



TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT –PHASE 1

BIDDING DOCUMENT

DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF
STANDARD TELECOM COLLOCATION FACILITIES IN SELECTED SUBSTATIONS

TENDER NO. KPI/9A/5F/OT/004/16-17

VOLUME 2/2

Technical Specifications

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Employer:

*Kenya Power & Lighting Company Limited
Central Office, Stima Plaza,
Kolobot Road, Parklands,
P.O. Box 30099-00100,
Nairobi, Kenya.*

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ABBREVIATIONS AND ACRONYMS

Table 0-1 Abbreviations and Acronyms

Abbreviation/ Acronym	Description
ACS	Access Control System
AP	Attenuation Profile
CAK	Communications Authority of Kenya
CCTV	Closed Circuit Television
CD	Chromatic Dispersion
CWDM	Coarse Wave Division Multiplexing
DSLSP	Direct Stroke Lightning Protection
DWDM	Dense Wavelength Division Multiplexing
DWSM	Dual Window Single Mode
DUT	Device Under Test
EMP	Environmental Management Plan
FACP	Fire Alarm Control Panel
FCP	Fiber Concentration Point
FDT	Fiber Distribution Terminal
GPON	Gigabit Passive Optical Network
GPS	Global Positioning System
HDPE	High Density Polyethylene
IEC	International Electrotechnical Commission
IL	Insertion Loss
KPLC	Kenya Power and Lighting Company Limited
LED	Light Emitting Diodes
MDU	Multi-Dwelling Units
NEMA	National Environmental Management Authority
NFPA	National Fire Protection Association (US based trade association)
NFPT2	Network Facility Provider Tier 2
NMS	Network Management System
OCWR	Optical Continuous Wave Reflectometer
ODF	Optical Distribution Frame
OFAC	Optical Fiber Approach Cable
OLT	Optical Line Terminal (usually at Point of Presence)
ORL	Optical Return Loss
OPGW	Optical Ground Wire
OPPC	Optical Phase Conductor

Abbreviation/ Acronym	Description
OTDR	Optical Time Domain Reflectometer
PCB	Polychlorinated Biphenyls
PDF	Portable Document Format
PMD	Polarization Mode Dispersion
PLB	Permanently Lubricated
PON	Passive Optical Network
QAP	Quality Assurance Plan
ROW	Right-of-Way (i.e. wayleave or easement)
RTS	Rated Tensile Stress
SDU	Single Dwelling Units
TSPs	Telecommunication Service Providers
UTM	Universal Transverse Mercator
UV	Ultra Violet
Weight and Measures	
km	Kilometre (1,000 m)
kV	Kilovolt (1,000 volts)
kVA	Kilovolt-ampere
kW	Kilowatt
kWh	Kilowatt-hour
M	Million
m	meter
MVA	Mega volt-ampere (106 volt-ampere)
MWh	Megawatt-hour
MW	Megawatt
Yr	Year
Currency	
USD	United States Dollar
KES	Kenya Shillings

1. INTRODUCTION

1.1. Background

As a licensed Network Facility Provider Tier 2 (NFPT2), Kenya Power is authorized to lease dark fiber and associated collocation services. The company therefore leases out available space in substations for construction of telecom shelters or collocates standard telecom racks within existing substation control buildings.

Increasing demand for collocation space within KPLC substations has presented a number of challenges including congestion as well as potential for non-compliance with applicable standards.

In order to address these challenges, KPLC has planned to establish standard telecom hubs at various substations across the country. The development of these hubs is to be carried out over a three-year period comprising of three distinct phases.

This document comprises technical specifications for the scope of works comprising the first phase of the proposed development which involves construction of standard telecom hubs at the following substations:

- 220/66kV Embakasi Substation
- 132/33kV Kiboko Substation
- 132/33kV Voi Substation
- 220/132kV Rabai Substation
- 132/33kV Kipevu Substation
- 33/11kV Mbaraki Substation
- 132/220kV Kamburu Substation
- 132/33kV Kiganjo Substation
- 132/33kV Naivasha Substation
- 132/33kV Lanet Substation
- 220/132kV Lessos Substation
- 132/33kV Kisumu Mamboleo Substation

1.2. Contract Packages

For the ease of implementation of the works, and considering the value, the works under project will be performed under a single contract package and which will be awarded to a single contractor through an open tendering process.

2. SCOPE OF WORKS

2.1. Introduction

The Contractor's scope of works includes design, manufacturing, pre-shipment inspection, seaworthy packing, shipment, clearing of goods at the port of destination, transportation to site, installation, testing and commissioning of telecom hub facilities complete with all equipment as specified.

For information on the scope of works, conceptual design drawings indicating the proposed location of the telecom hub buildings are attached as *Annex 1*. Bidders are requested to note that these drawings are provided for information and for tender purpose only.

In addition, the technical specifications of equipment to be supplied under Contract are detailed in *Annex 2* (Guaranteed Technical Data Sheets). Bidders are expected to complete the data sheets for each equipment and submit them with tender.

The scope of works is detailed in the following sections:

2.2. Overall Scope Works

The scope of works will comprise establishment of telecom hubs at the following substations:

- 220/66kV Embakasi Substation
- 132/33kV Kiboko Substation
- 132/33kV Voi Substation
- 220/132kV Rabai Substation
- 132/33kV Kipevu Substation
- 33/11kV Mbaraki Substation
- 132/220kV Kamburu Substation
- 132/33kV Kiganjo Substation
- 132/33kV Naivasha Substation
- 132/33kV Naivasha Substation
- 132/33kV Kisumu Mamboleo Substation
- 220/132kV Lessos Substation

Detailed description of the works is provided in the following sub-sections.

2.2.1. The 220/66kV Embakasi Substation

Embakasi Substation is located in Nairobi at a location described by the geographical coordinates UTM Zone 37M, (263459.44m Easting, 9851901.01m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type "A" telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.

- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System.
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Hub Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No x 42U Self- Standing Telecommunication racks.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Supply and installation of approximately 40m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Design and construction of stormwater drainage connecting to the existing substation storm water drainage system.
- Supply and installation, and testing of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 250m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Graveling of area from the control building to the nearby station access road.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.2. The 132/33kV Kiboko Substation

Kiboko Substation is located in Kiboko area of Makueni County at a location described by the geographical coordinates UTM Zone 37M, (358243.98m Easting, 9753577.80m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.

- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Hub Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 25m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 120m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area from the control building to the nearby station access road with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.3. The 132/33kV Voi Substation

Voi Substation is located in Voi town, Taita Taveta County at a location described by the geographical coordinates UTM Zone 37M, (452374.31 m Easting, 9625197.51m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System.
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Hub Building.
- Supply and installation of 18No x 42U Self- Standing Telecommunication racks in the customer equipment room
- Supply and installation of 18No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 120m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 200m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area from the control building to the nearby station access road with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.4. The 220/132kV Rabai Substation

Rabai Substation is located in Kilifi County at a location described by the geographical coordinates UTM Zone 37M, (562110.86 m Easting, 9565174.23 m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “B” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 100m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 260m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Design, supply and installation of a 15m long, 4m wide cabro paved access road from existing substation access road to the Telecom Hub building.
- Gravelling of area from the control building to the nearby station access road with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.5. The 132/33kV Kipevu Substation

Kipevu Substation is located in Mombasa at a location described by the geographical coordinates UTM Zone 37M, (570667.02m Easting, 9553480.94m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 60m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 200m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Design, supply and installation of a 1.5m long, 5m wide cabro paved access road from existing substation access road to the Telecom Hub building.
- Gravelling of area from the control building to the nearby station access road with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.6. The 33/11kV Mbaraki Substation

Mbaraki Substation is located in Mombasa at a location described by the geographical coordinates UTM Zone 37M, (573468.41m Easting, 9550528.15m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 20m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 50m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Graveling of area around the control building as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design supply and installation a steel gate complete with a pedestrian gate to Employer's requirements.

2.2.7. The 132/220kV Kamburu Substation

Kamburu Substation is located in Machakos County at a location described by the geographical coordinates UTM Zone 37M, (354054.13 m Easting, 9910622.27m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type "A" Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 20m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 60m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area around the control building as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.

2.2.8. The 132/33kV Kiganjo Substation

Kiganjo Substation is located in Nyeri County at a location described by the geographical coordinates UTM Zone 37M, (280530.67m Easting, 9952293.94m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “B” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System

- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 3No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 30m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 120m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area between the control building and fence as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design supply and installation a steel gate complete with a pedestrian gate to Employer's requirements.

2.2.9. The 132/33kV Naivasha Substation

Naivasha Substation is located in Naivasha along the Mai Mahiu Naivasha highway at a location described by the geographical coordinates UTM Zone 37, (217517.28m Easting, 9911724.64m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type "A" Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System.

- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 18No x 42U Self- Standing Telecommunication racks in the customer equipment room
- Supply and installation of 18No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 40m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 200m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Graveling of area between the control building and fence as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design, supply and installation of a 26m long, 4m wide cabro paved access road and parking area from existing substation access road to the Telecom Hub building as indicated on the layout plan drawing.

2.2.10. The 132/33kV Lanet Substation

Lanet Substation is located in Nakuru at a location described by the geographical coordinates UTM Zone 37M, (181544.63 m Easting, 9966466.40 m Southing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLSP) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.

- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System.
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 18No x 42U Self- Standing Telecommunication racks in the customer equipment room.
- Supply and installation of 18No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 40m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 80m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area between the control building and fence as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design, supply and installation of a 6m long, 4m wide gravel access road from existing substation access road to the Telecom Hub building as indicated on the layout plan drawing.

2.2.11. The 132/33kV Kisumu Mamboleo Substation

Mamboleo Substation is located in Kisumu City at a location described by the geographical coordinates UTM Zone 36M, (698426.28m Easting, 9993486.25m Northing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “A” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.
- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.

- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 18No x 42U Self- Standing Telecommunication racks in the customer equipment room
- Supply and installation of 18No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 50m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 150m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Graveling of area between the control building and fence as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design, supply and installation of a 9m long, 4m wide cabro paved wide gravel access road from existing substation access road to the Telecom Hub building as indicated on the layout plan drawing.

2.2.12. The 220/132kV Lessos Substation

Lessos Substation is located in Nandi County at a location described by the geographical coordinates UTM Zone 36N, (755374.78m Easting, 24148.55 m Northing).

The scope of works will comprise the following:

- Topographical survey
- Soil investigation (including geotechnical as well as soil resistivity assessment)
- Detailed design, supply and installation of Type “B” Telecom hub building including architectural planning, Civil & Structural design, Building Electrical Services Design, Building Direct Stroke Lightning Protection (DSLPL) System.
- Supply and installation of one (1) 50kVA Emergency Diesel Generator.

- Supply and installation of a water supply system comprising of a 5m³ elevated water storage tank, booster pump system and piping connections to the existing water supply system.
- Design, Supply, Installation, Testing and Commissioning for the Heating, Ventilation and Air Conditioning System for the Telecom Hub Building.
- Design, Supply, Installation, Testing and Commissioning for the Closed Circuit Television Surveillance (CCTV) system for the Telecom Hub Building including hardware and software integration to the KPLC CCTV System
- Design, Supply, Installation, Testing and Commissioning for the Access Control System(ACS) for the Telecom Control Building including all the necessary hardware and software integration to the existing KPLC Access Control System.
- Supply, installation, testing and commissioning of Fiber Approach Cables from existing junction boxes mounted to the KPLC ODFs including terminations at both ends.
- Design, Supply, Installation, Testing and Commissioning for a Fire Suppression System (FSS) for the Telecom Control Building.
- Supply and installation of 18No x 42U Self- Standing Telecommunication racks in the customer equipment room
- Supply and installation of 18No. 42U Self-Standing racks complete with ODFs in the KPLC equipment room.
- Supply and installation of approximately 120m long, 600x500mm cable trench extension works from existing cable trench to the Telecom Hub Building complete with reinforced concrete covers. The cable trench shall include cable support facilities for fiber approach cables as well as low voltage ac cable from the existing control room to the voltage ac distribution/metering board to be installed under Contract.
- Supply, installation, testing and commissioning of an outdoor type 415V Distribution/Metering Board complete with space for mounting of Three Phase/Single Phase Energy Meters.
- Supply and installation of approximately 250m of 70mm² 4/C Aluminium low voltage distribution cable from the existing ac distribution board in the substation control building to the 415V ac distribution/metering board including termination at both ends.
- Gravelling of area between the control building and fence as marked on the conceptual layout drawing with 30-40mm size gravel suitable for substation switchyard areas.
- Supply and installation of an earthing system comprising of tinned copper strip within the telecom hub building including connecting the same to the existing substation earthing grid.
- Design, supply and installation of a 9m long, 4m wide cabro paved wide gravel access road from existing substation access road to the Telecom Hub building as indicated on the layout plan drawing.

2.3. Scope of Civil Works

The scope of civil works under Contract shall be as detailed in the following sections.

2.3.1. The Telecom Hub Building

The design and eventual construction of the Telecom Hub Building shall include a reinforced concrete slab roof with an additional metallic roof as is the case for KPLC substation control buildings.

Two(2) pre-fabricated man-holes measuring 2m long x 1m deep x 0.5m wide (internal dimensions) shall be constructed outside of the building to provide a channel for incoming and outgoing fiber optic cables. The link between this man-hole and the control building shall be fitted with 100mm diameter

HDPE pipes. The outgoing lines from the man-holes shall also be fitted with similar pipes. The number of pipes shall be equal to the total number of customer and KPLC incoming and outgoing cables. The pipe for power cable shall be fitted with a pipe having sufficient diameter to contain the cable. Once incoming fiber optic and low voltage power cables have been installed and tested, the respective pipes shall be sealed with a suitable sealing compound to prevent water and rodents from accessing the interior of the telecom hub building. The sealing compound shall first be approved by the Client prior to its application. The man-holes shall be made up of reinforced concrete walls and shall be supplied complete with reinforced concrete covers of dimensions allowing for maintenance without the use of lifting machines. The man-holes shall be designed with suitable self-draining mechanism to ensure that they are not flooded with rain water.

The kitchenette unit shall be provided with shelves (wooden), granite worktop, water sink complete with hot and cold water mixer, electric kettle, a set of six (6) tea cups, a set of cutlery and the floor shall be fitted with suitable ceramic tiles.

KPLC equipment room and customer equipment rooms shall be fitted with pre-fabricated raised floor allowing for ease of installation of 42U racks and laying of cables. The specifications of the raised floor shall be submitted for review and approval of the Employer before commencement of manufacturing.

The office area of KPLC equipment room shall be provided with an office table (wooden) and one (1) office chair. In addition, the room shall also be fitted with a lockable document cabinet with a glass display.

2.3.2. Cable Trench Extensions

All new cable trench extensions shall as far as possible be harmonized to the existing substation cable trenches. The cable trenches shall be made up of reinforced concrete and shall be supplied complete with cable support structures which must be embedded in concrete as well as reinforced concrete covers.

The cable trenches shall be constructed with some slope and shall be connected to the existing substation storm water drainage to enhance drainage of rainwater to prevent flooding in the trench. Except otherwise approved, the cable trenches shall be 600mm wide and 500mm deep.

2.3.3. Road Extensions and Parking Areas

The scope of work shall include road extensions and parking areas as specified under *sections 2.2& 2.3* for each substation. Road extensions shall either have cabro paving finish or gravelling. The design of the roads as well as parking areas shall be done in accordance with local requirements and shall be submitted for approval before commencement of construction.

2.3.4. Water Supply System

Water supply system shall include design, supply, installation, testing and commissioning of an elevated water storage tank complete with support structures for a 5m³ water storage tank complete with a booster pumping system. The scope of services also includes water piping connections to the existing water supply system at the respective substations. Provision shall be made in the design to allow for filling of the elevated storage from mobile tankers.

2.3.5. Fence and Gate

This is to be constructed in some substations as specified in sections 2.2 & 2.3.

2.3.6. Storm Water Drainage

The scope of works under Contract includes construction of a stormwater drainage system to connect to the existing drainage at each of the substations.

2.3.7. Sewer System

The Contractor shall design, supply and install a septic tank and soak pit in each of the substations next to the Telecom Hub building.

3. DESIGN REQUIREMENTS

2.1. Introduction

Prior to commencement of manufacturing or site construction works, the Contractor is required to carry out detailed design and obtain approval from the Employer's Representative. The Contractor will be required to demonstrate design capacity by submitting detailed CVs of design engineers who will be deployed to carry out design for the various components of supply.

Design of the facilities shall be carried out in accordance with these technical specifications as well as local and international standards as applicable.

2.2. Design Programme

It is expected that the Contractor will complete all design works within a period of one (1) month after commencement of works.

2.3. For Construction Design

The scope of design for the proposed works will as a minimum include the following major components:

- a) Topographical survey of the site
- b) Soil investigation including geotechnical as well as soil resistivity surveys
- c) Site layout planning
- d) Building Architectural planning
- e) Building Civil & Structural design
- f) Building Electrical Wiring Design (including indoor and outdoor facilities)
- g) Water Supply System Design including plumbing
- h) Design for the storm water drainage system
- i) Design for the Septic Tank and Soak Pit
- j) Lightning Protection & Earthing Design
- k) Design Access roads, fence and gates (where applicable)
- l) Design for Cable trench extensions
- m) Design for CCTV Surveillance System including interface to existing KPLC system
- n) Design for Access Control System including interface to existing KPLC System
- o) Design for Fire Suppression System
- p) Design for Power Distribution/ Metering System including connections to KPLC distribution board as well as the proposed 50kVA Emergency Diesel Generator.
- q) Design for the Heating, Ventilation and Air Conditioning System (HVAC) for the Telecom Hub building.
- r) Fiber Network Planning
- s) Design for Environmental Monitoring System

2.4. Design Deliverables

The deliverables expected to be submitted to the Employer out of the design process are as follows:

- a) Master List of all design documents to be submitted by the Contractor
- b) Topographical layout of the site
- c) Soil investigation report
- d) Site layout plan
- e) Building Architectural plan
- f) Civil and Structural design drawings and calculations
- g) Building Electrical Wiring Drawings (including layout plan, single line drawings and design calculations confirming adequacy of the design).
- h) Water Supply System design drawings and calculations
- i) Storm water drainage layout drawings and details (where applicable)
- j) Septic Tank and Soak Pit drawings
- k) Lighting Protection and earthing layout connection layout drawing
- l) Access road drawings including sections and drainage
- m) Indoor raised floor design layout drawing and accessories
- n) Supply cable sizing calculations, layout drawings and single line drawing showing interface to existing KPLC Distribution Board at each of the substations.
- o) Design drawings and loss budget calculations for the fibre cables from existing junction boxes to the ODF in Telecom Hub building including drawings for all terminations to be done.
- p) Detailed drawings for gates, doors, windows
- q) Drawings for Cable trench layout and sections
- r) Layout drawing for CCTV as well as specifications for the proposed cameras and cables.
- s) Layout drawing for Access Control System complete with specifications of all accessories.
- t) Specifications of emergency diesel generator to be supplied
- u) Sizing calculations and layout plan for the proposed heating, ventilation and air conditioning system.

All design drawings shall be submitted in AutoCAD .dwg format as well as in portable document format (.pdf).

4. GENERAL TECHNICAL SPECIFICATIONS

4.2. Units of Measurement

In all correspondences, technical schedules and drawings, metric units of measurement shall be used. On drawings or printed pamphlets where other units have been used, the equivalent metric measurement shall be marked in addition.

4.2. Standards

4.2.1. Units of Measurement

Metric units of measurement (System International) shall be used in all Contract documentation. Angular measurement shall be in degrees with 90 degrees comprising one right angle.

4.2.2. Standard Specifications

All equipment supplied under this Specification shall conform to the latest editions of the ITU-T, International Electrotechnical Commission (IEC), IEEE or KPLC Specifications. Alternative standards will only be accepted if the Contractor is able to satisfactorily demonstrate to KPLC that such Standards are equal to or better than IEC/ BIS. Full details of differences, which affect the design or performance of the equipment, shall be stated in the Tender.

4.3. Site Conditions

Local site conditions in the project area are as shown *Table 3-1*.

Table 4-1 Site Conditions

Item No	Description	Value
1.	Altitude	2300m asl
2.	Maximum outdoor ambient temperature	+40°C
3.	Minimum outdoor ambient temperature	-1°C
4.	Annual average temperature	30°C
5.	Average annual isokeraunic level	180 thunderstorm days
6.	Average annual rainfall	800-1700 mm
7.	Maximum Solar radiation	169 kCal/cm ²
8.	Seismic coefficient	1.5
9.	Climate	Tropical wet
10.	Relative humidity	Above 90%
11.	Maximum wind pressure on projected area of cables and cylindrical objects	400N/m ²
12.	EMC Class (IEC 61000)	Industrial environments
13.	Pollution (IEC 60185)	Heavy: Class II

All equipment and materials must be tropicalized and shall operate efficiently under prevailing site conditions.

