/building any pressure shall be released through the openings as described.

Location of these openings must be beneath the ceiling on both longitudinal walls in the switch-gear room. The Contractor must calculate number and size of this pressure openings, and submit his proposal for approval.

Sufficient number of MV cable ducts through MV switch gear room wall joining the switchyard MV cable trenches shall be provided. The size of these ducts shall be big enough to accommodate Single core 630mmsqr MV cables. The position and number of the ducts shall be discussed and approved by the project manager. Spare duct shall be sealed to prevent entry by vermin.

4.1.4.11.2.10 Finishes

Schedule of Finishes

Room	Floor	Walls	Ceiling	Remarks/Notes
All Rooms	Terrazzo	Plaster and Painting, Tiles for wet areas	Sheet/plate-fire resistant	Sheets for ceilings = Prefabricated/ manufactured colour and type in accordion with approval of the employer. Switchgear building: External/internal colour in accordance with approval of the employer

4.1.4.11.2.11 Plaster and Floor Covering

Materials

Cement and water to be as before described. The sand to be screened through a sieve of 10 to 15 and meshes to 1 cm and to be washed if directed.

Mixing

All materials for mixing are to be used in proper gauge boxes and they are to be strike measured and not tamped down in boxes. Proper non-absorbent stages are to be used for mixing and storing mortar. No foreign matter must be mixed with the mortar.

The materials are to be mixed dry before adding water through a fine hose spray. No cement mortar which has taken its initial set will be allowed to be used.

Plaster Thickness

Unless otherwise specified all wall plasters should not be less than 13 mm thick and not more than 19 mm thick.

Cement Plaster

Cement plaster for external use to be composed of one part cement to four parts sand and for internal use to be one part cement to five parts sand.

Form Key
Rake out joints and roughen if necessary to form key for plaster.

For concrete surfaces, hack and apply 1:1 cement sand slush to form key. Continuously wet for 7 days and then apply plaster.

All brickwork and concrete works should be brushed down to remove dust and any other loose material.

Wetting
All internal and external brick or concrete surfaces are to be wetted well before plastering. All cement plaster must be kept wet for at least 7 days.
Repairing Defects
All defective plaster, cracks, hollows, etc., are to be cut out to a rectangular shape, the edges undercut to form a dovetail key and to be made good to finish flush with the edge of the surrounding plasterwork.

All patches will be to the approval of the Project Manager and if the defects cannot be made good satisfactorily then the whole surface is to be removed and re-plastered at the Contractor's expense.

4.1.4.11.2.12 Glazing and Painting

Glass
All glass is to be of approved manufacture, free from bubbles, waviness, scratches or other imperfections and is to be well bedded, puttied and back puttied and secured with glazing pins or clips in steel sashes or with sprigs in wood sashes.

All glass shall be carefully cut to the required sizes so that all panes of figured or textured glass are uniform in appearance with the pattern parallel to the edges and wired glass shall be so cut that the wires are parallel to the edges.
The window glass for switchgear room shall be shatterproof type.

Putty
Putty for glazing to steel sashes is to be of approved proprietary brand. Rebates are to be thoroughly back puttied before glazing and all putty is to be carefully trimmed and cleaned off so that back putty finishes level with the top of sections internally, external putty covers sight lines exactly and finished straight and true. Rough surfaces to putty will not be allowed and any defective putty will be cut out and replaced at the Contractor's expense.

Rebates of wood sashes are to be given one coat of priming immediately before glazing.

Mirrors
Glass mirrors are to be of the thickness specified, of selected quality glass, silvered on back, with protective sealing coat and erased edges, unless otherwise described.
Generally
Allow for removing and replacing all cracked, broken or defective glass and leave thoroughly clean and perfect at completion.
Materials for Decoration
All paints, primers, varnishes, emulsions, stopping, etc., to be of approved manufacture. The contractor is to use proprietary ready mixed paints obtained from an approved supplier.

When a coat of proprietary paint is applied, the manufacturer's priming and previous coats suitable for the particular type are to be used.

All materials must be brought on to the site in unopened tins, and no dilution or adulteration will be permitted, unless approved by the Project Manager.

Emulsion Paint
Emulsion paint shall be PVA (Polyvinyl Acetate) alkali-resisting formulated with high washability and capable of resisting 8000 scrub test. The first coat to be specially formulated base coat for direct application to the specified surface.