In choosing materials and their finishes, due regard shall be paid to the equatorial conditions. The bidder shall submit details on his practice and recommendations to the Employer.

4.4. Quality Assurance

4.4.1. General Quality Assurance Program

Within three (3) weeks after commencement date of the works, the Contractor shall submit a detailed Quality Assurance Plan (QAP), which shall generally conform to relevant ISO requirements. Approval to proceed with manufacture of equipment within this Contract will not be given until the QAP for all major equipment / material has been received and approved by the Employer. Delays to the Contract completion date due to non-compliance with this specification requirement will be the Contractor's responsibility.

4.4.2. Features of the Quality Assurance Plan

Major features of the QAP shall ensure:

- a) The Contractor has defined all staff responsibilities and the QA systems operating within the organization for the purpose of ensuring adequate quality of the end product.
- b) The Contractor has a senior officer with the authority available at site all the time to resolve matters of quality to the satisfaction of the Employer.
- c) The Contractor has adequate facilities under the control of properly trained staff to perform the quality control duties available to any relevant member of the Contractor's workforce.
- d) A detailed inspection and test plan is prepared for the whole manufacturing operation.
- e) Regular and systematic programmes of testing are carried out for all incoming raw materials.
- f) Regular calibration checks are carried out on all measuring equipment used in the manufacturing operations.
- g) Statistical analyses are carried out regularly on appropriate test results to confirm that all processes are performing within the specified tolerances.
- h) Adequate procedures are planned for corrective action in the event that quality checks show that performance is not satisfactory.
- i) All checking activities, test results etc. are recorded on appropriate standardized forms and these are verified, certified, recorded and filed in a systematic manner.

The above listing is not exhaustive and any additional systems are to be put in by Contractor to ensure timely and effective execution of the project.

4.5. Working Stresses & Design

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

The equipment and apparatuses shall be designed and manufactured in the best and most substantial and skilful manner with materials best suited to their respective purpose and generally in accordance with up-to-date recognized standards of goods practice.

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

All designs shall be such that the installation, replacement and general maintenance may be undertaken with the minimum of time and expense. The tolerances used for dimensions and finishes shall be selected with due consideration to the particular properties and functions of the parts and the corresponding accuracy required to obtain proper operation and tight sealing.

All materials and equipment shall be designed, to minimize the risk of fire and consequential damage, to prevent ingress of vermin, dust and dirt, and accidental contact with electrically live parts or moving parts. The different Materials and Equipment shall be capable of continuous operation with minimum attention and maintenance in the exceptionally severe conditions likely to be encountered in a tropical climate.

The Facilities shall be designed for reliable, long and continuous service and safe operation under all conditions, with high economy and low maintenance cost. Facilities shall be available to simplify inspection, testing, maintenance and repair of the Plant. The design shall also include all necessary provisions ensuring the safety of the operating and maintenance personnel.

All materials and plant used under this Contract shall be new and of the best quality; workmanship shall be of the highest class throughout the Facilities. All outdoor Plant including towers, insulators, busbar conductor, hardware and fittings shall be designed so that water cannot collect at any point. Welding, filling, plugging or any repairs to defective items of Plant or parts thereof shall not be permitted without the approval in writing of the Employer's Representative.

4.6. Nuts and Bolts

Nuts and Bolts shall conform to ISO Metric. On outdoor equipment and structures all steel bolts and screwed rods shall be galvanized including the threaded portions. All associated nuts shall be galvanized with the exception of the thread that shall be oiled. The thickness of zinc coating shall be not less than 70 μm of surface area.

On outdoor equipment all bolts, nuts and washers shall be of non-corroding material where they are in contact with non-ferrous parts in conductor clamps and fitting.

In order to prevent risk of corrosion, bolts shall protrude by no more than three thread pitches from the surface of the nuts.

4.7. Surface Coating & Galvanizing

Unless specifically mentioned to the contrary, all iron and steel used in the Contract shall be protected against corrosion effects, after the whole fabrication is completed, by galvanization, metal coating or paint applications.

The surface coating shall be uniform, clean and smooth. The formulation and application procedure shall be as recommended by the manufacturer for the appropriate exposure conditions.

All iron and steel wires shall be galvanized by an approved process (e.g.: hot dip process) before straining. The galvanization shall be smooth, clean, of uniform thickness and free from defects and shall withstand the tests set out in ISO 1460 or equivalent.

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

The colour of all outer coats shall be approved by the Employer, if not described in detailed specification below.

Any coated part found to be imperfect must be replaced. The whole of the expense involved in the replacement of the imperfect part shall be borne by the Contractor.

4.8. Spares, Special Tools & Appliances

The Price Schedule covers all items that are required under the contract. Any spares ordered shall be strictly interchangeable with the original parts intended and shall be packed or treated in such a manner as to be suitable for storage in the tropical climate at site for an indefinite period and each part shall be clearly marked for identification purpose, outside the package when applicable.

All spares, special tools and appliances shall be subject to inspections and/or tests on the functions specified in the Specifications.

Spare parts supplied under the contract shall be packed and preserved for long time storage.

Instruction manuals of special tools and appliances as well as the drawings shall be prepared and 3 copies forwarded to the Employer.

The Contractor shall supply in lockable boxes, for the Employer's use, any special tools that may be required for assembly, dismantling adjustments and maintenance of the equipment. The tools shall be unused and in new condition at the time of handover. Suitable special spanners shall be provided for bolts and nuts, which are not properly accessible by means of an ordinary spanner.

Each special tool and appliance shall be clearly marked with its size and/or purpose and shall be packed in the appropriate box with three (3) sets of operation and maintenance instruction books.

4.9. Packing & Shipping

All goods shall be packed or bundled properly so that no damage shall be sustained through rough handling during overseas and inland transportation to the tropical country.

The contents of packing cases shall be securely fixed or fastened in position in their cases with struts or cross battens. Wood fiber shall not be used for packing purpose.

All wood and other materials used in packing cases shall be insect free. Adequate protection and precaution are to be taken to exclude termites and other vermin, noxious insects, larvae or fungus from the packing materials.

The Contractor shall protect all steelworks before shipment, to prevent corrosion and/or damage.

Bundles of steel sections shall be properly tied together by a proven method and care shall be taken to ensure that they are robust and that they can be handled easily during shipment.

Packing cases where used shall be constructed rigid and strongly and in no case shall timber less than 20 mm in thickness be used. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood, but shall be supported by cleats secured from the inside.

Waterproof papers and felt linings shall overlap at seams and the seams secured together in an adequate manner, and the enclosure shall be provided with screened openings to obtain ventilation.

The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and transportation.

4.10. Nameplates and Escutcheon Plates

Where equipment is provided with a permanently attached nameplate or escutcheon plate for identification, the plates shall be made of weatherproof and corrosion-proof material and shall not be deformed under the service conditions at the Site. The entries on the plate shall be indelibly marked, by engraving to black letter, on a white background or contrasting colours. The language of all plates shall be English in accordance with the instruction of the Contractor.

4.11. Locks

All padlocks for equipment or keys for locking devices of boxes as required by the specification or necessary to limit access, or for the safety of personnel shall be provided by the Contractor.

4.12. Welding

Welding where specified or required shall be by metal-arc welding and shall be as per BS5135. After welding and before galvanizing, welds shall be thoroughly cleared to remove slag and spatter, preferably by sand blasting.

All materials before and after fabrication shall be straight and free from twists. The material shall be free from blisters, scale and other defects.

All dimensions specified shall be subject to the following tolerances, unless otherwise stated.

- Dimensions up to and including 50 mm: ± 1 mm
- Dimensions greater than 50 mm: ± 2 mm

Erection clearance for cleated ends of members connecting steel to steel shall not be greater than 2mm at each end. Bolt holes shall not be more than 2mm greater than the diameter of the bolt for bolts up to 24mm diameter.

Cutting may be by shearing, cropping, sawing or machine flare cutting. Sheared or cropped edge shall be dressed to a neat finish and be free from distortion where parts are to be in metal contact.

All holes shall be drilled in one operation and burrs shall be removed. Holes shall not be formed by a gas cutting process. All matching holes for bolts shall register with each other so that a gauge 2mm less in diameter than the diameter of the bolt shall pass freely through the assembled members in a direction at right angle to such members.

4.13. Site Supervision

The Contractor shall provide a sufficient number of suitable personnel throughout the erection and maintenance periods to supervise efficiently all work carried out under the Contract. The personnel shall have had thorough experience in the erection, commissioning, operation and maintenance of plant comparable with that being supplied under the Contract.

The Contractor shall nominate a representative who shall be engaged solely in a supervisory capacity and shall be capable of dealing with and making decisions in relation to all matters arising in connection

with the execution of the Facilities and Temporary Facilities on the Site. He shall have had previous experience in supervising Facilities of a similar type and magnitude and shall co-ordinate the work of the Contractor and its Sub-Contractors at the Site. He shall maintain to the satisfaction of the Employer's Representative a reasonable standard of discipline amongst the Contractor's and his Sub-Contractor's employees whilst they are on the Site.

Both the Contractor's Representative shall remain in the Project area during the periods when erection or commissioning of any of the Facilities is taking place. He shall not leave the Project area during these periods without the approval of the Employer's Representative.

The Contractor shall maintain a Project Office at which its Representative is based. This Office shall be adequately staffed to enable the representative to be conveniently contacted and the Site Facilities and properly co-coordinated. It shall have telephone and internet communications facilities.

The Contractor shall keep in his Project Office a copy of the Contract including all variation orders and a copy of all standards, design documents, codes and statutory regulations relevant to execution of the Facilities and all related Installation Services.

The Contractor's Representative shall when requested by the Employer's Representative, attend any meetings convened for the purpose of co-coordinating the Facilities.

The Contractor's Representative may be contacted by telephone outside normal working hours throughout the erection and commissioning periods (and Defects Liability Period) if required by the Employer's Representative). The Contractor shall notify the Employer's Representative of the 'after hours' telephone number of its Contractor's Representative and Construction Manager and of any change in those numbers.

4.14. Training

The Contractor shall perform comprehensive formal classroom training in Nairobi or at location agreed upon with the employer, at a training centre as well as at site as it may be considered appropriate.

Training can take place at the contractor's offices if suitable.

Training shall be arranged for a number of about ten (10) persons of the Employer's project and maintenance crews.

During training, lunch will be provided to the trainees.

The Employer will nominate the persons to participate in the training.

During the training, the Contractor's Representative and his representatives will be responsible for assignment of the trainees.

The trainees shall be furnished with supporting material, e.g. erection, installation and maintenance instructions and drawings.

The Contractor shall prepare a draft training proposal showing the main activity for each type of issue to be covered. The training schedules shall be submitted for approval prior to training implementation. Details will be discussed and agreed.

The scope of the training shall cover the following:

- a) Data Center Design and Management
- b) Fire Alarm and Suppression System
- c) Fiber Optic Splicing Kit and OTDR
- d) Emergency Diesel Generator

4.15. Site Facilities

4.15.1. Contractor's Site Accommodation

The Contractor shall make his own arrangements with regard to living and office accommodation for staff and labour during the construction of the Facilities together with all associated work including storage and workshop facilities.

All dwellings and buildings, existing or erected by the Contractor shall comply with local regulations with regard to construction, water supply, sanitation and other requirements. Where temporary construction camps are provided by a Contractor, it shall ensure such camps are provided with proper sanitation and other necessary facilities. All such accommodation, office, storage and workshops erected by the Contractor shall be removed when no longer required. Following removal of such facilities, the grounds they occupied shall be left in a clean and tidy condition.

The Contractor shall supply safe drinking water for all living/office accommodation and at all work sites.

The cost for site accommodation shall be deemed to be included in the Contract Price.

4.15.2. Site Storage Facilities and Services

The Contractor shall make his own arrangements for site facilities including electricity, water, communications and crane lifting facilities.

All storage, facilities workshop or labour camp locations shall only be made by appropriate arrangements with the relevant property owners, at the Contractor's own expense.

The Contractor shall in all cases obtain the approval of the Employer's Representative in respect of the locations of any of the above temporary including facilities.

The Contractor shall arrange for protection of all Plant; shipping and transport packaging to be robust and placed in suitable outdoor storage until incorporation into the Facilities. All packages shall be placed on packing, to raise them above ground level. If any package or plant is unsuitable for outdoor storage, the Contractor shall arrange for indoor storage elsewhere.

The Contractor shall exercise special care in the storage of electrical plant.

4.15.3. Employer's Project Office Facilities and Supervisory Personnel

Employer shall provide his own office for use by Employer's engineers for the purpose of supervision of the work. However, the Contractor is expected to provide the following facilities to be used by the Employer's personnel:

- Two (2) laptop computers, Intel Core i7, 2.6GHz, HDD 500GB, 4GB complete with Microsoft windows 7 and Microsoft Office 2016 Licenses.
- Three (3) latest version Autodesk AUTOCAD Software license (Civil 3D) for Employer
- Four (4) Licenses of PDF Exchange.
- One (1) A3/A4 Size Colour Printer/Scanner/Photocopying Machine. Costs to include supply of 20 reams of printing paper.
- One (1) overhead portable digital video projector.
- Twelve (12) GPS enabled cameras (minimum of 20 Megapixels) for site supervision. The cameras should have capability.

All software shall be licensed to the Employer.

The Contractor shall provide one (1) Clerk of Work at each site to assist the Employer in site supervisory works. Although the Clerks shall be paid by the Contractor, these personnel shall only receive instructions from the Employer's Resident Engineer and shall be available throughout the duration of construction at each site. The Clerk of work shall possess as a minimum, a diploma in civil engineering and shall have supervised similar works in at least three sites. Prior to deployment of these personnel, the Contractor shall submit their detailed particulars to the Employer's Representative for review and approval. The Contractor shall not assign any duties to these personnel.

Remuneration for the Clerk of Works shall also include transportation to site and shall be included in the Contract Price. The contractor shall also facilitate the Clerks of Works to communicate via email for the purpose of sending daily and weekly reports.

4.15.4. Transport for Employer's Representative

The Contractor shall provide three (3) four wheel drive cars (Ford Ranger, Toyota Fortuner or equivalent) to be available for use by the Employer's Representative during the entire duration of the Contract. The Contractor shall also provide three (3) drivers and shall provide fuel and maintenance of the car for the entire duration of the construction phase of the project. These vehicles shall be for use by the Employer's Representative and resident engineers. The vehicles shall be available for use 24 hours /7days a week.

The cost of providing the service shall be included in the Contract Price. Transport shall be a service only to be provided by the Contractor during implementation period of the project. The Contractor may provide this service through a lease arrangement covering the entire duration of the construction period.

4.15.5. Contractor's Water Supplies

The Contractor shall be responsible for providing, obtaining and making all arrangements for the supplies of water required (if any), including the provision at his own cost of all apparatus necessary for such use.

Even where water is provided by the Employer, it shall be metered and sold at prevailing tariffs and such the cost of the services should be included in the Contract Price.

4.15.6. Electricity Supplies

The Contractor shall be responsible for providing, obtaining and making all arrangements for supplies of electricity required, including the provision at his own cost of all apparatus necessary for such use. All precautions which are necessary to ensure the safety of every person on the Site shall be taken.

The Contractor's installation shall be to the satisfaction of the Employer's Representative who may require the disconnection or alteration of any parts that he considers may be dangerous. Such installation shall comply also with all appropriate statutory regulations and be in accordance with IEC 60364 and IEC/TR 61200-704.

As soon as any parts or whole of the Contractor's installation is no longer required for carrying out the Contract Works, the Contractor shall disconnect and remove the same to the satisfaction of the Engineer.

Even where electricity is provided by the Employer, it shall be metered and sold at prevailing tariffs and such the cost of the services should be included in the Contract Price.

4.15.7. Contractor's Communication

The Contractor shall make arrangements for voice communication between his project office and all locations at which he has people working. The cost of the site communication facilities shall be deemed to be included in the Contract Price.

4.15.8. Communication for the Employer's Representative

During the entire duration of the Contract, the Contractor shall provide air time for use by the Employer's representative for an amount of Ksh. 50,000 per month for the entire period of the construction phase of the works. This cost shall be included in the Contract Price.

4.16. Health & Safety, Environmental and Social Management

The contractor shall comply with the Labour Regulations of the Republic of Kenya and enforce requirements for gender inclusiveness in staffing.

4.16.1. Laws & Regulations

The Contractor shall comply with all the relevant statutory regulations of South Sudan with respect to safety and occupational health.

4.16.2. Health & Safety

The Contractor is responsible for employing a health worker to inform the workforce and affected villages about the increased health risks, especially HIV/AIDS.

The Contractor is also responsible for equipping all his workers with necessary safety equipment as helmets, eye protection glasses and safety belts and enforce the non-use of toxic materials (such as Halon, PCB, Asbestos) shall be utilized neither during construction nor under operation and maintenance.

The Contractor shall at all times during the course of work prevent accumulation of debris caused by the work. He shall also remove all debris and temporary structures when finishing the work. The Contractor shall also be responsible for removal of old equipment and cables.

All surplus material should be disposed in an environmental satisfying way. Particular attention should be given to safe disposal of environmentally hazardous substances such as battery acid, transformer oil and capacitors. Workable equipment shall be handed over to the Employer.

The Contractor shall provide at all accommodation and work sites, medical and first aid facilities for its employees. The extent of medical facilities at each location shall be agreed with the Employer's Representative.

All working areas shall be deemed safety helmet and safety boots areas and the Contractor shall provide all his employees with safety helmets, safety boots, and subject to task, safety gloves, disposable air/fume filtering facial masks and safety glasses or goggles.

Contractor's personnel working at heights and aerial work of any kind must be equipped with safety belts/harness and their associated straps and safety rope lines and shall make available such plant to the Employer's Representative for associated inspections.

In the performance of the Facilities, the Contractor shall exercise every reasonable precaution to protect persons or property from injury.

The Contractor shall co-operate fully with the Employer's Representative's supervising staff on all matters affecting safety.

The Employer's Representative may require the immediate removal from the Facilities of any person who in the opinion of the Employer's Representative fails properly to observe these provisions and such person shall not be employed upon the Facilities without the permission of the Employer's Representative.

The contractor shall follow the required measures for Health and Safety as shown in *Table 4-2*.

Table 4-2 Health and Safety Measures

Risk	Cause (Source) / requirements	Safety action in place
Physical injuries	Falling debris	<ul style="list-style-type: none"> • Safety gear that includes Wellington boots, helmets, overalls, leather gloves etc will be given to workers on site
	Sharp objects	
	Hard objects and surfaces	
Respiratory tract effects	Inhalation of dust and cement particle	<ul style="list-style-type: none"> • Gas masks and eye goggles will be provided to protect workers against cement and other dust particles.
Fire outbreak	Inflammable fuels	<ul style="list-style-type: none"> • Proper storage of fuels and gas cylinders in designated areas. • Elementary firefighting equipment such as fire extinguishers will be installed on site.
	Welding and other gases	
	Burning waste	
Welfare on site	Toilet/sanitation facilities	<ul style="list-style-type: none"> • Toilets will be installed where applicable on site under guidance of site engineer
	Storage and changing clothing	<ul style="list-style-type: none"> • Site will be provided with a store for keeping clothes not used during working hours • Changing cubicles for both men and women will be put up
	Drinking water	<ul style="list-style-type: none"> • The site will be provided with clean drinking water • Water storage containers will be properly marked and protected from potential contamination
HIV/AIDS & other Pandemics		<ul style="list-style-type: none"> • Sensitize site workers on HIV/AIDS and Provide condoms to avoid negative effects from social& multicultural inclusion at the area.

Note:

To comply with these, Contractors will be required to produce the following documents and implement them:

- ESMP & ARAP (separately)
- Risk Management and Mitigation (Health, safety and emergency) Plans
- HIV/AIDS Strategy

4.16.3. Environment and Social Management

The Contractor shall comply with all local and international laws and regulations applicable to the project area with respect to environmental matters.

The Contractor shall prepare and implement an environmental management plan which includes, but is not limited to, the following:

- The operation of the Contractor's accommodation facilities
- The operation of any manufacturing facilities at site
- Operation of the site erection Facilities
- Waste management
- Storage of fuel, oil and other hazardous substances
- Internal environmental audit plan
- Emergency response plan.

The Contractor shall obtain all approvals required from Government authorities and agencies for his operations and activities.

The Contractor's environmental management plan and associated records may be audited by the Employer's Representative or by a third party agency appointed by the Employer.

In addition, the Contractor shall be furnished with a copy of the Environmental and Social Impact Assessment Report and NEMA License for the project. The Contractor will be required to review the report and comply with the Environmental Management Plan (EMP) as well as the conditions of license.

4.16.4. Work on Live Electric System

If work is to be done on live electric systems the following factors are of paramount importance:

- a) Minimization of outage time and
- b) Adaptation to operational constraints.

All work must be planned with this in mind. The Contractor must obey all instructions and safety rules given by the Government and the Employer and must strictly follow all instructions from the Employer's supervisory personnel. The Contractor shall appoint his Safety Personnel who will be authorized to receive work permits at the work sites as required by safety rules. All outages shall be discussed with the Employer and the Employer's Representative at least three (3) weeks before the outage is required. The Contractor will normally only be allowed to have only one medium voltage circuit out of operation at a time. No work must start before Employer's Representative has authorized the work, established the required earthing and marked the safe area. All switching on live parts shall be done by the Employer. In the rare cases where more than one circuit have to be taken out of operation the Contractor must be prepared to do the work during nights or at off-peak time. The Contractor and his personnel must respect the physical constraints as well as constraints for scheduling set by these circumstances. However, the Employer will co-operate in making the work conditions and the scheduling as efficient as possible for the Contractor and keep a responsible person with switching authority at site during all working hours (including night time).

If physical constraints make it necessary to replace cabinets needed for operation, the Contractor must as far as possible erect and connect the new cabinets temporarily adjacent to the one in operation. A quick disconnection and removal of the old cabinets can then be performed and the

new cabinets pulled in with most of its cables already fitted. Location of new cabinets shall be approved by the Employer's Representative and a proposal for such shall be given by the Contractor one month prior to erection.

4.16.5. Cleaning Up By Contractor

Throughout the conduct of all work at Site, the Contractor shall maintain the Facilities, Plant, its Contractor's Plant and all related Installation Services at all locations in a clean and tidy condition.

All Contractor's Plant and/or Plant and its component materials not in use and/or no longer required for the Facilities completion and related Installation Services, all condemned materials and all rubbish shall be removed from the Site at the least once per week. Combustible rubbish shall be removed daily and may be burned in an area designated by the Employer's Representative.

Upon completion of the Facilities, the Contractor shall deliver any surplus Plant to the Employer in a manner agreed with the Employer's Representative.

The Contractor shall also remove all its Contractor's Plant together with all manner of items or material associated to its Installation Services, whether specified or not, and any remaining rubbish which may have accumulated in the execution of the Contract and shall leave the whole of the Site in a clean and tidy condition.

If the Contractor fails to comply with any of the above requirements within 24 hours of notice in writing by the Employer's Representative, the work may be carried out by the Employer's Representative and the total cost to the Employer of the work will be charged to the Contractor.

4.16.6. Exchange of Interface Information

The Contractor shall where needed supply in a timely manner all interface information to its sub-contractors/Contractors, the Employer's Representative and/or other Contractors engaged by the Employer in other Facilities.

If the Contractor lacks such information from other contractors, he is obliged to request such from the Employer's Representative. The Contractor cannot claim liability exemption for his own contractual responsibilities because of actions performed or omitted by other sub-contractors.

4.16.7. Mandatory Safety Authorization Training

Given that the work under Contract shall be done within the substation, the supervisory personnel of the Contractor for each site will be expected to undergo a mandatory safety authorization training to be conducted by the KPLC Institute of Energy Studies and Research (IESR). Bidders should obtain a quotation from IESR for performing this training and include the same in the Contract Price.

4.17. Correspondence, Meetings & Reports

4.17.1. Correspondence

The Contractor shall address all correspondence on matters arising out of the Contract, to the Employer's Representative with copies to the Employer's personnel and Employer's Representative's personnel as shall be advised in the course of the construction phase of the project.

4.17.2. Progress Reports

After approval of the Program of Performance by the Employer's Representative, the Contractor shall submit formal, detailed progress reports in an approved format, indicating the status of design, material procurement including, manufacture, testing, delivery, transport and erection Facilities, at monthly intervals. The reports shall clearly identify any delay in progress and its cause including its sub-contractors or manufacturers and Contractors, with intended remedial action to recover programmed progress.

These reports shall clearly state all the Contractor's resources including manpower and Contractor's Plant employed by the Contractor during the reporting period. These reports shall be forwarded promptly so that on receipt by the Employer's Representative the information contained therein is not more than 5 days out-of-date.

The monthly progress reports shall also include an appendix presenting a reasonable number of photographs depicting the progress of the Facilities during the report period, including any unique or irregular aspects of construction work carried out during the reporting period. The photographs size and finish shall be as agreed with the Employer's Representative. When requested, the Contractor shall provide up to 3 additional copies of the progress photographs to the Employer's Representative for use by the Employer.

Monthly reports shall be provided in bound hardcopy and softcopy (pdf) format. The progress photographs shall be provided in hardcopy colour prints and softcopy (jpg) format and accompany the report due within seven days of the defined reporting period.

4.17.3. Meetings

The Contractor shall participate in regular project progress meetings with the Employer and the Employer's Representative. In addition to the regular monthly meetings, the Contractor shall participate in meetings called by the Employer or Employer's Representative, where specific aspects of work in progress require particular attention whether technical, commercial or where the Employer or Employer's Representative consider the progress position of any section of the work to be unsatisfactory.

Unless otherwise agreed, all Monthly Progress Meetings will be held at the Contractor's Project Office in Nairobi.

Access to the Contractor's and sub-contractor's Facilities shall be granted to the Employer's Representative at all reasonable times for the purpose of ascertaining progress and for supervisory Facilities.

4.18. Contractor's Documents

4.18.1. General

The Contractor shall prepare and shall be fully responsible for the correctness of all drawings and other documents which are necessary for the manufacture, supply, delivery, erection, operation, commissioning and maintenance of the Facilities.

The Contractor shall use the English language in all drawings, information and documents pertaining to the Contract and in all correspondence between the Contractor the Employer and the Employer's Representative. Whenever anything is required under the terms of the Contract to be written, marked, printed or engraved, the English language is to be used except where otherwise may be provided in these Employer's Requirements.

'Preliminary drawings' means drawings to be provided by the Contractor to the Employer's Representative for review and comment.

'Final drawings' means all approved drawings embodying, where required, all design modifications as approved by the Employer's Representative.

'Work-as-executed drawings' means drawings showing the arrangement of the Facilities in the final and complete state as installed or to be installed at the time of Take-Over of the Facilities.

Submission by the Contractor of drawings for approval, including those prepared by others, shall be deemed to mean that the Contractor has fully examined such drawings and that they comply with the requirements of the Contract.

Approval of a drawing by the Employer's Representative will imply that:

- General arrangement and layout drawings and key diagrams have been examined and appear to be in accordance with the basic design concept as provided for by the Employer's Requirements;
- Other drawings of plant and plant have only been examined in relation to compatibility of the plant and plant with the Employer's Requirements;
- Approval of a drawing shall not relieve the Contractor of his responsibilities under the Contract.

The Employer's Representative will not normally require copies of detailed manufacturing drawings, but the Contractor shall make these available to the Employer's Representative if so requested.

The Employer's Representative may require the Contractor to make changes to the drawings which are necessary, in the opinion of the Employer's Representative, to make the Facilities conform to the intent of the Contract.

4.18.2. Drawing Management

Drawings/sketches shall be ISO standard size, between A1 and A4 and shall be completely legible when printed at the appropriate size.

All drawings and other documents shall be identified using a systematic document numbering system which gives a unique identifier for each document, shown on each sheet of the document.

The Contractor shall maintain a drawing and other document register, which identifies each document and the date and reference of submission of the original and each revision. The register shall be in electronic format and shall include a facility by which associated groups of documents may be readily identified and retrieved, for example, one such group could be transmission tower foundation drawings. The document register shall be maintained at current status and an electronic copy submitted with each of the Contractor's monthly reports.

The number and format of documents to be submitted to the Employer's Representative shall be as indicated in the following section.

If a document includes generic material provided by any plant Contractor, that material shall be clearly marked to identify which portions are applicable to the Contract.

All drawings and other documents shall be included in the operation and maintenance instruction manuals (see "Standard Technical Requirements). In addition, the Contractor shall provide two complete sets of drawings and other documents revised to 'Work-as-Executed' status in the same electronic format as the source file (e.g. AutoCAD or MS Word).

4.18.3. Document Submission & Management

All documents shall be submitted in the language of the Contract as stipulated in the Conditions of Contract. Upon commencement of the Works, the Contractor shall in consultation with the Employer's Representative establish a document management system for handling all correspondence, submission, issue and back up of all documents under Contract. All documents shall be submitted in the numbers and forms as detailed in the following *Table 4-3*.

Table 4-3 Drawing Submissions

Descriptions	Hard Copy	Electronic Copy by E-mail (see notes)	Electronic Copy by CD or DVD Format
For approval			
Calculations and drawings		20	
Other design documents		20	
Method statements		20	
Commissioning procedures		20	
For construction			
Calculations and drawings		20	
Other design documents		20	
Method Statements		20	
Commissioning procedures		20	
Final As-Built			
Calculations and drawings	3	20	3
Other design documents	3	20	3
Method Statements	3	20	3
Commissioning procedures	3	20	3

Note: In addition to pdf formats, design drawings for approval, construction and final records shall where applicable be submitted in AUTOCAD format.

Apart from “For Construction” design documentation as detailed in Section 2, the Contractor will also be expected to submit the following documentation for review and approval of the Employer:

- a) A master list of all documents to be submitted by the Contractor under Contract.
- b) Programme of Performance with the details of activities to be performed complete with the sequence in which the Contractor intends to perform in form of gantt- chart in Microsoft Project format.
- c) Project Insurance Documents as specified
- d) Contractor’s Quality Assurance Plan
- e) Contractor’s Environmental, Health and Safety Plan
- f) Site Mobilization Plan
- g) Contractor’s Cash Flow Projections
- h) Method Statements for all Construction Works
- i) Contractor’s Inspections and Test Plan detailing tests to be performed, test methods, reference standards, test criteria and the timing for the tests
- j) Type Test Reports, Routine Test reports and or Acceptance Test reports for all tests to be performed

- k) Guaranteed Technical Parameters and Technical Specifications for all equipment to be supplied under Contract.
- l) Operations and Maintenance Manuals (as applicable)
- m) As- Built Drawings
- n) All other documents as required by the Conditions of Contract

4.18.4. Operations & Maintenance Instructions

The Contractor shall provide operation and maintenance instructions, the scope of which shall be suitable for fully informing the Employer's staff on all aspects of the erection, Operation and Maintenance of the Plant and Equipment, as further defined in this section.

The content of the instructions shall be directly applicable to the Plant. Typical instructions will not be accepted. Standard instructions and brochures covering a number of sizes and/or models of proprietary equipment will be accepted provided they cover the items supplied and these items are clearly identified throughout the instructions and brochures. Clear and concise cross-references to these brochures and standard instructions shall be made in each appropriate section of the operation and maintenance instructions.

The Contractor shall, in preparing the instructions, assume the lack of experience and lack of familiarity of the operating and maintenance staff with the type of equipment supplied. The information shall be presented as simply, clearly and precisely as possible.

The Operations and Maintenance Instructions shall be submitted for all major items of plant including splice enclosures, Fiber Distribution Terminals, maintenance tools and any other items as shall be advised by the Employer's Representative. The instructions shall be delivered at least two (2) weeks prior to commencement of installation works. Should any errors be noticed during installation, the Contractor will be required to correct and resubmit corrected versions of the instructions. The last final date of submission of the corrected instructions shall be one (1) month after commissioning of the facilities.

4.18.5. As-Built Documentation

Preliminary (initial), final (approved) and Work as Executed (as built) drawings shall be submitted as CAD files readable by the latest version of Autodesk's AutoCAD. All drawings shall be clear and legible. As – Built drawings shall also be submitted in a version readable by the latest version of Autodesk AutoCAD software.

Work as Executed drawings presented by the Contractor in accordance with the Employer's Requirements shall be the Contractor's original drawings.

The Work as Executed CAD files shall be delivered to the Employer in the form of CD-ROMs. Five (5) copies of the CD-ROMs shall be provided.

4.19. Making Good

The Contractor shall take every reasonable care in the execution of the Facilities to avoid loss of or damage to any property of the Employer or of others, including landholders.

Where, in the performance of its obligations under the Contract, the Contractor causes loss of or damage to any property of the Employer or others, he shall make good such loss or damage to the reasonable satisfaction of the Employer's Representative.

4.19. Fire Protection & Fire Fighting

The Contractor shall be responsible for the fire protection of its Site facilities at all locations, whether living or office accommodation, storage facilities, Facilities, shops or other work areas, all Plant and Contractor's Plant at any of these locations and any place at which it has Facilities.

Portable firefighting plant shall be available at work sites at all times, when the Contractor's employees are present and shall be kept available at other times as directed by the Employer's Representative.

The Contractor shall maintain the firefighting plant in a condition satisfactory to the Employer's Representative and shall re-charge extinguishers after use, regardless of by whom they were discharged. Adequate stocks of fresh extinguisher charges including chemical charges shall be kept in readiness by the Contractor.

All firefighting plant provided under this Clause shall be the property of the Contractor and shall be removed by the Contractor when requested by the Employer's Representative.

4.20. Resistance to Environmental Conditions

All cables, Joint boxes/enclosures, Fiber Distribution Points, clamps, fittings, Fiber Access Terminals to be supplied under contract shall withstand prevailing environmental conditions including ultra violet radiations without degrading in performance for a period of more than 25years.

4.21. Degree of Protection

For all outdoor equipments, the degree of protection shall unless specified be IP65 while for indoor equipment, the degree of protection shall be IP54 in accordance with IEC 60529.

4.22. Equipment Earthing

All passive equipment including Fiber Distribution Terminals, Fiber Access Terminals, Splice Enclosures, Cable Storage Kits, Optical Distribution Frames (ODF), shall be earthed. Resistance to ground for all earthing points shall not be more than 10 ohms.

5. FIBER OPTIC APPROACH CABLE

5.1. General

This section describes the functional & technical specifications for supply and installation of Fiber Optic Approach Cable and the underground cable.

For purposes of this specification, a fiber optic approach cable is defined as the cable installed between the high voltage substation and the outgoing distribution pole and other areas where overhead installation on distribution poles are not possible.

The estimated fiber optic approach cabling length requirements are indicated in table below and same has been reflected in Price Schedule. However, the Contractor shall supply & install the optical fiber approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contractor shall be paid for the actual quantity supplied and installed at site.

5.2. Requirements

The Approach cable shall be Dual-Window Single Mode (DWDM) telecommunications grade fibres as specified in Clause 2.2(G.652 D). All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 30 years.

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with non-metallic type of armouring.

The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to low density, medium density and high density polyethylene standards as defined in ASTM D1248.

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Buffer tubes shall be filled with a water-blocking gel.

The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

A suitable marking indicating Employer's Name, Manufacturer's name, running meter length, Number of fibres, Year of manufacture and Laser symbol & caution notice shall be applied in order to identify the cable.

5.3. Cable Drums, Marking, Packaging and Transport

The length of the cable should be as per the drum schedule approved by the Employer's Representative. All optical fibre cable shall be supplied on strong drums provided with lagging with adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both cable ends in the drum shall be sealed and shall be readily accessible. The drum shall be marked with consignee details.

Packing list supplied with each drum shall have all the information provided on marking on the respective cable drum, OTDR length measurement of each fibre and Ratio of fibre and cable length.

5.4 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

- (a) Outdoor Cable Service Loops: in-line splice enclosures installed outdoors and mounted on the utility gantry structures, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.
- (b) Indoor Cable Service Loops: shall provide at least five (5) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.
- (c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.
- (d) Fibre Service Loops: At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

5.5. Installation of Approach Cable

A network of cable trenches and/or ducts exists at sites at some of the stations. The contractor shall route the cable through the existing available cable trenches. In case, small amount of works are need in widening the cable trenches or ducts, the contractor is expected to do the same and accommodate the cost in the unit rate of other items.

The Contractor is therefore advised to visit sites and understand the site situations before quoting for the tender. It shall be the responsibility of the Contractor to efficiently use the existing infrastructure for the on-station communications cabling. The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report.

It may be noted that in order to utilize the existing trenches, the approach cable may be required to be co-located with HV and LV cables. Accordingly, the approach cable shall be installed in corrosion resistant flexible conduit also across the trenches and other areas/sites where necessary. Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable.

Approach cables exiting from the ground or passing through floors shall be protected against mechanical damage.

Approach cables shall penetrate buildings through cable ducts. The cabling shall route within buildings in cable raceways or under raised floors. The Contractor may utilize existing ducts, building penetrations, cable trays, racks, etc., where appropriate and approved by the Employer. The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals.

On short approach cable runs for which cable supports are not required, the Contractor shall fix the cable to the structure of the building using approved fixings and cable cleats.

The Contractor shall be responsible for new building penetrations required for approach cabling. Caution shall be taken to ensure existing equipment and site personnel are protected from dust and debris incident to the cable penetration work. Penetrations shall be neatly formed and sealed for protection from moisture, dust, wind and vermin intrusion. The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for lay and installation of approach cables shall be supplied and installed by the Contractor as part of this Contract.

Similar methodology will have to be adopted for underground armoured optical cables to sufficiently protect the optical fiber cable from physical damage with the use of corrosion resistant conduits and sufficiently bury it to an adequate depth with sand bedding.

5.6 Cable Raceways

The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. The cable raceways shall conform to the following:

- (a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.
- (b) Indoor cable raceways shall be fabricated from construction grade aluminium, galvanized iron or anodized sheet metal or any other suitable material approved by the Employer. Suitable anti-corrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to-paint bond.
- (c) Mechanical construction drawings of the cable raceways shall be submitted for Employer's approval.

6. OPTICAL DISTRIBUTION FRAMES

6.1. General

The Contractor shall supply and install Optical Distribution Frames (ODFs) in the KPLC equipment room. The numbers of ODFs shall be as indicated in the schedule of prices.

6.2. Technical Specifications

The ODFs shall be 19 inch rack mounted and shall be mounted in the 42U racks to be installed in KPLC equipment room of the Telecom Hub building. The ODFs shall be of modular design allowing for users to choose according to the quantity and specifications of the fiber optic cable phase corresponding module, to facilitate the adjustment and expansion of the network.

The ODF shall generally conform to IEC 60297 standards for 19" racking and shall be sized for a minimum of 48 fibers.

7. OPTICAL CONNECTORS AND ADAPTERS

7.1. Scope

This section specifies the requirement of optical connector sets of FC-type to be used in single-mode optical fiber telecommunication systems.

A connector set is: "The complete set of connector components required to provide demountable coupling between optical fibers". The length of fiber or cable on each side of the connector set shall be 3 meters (minimum).

7.2. Design

7.2.1. General

The ferrule of the optical connector shall be made of zirconia stabilized ceramic. When the connector is mounted on a cable (or a tight buffered fiber) the fiber shall be fixed with epoxy in the cavity of the ferrule. Then the end face of the ferrule with the fiber shall be polished. In order to ensure physical contact the shape of the ferrule shall be spherical.

The cable (jacket and strength members) shall be fixed to the connector by means of a crimp sleeve. Mating with another connector shall be accomplished by the means of an adapter with a split sleeve.

7.2.2. Material

The supplier shall give details of the materials used in different parts of the proposed connector. The connector housing shall be of an all-metal design.

7.2.3. Ferrule

The ferrule end face shall meet the following requirements:

Ferrule end face curvature	$10 < r < 25 \text{ mm}$
Vertex offset of ferrule tip (convex vertex eccentricity from ferrule center)	$< 50 \text{ } \mu\text{m}$
Fiber undercut from ferrule end face	$\leq 0.05 \text{ } \mu\text{m}$
Fiber protrusion from ferrule end face	$\leq 0.10 \text{ } \mu\text{m}$
Outside Diameter (A)	$2.4990 \pm 0.0005 \text{ mm}$
Tolerance of Cavity Diameter	$+1, -0 \text{ } \mu\text{m}$
Concentricity error of cavity	$< 1.4 \text{ } \mu\text{m}$
Angular Misalignment	$< 0.2^\circ$

7.3. Performance Requirements

7.3.1. Visual Inspection

Each connector shall be properly packed. The package shall be marked with, the name of the manufacturer and the manufacturing date. The connector itself shall be legibly and durably marked with the identity mark of the manufacturer and the manufacturing date code.

The end face shall be clean and free from residues of glue. Using a microscope with a maximum magnification of 200x no scratches or break out of glass pieces shall be seen.

7.3.2. Insertion Loss

Requirements:

Property	Mean	Maximum
Allowable Attenuation	$\leq 0.25\text{dB}$	$\leq 0.50\text{dB}$

7.3.3. Return Loss

Property	Maximum
Allowable Return Loss	$\geq 40\text{dB}$

7.3.4. Temperature

The connector shall be capable of operating over a full temperature range of (-30°C to +70°C), without any damage or significant change in optical performance.