Fillers
Higher grade cellulose fillers are to be used internally and premixed filler to be used externally.

High Gloss Paints
Primers for application to bare metal to be red oxide primer for iron and steel. For galvanised metal to be an approved zinc chromate or galvanised iron primer. For application on wood or plaster etc., to be an approved alkali primer.

Finish enamels
Finish enamels to be synthetic enamel high capacity paint with high coverage and high gloss finish unless otherwise described.

Workmanship
All surfaces are to be free from moisture, dust, grease and dirt and rubbed down smooth according to approved practice.

All plaster to be free from efflorescence and treated with one coat of petrifying liquid, approved sealer or alkali primer if required. Hard wall plaster to be glass papered before decorating.

Rectifying defects to decorated surfaces due to dampness, efflorescence, chemical reaction, etc., will be to the Contractor's account, as these surfaces must be checked and the appropriate precautions taken before applying the decoration.

Metalwork must be scraped free of rust, primed as described and finished as later specified.

Galvanised sheet iron, pipes, etc., are to be cleaned down to remove manufacturer's ammoniated dichromate protective covering, primed as described and finished as later specified.

Coated pipes are to be cleaned down, stopped and primed with one coat of aluminium primer and finished as later specified.

All knots in woodwork to be treated to prevent bleeding. Large or loose knots to be cut out and be replaced with sound wood, or cut back and filled. Small knots to be treated with two thin coats of Shellac in methylated spirits. Woodwork to be glass papered to a smooth surface with all sharp arises removed, all cracks, crevices, holes, etc., to be scraped out, primed as described and stopped with hard stopping, faced up and rubbed down to an even surface and finished as later specified.
All metal and woodwork to have the specified number of coats in addition to the priming coat.

Every coat of paint must be a good covering coat and must dry hard and be well rubbed down to a smooth surface before the next coat is applied, otherwise the Contractor will be required to apply extra coats at his own expense.
Each coat of paint to be of a distinctive colour: sample colours are to be prepared for the final coat which is to be an approved colour scheme and must not be applied without the permission of the Project Manager. After undercoats are on, the painter shall check all work and grain fill as necessary with filler as described.

Note
a) *All paints specified are to be obtained from an approved manufacturer by project manager and used in strict accordance to manufacturer instructions.*
b) Their representative will check the paints being used and the method of application and will advise accordingly.
c) This section of the work to be carried out by an approved firm of decorators who must allow for the very best finish possible and of the highest quality obtainable.
d) The prices must allow for the removal and refitting of all beads, fittings, fastenings, ironmongery, etc., removed for decoration purposes to be carried out by skilled tradesmen of the appropriate trade

4.1.4.11.3 Structural Design

The Contractor shall provide a detailed structural design for the Control Building and the Guardhouse. They shall apply the same principles as the Foundation designs in this section of the document.

4.1.4.11.4 Furniture

The Contractor shall provide furniture in the Office room of the Control building, as well as the guardhouse to Project Manager's Approval. Provision shall be made for storage of PPEs in the guardhouse leigh

4.1.4.11.5 Mechanical System- Plumbing and HVAC

Washrooms
The contractor shall include in his designs, two gender separated washrooms. These shall have a water closet each, a wash hand basin and a showerhead. They shall be supplied from the high-level water storage. Extractor fans shall also support proper ventilation. These shall be accessed from outside.
Kitchen
The contractor shall design for a kitchen area with countertops for microwave and utensil drying rack, as well as storage cabinets.

AC Installation
The Contractor shall supply and install minimum six (6) number AC units including wiring and insulator for the unit. The design for these AC units shall be done by the contractor and calculations approved by the Project Manager. The design shall take special consideration for projects in coastal or high humidity areas. The external AC unit drain ducts shall be directed to main drain and should not drain to the building apron. Wall mounted extractor fans shall be provided in the battery and washrooms.

4.1.4.11.6 Electrical System

This section of the specification relates to the supply, installation, testing and commissioning of the complete electrical services within the switchgear building, including:

The Employer reserves the right to reject any of the contractor suppliers if he feels the product does not meet the contract specification. All electrical fittings and plumbing materials are subject to Project manager approval.