8. OPTICAL CABLE SPLICE BOXES

8.1. Scope

This specification covers the requirements of splice enclosures to be used for splicing of all types of optical cables. Thus it is applicable for both duct and aerial cables.

8.2. General

The design of the splice closure shall consider ITU-T recommendation L.13 “Sheath joints and organizers of optical fiber cables in the outside plant” and the requirements of this specification.

It shall be possible to use the splice closure installed in manholes, in hand holes, on poles, in cable vault, etc. It is the intention to use the splice closure to be installed in chambers or on poles.

The closure shall be re-enterable, i.e. possible to open and close several times, without wear or impairment of its water tightness and/or other essential features.

The closure shall be equipped with fiber cassettes and organizers that are easy to use and which provide full protection to the fibers.

8.3. Handling Aspects

The splice closure shall have a robust and reliable design and well adapted to the conditions in the field. It has to work even if minor un-intentional deviations at the installation procedure are made.

The splice closure shall have as few parts as possible. Tools that require calibration should not be required for work with the closure.

The use of melt resin or glue shall be avoided if possible.

Work with the closure shall be possible in a cramped room, e.g. manholes.

Work with the closure shall be possible without bending the fibers below their minimum allowed bending radius at any stage of work.

Work with the closure shall not require extensive training.

Work with the closure shall be possible to be carried out by one man alone.

Work with the closure shall not involve any risk of injury to the working personnel.

The method of work shall be described in an easy to understand installation instruction or manual enclosed with each closure in English language.

All the parts of the splice closure, except for the materials required for jointing of the fibers, shall be packed in one package, with a clear marking of its contents if required. If the storage time is limited that shall be stated on the package.

8.4. Design

The contractor shall furnish and install fiber optic splice closures in locations as confirmed by Employer’s Representative through approval of installation plans. The fiber optic splice closure shall meet the following requirements:

- Shall provide a good mechanical protection.
- Shall incorporate a mechanical compression and/or mastic tape sealing system to maintain a barrier against water and moisture penetration.
- shall be reasonably resistant against unauthorized tampering, vibration and wear, as well as against biotic attack (rodents, termites, etc.).
- Shall be resistant against corrosion.
- Shall be resistant against UV-radiation.
- Shall be made of materials, which are mutually compatible.
- The size of the splice closure shall be in proportion to the number of cables, fibers in each cable and to the number of splices.
- It shall be easy to re-enter the splice closure and close it again several times. Also the closure shall be capable of accepting additional cables without removal of the sheath retention or strength member clamping hardware on previously installed cables or disturbing existing splices.
- The design of the closure must be such that the fibers are never bended below their minimum allowed bending radius during any phase of the splicing work.
- A splice closure, which shall be used for a branching joint, shall be possible to assemble without the necessity to cut all the fibers.
- The fiber optic closure shall be available in distinct sizes to accommodate a variety of cable entries. A fiber optic closure shall be capable of accommodating up to four cables in a butt or branch configuration.
- It shall be possible to split and branch groups of 6 fibers from the splice closure.
- Inside the splice closure there shall be space enough for an excess length of fiber of at least 2 meters. This length is based on expected future needs for maintenance or redistribution of fibers.
- The splice closure shall contain, or have the space for, fiber organizers for storage of fiber joints as well as the excess lengths on fibers.
- The fiber organizers shall provide good protection to the fibers and their joints, and have space for identification of each fiber.
- The splice closure together with the fiber organizer shall facilitate easy access to any optional fiber within the closure for work without affecting the service on the other fibers.
- In the splice closure it shall be possible to terminate any possible metallic conductor in the optical cable in such a way that they are easily accessible and possible to equip with over voltage protection devices.
- The splice closure shall be possible to use on cables with basically a circular cross-section and shall be adapted to the dimensions of the cables to be connected.
- The splice closure shall provide satisfactory anchorage of the jackets, armoring and strength members of the cables.
- The splice closure shall allow metallic parts of the cables, if any, to be bridged over so that a satisfactory electrical connection between them is achieved. It shall be possible to ground metal parts of the cable, and it shall also be possible to separate all the metal parts.
- It shall be possible to attach the splice closure to the pole by the means of attachment devices, all necessary materials for fixing shall be included in the scope of supply.
- This shall be designed with adequate mechanical strength, good air tight, anti-corrosive and shall allow easy operation, expansion, maintenance, repeat use. The box shall be cap-type and shall be made of fiber reinforced plastic metallic material.
- Sizes used shall depend on the number of fibers which shall either be 48, 96. The excess loss shall be less than 0.01dB and the bending radius shall be greater than or equal to 45mm.

- The Joint boxes shall operate normally under temperature conditions from 0deg to 80deg Celsius.
- Visual amenity shall be considered when selecting pole-mounted splice enclosures. All pole-mounted splice enclosures shall be UV stabilized.
- An IP68 rating shall be the minimum rating for all outdoor splice enclosures. Splice enclosures using a grommet and gland cable sealing system shall be used. Tape wrapping of the cable shall not be accepted.

9. LOW VOLTAGE AC SYSTEM

9.1. The 415/240V Distribution Board

The Contractor shall supply, install and test 415/240V distribution/metering board to be located outside Telecom Hub building.

The distribution board/metering boards shall have a minimum continuous rating of 200A shall be designed for a minimum of 24 outgoing circuits.

The distribution boards shall be suitable for installation outdoor and shall comply with IEC 60439 and with degree of protection of IP65 in accordance with IEC 60529. Each distribution board shall comprise of incoming disconnecting switches, AC busbars and load circuit moulded case circuit-breakers. The supply disconnecting switches shall be pad lockable in the open position.

The cable compartment shall be free of exposed live 415/240 V AC connections, so that cabling of circuits can be accomplished at any time with complete safety without shutdown of the distribution board and, to this end, all terminals for outgoing cables shall be fully shrouded with insulating covers. No outgoing circuits shall be mounted within 300 mm of the bottom of the board.

Some boards shall require front only access but access doors shall be provided for the rear cabling compartment. Appropriate detachable covers shall be provided to enable the tightness of all bolted and screwed electrical connections to be checked.

All instruments and switches shall be mounted in the front of the board and all instruments shall be at least 96 mm square.

A copper earthing conductor running the full length of the distribution board shall be provided. It shall be dimensioned to withstand the maximum fault current for 1 second without its temperature exceeding 300°C and it shall be connected, at each end, to the earthing system. The neutral conductors in the distribution board shall be connected, through a bolted link, to the earth conductor.

The Contractor shall determine the continuous and fault current ratings of all components of the distribution boards.

The design calculations for the ratings of each of the distribution boards and associated equipment shall be submitted for approval.

Each distribution board shall include a circuit schedule mounted behind a transparent sheet on the inside of distribution board door. The schedule shall identify for each circuit:

- the name of the location
- The number and function of the distribution board for each final sub-circuit in tabulated form;
- the MCCB/MCB or fuse number and phase colour;
- the MCCB/MCB or fuse rating;
- the location of the points connected to the circuit; and
- the circuit identification.

The circuit identification shall be shown on the circuit schedules, on switches and on socket-outlet and shall consist of alpha-numerical characters identifying the final sub-circuit by distribution board number and final sub-circuit number, e.g. DBPXX-Y identifies the circuit as final sub-circuit number of distribution board power DBPXX.

The Contractor shall provide the distribution boards complete with MCCB/MCB for the two incoming circuits i.e. KPLC (Incoming) and Diesel Generator. On outgoing circuits, the Contractor shall provide an MCB on each outgoing circuit. The Energy Meter and Service Cut-Out (SCO) shall be supplied and installed by the Employer.

The meter area within the panel shall be fitted with glass to allow for meter reading without opening the panel.

9.2. Lighting and Small Power

9.2.1. Outdoor Lighting

The lamps shall be non-colour-corrected, LED type lamps, 200W, and 240V and shall have minimum L⁷⁰ design life of not less than 50,000 hours.

9.2.2. Indoor Lighting

Indoor lighting shall in general use tubular fluorescent lamps to IEC60081 with a rated life not less than 7,500 hours; lamp colour co-ordinates shall be X = 0.373, Y = 0.380. Unless otherwise approved, their circuits shall be of the switch start type with shunt capacitors. Ballasts shall comply with IEC60921.

Room lights shall generally be controlled by wall mounted light switches of industrial grade and of flush pattern with white finished plates. These switches shall be located at the access doors of the rooms and approximately 1.35 m above floor level. Two-way and intermediate switching shall be provided where appropriate. Loads in excess of 10 A shall be switched via contactors.

Required minimum lighting levels are as follows. These levels include a 20% loading factor to coverage:

- Main equipment room - 500 lux
- Other rooms - 120 lux

Lighting cables for fluorescent lamps shall have a cross section of at least 2.5mm². All metal work on luminaries shall be connected to earth by an insulated conductor.

9.6.3. Portable Lights

The Contractor shall provide two portable lights for supplementary illumination. The portable lights shall be housed in a lockable cabinet at the entrance to the telecom hub building. The cabinet shall include a permanently connected charging facility for the portable lights. It shall not be possible to recharge the lights without using this facility.

Each portable light shall be of the LED type, with an output not less than 200 lumens and a battery life not less than 2 hours.

9.6.4. Small Power

The Contractor shall provide for building wiring in accordance with BS 7671 as well as other local regulations and standards.

The Contractor shall install one (1) 3-phase, 5-pin, switched and interlocked socket outlet within the main equipment room.

Where socket-outlets or switches cannot be mounted on walls or columns, suitable stands shall be provided. Such stands shall be manufactured from heavy gauge rolled steel or pipe, hot-dipped galvanised after manufacture and shall consist of a base plate, suitably drilled for fixing to the concrete floor, a single column and equipment mounting plate. The stand shall be predrilled before galvanising to allow fixing of the equipment and the supply cable or conduit.

All circuits supplying socket outlets throughout the substation shall be protected by sensitive core-balanced earth leakage circuit breakers, tripping at 30 mA earth leakage current.

10. FIRE ALARM AND SUPPRESSION SYSTEM

10.1. Introduction

The Contractor shall design, supply, install, test and commission a Fire Alarm and Suppression System adequate for each of the proposed Telecom Hub building and meeting the requirements of this specification. The scope of supply shall also include training of employer's personnel on operation and maintenance of the facility.

The equipment supplier shall have accredited agency in Kenya for the make of equipment set offered and also shall have proven record of providing after sales services including maintenance services over a period of at least five years.

10.2. Reference Standards

As a minimum the system shall meet the following standard:

- a) NFPA 2001 - Standard for Clean Agent Fire Extinguishing Systems.
- b) UL Standards

10.3. Technical Requirements

The Fire Suppression System shall meet the following minimum requirements.

10.3.1. Control System

The Control System shall be UL Listed or FM approved and shall be utilized with listed or approved compatible operating devices. The system shall have a GSM module with capability to send alarms vide email and sms to user list to be provided to the Contractor by the Employer.

The System shall have a fire alarm control panel (FACP) which shall be the central processing unit of the system, receiving and analyzing signals from fire sensors, providing audible and visual information to the user, initiating automatic alarm response sequences and providing the means by which the user interacts with the system.

The FACP shall be certified as meeting the requirements a suitable and notified body. A certificate and test report shall be made available for inspection as evidence of certification. FACP shall be microprocessor based and shall incorporate a real time clock to enable events to be referenced against time and date.

10.3.2. Sounders

Sounders shall be Electronic and shall be UL Listed or FM Approved. Electronic sounders shall be field programmable without the use of special tools to choose one (1) of eight (8) tones with an output sound level of at least 90 dBA measured at 10 feet (3m) from the device.

Electronic sounders shall be flush or semi-flush mounted as per the engineer's direction.

10.3.3. Strobe Lights

Strobe lights shall meet the requirements of the Americans with Disability Act of 1990 (ADA) as defined in UL standard 1971 and shall meet the following criteria:

- The maximum pulse duration shall be 2/10ths of one second.
- The strobe intensity shall meet the requirements of UL 1971.
- The flash rate shall meet the requirements of UL 1971.

The appliance shall be placed 80 in. (2 m) above the highest floor level within the space, or 6 in. (152 mm) below the ceiling, whichever is the lower.

10.3.4. Addressable Devices

Addressable devices shall provide an address-setting means using rotary decimal switches. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches.

Devices which use a binary address setting method, such as a dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.

Detectors shall be intelligent and addressable, and shall connect with two wires to the fire alarm/release control panel signaling line circuits.

Addressable smoke detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions indicating that the detector is operational and in regular communication with the control panel. Both LEDs shall be placed into steady illumination by the control panel indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be optional through the system field program.

An output connection shall also be provided in the base to connect an external remote alarm LED.

Smoke detector sensitivity shall be set through the FACP and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper-proof feature. An optional base shall be available with a built-in (local) sounder rated at 85 dBA minimum.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

10.3.4.1. Addressable Manual Pull Station

Addressable manual pull station shall, on command from the control panel, send data to the panel representing the state of the manual switch. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

All operated stations shall have a positive, visual indication of operation and utilize a key-type reset.

Manual stations shall be metal with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front and both sides of the stations.

Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1.06 m), nor more than 48 inches (1.22 m) above the finished floor.

Operation shall require two (2) actions.

10.3.4.2. Analog Addressable Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

10.3.4.3. Analog Addressable Ionization Smoke Detector

The detectors shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.

10.3.4.4. Addressable Dry Contact Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the FACP signaling line circuit (SLC) loops.

The monitor module shall mount in a 4-inch square, 2-1/8" deep electrical box C. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions indicating that the monitor module is operational and in regular communication with the control panel.

For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4" x 1-1/4" x 1/2" (69 x 32 x 13 mm). This version need not include Style D or an LED.

10.3.4.5. Addressable Two-Wire Detector Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional two-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

The two-wire monitor module shall mount in a 4-inch square, 2-1/8" deep electrical box or with an optional surface back box. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions indicating that the monitor module is operational and in regular communication with the control panel.

10.3.4.6. Addressable Control Module

Addressable control modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 Vdc powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.

The control module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, or to a surface mounted back-box.

The control module NAC circuit may be wired for Style Z or Style Y (Class A/B) with up to 1 Amp of inductive A/V signal, or 2 Amps of resistive A/V signal operation, or as a dry contact (Form C) relay.

The relay coil shall be magnetically latched to reduce wiring connection requirements and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

Audio/visual power shall be provided by a separate supervised power loop from the main FACP or from a supervised, UL listed remote power supply.

The control module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device.

An LED shall be provided that shall flash under normal conditions indicating that the control module is operational and is in regular communication with the control panel. A magnetic test switch shall be provided to test the module without opening or shorting its NAC wiring.

The control module shall be suitable for pilot duty applications and rated for a minimum of 6 Amps at 30 Vdc.

10.3.4. Smoke Detectors

Smoke detectors shall be preferably be 24 VDC and shall be UL Listed and FM approved. Each detector shall include a visual status indicator, provide remote LED output, and include a built-in test capability.

The sensitivity shall be factory set per UL 268. The detector cover and screen shall be easily removable for field cleaning.

A special vandal-resistant locking screw shall be provided to lock the head to the base.

The head-to-base connection shall be made by use of bifurcated contacts. Terminal connections to the base shall be of the screw type that are accessible with the base installed on the mounting box.

Where specifically identified on the contract drawings, detector bases shall incorporate a relay with Form C contacts rated at 1 Amp at 120 VAC and 2 Amps at 28 Vdc.

Ionization-type smoke detector shall be dual chamber type. The detector shall have an LED in its base which is illuminated in a steady-on mode when in alarm and pulse mode when in standby.

Reset of the detector shall be performed by the control unit reset switch.

The design of the ionization detector compensating circuits shall provide stable operation with regard to minor changes in temperature, humidity and atmospheric conditions.

Photoelectric-type smoke detector shall be light reflective type and compatible with the DF6000 control system. The detector shall have an LED in its base which is illuminated in a steady-on mode when in alarm and pulse mode when in standby. Reset of the detector shall be performed by the control unit reset switch.

The design of the photoelectric detector compensating circuits shall provide stable operation with regard to minor changes in temperature, humidity and atmospheric conditions.

10.3.5. Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

The isolator module shall not require any address-setting and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

The isolator module shall mount in a standard 4- inch deep electrical box or in a surface mounted back box. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

10.3.6. Abort Switch

The abort switch shall be used where an investigative delay is desired between detection and actuation of the fire suppression system.

This switch shall be a momentary contact "dead-man" type switch requiring constant pressure to transfer one set of contacts. Clear operating instructions shall be provided at the abort switch.

This switch shall be rated at 28 Vdc at 1.1 Amp make/break or 6 Amp continuous carry.

The terminal connections shall be of the screw type.

10.3.7. Maintenance Lock-Out Switch

The maintenance lock-out switch shall be used where it is desired to disable the fire suppression system during routine maintenance.

This switch shall be key operated allowing removal of the key in either the "normal" or "lock-out" position. A red indicator lamp shall be included on the switch assembly to be illuminated when in the "lock-out" position. The control unit is to indicate a trouble condition when in the "lock-out" position.

The switch shall include one (1) set of normally open and one (1) set of normally closed contacts rated at 28 Vdc at 1.1 amp make/break or 6 amp continuous carry.

The switch shall include one (1) set of normally open and one (1) set of normally closed contacts rated at 24 Vdc at 1.1 amp make/break or 6 amp continuous carry.

The terminal connections shall be of the screw.

10.3.8. The FM200 Suppression System

FM200 fire suppression system shall be of the engineered, permanently piped, fixed nozzle type with all pertinent components.

All agent storage cylinders shall be centrally located as vertical, free-standing cylinders with wall and/or floor mounted retaining brackets. Where multiple cylinders are required for the same hazard, a common manifold shall be employed. (Cylinders mounted horizontally shall be installed in accordance to the Manufacturer's design manual.)

On multiple cylinder arrangements (discharging into a common hazard), one cylinder shall be designated as the pilot cylinder and employ the restorable electric actuator, and mechanical manual actuator, or both. All remaining cylinders shall be pneumatically operated from the FM200 agent.

Manifolded cylinders shall employ a flexible discharge hose to facilitate installation and system maintenance.

Each cylinder on a manifold shall also include an agent check valve installed to the manifold inlet.

10.3.9. Extinguishing Agent

The agent shall be as FM200.

10.3.10. FM200 Storage Cylinders

Cylinder assemblies shall be of steel construction with a standard RED epoxy paint finish. Each cylinder shall be equipped with a pressure seat-type valve and gauge. Each valve shall be constructed of forged brass and shall attach to the cylinder providing a leak tight seal. Each valve shall also include a safety pressure relief device which provides relief at 3000-3360 PSI per CGA test methods.

Filling of the cylinder assembly shall be by an authorized FM200 systems distributor in conjunction with a factory authorized FM200 agent filling station. Initial filling and recharge shall be performed in accordance with the manufacturer's established procedures and shall not require replacement components for normal service.

10.3.11. Cylinder Bracket

Each cylinder assembly shall be furnished with a bracket made from welded steel. The bracket shall hold the cylinders in a saddle with a front bracket piece that secures the cylinders. The brackets shall be modular in design to allow added bracketing or stacking of cylinders depending on installation requirements.

Cylinder brackets shall be UL listed and/or FM approved for use with the FM200 system.

10.3.12. Valve Actuators

Electric valve actuators shall be of brass construction and stackable design with swivel connections to allow removal of actuators for maintenance or testing.

Operation of actuators shall not require replacement of components. NO ELECTROEXPLOSIVE DEVICES may be used to actuate the valve assembly.

Electric actuators shall be continuous duty type for 24 Vdc operation.

Actuation devices shall be UL listed and/or FM approved for use with the INERGEN system.

10.3.13. Discharge Hose/Check Valve

When manifolding, all cylinder assemblies shall include a flexible discharge hose and check valve for connection to the manifold inlet. All hose/check valves shall be UL listed and/or FM approved.

10.3.14. System Checkout and Testing

The completed installation shall be inspected by factory authorized and trained personnel.

The inspection shall include a full operational test of all components per the equipment manufacturer's recommendations (including agent discharge).

Inspection shall be performed in the presence of the owner's representative.

All mechanical and electrical components shall be tested according to the manufacturer's recommended procedure to verify system integrity.

Inspection shall include a complete checkout of the detection/control system and certification of cylinder pressure. A written report shall be filed with the owner.

As-built drawings shall be provided by the contractor indicating the installation details. All routing of piping, electrical conduit and accessories shall be noted.

Equipment installation and maintenance manuals shall be provided in addition to the as- built drawings.

Prior to final acceptance, the contractor shall provide operational training in all concepts of the system to the owner's key personnel. Training shall consist of:

- The quantity of agent shall reflect the actual design quantity of Control system operation
- Trouble procedures
- Abort procedures
- Emergency procedures
- Safety requirements
- Demonstration of the system (excluding FM200 release)

FM200 agent. A functional test shall be completed prior to the concentration test consisting of detection, release, alarm, accessories related to the system, control unit and a review of the cylinders, piping, fittings, hangers and cylinder pressure. Concentration testing shall be performed under the supervision of the contractor's authorized personnel in the presence of the owner's representative, local authorities and any other insuring authority.

FM200 test procedures shall be recommended by the equipment manufacturer and/or the FM200 equipment supplier. FM200 equipment supplier.

The contractor shall provide a gas analyser capable of automatically recording sampling points. Concentration recording shall continue until authorities are satisfied with hazard. The sampling point(s) shall be located at a strategic area(s) but no higher than the highest combustible contents.

If the test results indicate that the design concentration was not achieved and/or held, the contractor shall determine the cause of the failure. After determination of the cause, the system shall be recharged and again placed in operation. The contractor shall only be responsible for retest based on equipment design failure.

10.3.15. Mandatory Consumables, Spare Parts & Tools

The cost of the following consumables, spare parts and tools for service and maintenance and which shall be supplied with equipment is included in the Contract Price:

- a) One(1) FM200 Cylinder
- b) Six(6) release nozzles
- c) Six(6) release valves
- d) Two(2) Abort Switches
- e) Six(6) Smoke detectors

11. ENVIRONMENTAL MONITORING SYSTEM

11.1. Introduction

The Contractor shall design, supply, install test and commission an environment monitoring system for monitoring of environment within each of the telecom hub buildings.

11.2. Specific Requirements

The environment system should be in a position to monitor temperature and humidity levels within the building and should transmit alarm in case set points are exceeded. The system should comprise of a laptop computer to be positioned in one of the KPLC room of the telecom hub building. The computer should have appropriate software to record temperature, humidity and power measurements and provide logging so as to enable a historical review of the trends.

The Contract price shall include the cost of the laptop computer, all the temperature, humidity and power sensors as well as licenses for all software employed in analysis and transmission of environment data.

The system should have an integrated GSM module enabling transmission of data through email or sms to a client list to be provided.

The data to be transmitted and which shall be programmable to user's requirements shall a minimum include:

- Alarms
- Periodical reports (daily, weekly and monthly)

12. ACCESS CONTROL SYSTEM

12.1. Introduction

KPLC has an Access Control System (ACS) operated on Genetic Software System. The Contractor will be expected to:

- a) Supply, install, and test and commission access readers (both biometric and card) at the main entrance to the Telecom Hub building at each substation. The supply has to include the necessary licenses to the Genetec Software system.
- b) Supply and install the interconnecting cables from the reader to a switch in the telecommunication room in the existing substation control building. Unless otherwise approved by the Employer, the cables shall be CAT 6 Shielded Twisted Pair (STP) cable.
- c) Configure the readers to operate directly from the Genetic System.

12.2. Specifications for Access Readers

The readers to be installed shall be new and shall comply with the technical requirements as detailed in the Technical Data Sheets attached as *Annex 2*. A confirmation of fulfilment if these requirements has to be submitted with tender.

12.3. Scope of Supply

One (1) access reader combining both card and biometric shall be installed at the main entrance of each Telecom Hub building. The reader shall be ruggedized for outdoor environment of each substation and shall comply with the requirements as outlined in the Guaranteed Technical Data Sheets.

Each access reader shall be supplied complete with a license for integration to the client owned Genetec system. The scope of supply shall also include connecting cables and any accessories for mounting of the reader.

13. AIR CONDITIONING AND VENTILATION SYSTEM

13.1. General

The scope shall include design, supply, installation, testing, commissioning, training and management of defects during the defects liability period.

The equipment supplier shall have accredited agency in Kenya for the make of equipment set offered and also shall have proven record of providing after sales services including maintenance services over a period of at least five years.

Communications equipment and battery room shall be air-conditioned. Air conditioning shall be provided in the form of self-contained air conditioning units, in a designed capacity for proper operation and maintenance of communications equipment proposed by the Contract. The air conditioning units shall be individually thermostatically controlled to maintain internal conditions at 20 to 22 degrees centigrade.

This specification covers the basic requirements for the design, manufacturing, supply, factory testing, delivery to site, erection, commissioning and testing at site of the air-conditioning and ventilation systems.

The latest edition of the following codes and standards are specifically applicable to the design, manufacturing and testing of the equipment included in this Specification. IEC 60378, Safety requirements for the electrical equipment of room air-conditioners.

13.2. Service Conditions

The air-conditioners shall be designed for providing the required temperature and the relative humidity of substation buildings. The Contractor shall ensure that all materials, equipment, finishes, devices and systems provided in the Contract can withstand, without deterioration or malfunction, the environmental conditions to which they will be subjected during transportation, unloading, removal to storage, storage, erection and operation.

In general all hardware and accessories shall be made from corrosion proof materials.

13.3. Technical Requirements

13.3.1. General

The Contractor shall verify the dimensions and the constructional aspects of the rooms as well as the prospective activities of the rooms for designing and selecting the appropriate air conditioning systems.

The air-conditioner provided for a particular room shall ensure that the following ambient conditions of the room are met at all times:

Temperature range	20° C – 27° C
Relative humidity	max. 45 %

13.3.2. Type and Rating

The air-conditioners shall be of the split unit and automatic temperature-controlled type. They shall be designed for 24 hour a day operating duty and shall have the following ratings:

Table 13-1 Ratings for Air Conditioners

Input	AC single-phase or three-phase
Compressor capacity	>4.0 kW
Cooling capacity	> 5000 kcal / hour
Moisture removal	> 2.5 l/hour
Air circulation	> 15 m ³ / minute

13.3.3. Construction

Each air-conditioner shall be constituted by a complete set of wall mounted compressing/cooling unit and two wall mounted blowers together with their connecting hoses and accessories. The compressing /cooling units shall be designed for outdoors installation whereas the blowers shall be designed for indoors use. The operating and the temperature controls of the air conditioner shall be through a remote hand set to be pointed to either blower of the relevant air-conditioner and local control. The conditioners shall be used for cooling, removal of excess moisture and dust as well as for air ventilation of rooms.

13.3.4. Inspection and Tests

The following inspection and tests shall be carried out after completion of the installation:

- Appearance and construction inspection
- Operation test
- Measurement of insulation resistance and withstand voltage test
- Measurement of room temperature during operation of the air-conditioner
- Measurement of room ambient relative humidity during operation of the air-conditioner

The following inspection and tests shall be carried out at the end of the guarantee period:

- Measurement of room temperature during operation of the air-conditioner
- Measurement of room ambient relative humidity during operation of the air-conditioner

13.3.5. Performance and Guarantees

The Contractor shall guarantee his equipment for the time stated in the Contract from the date of commissioning of his equipment. During this period, no servicing (refilling of coolant or otherwise) of the unit should have been required to maintain the performances of the air-conditioner except the cleaning of the screen filter. No appreciable loss of the performances of the air-conditioner should be recorded during the field tests to be carried out at the end of the guarantee period. Should the unit fail to comply with these requirements, the Contractor shall replace the equipment at his own cost and renew the guarantee period from the date of commissioning of this new unit.

13.4. Mandatory Consumables, Spare Parts and Tools

The cost of the following mandatory consumables, spare parts and tools for service and maintenance shall be supplied and shall be included in the Contract Price:

- a) One(1)Toolbox

14. CCTV SURVEILLANCE SYSTEM

14.1. Introduction

KPLC has a CCTV Surveillance System operated on Genetic Software System. The Contractor will be expected to:

- a) Supply, install, and test and commission cameras in various sections of the Telecom Hub building at each substation. The supply has to include the necessary licenses to the Genetic Software system.
- b) Supply and install the interconnecting cables from the reader to a switch in the telecommunication room in the existing substation control building.
- c) Configure the cameras be visible and to operate directly from the Genetic System

14.2. Specific Requirements

The cameras to be installed shall be new and shall comply with the technical requirements as detailed in the Technical Data Sheets attached as *Annex 2*. A confirmation of fulfilment if these requirements has to be submitted with tender.

14.3. Scope of Supply of Cameras, Switch, Cables and Accessories

As a minimum the scope of supply of the CCTV surveillance system for each substation shall comprise of the following:

- 5No x 5Megapixel Environmental IP Outdoor/Indoor Fixed Mini-Dome IR Camera – Type 1.
- 2Nox12- Megapixel H. 264 WDR 1800 Panoramic Day/ Night Indoor/Outdoor Dome IP Camera-Type 3
- 4Nox 12-Megapixel H.264 WDR All In One Directional User- Configurable Multi-Sensor True Day/Night Indoor/Outdoor Dome IP Camera-Type 4
- 1NoxCisco SG 300-28 switch
- CAT 6 connecting cables
- Fiber cables for connection from the SG 300-28 switch to switch in existing KPLC substation control building.
- Genetec License for the number of cameras being supplied.

All the cameras shall be supplied complete with all mounting and connecting accessories and necessary licenses to operate on Genetec System owned by the Employer.

The Contract Price shall include cost for configuration to the existing KPLC Genetic System so that the cameras are visible from these control centers.

Refer to the Guaranteed Technical Data Sheets for specific requirements of the cameras.

14.4. Scope of Supply of Work Station and Monitor

The scope of supply shall comprise of the following to be installed at the Institute of Energy Studies and Research:

- One (1) Workstation for CCTV surveillance
- One(1) LCD monitor

15. EMERGENCY DIESEL GENERATORS

The specifications for the Emergency Diesel Generator shall be as detailed in this section.

15.1. Scope of Supply

The generator shall be three Phase, silenced type (achieved by canopy), 415V with a prime rating of 50kVA, with auto start feature and having 10 % overload capability for a period of 1 hour within 12-hour period of operation, in accordance with ISO 3046.

The diesel generator shall be canopied and suitable for outdoor installation within the environmental conditions of each of the sites. Components of generators to be installed in the coastal areas which are prone to marine corrosion shall be corrosion resistant and suitable for such environment.

The generator shall have an energy meter with capacity to record cumulative energy generated (in kWh).

The equipment supplier shall have accredited agency in Kenya for the make of equipment set offered and also shall have proven record of providing after sales services including maintenance services over a period of at least ten (10) years.

The generator set shall be brand new; having diesel engine and alternator and the offered make and type of generator shall have satisfactory service record in South Sudan at least during last five years.

The diesel generator set shall be supplied complete with all ancillary equipment necessary for starting and running of the set, including cooling systems, fuel storage and supply system, instrumentation, control and protection arrangements, spares and special tools.

Generator body and Generator neutral shall be solidly earthed. The body shall have a canopy and having a degree of protection suitable for outdoor installation

The set shall be reasonably self-contained to minimize installation works at site. The engine, alternator and cooling radiator shall be mounted on a combined under-base of stress relieved fabricated steel and engine accessories shall also be mounted on the under base where appropriate, provided that this does not result in difficulty of access for maintenance.

The set shall be mounted on suitable arrangement of anti-vibration mounting designed to minimize the transmission of vibration but without resulting in excessive amplitudes of movement of any parts of the set. If rubber is employed in the mounts, their design shall incorporate means of preventing deterioration due oil leakages.

Flexible connection shall be provided to all exhaust, water, air, fuel and oil piping that leaves the engine to prevent the transmission of vibration and the fracture of the piping due to movement of the set. The choice of connections and their installation shall be such as to give long life under normal operating condition of the set.

15.2. Standards

The following Standards apply:

<i>BS 5000 Part 3</i>	<i>Generators to be driven by Reciprocating Internal Combustion Engines</i>
<i>BS 5514 (ISO3046)</i>	<i>Specification for Reciprocating Internal Combustion Engines (Part 1-6)</i>
<i>BS 5486 (IEC 439)</i>	<i>Factory Built assemblies of Low Voltage Switchgear and Control Gear</i>
<i>BS 4999(IEC34-1)</i>	<i>General requirements for Rotating Electrical Machines</i>

The Contractor may provide generators manufactured to alternative standards provided they are equivalent or better than the proposed standards. Such standards shall be subjected to the approval of the Project Manager.

15.3. Design Criteria

Rated continuous output shall be not less than 50 kVA at 0.8 power factor at generator output terminals. (Based on 35°C ambient temperature a relative humidity of 90% and at altitude of up to 2000m asl).

The unit shall be capable of delivering the rated output for continuous period of not less than 12 hours at a time. It shall have overload capacity of 110% of the rated output for one hour during a period of 12 hours.

15.4. Engine

Major specifications of the engine are as shown in the

Table 15-1 Diesel Engine Specifications

Item No	Description	Value
1.	Number of strokes	4
2.	Speed Range	1500 rpm - 3600 rpm
3.	Loading	Asynchronous motor loads up to 100% may be switched on with a maximum admissible speed drop of 12%.

Diesel engine shall be of a well-proven make, complying with the requirements of BS 5514 (ISO 3046). The engine shall meet all the performance requirements of the set under the specified operating conditions.

A sturdy elastic coupling shall connect the engine and the generator, and both shall be mounted on a common base plate forming part of the supply, Proven and highly effective anti-vibrating mountings shall be provided between base plate and concrete foundation.

The engine shall be started by 24 V/12 V starter motor engaging with the fly wheel ring gear and disengaging automatically when the engine starts. The equipment shall include an adequately rated lead/acid battery together with an automatic mains energized battery charger.

The charger shall have a continuous output rating sufficient to recharge the battery from 1.8 V/cell to a fully charged condition in a period of 8 hours. The battery shall be capable of providing at least six starting cycles within a period of 5 minutes.

The engine shall be water cooled. A sectional radiator shall be provided and mounted on the combined underbase and arranged to cool the engine jacket water, lubricating oil and charge air as appropriate. Circulation of cooling water through the engine and radiator shall be by means of engine driven pump. The water circuits shall be fitted with an easily accessible drain point. Engine with alternative cooling method shall be accepted subject to approval of the Project Manager.

The cooling fan shall be arranged to drive directly by the engine and the hot air shall ducted to suitable openings in the generator room wall. The duct shall be incorporated with a suitable flexible section to prevent the transmission of vibration from the engine and the discharge end shall be provided with louvers and an insect screen.

Lubrication of the engine shall be by means of an engine driven integral pump. The pump shall have on the suction side a coarse strainer and on the delivery side a duplex 'full flow' fine filter complete with changeover cock incorporating pressure by-passes to facilitate oil flow to the engine should the filter become blocked. The lubricating oil system capacity shall be sufficient to enable the engine to run continuously for 12 hours at any load without replenishment.

The governor of the engine shall be mechanical/electronic type and be capable of fine governing of speed to Class A2 of BSS 5514/1977, ISO 3046/IV.

The engine shall be efficiently silenced with suitable noise attenuators provided at cooling/combustion air inlets and outlets and exhaust silencers complete with interconnecting pipe and fittings. Supports for each complete system shall be of the anti-vibration type and due allowance for expansion of the exhaust system shall be made by the inclusion of expansion bellows.

Exhaust pipe shall be lagged with a removable Aluminium cladding. Exhaust pipe outlet point shall be 4m above ground level.

The engine shall be provided with the following protection devices for alarm and shutting down the engine automatically.

- Low lubricating oil pressure
- Engine overspeed
- High cooling water temperature
- Over crank

15.5. Generator

As a minimum the specifications of the generator shall be as shown in the table below:

Table 15-2 Generator Specifications

Item No	Description	Value
1.	Frequency	50 ± 2% Hz
2.	Voltage	415/230 V ± 5% 3 phase & neutral
3.	Speed	1500 rpm - 3600 rpm
4.	Deviation Factor of voltage wave form	5%
5.	Insulation Class for rotor and stator windings	H
6.	Protection class of enclosure	IP 23

The Generator shall comply with BS 5000 (IEC 34-1) and shall be brushless, self-exciting and self-regulating type. The exciter shall be with rotating silicon rectifiers, auxiliary exciter of permanent magnet type, damper cage, static voltage regulator and compounding equipment.

The voltage regulator shall maintain its setting for long periods without adjustment. Means shall be provided for a limited degree of manual adjustment of the output voltage setting.

The Generator shall be directly coupled to and share a common high bedplate with the prime mover. The degree of protection for the generator and exciter shall be not less than IP 23.

Cooling of the generator shall be by a radial-flow fan. Generator bearings shall be of the ball or roller type, rated for long life and pre-packed with sufficient grease for operating over long periods without replenishment.

The stator and field windings shall consist of electrolytic copper conductors insulated throughout with Class H materials as defined in IEC 85. A generator winding temperature detector (thermistor) installed at the hottest spot and wired to give alarm and shutdown.

Thermostatically controlled tubular low-temperature heaters of sufficient rating to maintain the windings in dry condition during long periods of standstill shall be fitted in the stator casing and wired out to a terminal box on the bed plate, which in-turn shall be connected to the 230-volt single-phase supply.

Voltage regulation shall be maintained within $\pm 2\frac{1}{2}\%$ from no load to full load including cold to hot variation at any power factor from 0.8 to unity. Neutral shall be solidly earthed.

15.6. Fuel Storage and Transfer

The machine shall have one integral metal fuel tank (capacity sufficient for 12 hour continuous operation at full load) and shall be installed in a position where any fuel leakage cannot impinge on exhaust pipe or other hot engine surfaces.

The tank shall be provided with all necessary fittings including fill, vent, drain and overflow line, level indication and access for inspection and maintenance. Level switches shall be provided for the following services.

- (a) Low level alarm
- (b) High level alarm

15.7. Control Equipment

A control cubicle fabricated with welded steel panels supported by structural steel frame, shall be provided and installed for the stand-by plant, together with all necessary inter-connections, anti-condensation heaters etc. The primary function of the control equipment shall be;

- a) Automatic starting and stopping of the generator on receipt of signal from main panel board
- b) Fault indicating and appropriate action.
- c) Manual start and stop operations in remote and local positions.

Automatic shutdown of the set and lockout of the starting system shall result from any of the following:

- a) Low lubricating oil pressure
- b) High cooling water temperature
- c) Failed to start
- d) Engine over speed (if speed exceeds 20% above normal)
- e) High stator temperature

The control system shall include the following:

- a) Overload protection
- b) Restricted Earth fault protection
- c) Visual & Audible Fault indication and alarm accept/reset
- d) All necessary controls needed to prevent starting of machines on momentary fluctuations of main voltage.

The following equipment shall be included in the control panel;

- a) Voltmeter and selector switch to indicate individual phase and line voltage
- b) Ammeter and selector switch to indicate the line current
- c) Frequency meter
- d) Hour run counter
- e) Engine 'start' & 'stop' push button and lock switch
- f) 'Remote' & 'Local' selector switch with provision for start & stop at main panel board
- g) 'Auto', 'Manual' & 'Off' selector switch
- h) 'Emergency Stop' push button
- i) Mains operated battery charger of the constant potential type with MCCB, ammeter, incorporating mains failure relay.
- j) Run indicator lamp
- k) Fault indicator lamp
- l) Audible Alarm
- m) Lamp test push buttons, Alarm accept and reset buttons
- n) Tachometer and Speed indicator
- o) 3 Pole MCCB with neutral link
- p) Battery charge indicator
- q) Lubrication oil pressure indicator
- r) Cooling water temperature indicator
- s) Engine speed adjustment (speed droop between 0 and 6 %)
- t) Fuel level integral fuel tank low
- u) Fuel level integral fuel tank high

Microprocessor Control Panel with Alphanumerical character digital display is acceptable alternative to hardwired equipments. Microprocessor Control Panel shall incorporate all above mentioned facilities.

The Microprocessor Control Panel shall be able to connect to Standard Personal Computer to download data and information from module and to programme the Module.

It should be noted that control equipments shall be suitable for tropical climatic conditions so that their parameters shall not vary due to ambient temperature or aging.

15.8. Tests

The required tests shall be carried out to show that the generator set meets the duty requirement specified. The tests shall include:

- Factory Acceptance Tests
- Site Acceptance Tests

15.9. Operation and Maintenance Manuals

The Operation and Maintenance manuals of equipment supplied shall be furnished with the generator set with detailed drawings of wiring of equipment, frequency of lubrication, operating instructions, and any other relevant information.

15.10. Free Maintenance and Defects Liability Period

The contractor shall provide regular maintenance services as per the manufacturer's instructions, which shall include but not limited to the following work, during the twelve (12) months warranty period.

- a) Inspect, clean, oil and grease where necessary
- b) Adjustment of machinery
- c) Replacement of any defective parts

15.11. Mandatory Consumables, Spare Parts and Tools

The cost of the following spare parts to be supplied with the diesel generator sets shall be included in the Contract Price:

- a) 6No x Air Filter (of each type)
- b) 6No x Fuel Filter (each type)
- c) One(1) complete tool box for maintenance
- d) Lubricating Oil
- e) Temperature/Pressure Switches (5No of each type)
- f) Assorted solenoids, relays, fuses and lamps (5No of each type)

16. CIVIL ENGINEERING WORKS

16.1. General

This part of the specification covers the civil works for the equipment, as well as all civil works necessary for erection and installation of the switchgear and the related cable connections etc. The works comprise the topographical survey of site, subsoil investigations, detailed design, production of working drawings, and provision of labour, drawings and materials, and construction of the civil engineering and building works. The works include site clearance and earthworks; access road works, surfaced water drainage, elevated water storage support structures, drained outdoor cable trenches, perimeter fencing and gates, etc. The framed structure of telecom hub buildings will be completed with communications equipment room, office, washrooms, drainage infiltration tanks, septic tank(where applicable), water supply with pumping boost .