4.1.4.11.6.1 Electrical Services General Description

The complete electrical installation shall comply with all local standards and codes. Should there be any conflict between local standards and what has been specified the sub-contractor should draw it to the attention of the Project Manager.

Lighting

Luminaries shall be fluorescent lamps except for the toilets and outdoor lighting (except switchyard and perimeter lighting) where GLS lamps can be utilized. In switchgear room: 250 lux is required. In offices 500 lux is required.

a. All luminaries shall be supplied, installed and tested by the electrical sub-contractor.
b. All metal work on the luminaries shall be connected to an insulated earth protective conductor.
c. Lighting Control Switches
d. Outdoor lighting shall be controlled from an automatic timer control system.
e. Lighting control switches shall be flush pattern with white finished plates.
f. Grid switches shall have 5 or 10 Amp rating, generally where fluorescent discharge luminaries are controlled switches have 10Amp rating whereas with low energy PL lamp, 5 Amp switches shall be installed.
g. Provide emergency lights both inside and outside the building on each side on DC supply.
h. Provide security lights with solar backup system.

Socket Outlets and Accessories

Reference should be made to the Standards given above for details on the socket outlets and accessories. Socket outlets to be mounted at 300 mm above floor level.conduit cast into the building structure shall be of the heavy duty PVC type. PVC conduits shall not be fixed to the surface of the structure

4.1.4.11.6.2 Battery Bank room

The room shall have an independent door opening to the switch yard, and shall have no inter connecting alley between this room and rest of the switchgear/control room. It shall also be installed with 2no. Exhaust fans for blowing battery fumes out of the room, one working and one on standby. They shall be composed of a non-sparking wheel construction and motor shall be explosion-proof type. Fans shall be wall mounted axial type with back draught dampers. The room's doors shall have applicable fire and security rating. Walls shall be protected against electrolyte splashing by applying an approved light-colored and resistant enamel paint. OSHA 1925.4.03 (A) General Requirements shall apply.

The battery room shall be provided with a tap and sink with cold water supply. Heavy duty PVC pipes shall be used instead of cable trench and they must not be on flush level with the floor (minimum 50mm off and above the floor).

Appropriate signage shall be provided outside the battery room. Appropriate PPEs for maintenance and handling of the batteries shall be provided. Racks and trays shall be designed for and provided. These shall be treated for resistance to electrolyte.

Floor finish shall be an approved acid-resistant epoxy coating applied as per approved manufacturer's specifications.

Lighting luminaries, sockets and switches within the battery room shall be explosion-proof and subject to approval by the PM The design shall consider that all possible sources of ignition including arcing sparks excessive surface temperature can be controlled and the probability of explosion reduced to acceptable low levels.

4.1.4.11.7 FIRE PROTECTION

4.1.4.11.7.1 External Fire Protection

A minimum of 2no. 25kg Dry powder Fire extinguishers with trolleys shall be provided with proximity to the Transformer in the yard. The contractor shall provide 6no. sand buckets.

All instructions and labels shall be in English. Fire extinguishers shall be provided in the guardhouse. One fire extinguisher (foam) shall also be provided at the control building on the side facing the switchyard.

In the cable trenches, fire retardant approved by the Project Manager shall be used at junctions of cable trenches and sprayed on the cables. Reinforced Concrete firewall shall be provided between equipment and the control building and/or transformers that breach the relevant clearance allowed. Design for the firewall to be done to BS 8110 with special consideration for fire rating.

4.1.4.11.7.2 Building Fire Protection system

Fire Detection and suppression

The building shall be fitted with addressable fire and smoke detection system. The contractor to train the local staff on use of the installed system. The system shall be integrated with station SCADA system for regional Control Centres remote monitoring.

Fire Suppression system at substation level

Portable fire extinguishers shall be provided under this Contract. Portable, wall mounted, hand held extinguishers shall be 9.5kg pressurized control discharge BCF units. The number of units within the Substation shall be a minimum of 6 Number. 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 walls mounted, attached, and located 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.

Fire Evacuation Plan

The station layout shall have areas designated for assembly of people in the event of a fire alarm. A fire evacuation plan shall be designed and displayed at all entry points and approved by the Project Manager. Adequate signages shall also be placed within the substation to guide movement during evacuation