This specification covers the following:

- Site clearing, cleaning and preparation
- Earth and rock works
- Concrete and reinforced concrete
- Building Works
- Road Works
- Finishing work
- Equipment Foundations
- Dewatering
- Trenches and cable ducts as required
- Lighting system
- Plumbing
- Site arrangement and access

All work shall be complete in every respect and ready for operation. Provisions have to be made for maintenance and insurance of the completed work until handing over. Further details of works to be performed are described in Scope of Works. Since adequate measures for rehabilitation of the different existing parts have to be elaborated, the Contractor shall describe the measures intended to perform this works very detailed.

16.2. Preparation of Sites

All site installations required by the Contractor for the performance of the work under this Contract shall be included in the offer. The Contractor shall make his own arrangements for the transport of material, equipment and staff to the different sites. It has to be assumed that soft ground may have to be crossed when approaching some of the sites. The Contractor shall have to take his own precautions to ensure transport to and execution of his work at such sites.

16.3. Site Survey and Investigation

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

16.3.1. Site Survey

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

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

A site survey plan shall be prepared in the scale of 1:2500 showing the survey results and proposed layout of the work.

16.3.2. Sub-Soil Investigation

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

- a) Depth of sounding tests shall be less than 5 metres unless rock is encountered; in which case the thickness shall be proved to be greater than 1.5 metres on two boreholes. Where weak soils are encountered, the test shall be taken down to a load bearing stratum and adequate thickness.
- b) Test records shall describe and indicate level of all soils encountered and indicate the natural water table level. Rock core records should specify total core recovery, solid core recovery and quality of the rock cored.
- c) Electrical resistivity of the soil shall be verified on four samples, in accordance with approved practice.

16.4. Design of Works

16.4.1. Design and Drawings

The Contractor shall design the civil engineering and building works and prepare design report complete with working drawings in size A3 as necessary for the construction of the works.

The Contractor is required to produce full design calculations for the foundations, building structures, etc. and detailed working drawings. He shall be responsible for the detailed designs, strength and safety of the structures, to meet the structural, acoustic and environmental requirements of the buildings and other works. He shall be responsible for ensuring that the design satisfies the requirements of all authorized local and international bodies. Design calculations and detailed drawings must be submitted to the Employer for approval before the relevant construction work is carried out. Design calculations shall be in accordance with an approved method of computation and appropriate design criteria.

Standards shall be the latest amendments of the British Standards in the respective category, Standards of the International Electro-technical Commission ("IEC") and the International Standardization Organization ("ISO") or as otherwise referenced in these Employer's Requirements for all materials and Plant used and provided under this Contract. Suppliers who do not normally manufacture to IEC or ISO or Employer specified Standards may offer plant in accordance with other recognised International Standards provided that they draw attention to any essential differences between the proposed and IEC/ISO or Specified Standards and that they certify the plant offered

is not to a standard less than that required of IEC/ISO or Employer specified Standards. Acceptance of any standards other than those referenced within these Specifications, will be subject to the Project Manager's approval and on satisfaction that quality, finish and performance of the plant offered shall be comparable to plant that complies with IEC, ISO or other Specified Standards.

The Works shall be designed to facilitate maintenance and simplicity of operation, inspection, cleaning and repairs, and for operation where continuity of supply is the first consideration. All apparatus shall also be designed to ensure satisfactory operation under the atmospheric conditions prevailing at the site and under such sudden variations of load and voltage as may be met with under working conditions on the system, including those due to faulty synchronizing and short circuit

Calculations shall clearly identify the subject of the calculations and shall include but not be limited to providing the following information:

- a) Assumption used for design purposes
- b) Codes or standards used
- c) Loading used
- d) Calculation
- e) Technical specification section and paragraph number

The Contractor shall prepare and shall be fully responsible for the correctness of all drawings and other documents which are necessary for the manufacture, supply, delivery, erection, operation, commissioning and maintenance of the Facilities.

The Contractor shall use the English language in all drawings, information and documents pertaining to the Contract and in all correspondence between the Contractor the Employer and the Employer's Representative. Whenever anything is required under the terms of the Contract to be written, marked, printed or engraved, the English language is to be used except where otherwise may be provided in these Employer's Requirements. The Engineer reserves the right to request any further additional information that may be considered necessary in order fully to review the Contractor's drawings.

'Preliminary drawings' means drawings to be provided by the Contractor to the Employer's Representative for review and comment.

'Final drawings' means all approved drawings embodying, where required, all design modifications as approved by the Employer's Representative.

'Work—as-executed drawings' means drawings showing the arrangement of the Facilities in the final and complete state as installed or to be installed at the time of Take-Over of the Facilities

Submission by the Contractor of drawings for approval, including those prepared by others, shall be deemed to mean that the Contractor has fully examined such drawings and that they comply with the requirements of the Contract.

Approval of a drawing by the Employer's Representative will imply that:

- General arrangement and layout drawings and key diagrams have been examined and appear to be in accordance with the basic design concept as provided for by the Employer's Requirements;
- Other drawings of plant have been examined in relation to compatibility of the plant and with the Employer's Requirements;
- Approval of a drawing shall not relieve the Contractor of his responsibilities under the Contract.

Drawings/sketches shall be ISO standard size, between A1 and A4 and shall be completely legible when printed at the appropriate size.

All drawings and other documents shall be identified using a systematic document numbering system which gives a unique identifier for each document, shown on each sheet of the document.

The Contractor shall maintain a drawing and other document register, which identifies each document and the date and reference of submission of the original and each revision. The register shall be in electronic format and shall include a facility by which associated groups of documents may be readily identified and retrieved, for example, one such group could be transmission tower foundation drawings. The document register shall be maintained at current status and an electronic copy submitted with each of the Contractor's monthly reports.

The number and format of documents to be submitted to the Employer's Representative shall be agreed with the Employer's Representative and may be varied from time to time. At commencement of the Contract, two paper copies and one electronic copy shall be submitted.

If a document includes generic material provided by any plant supplier, that material shall be clearly marked to identify which portions are applicable to the Contract.

All drawings and other documents shall be included in the operation and maintenance instruction manuals (see "Standard Technical Requirements). In addition, the Contractor shall provide two complete sets of drawings and other documents revised to 'Work-as-Executed' status in the same electronic format as the source file (e.g. AutoCAD or MS Word)

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

16.5. General Site Works

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

16.6. Temporary Fencing

The Contractor shall, in connection with the works, provide and maintain at his own cost all light guards, temporary fencing and security when and where necessary, or required by the Employer's Representative for the protection of the works and for the safety and convenience of the public.

16.7. Setting-Out

The Contractor shall be responsible for the true and proper setting out of the work and for the correctness of the positions, levels, dimensions and alignment of all parts of the work and for the position of all necessary instruments, appliances and services in connection therewith. The accuracy of all setting-out is to be better than ± 1 part in 3,000.

If, at any time during the progress of the work, any error should appear or arise in any part of the work, the Contractor shall rectify all such errors at his own cost and to the satisfaction of the Employer. The checking of any setting out or of any level by the Employer's Representative shall not in any way relieve the Contractor from his responsibility for the correctness thereof.

The Contractor shall carefully protect and preserve the benchmarks, reference levels, etc., used in setting out the work

The Contractor shall advise the Employer within 24 hours whenever a new setting-out peg is established, and shall regularly furnish the Employer's Representative with layout plans showing all current setting-out and survey stations.

16.8. Tolerances

The tolerances shown below shall rule on site unless otherwise agreed upon by the Employer and the Contractor.

16.8.1. Block Work

Tolerances for Block work are shown in table below:

Table 16-1 Tolerances for Block Work

Item	Description	Tolerance
Position in plan	Fair-faced or specified side from the designed position $\pm 15\text{mm}$	$\pm 15\text{mm}$
Length	Up to and including 5m	$\pm 15\text{mm}$
	Over 5m up to and including 10m	$\pm 20\text{mm}$
	Over 10m	$\pm 25\text{mm}$
Height	Up to and including 3m	$\pm 15\text{mm}$
	Over 5m up to and including 6m	$\pm 20\text{mm}$
	Over 6m	$\pm 25\text{mm}$
Thickness	More than one block	$\pm 15\text{mm}$
Level of bed joints	Length up to but not exceeding 5m	$\pm 10\text{mm}$
	Over 5m but not exceeding 10m	$\pm 15\text{mm}$
	Over 10m but not exceeding 20m	$\pm 20\text{mm}$
	Add for every 5m	$\pm 5\text{mm}$
Straightness	In any 5m (not cumulative)	$\pm 10\text{mm max}$
Verticality	In any 3m	$\pm 15\text{mm}$

16.8.2. Permissible Deviation on In-site Concrete

The tolerances for In-site concrete works are shown in the table below:

Table 16-2 Tolerances for In-Site Concrete Works

Item	Description	Tolerance
Plant and other foundations	a) Position of center line on plan from nearest building grid line	±10mm
	b) Dimensions on plan	-5mm + 20mm
	c) Formation level	±25mm
	d) Surface level	-5mm + 0mm
	e) Sleeved bolt location	±15mm
	f) Sleeved bolt vertically	1 in 100
	g) Cast-in bolt location	±2mm
	h) Cast-in bolt vertically	1 in 300
	i) Bolt levels	0mm + 20mm
		NB: Where tolerances (e) and (f) conflict with (g) and (h) the latter shall govern.
Components above foundation (excepting items in (c) below)	Position of centre line on plan from Nearest building grid line	±19mm
	Verticality: Plumbers in height of up to 0.5m	±5mm
	Verticality: Over 1.5m to 1.5m inclusive	±10mm
	Verticality: Over 1.5m to 3m inclusive	±15mm
	Verticality Over 3m to 30m inclusive	±20mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Up to 300mm	±5mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Over 300 to 600mm	±10mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Over 600 to 1500mm	±10mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Over 600 to 1500mm	±15mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Over 1500 to 3000mm	±20mm
	Cross section and linear dimensions of beams, slabs, columns and walls. Over 3000mm	±30mm
	Level of specified surface relative to the nearest Bench Mark	±10mm

Overall dimensions of a concrete framed building	Length and width measured at external ground level - For dimensions up to and including 15m	±15mm
	Length and width measured at external ground level - For dimensions over 15m up to 30m	±50mm
	Length and width measured at external ground level - For each subsequent 30m	±20mm
	Height of structural roof level with reference to the transferred Bench mark	± 40mm

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

16.9. Drainage

The Contractor shall be responsible for setting-out and shall include for such work in his rates. Prior to excavating a section of pipeline, sight rails shall be erected at each end and at each change in. Drainage shall be designed in accordance with relevant latest local construction and building .In the absence of this, Codes for Practice published by authoritative Standards Organization can be used All drains shall be laid in straight lines and regular gradients as described or directed.

A surface water drainage system covering the switchyard shall be installed. The number of runs and outfalls and pipe sizing must be sufficient to cope with the severest precipitation, with a factor of safety of 1.2. Within switchyard and other areas in which maintenance will be carried out the drainage must allow uninterrupted access. Embankments and cuttings are to have drainage facilities at their top or bottom. The formation level of switchyard areas is to be formed with uniform cross-falls of about 1 in 300 in the same direction as the natural drainage path of the surrounding country. Surface water from roofs of buildings shall be drained to down pipes, which connect with the site drainage system. All drains shall be kept clear from earth, debris, superfluous cement and other obstructions during and after laying. Underground drains shall be provided with inspection well at appropriate sections and connected to common underground infiltration tank.

16.10. Earth and Rock Work

16.10.1. General

This chapter applies to all earth and rock work required under this Contract in connection with the installation of all buildings, any type of structure and underground service, pavements, road works and landscaping, and for the disposal of useful and waste material.

Generally, all buildings and structures shall be founded on the bearing strata in a way determined in the soil investigations and fixed during the structural analysis, but also in accordance with the information and instructions given in writing by the Employer. All excavation work for foundations has to be carried out accordingly.

16.10.2. Material

The ground characteristics shall be defined as per DIN 4020 (2003-09): Geotechnical investigations for civil Project Management purposes. For tender purpose, the characteristics of various types of ground and allowable bearing pressure can be assumed as defined in the British Code of Practice (CP) 2004 or the equivalent DIN Standard DIN 1054 (2005-01): Ground – Verification of the safety of earthworks and foundations.

16.10.3. Execution

The work shall be executed either by manpower or by use of fuel driven machinery and tools acceptable to the Employer's Representative. The Employer's Representative in the vicinity of existing installations may require exploratory trenches by hand excavation. The Contractor shall carry out all kinds of earth and Rock Work for the particular work as defined hereafter (where applicable):

- clearing and grubbing
- excavation of top soil
- mining
- back-filling
- precaution during earthwork
- demolition of existing structures
- grading
- open cut excavation
- obstacles and archaeological findings
- replacement of material
- trench excavation for services

Burning and blowing-off of any material is generally not permitted, except where explicit written instruction has been issued by the Employer's Representative.

16.10.4. Auxiliary Work

All and any kind of work, material, services, safety measures, etc., as well as all tests and samples requested by the Employer's Representative and required for the completion of the work, shall be included in the tender. The auxiliary work comprises, but is not necessarily limited to, the following:

- Removal and storage of boundary stones, bench marks, etc.
- Protection of survey points, designations by means of boards
- Survey and protection of all secondary survey points, profiles, etc.
- Solution of difficulties where excavation may have to be carried out in layers
- Keeping off or diversion of water, including any pumping required, difficult work caused by water, etc.
- Removal of any groynes, buried pipes, wattle work, fascines and the like which might interfere with excavation profiles, irrespective of whether or not such structures are specified in the Tender Specifications
- Solution of difficulties resulting from the Tender Specifications with regard to fills, compaction tests, elimination of unsuitable material from fills and, if necessary, mixing of different soil materials
- Transport of excavated material to fill or deposit, placing and spreading in layers according to conditions and drawings, and careful compaction
- Solution of difficulties in transport due to existing ground conditions

- Grading of intermediate and top fill surfaces and slopes to final levels required
- Sorting of excavated material which, if necessary, is to be used for special purposes
- Any expenditure for provision, maintenance and later removal of driveways; maintenance of existing ways and roads: provision, placing, maintenance and later removal of conveying and dumping equipment which might be required.

16.10.5. Tests and Properties

To ensure that the supply and services under the Scope of this Contract, whether manufactured or performed within the Contractor's works or at his subcontractors' premises or at Site or at any other place of work are in accordance with the Specification, with the Regulations and with relevant authorized standards, the Contractor shall adopt suitable quality assurance programmes and procedures to ensure that all activities are being controlled as necessary.

The Contractor shall have a documented quality assurance program which is accredited as complying with ISO 9001 and which is capable of providing assurance that all plant, materials and services meet the specified requirements.

The Contractor shall have a quality assurance section responsible for establishing and conducting the quality assurance program. The program shall describe the quality assurance management, their responsibility and authority. Quality assurance personnel shall be independent from those personnel performing assigned activities and shall have the organisational freedom required to resolve quality assurance problems.

The program shall cover, as a minimum, the following areas:

- Design control
- Procurement control
- Document control
- Control of inventory, including component identification
- Control of special processes

The Contractor's quality assurance system shall apply to all work undertaken by subcontractors. The Contractor shall perform periodic documented reviews of his Facilities and quality controls to assure conformance to the program and contract requirements. The Contractor shall provide the Employer's Representative with access to its records so that the Project Manager may undertake quality audits and inspections.

Quality control and test operations shall be carried out by the Contractor in the presence of the Project Manager, or under the supervision of an experienced representative of the Employer's Representative, e.g. an approved and licensed office for testing of such work.

The systems and procedures which the Contractor will use to ensure that the Works comply with the Contract requirements shall be defined in the Contractor's Quality Plan for the Works.

The Contractor shall operate systems that implement the following:

- **Hold point** - "A stage in material procurement or workmanship process beyond which work shall not proceed without the documented agreement of designated individuals or organizations."

The Engineer's written agreement is required to authorize work to progress beyond the hold points indicated in reviewed quality plans.

- **Notification point** - "A stage in material procurement or workmanship process for which advance notice of the activity is required to facilitate witness."

If the Engineer does not attend after receiving documented notification in accordance with the agreed procedures and with the correct period of notice then work may proceed.

The Contractor shall prepare forms for the analysis of field and laboratory tests for Employer/Employer's Representative's approval. Quality control will comprise of field and laboratory tests, such as compaction and density tests, grain- size distribution, and shear tests. If not otherwise specified under relevant items, at least following tests have to be carried out:

- Two (2) analyses of the existing ground water. Samples shall be taken from different spots or as directed by the Employer.
- Two (2) analyses of water to be used during the works. The first test is required before any structural member is executed. The second test is required at the beginning of the super structural work, or as requested by the Employer's Representative.
- Three (3) tests for specific gravity of soil as per ASTM D 854-58 or equivalent DIN, latest issue.
- One (1) test for bearing capacity of soil for static load as per ASTM D 1194-57 or equivalent DIN.
- Three (3) tests for grain size analysis of soils, if "Replacement of Material" is required as per ASTM D 422-63 or equivalent DIN.
- Three (3) tests for density of soil in place (Sand cone method) for every second layer of "Backfilling and/or replacement of material and/or roadwork" are required as per ASTM D 1556-64 or equivalent DIN, or as instructed by the Employer's Representative.
- If not otherwise specified, the minimum required degree of the compaction of the modified proctor density shall be as shown in table below:

Table 16-3 Minimum Compaction Levels

under building foundations and slabs	97%
under pavements, parking areas and roads	95%
under transformer foundations	97%
under embankments	95%

Material sampling for tests shall be done as follows:

- Approved sources, graded aggregates, sampling and testing to BS 812,
- Workability
- Fresh concrete slump test. Slump range 25 – 50mm, mechanical vibration and maximum 1.5m fall method of placing.
- Strength/durability
- Compression/cube (150mm) test, three after seven days and three at twenty-eight days. Test to BS 1881.

Works cubes are to be made at intervals as required by the Employer. The cubes shall provide a continuous record of concrete work. The cubes shall be made in approved in 150mm moulds in strict accordance with code of practice.

Three cubes shall be made on each occasion from different batches, the concrete being taken from the point of deposit. Each cube shall provide a distinguishing number (numbers to run consecutively and the date, and a record shall be kept on site, giving the following particulars :-

- a) Cube number
- b) Date made
- c) Location in work
- d) 7 –day Test Date; Strength
- e) 28 –day Test..... Strength.....

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

If the strength required above are not attained, and maintained throughout the carrying out of the contract, the contractor will be required to increase the proportion of cement and/or substitute better aggregate so as to give concrete which does comply with the requirements of the contract The contractor may be required to remove and replace at his own cost any concrete which fails to attain the required strength as ascertained by Work Cube Tests. The contractor must allow in his rates for concrete test cubes for all expenses in connection with the preparation and conveyance to the Testing Authority and of test cubes and no claim in respect of his failure to do so will be entertained.

16.11. Excavation

16.11.1. General

All kinds of soil encountered at site shall be excavated according to relevant drawings, and shall be loaded, transported and dumped at areas approved by the relevant authorities and the Employer/ Employer’s Representative. For all excavation work, dewatering down to the bottom of the pit must be considered and shall thus be included in the contract price. If buried obstacles are encountered during excavation work, the Project Manager has to be informed immediately and any demolishing and/or removal of such obstacle shall commence only after receipt of instructions from the Employer’s Representative. Material approved to be used for backfilling may be stockpiled separately nearby.

16.11.2. Excavation of Top Soil

If the upper layer of soil is rich in organic matter, it shall be removed and stockpiled in stacks of trapezoidal cross section 1.20 m in height and 2.00 m average width. After the completion of all civil and pertaining works, the surfaces of the project area shall be reinstated by placing the top soil in layers as directed by the Project Manager. No additional payment shall be allowed for this work.

16.11.3. Finish of Excavation and Inspection

No excavation shall be refilled or any permanent works commenced unless the Employer’s Representative or his representative has inspected the formation, and given his permission to proceed.

If required by the Project Manager's representative, the bottom 15 cm of excavation shall not be removed until immediately before the commencement of construction of permanent works.

16.11.4. Over-Excavation

If for any reason, excavations are executed beyond the established lines, the Contractor shall backfill the over-excavation with lean concrete at his own expense.

16.11.5. Manual Excavation

During work execution, the contractor shall submit to the Employer's Representative for approval the type of excavation that is to be carried depending on the installation of the various equipment.

Manual excavation of soil shall be made on special instruction and approval by the Employer's Representative, and wherever the care of the work requires. This shall be applicable for the observation of underground services in the vicinity of any construction prior to commencement of the main excavation.

16.11.6. Obstacles, Groynes, Existing Pipework

The Contractor shall take all necessary precautions to prevent damage of existing services, cables and pipes. The Contractor will be liable for any damage that might occur. He shall make arrangements in good time for the Employer and Employer's Representative to be present, when the cables and pipes are to be exposed and / or relocated, should this be necessary. The costs of relocation (permanent and temporary) of any service shall be borne by the Employer after approval of the Employer's Representative has been obtained.

If buried obstacles are encountered during excavation works, the Employer's Representative has to be informed immediately and demolishing and/or removal of such obstacle shall commence only after receipt of instructions from the Employer's Representative. The removal of any groynes, buried pipes, wattle works, fascines and the like which might interfere with the excavation profiles, irrespective of whether or not such structures are described in these Specifications, must be included in the contract price.

16.11.7. Excavation and Removal of Concrete Structures

The offered price shall be deemed to include all auxiliary works required for full completion and of works in accordance with the drawings and conditions. Hence, the auxiliary works comprise, but are not necessarily limited to the following:

- Structures to be demolished
- excavation and removal of concrete plates, beams, floors, boulders, rocks, large stones or concrete foundations (if any)
- removal of drainage and the like under embankment fills, difficulties resulting from the specifications relating to fills, compaction tests,
- elimination of unsuitable material from fills any transport and intermediate storage
- removal of any groynes, buried pipes, wattle works, fascines and the like which might interfere with the excavation profiles, irrespective of whether or not such structures are specified
- removal of loose earth at excavation bottoms and for fill concrete.

16.11.8. Disposal of Excavated Material

Excavated material suitable and approved for use as filling material shall be deposited as directed by the Employer's Representative. The Contractor shall dispose of surplus or material unsuitable for use as filling; no additional payment shall be allowed for this work.

16.11.9. Filling and Reinstatement

Filling shall be approved selected material from excavation of predominantly granular material, free from slurry, muddy, organic or other unsuitable matter, and shall withstand compaction by ordinary means. Filling in trenches and around foundations shall be placed in 15 cm layers and compacted at optimum moisture content by mechanical means where possible. Brackish water may be used for this purpose. Filling around pipes and cables shall be carefully placed fine material to cover the pipe or cable completely before the normal filling is placed. All filled areas shall be left neat, smooth and well compacted, the top surface comprising normal site surface soil, unless otherwise directed. The Contractor shall be responsible for the reinstatement of any surfaces or structures which may move or otherwise be affected by settlement of backfill.

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

The whole of the excavations shall be carried out to the widths, lengths and depths shown on the approved drawings. No unlicensed or indiscriminate digging will be permitted.

Whereas Employer acquired plot might be bigger than Substation site requirement, the Contractor shall only use the Substation site as will be in the approved Substation layout drawing, use of land outside this area will require Employer approval.

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

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

The bottom of all excavated areas shall be trimmed, levelled and well rammed. Concrete shall not be deposited thereon until the bottom has been inspected and approved by the Employer. All excavation works are to be kept dry and clean, in order that work is not affected or interfered with by water entering the excavations.

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

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

- a) Civil Engineering Code of Practice No.2 on Earth Retaining Structures, Issued by Institute of Structural Engineers
- b) BS 8002:1994 Earth retaining structures and any other applicable equivalent standard

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

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

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

16.11.10. Explosives

Written approval shall be obtained from the Engineer for each location or series of locations before explosives are used for excavating foundations in rock. Such approval shall not in any way relieve the Contractor of his liabilities under the Conditions of Contract. The Contractor shall be responsible for complying with local regulations concerning the use of explosives and for the safekeeping and handling of explosives. Proper warning shall be given of all blasting operations. During operations involving the handling or use of explosives, the Contractor shall be responsible for the safety of personnel, animals, Site Works and people or properties in the vicinity of the Site. The Contractor shall make good at his own expense any damage caused by the use or mishandling of explosives. No blasting is permitted near permanent work or dwellings. The Contractor shall store explosives in a licensed store or magazine provided with a separate compartment for detonators. Explosives shall be used in the quantities and manner recommended by the manufacturers. Special care shall be taken when blasting in wet ground to ensure that individual explosions are reduced to such a size as to preclude damage to any buildings or structures.

16.12. Concrete and Reinforced Concrete Works

16.12.1. General

All concrete and reinforced concrete works under this section are generally to be carried out in line with as further detailed below.

16.12.2. Auxiliary Works

All and any kind of work, material, services, safety measures, etc., as well as, and if so requested by the Employer's Representative, all tests and samples required for the completion of concrete works shall be included in the tender but are not necessarily limited to the following:

- measurements for the execution and payment of the work, including provision of the measuring equipment, gauges, marking-out pegs, etc., the maintenance of the gauges and marking out pegs during building construction, and the engagement of labour
- connection of water, gas and electricity from the mains on the site to the points of use indicated by the Employer's Representative
- provision of small equipment and tools
- transport of all material and building components, even if ordered by the Employer's Representative, from the stores on site to the points of use, and possible return transport
- supply of all required materials
- securing the work against surface water, which must normally be reckoned with, and its removal grouting of precast concrete units insofar as building in of precast concrete units appertain to the labour of the Contractor

- raking out of slots, small openings and the like, insofar as this is provided for in the Tender Specifications according to type, size, and number of the rakings out, and the details are notified in good time
- Provision of scaffolding for the common use of other Contractors, as well as covers and enclosures of openings, up to three weeks beyond the Contractor's own period of use or as otherwise directed by the Employer's Representative. Conclusion of the Contractor's own use shall be notified to the Employer/Employer's Representative in writing without delay.
- protection of the placed concrete against heat, wind, cold, chemical attack, vibration, and drying outwork of proofing the quality of the building material and of the concrete in accordance with all of the requirements of the Tender Specifications
- test loads according to standards and as laid down in this chapter if the contractual quality of the work cannot be proven by other methods
- removal of all pollution resulting from the Contractor's work, and of the Contractor's debris
- protection of the completed works and the articles handed over for construction against damage and theft until acceptance
- arrangement of any kind of joints required
- fixing of embedded parts in proper position, material supplied by the Contractor and/or others
- provision of block outs, grooves, rabbets, recesses, openings, etc., in accordance with the working drawings and/or as directed by the Employer's Representative
- apparatus, equipment and tools required for testing.

The Contractor shall provide all materials and facilities and design, transport, place, finish, protect a cure concrete. He shall also construct, erect and dismantle forms. Non-reinforced or reinforced concrete shall be provided as required. Reinforced concrete shall be used at locations where foundations of non-reinforced concrete are inadequate to meet loading requirements and ground conditions.

16.12.3. Concreting Work Specification

16.12.3.1. Reference Standards

The reference standards for concreting works shall be as shown in *Table 5-3*.

Table 16-4 Reference Standards for Concreting Works

Item No	Standard	Date of Publication	Title
1.	BS 12	1989	Portland Cement (Ordinary and rapid hardening)
2.	BS 812		Methods for sampling and testing of mineral aggregates, sand and fillers
3.	BS 882	1983	Aggregates from natural source for concrete (including granolithic)
4.	BS 1881		Methods of testing concrete
5.	BS 5328	1981	Method of specifying concrete
6.	BS 2499	1973	Hot applied joint sealants for concrete pavements
7.	BS 3148	1980	Tests for making concrete
8.	BS 3921	1985	Clay bricks
9.	BS 4251	1974(1980)	Trunk type concrete mixers
10.	BS 4449	1988	Carbon steel bars for the reinforcement of concrete
11.	BS 4466	1981	Bending dimensions and scheduling of bars for the reinforcement of concrete (old edition)
12.	BS 4483	1985	Steel fabric for the reinforcement of concrete
13.	BS 5075		Concrete Admixture
14.	BS 6073:Pt 1	1981	Precast concrete blocks
15.	BS 8810:Pt 1&2	1985	The structural use of concrete
16.	BS 5950		The use of structural steel in buildings
17.	BS 5400:Pt 5	1979	Steel, concrete and composite bridge
18.	BS 8007	1987	The structural use of concrete for retaining aqueous liquids
19.	BS 3110	1972	Safe use of cranes (cranes, tower cranes and derrick cranes)
20.	KS95	2003	Specification for Natural Aggregates for use in Concrete

16.12.4. Materials and Specifications

16.12.4.1. Concrete Quality

Unless otherwise approved, concrete for foundations and for encasing concrete shall be to Design Mix Grade C25 to BS 5328 (BS EN 206-1 AND BS 85 00).

All cement used shall be of Portland or other approved composition obtained from an approved maker. Portland cement shall conform in all respects to BS 12 (BS EN 197-1). Where Portland

cement concrete may be liable to chemical attack sulphate resistant cement to BS 4027 may be used where approved . Cement shall be stored in an approved manner.

Concrete shall be composed of Portland cement, water, fine and coarse aggregate, and, when approved or directed by the Employer's Representative, set-accelerating admixtures. The design of concrete mixtures will be based on securing a plastic, workable mixture suitable for the specific conditions at placement and when properly cured, a product having durability, impermeability and strength in accordance with foundation requirements.

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

Table 16-5 Minimum Crushing Strengths

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

The average strength obtained from cube tests shall be 10 per cent higher than the Strength shown above. Subject to design the minimum grade for structural concrete shall be Grade 25, Grade 15 will be allowed for blinding concrete, precast concrete minimum grade shall be Grade 30

At least four weeks before commencing any concreting work; the Contractor shall make trial mixes using samples of cement and fine and coarse aggregates. The test specimens for the trial mixes shall be of cube type. Preliminary test specimens shall be taken from the proposed mixes as follows:

For each proposed mix a set of 6 specimens shall be made from each of 3 consecutive batches. Three from each set of six shall be tested at an age of seven (7) days and three (3) at an age of 28 days. The test shall be carried out in a certified approved laboratory after which the report will be presented to the Client. The report shall include proportions of cement, fine and coarse aggregate, and water, the maximum and minimum slump and the target strength for each grade. Cost of mix designs shall be borne by the Contractor.

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

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

16.12.4.2. Portland cement

All cement shall be Portland composition obtained from an approved maker. Portland cement shall conform in all respects to Standards BS 12: Special cement or equivalent standards. Where Portland cement concrete may be liable to chemical attack, high resistant cement concrete may be used when approved by the Employer's Representative.

16.12.4.3. Aggregate

All aggregates shall consist of hard, tough, durable and un-coated particles. The Contractor shall select the sources of aggregates, and the aggregate sources shall be approved by the Employer and/or Employer's Representative. The aggregates shall be clean and free of clay, earth, organic matter, salt or other impurities and shall comply generally with the requirements of Standard BS 812

Fine aggregate, washed and free of clay, shall be either well graded natural sand or well graded manufactured sand from 4 mm gauge downwards. No seashore sand shall be used.

Coarse aggregate, washed and free of clay, shall consist of crushed stone, gravel or other approved inert materials with similar characteristics or a combination thereof and shall pass a mesh of not less than 5 mm square and of not more than 40 mm square subject to KS 95:2003. Where specially approved in writing by the Employer, coarse aggregate of uniform size not larger than will pass a 25mm mesh may be used throughout.

Laterite aggregates are not allowed.

16.12.4.4. Steel Reinforcement

Reinforcing bars shall be structural grade steel and shall comply with BS 4449 equivalent standards. They shall be free of loose, flaky, rust and scale and of oil, grease, mud, concrete or other coating, which might destroy or reduce its bond with concrete. Bends, cranks and over lappings on reinforcing bars shall be carefully formed in exact accordance with the appropriate standard, and as shown on the approved drawings. Deformed bars of high tensile steel may be used if approved by the Employer's Representative or if shown on the approved drawings.

The steel reinforcement shall be so connected as to form a rigid cage or mat. To prevent displacement before or during concreting, the bars shall be secured one to the other with 18-gauge soft iron wire. Sufficient precast rings or distance blocks shall be used between the reinforcement and the bottom and sides of the excavations to ensure the correct cover of concrete around the bars. The distance blocks shall be made of concrete of not less strength than that of the concrete in which they occur. The foundation reinforcement shall be bonded to the tower stub with 7/4 mm galvanized steel wire strand before concreting. Steel rod reinforcement shall be bent cold in a manner that will not injure the material. Bending hot at a cherry red heat (i.e. not exceeding 840°C) may be allowed except for bars that depend for their strength on cold working. Bars bent hot shall not be cooled by quenching. Bends, cranks or other operations on reinforcing bars shall be in accordance with approved drawings. Where splices or overlapping in reinforcement are required the bars shall unless otherwise approved have an overlap as specified in BS 8110.

16.12.4.5. Water

Water used in mixing concrete shall be clean and free from harmful amounts of rock flour, sewage, oil, acid, alkalis, salts, organic matter oil acid and alkaline substances either in solution or in suspensions. It shall be chemically neutral. Quality shall be confirmed by lab test.

16.12.4.6. Forms

The Contractor shall construct, erect, and maintain all appropriate forms necessary to confine the concrete within the lines and grades shown on the drawings. Form surfaces shall be thoroughly cleaned before erection to be left smooth and free from sawdust, dirt, rust, and foreign matter. Forms shall be left in place until the concrete has gained sufficient strength to support its own weight and any loads imposed thereon, but form removal shall be made as soon as practicable to avoid delay incurring and repairs of surface imperfections.

16.12.4.7. Foundation Preparation

The preparation of all base surfaces shall be properly completed before concrete is placed. Rock surfaces shall be worked clean of all loose particles, mud, debris, and other material not an integral part of the base rock, using water jets, air and water jets, sand blast or other means. Surfaces shall be thoroughly moistened before concreting. Surfaces of parts to be embedded shall be free from dirt, dried mortar, grout, grease, oil or other substance which would interfere with the bond.

16.12.4.8. Proportioning of Concrete

The quantities of cement, aggregates and water shall be proportioned that when combined and mixed, they will produce concrete of uniform consistency and characteristics to meet adequately the strength and finish requirements. The proportions shall be adjusted whenever such change is necessary in order to maintain the standard quality required by these Specifications.

16.12.4.9. Batching and Mixing

Cement shall be measured by weight, either by use of one or more complete bags or by weighing on site. Other ingredients shall be measured by weight or by volume. All concrete shall be thoroughly mixed in a mechanical batch mixer of approved type and size, and one so designed as to ensure a positively uniform distribution of all the component materials throughout the mass during the mixing operation. This will be mixed with only sufficient water to ensure a workable mix.

Consistency tests shall be made when required by the Engineer by checking the maximum slump in a truncated cone 300 mm high and of standard dimensions. No concrete shall be mixed or placed when the temperature of the air or the ingredients is less than 2°C nor shall concrete be placed when its temperature is greater than 32°C. In hot conditions the initial temperature of the mix should be kept as low as possible, by shading the materials against the sun. Retarding admixtures may be used subject to the Engineer's approval. Freshly placed concrete shall be properly protected against the weather.

Test cubes of 150 mm face in accordance with BS 1881 shall be made during the progress of the works, comprising a minimum of one set of four cubes per foundation.

16.12.4.10. Conveying, Placing and Curing

Only methods of transporting and placing, which will prevent segregation or loss of ingredients and deliver concrete of the proper consistency, will be permitted. Concrete shall be placed before the cement takes its initial set or within 30 minutes from the original mixing times, whichever is sooner. There shall be no vertical drop of concrete mix greater than 1.5 m, except where suitable equipment is provided to prevent segregation and where this is specifically authorized. Concrete shall be worked readily into the corners and angles of the forms and around all reinforcement and embedded items without permitting the component concrete materials to segregate. Concrete shall be placed with the aid of mechanical vibrating equipment and supplemented by hand spading and tamping. The concrete shall be vibrated or thoroughly rammed during placing to ensure that it is homogeneous and free from voids. Excessive vibration shall be avoided.

All concrete shall be cured by use of a membrane curing compound or by keeping the concrete continuously wet for a period of not less than 14 days by methods approved by the Employer's Representative. After curing the foundations shall be air-dried for a period of 14 days.

The upper surface of the concrete for all types of foundations shall be made by a continuous pour of foundation concrete and shall be sloped in an approved manner to prevent accumulation of water.

Unless otherwise approved, there shall be no joints in the concrete foundation. Where the construction of the foundation is such that joints are unavoidable adequate bond between the old and new concrete shall be ensured by chipping the old concrete to a rough, clean surface free from loose particles. Immediately before placing the new concrete, this cleaned surface shall be primed with a layer approximately 15 mm thick of a wet mix of cement and fine sand in equal proportions. Particular attention shall be paid to the need to ensure complete curing of all concrete and the Contractor shall supply information in his method statement relating to his proposed methods for curing and for protecting the concrete. Curing and protection shall start immediately after the compaction of the concrete and shall ensure adequate protection from:

- premature drying out, particularly by solar radiation and wind
- leaching out by rain and flowing water
- rapid cooling during the first few days after placing
- high internal thermal gradients
- low temperature or frost
- vibration and impact which could disrupt the concrete and interfere with its bond to the reinforcement.

16.12.4.11. Concreting under Extreme Weather Conditions

Concreting under extreme weather conditions shall be referred to **Hot Weather** For the purpose of these Specifications, hot weather shall be defined as any combination of high air temperature, low relative humidity, rain, drying wind, running or surface water and shock and wind velocity which tends to impair the quality of new or hardened concrete, or otherwise result in abnormal properties. In hot weather and in places where the ambient shade temperature exceeds 30°C, the Contractor shall take special measures in mixing, placing and curing of concrete. These shall be such as to ensure that the temperature of the concrete during mixing, transporting, placing, setting and curing shall not exceed 30°C. Care shall be taken to protect all stored materials from the harmful effects of hot weather. Silos, mixers and water tanks being painted white. Cement shall be stored in watertight silos free from internal condensation, or as otherwise approved by the Employer's Representative, and shall have a temperature not higher than 77°C. Aggregate stockpiles shall be shaded, carefully sprinkled or fog sprayed to maintain constant surface moisture content. Additional water shall not be added to the mix to improve workability without the Employer's Representative's permission.

16.12.4.12. Piling and Other Special works.

Piling will be carried out using an approved procedure throughout. The actual length and numbers of piles required at any location will be approved by the Employer on the basis of the final agreed design data; and payment made for departures from the assumed tender design quantities on the basis of the difference of quantities times the schedule variation rates. Tender Prices shall include for all necessary casings, pumping, depreciation of piling machines, materials, transportation and others.

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

Where ordered by the Employer, the contractor shall carry out pile bearing and uplift test for all types of pile generally in accordance with the method given in the EN-61773 BS. Such tests shall be carried out to determine the ultimate uplift and bearing values.

Following special requirement shall additionally be considered:

(I) Construction Joints

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

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

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

(II) Construction Bays

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

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

In the light of experience the Employer may consider the above pour size limits to be excessive and will have the authority to reduce them. Expansion joints shall be fully detailed on construction drawings for approval. Expansion joints shall be filled with bitumen-impregnated fibreboard to full depth and width. The infilling will be permitted to be used as permanent formwork only for the second casting. Where the fibreboard is exposed it shall be cutback for a depth of at least 2cm from the chambered edge, filled and pointed with a resilient liquid polysulfide polymer sealant to the manufacturer's instructions.

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

(III) Formwork

All, "forms, false work or shuttering" shall include all temporary moulds forming the concrete to the required to correctly shape and size together with any special lining that may be required to produce the concrete finish specified and ensure no loss of aggregate or cement. All formworks shall be sufficiently strong to withstand the pressure arising from the concrete during compaction and shall be capable of removal without undue disturbance to the concrete.

Formers may consist either of steel, timber or plywood elements. All timber for formwork, false work and centering shall be sound wood, well-seasoned and free from loose knots, shakes, large cracks, warping and other defects.

The faces of the formers that are in contact with the concrete shall be cleaned and oiled or coated to prevent any concrete adherence to them and to facilitate their removal.. Formers shall not be removed before sufficient hardening of the cast-in concrete has taken place and in no case less than 24 hours after the concrete has been placed. Any concrete that has been damaged during formwork removal or is honeycombed must be removed by chipping to sound concrete and then repaired at the Contractor's expense and to the Engineer's approval..

Before and after use on the work, it shall be properly stacked and protected from injury from any source. Any timber which becomes badly warped or cracked prior to the placing of concrete shall be rejected.

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

Struts and props shall, where required by the Employer, be fitted with double hardwood wedges or other approved devices so that the moulds may be adjusted as required and eased gradually

when required. Wedges shall be spiked in to position and any adjusting devices locked before the concrete is cast.

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

All formwork shall be approved by the Employer before concrete is placed within it. The contractor shall if required by the Employer provide the latter with copies of his calculations of strength and stability of the formwork or false work but notwithstanding the Employer's approval of these calculations, nothing shall relieve the contractor of his responsibilities for the safety or adequacy of the formwork.

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

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

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

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

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

When concrete is to be deposited to a steeper slope than 45 deg. to the horizontal, top forms shall be used to enable the concrete to be properly compacted. Forms in position during placing of concrete will not be permitted. Tie bolts and clamps shall be positive in action and of sufficient strength and number to prevent spreading or springing of the forms. They shall be of such type that no metal part shall be left within the specified concrete.

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

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

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

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

Only approved chemical release agents, mould creams (emulsions of water in oil) or oils containing a proportion of surfactant not exceeding 2% will be permitted. Water-soluble emulsion and oils without surfactant shall not be used. Oil based release agents shall be applied at a ratio of 7m²/litre, 24 hours in advance of concreting, preferably by spray or roller. Chemical release agents shall be applied in accordance with the manufacturer's recommendations.

The greatest care must be taken that all sawdust shavings, chips and debris is removed from the formwork before concrete is placed in position and the necessary arrangements must be made by leaving out a board in the bottom of the formwork or otherwise required.

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

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

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

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

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

Table 16-6 Permitted Striking Times

Forms	Ordinary Portland Cement (Days -24hours)	Rapid Hardening Cement (Days-24hours)
Walls, Columns (unloaded Beam sides)	2	2
Slabs – props left under	7	2
Beams soffits – props left under	14	5
Slabs – props	14	5
Beams – props	18	8

The time for removal of forms as set out shall not apply to slabs and beams spanning more than 10 metres. For such spans appropriate times shall be recommended or advised by the Employer. The periods given above are based on the removal of all props and formwork using ordinary Portland Cement under average weather conditions. Adverse weather conditions or different cement may cause the above periods to be increased. Should the contractor wish to make use of reduced striking time then he must satisfy the Employer that the strength of the concrete at such time and the structural system is adequate to withstand the dead and imposed loads applied to it. Before making use of reduced striking times the Employer's agreement must be obtained in writing.

16.12.4.13. Requirements for Sub- and Super-Structural Work of Substations

Concrete and reinforced concrete for the sub- and super-structural work shall be designed and constructed in accordance with BS 5328 (BS EN 206-1 AND BS 85 00)., the Contractor's statistical analysis and be performed according to the drawings designed by the Contractor and approved by the Employer's Representative. Concrete and reinforced concrete shall be placed either in-situ or in prefabricated units. The minimum requirements for sub- and super-structural work are indicated in the following table:

Table 16-7 Minimum Requirements for Sub and Super structural Work

Lean Concrete (blinding)	C15 as per DIN 1045
Beams, slabs, columns, walls, etc.:	C25 as per DIN 1045
Prefabricated units	C30 as per DIN 1045
Minimum Concrete cover	
Slabs (internal / external)	25 mm / 35 mm
Internal columns and beams	35 mm
Walls, external columns and beams	40 mm
Concrete subject to aggressive* conditions, concrete for liquid structures, and concrete in touch with soil or backfilled	50 mm
Cast-in-situ piles	75 mm
Reinforcement Yield point: 420 N/mm ²	Tensile strength: 50 N/mm
Cement for super-structural work	Type I conforming to ASTM C 150

16.12.4.14. Precast Concrete Covers

The construction of precast concrete covers and the arrangement of recesses for handling shall be approved by the Employer's Representative. The precast trench covers shall be made of concrete B35 as specified above. A wheel load of 30kN has to be considered. The covers shall be protected on all sides by means of hot dip galvanised angle profiles, and to be provided with adequate handles/each to allow easy handling. When placed in position, the covers shall be good in level and matching the formed surface of the floor.

16.12.4.15. Cement Screed

Concrete floors, which are required to be surfaced with screed, shall have a roughened surface, produced by hacking and wire brushing. The roughened concrete floor shall be cleaned, wetted preferably overnight, the surplus water removed and 1:1 cement/sand grout brushed into the surface, keeping just ahead of the screeded bed. The screeded bed shall be 40mm thick and shall be well compacted and levelled. At the wall sides and around the columns, expansion joints shall be provided. Joint filler of bituminous mineral wool 10 mm thick sealed with cold-poured, high duty seal shall be used for such joints.

If the screed is the finished surface, it should be treated with an approved silicate of soda solution hardener to prevent dusting. The screed shall be mixed in the proportions of 1:2:4 (cement, sand, and 10mm-pea shingle) by volume with the minimum quantity of water.

All screed shall be mixed in a power driven mixer in quantities for the work immediately in hand. No partly set screed shall be used. The screed shall be spread on the moistened floor, evened by straight-edge and shot by use of vibration plate.

Non-abrasive additives shall not be used if floor covering is applied. Until the screed has stiffened, the surface shall receive a fine steel float finish. The screed batten shall be fixed to true lines and levels. The

bay sizes shall not exceed 15 square meters and the length of any one bay shall be limited to 1.5 times the width, or as advised by the Employer's Representative. The bays shall be laid alternately, ie. in chequerboard fashion, a minimum of 24 hours being allowed to elapse between the laying of adjacent bays. The bays shall be separated by strips of hard plastic or other suitable material. Screeded beds shall be cured for at least seven days, using polythene sheeting or other approved method. Floor finish shall be terrazzo, granito tiles and ceramic tiles mixture as approved. Thickness of joint shall be minimum 1.0 cm and shall be sealed by permanent sealing compound approved by the Employer's Representative. The screed shall be kept moist for a minimum of 7 days, and shall be protected by approved methods.

Minimum screed quality required:

- cement Type I as per ASTM C 150 or equivalent DIN
- sand shall comply with BS 1200 or equivalent DIN
- water potable water
- thickness of screed 60 mm
- sealing compound fire resistant, non-shrink.

16.13. Structural Steel

16.13.1. Quality of Materials and Workmanship

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

B.S 4 (part 1) Hot Rolled Sections

B.S 4 (part 2) Hot Rolled Hollow Sections

B.S 449 The use of Structural Steel in Buildings

B.S 638 Arc welding plant equipment and accessories

B.S 639 Covered Electrodes for manual Metal Arch
Welding of Mild Steel and Medium tensile steel

B.S 916 Black Bolts, Screws and Nuts

B.S 1449 Steel plate, sheet and strip

B.S 1775 Steel Tubes for mechanical, structural and General Engineering Purposes

B.S 2994 Cold rolled Steel Sections

B.S 4190 ISO metric black hexagon bolts, screws and nuts

B.S 4320 Metal washers for general engineering purposes

B.S 4360 Weldable structural steel

B.S 4848 Hot rolled structural steel sections

B.S 4872 Approved testing of welds when welding Procedures approval is not required

B.S 5135 General requirements for the Metal Arc Welding of Structural steel

B.S 5493 Protection of iron and steel structures from corrosion

BS 729 Specification for hot dip galvanized coatings on iron and steel.

16.13.2. Tolerances

All members shall be fabricated with a tolerance in length of + 0mm and -3 mm, all shall not deviate from straightness by more than 1 in 400. The allowance for angular twist shall be $(3 + 0.6L)$ in the length of the member under consideration in metres. Twist shall be measured by placing the member as fabricated against a flat surface measuring the differences between the two corners of the opposite end. The above tolerances shall be adhered to unless otherwise specified in the Contract.

All metals and metal work components whether fabricated on or offsite shall conform to the requirements of the relevant British Standards and other standards to the approval by the Employer. Metalwork articles shall have a first class finish, and be free from scale, rust, damage or other defects. Components shall be properly assembled and joined in a neat and functional manner. Welded connections shall be ground off as necessary to present a clean smooth finish without detriment to the strength of the connection. Particular attention shall be given to the protection of metalwork from degradation caused by the environment in which it is to be used. This shall be accomplished by galvanizing, surface coating or such other treatment suitable for the metalwork under consideration.

I. Mild Steel

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

II. Copper

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

III. Zinc

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

IV. Aluminum Sheeting

Aluminum for profiled roof sheeting and flashing shall be manufactured from alloy in hard temper conforming to BS 1470 Ns3 Specification not less than 0.7 mm thickness and with a colour coated surface finish. Profiled sheeting shall conform to BS CP 5427. Fastenings shall be by means of aluminum hook bolts or other approved fixes in accordance with BS CP 143 Part 1 and recommendations of the manufacturer. Laps shall be sealed as necessary.

V. Galvanizing

Where steel members are specified to be galvanized they shall be so treated after all cutting, drilling, punching and removal of burrs has been carried out. Galvanizing shall be applied by the hot dip process and shall consist of a coating of zinc weighing not less than 610 g/sq .m of surface. The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanizing itself shall not adversely affect the mechanical properties of the steel. The testing of the zinc coating on galvanized articles shall be carried out in accordance with BS 729.

16.13.3. Steel External Doors

Steel external doors shall be fabricated from steel sheet covering a framework of steel angles and galvanized after fabrication. Door frames shall also be galvanized steel. All external doors shall be insulated and fitted with panic latches, which are lockable from outside. External doors shall be effectively sealed to reduce the ingress of dust as far as practicable, using heavy duty seals which shall be guaranteed for a minimum period of five years from date of commissioning. Doors and seals shall be designed so that replacement of worn seals can be achieved easily on site.

16.13.4. Workmanship

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

16.14. Block Work

16.14.1. Cement

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

16.14.2. Sands and Aggregates

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

16.14.3. Lime

Lime for mortar shall be hydrated gray-stone lime in accordance with BS 890 for hydrated calcium limes. Magnesia lime shall both be used in mortar for brickwork below the damp-proof course. The Contractor shall forward copies of Manufacturers certificates to the Employer, which in addition to certifying compliance with BS 890 shall give details of the type of lime. If lime is delivered as lime putty, the certificate shall state whether quicklime or hydrated lime was used in its manufacture. All lime shall be efficiently protected against deterioration during transport and whilst stored on site. Different type or brands of lime shall be stored separately in dry conditions in a manner that allows it to be used in the order of delivery. When lime putty is to be used the Contractor shall obtain the approval of the Employer of his arrangement for transport handling and storage. Precautions shall be taken to prevent contamination and drying out of lime putty stored on site. Lime putty made from quicklime should mature for at least 14 days before being used. Where it is made from hydrated lime (powder), lime putty should stand for at least sixteen hours before use.

16.14.4. Concrete Blocks

Concrete blocks (if used) shall be solid or hollow blocks to comply with the relevant standard as previously mentioned and shall be solid hard, true to size and shape and sharp arises in accordance with Ministry of Works Standard Specification for Metric sized concrete block for building dated September, 1972. They shall be obtained from an approved manufacturer or manufactured on site in approved block making machines. The mix used shall be less than (1:9) by volume and maximum size of aggregate shall be 12mm size. The blocks on removal from the machine shall be laid

on edge or racks under sheds erected by the Contractor and left for 3 days during which period they shall be kept constantly wet.

After this initial period they shall be placed on edge in the open racks and protected by sacking or other approved covering and kept wet for further 5 days. Thereafter the blocks shall be left in the same position without wetting for a further 20 days. No blocks shall be used in the works until 28 days old and until samples have been tested approved by the Employer. The Contractor shall ensure that the blocks are stocked separately in their respective categories in the structure in the position shown on the drawings. Any stone for walling shall be good hard local stone equal in standard and quality. Stone shall be squared, dressed and joints chisel dressed on the face. Stone to receive render, shall be so dressed to reduce dubbing-out to a minimum.

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

16.14.5. Block Laying

All blocks shall be kept completely filled with mortar. The thickness of the horizontal mortar joints shall not exceed 40mm to every four joints. Where block work is to be plastered or rendered, joints shall be struck off and left rough to provide a key. Movement joints shall be provided where required. They shall incorporate a joint filling strip and sealant Gaps in movement joints shall be left free from debris and shall not be pointed with mortar. Block work shall be built with three courses to 600 mm in a uniform manner, in truly level courses and truly vertical or battered. Corners and other advanced work shall be racked back and not raised above the general level more than one meter. Tothing shall be used only where provision has to be made for a future extension. Both leaves of cavity shall be built up simultaneously. Galvanized flat twist wall ties of an approved pattern shall be bedded with a slight fall towards the outer face and shall be provided in alternate courses at intervals of 900mm and staggered horizontally. Additional ties shall be used near the sides of all openings at the rate of one for each 300mm of opening height. The cavity shall be kept clear of mortar droppings and rubbish, and the inside mortar joints shall be finished flush as the work proceeds. Cavities shall be 50-75 mm in width. Both holes shall be built into the external skin of cavity walls in the form of sand filled vertical joints at 1m centres and are to be racked out on completion. Weep holes shall be laced over all lintels or to her significant obstructions to the cavity. Walls shall be constructed with an approved metal reinforcement every second course. Additional horizontal reinforcement shall be provided in bed joints in walls for each 2 courses above and below all openings greater than 300mm wide. The reinforcement shall extend a minimum of 900mm beyond the opening on both sides.

Below ground level and at the jambs of all openings, the hollow concrete blocks shall be filled with weak concrete, well taped down and carried from base slab to top of such openings. Cavities shall be kept clear of mortar droppings or other debris, by the use of lifting battens or other suitable means. Where external block work abuts concrete surfaces and where indicated elsewhere, the blocks shall be tied to the concrete every second course with adjustable galvanized steel ties fixed in slots cast into the concrete. Concrete abutting external block work shall be coated with two coats of bitumen paint. Holes and chases shall be cut out or left in the walls as required and provision shall be made for making good to the satisfaction of the Employer. On completion, all block work shall be cleaned down and mortar dropping and other marks removed. Defective blocks or workmanship shall be made good.

16.14.6. Reinforcement

When required, vertical reinforcement for hollow concrete blocks shall be high yield deformed steel conforming to BS 4449 requirements. The minimum to be provided shall be 10mm diameter bars at 150mm centres. Lap lengths for vertical reinforcement shall be a minimum of 50 diameters. Horizontal bed joint reinforcement shall be made from hard drawn steel wire to BS4482 consisting of two wires with diameter a minimum of 5 mm and separated by cross wires welded at 304-mm centers. The main wires shall be at 50 mm centers and 160mm centers for 100 and 200mm block work respectively. Alternatively, approved expanded mesh reinforcement may be used.

16.14.7. Lintels

The block work over all openings in walls shall be supported on reinforced concrete grade 25 lintels. All lintels shall be the same width as the block work into which they are being built.

16.15. General Construction Features

The reinforced concrete framed structure control buildings will be completed with control and relay room, communications equipment room, office with attached coffee room, washroom, drainage infiltration tanks, septic tank, water supply with minimum head 3m tower tank and ground storage tank with pumping boost. Walls and partitions shall be dressed stone masonry with minimum compressive strength of 12N/mm². Control building floor layout shall be approved by the employer before detailed drawings production. All walls and roofs shall be fully insulated, to produce maximum thermal transmittance (U) values of 1.14 (watts/m².) for walls and 0.57 for roofs. Architectural treatment of the buildings shall be in accordance with the Employer's usual standard or preference. The buildings will have been designed with ease of operation and maintenance as a major factor. Materials, workmanship and finish must be of an appropriately high standard. In considering the various materials, details, and construction methods, Contractors must investigate the availability, delivery and transportation to the sites of all materials, plant, and labour, to enable the programme to be maintained. Internal partition walls shall be generally for concrete block work with emulsion painted smooth plastered finish. The equipment areas shall have screed floors finished with a surface hardener. All finishes shall be fireproof or flame retarding. Floor finished shall be sand-cement screed throughout. Room heights shall be governed by the criteria that there should be 1-meter clearance between the top of cubicles or panels and ceilings. Particularly, attention must be given in the design of the buildings to fire prevention and safety of the personnel at all times. A number of opening lights shall be provided in all rooms, including air-conditioned rooms.

The general construction features for all buildings of the substation project (new substation and extensions as far as concerned) shall be as follows:

16.15.1. Foundations

Foundations shall normally be designed as slab foundations. However, if required by the structural analysis, alternative foundations, e.g. cast-in-situ piles, may be proposed. All concrete in touch with soil and foundation concrete below and 25cm above ground, as well as concrete in contact with organic matter, water or aggressive substances, shall be provided with an approved coating of either triple bitumen or coal tar epoxy before installation and backfill.

16.15.2. Damp Proof Course (DPC)

A damp proof course shall be laid in walls, above ground level so as to exclude rising moisture. Damp-proof course to be applied shall first be approved by the Employer prior to purchase or delivery to site.

16.15.3. Damp-Proof Membrane

An approved bitumen/PVC waterproof membrane shall be placed on the blinding under concrete floor slabs, to exclude rising moisture. The membrane shall be taken up walls and lapped with the wall DPC. All floor finishes shall be protected from damage by following trades and other causes and any damage, howsoever caused, shall be made good by the Contractor at his own expense to the satisfaction of the Employer.

16.15.4. Structures

The telecom hub building shall normally be constructed as reinforced concrete skeleton structure, consisting of columns, beams, slabs, and - at some parts – masonry stone.

16.15.5. Building in Frames

Openings in masonry for doors, windows, air conditioning units ventilators and fans etc. shall be properly marked out and built in as the work proceeds with approved anchors. The fittings shall be propped and strutted where required. The back surface of steel and galvanized fittings shall be coated with a bituminous paint before fixing. All fittings shall be bedded in 1:3 sand cement mortar 12mm thick. Precautions during Inclement Weather Newly laid masonry work shall be protected from the harmful effects of sunshine, rain, drying wind, running or surface water and shocks. Any work that may be damaged shall be taken out and pointed as directed by the Employer. Any costs incurred in carrying out such remedial work shall be borne by the Contractor.

16.15.6. Walls

All outside walls shall be masonry wall keyed to finish. Interior partition walls shall be made either of approximately 10 cm thick aerated concrete blocks, or fair faced cast in situ or precast panels. Calcium silicate block work, as well as locally manufactured concrete blocks or clay bricks may also be used after Employer's Representative's approval.

16.15.7. Roofs

Flat Roofs and Hipped Roofs

A so called "upside-down" roof with the below listed build-up (bottom to top) shall be provided for all concrete roof slabs:

- roof slab
- light weight concrete screed, sufficiently sloped
- water proofing membrane, to be at least 4 mm thick, placed in two (2) layers, of tropical grade, bituminous felt, reinforced with 180 g/m²., with a non-woven polyester inlay
- thermal insulation of extruded closed cell polystyrene boards, 50 mm thick with 32 kg/m³ density, a minimum compressive strength of 250 kN, and thermal conductivity of less than 0.030 W/mK (at 24°C mean temperature).
- separation layer, of polyester fabric separation layer to be placed between the insulation boards and the covering tiles or gravel and tiles or gravel covering

16.15.8. Ceilings

The roof of the Telecom Hub building shall be a reinforced concrete slab. This shall be fitted with a false ceiling comprising of fire retardant material.

16.15.9. Floors

Floors shall be made of cement screed. The surface of floors exposed to extremely heavy wear and tear shall be improved by additives against abrasion and shall receive a plastic based (two components) paint finish or shall be covered with PVC - tiles. Terrazzo tiling instead of screed is also acceptable.

16.15.10. Windows

All windows shall be made of aluminium profiles with double or single glazing, as indicated on drawings. All windows shall be dustproof.

16.15.11. Doors

All escape doors shall be of double walled steel. Access doors and escape doors shall be provided and fitted with panic bolts where necessary, so that operating and maintenance staff can always exit safely from the buildings in fire emergencies of any nature or location. All doors must be of fireproof design (at least protection class F90).

16.15.12. Cable Channels and Pipe Ducts

For the accommodation of interconnecting cables and pipes leading from and into the different station buildings across roads, cable channels have to be installed. They shall be made of a concrete bottom and two concrete walls covered with a precast concrete slab. The precast concrete slab cover will be design for the maximum likely imposed load appropriate to their location. In general, a waterproof construction with water stop ribbons at the joints has to be provided. The outside of the joints shall be closed with plastic filler. A sufficient number of pipes have to be laid below the roads around, respectively in front of the substation ending outside the perimeter wall in the public road to enable later cabling without any excavation inside the perimeter wall. All excavation work for pipes and cables to be laid directly in the ground for other Contractors' work has to be executed under this Contract. Cable entries into buildings shall be sealed to prevent the entry of dust, vermin, etc., using suitable materials.

16.15.13. Water Supply

The Contractor shall be responsible for the provision and installation of a water supply serving the station buildings with a water tank. Every cistern, sink, basin, etc. shall be provided with a stopcock in the supply pipe adjacent to the fittings. The water supply system for each site shall constitute an elevated tank with a capacity of 5m³. The tank shall be properly ventilated and fitted with an electric pump.

16.15.14. Sanitary Fittings

Wash hand basins shall be supported on cantilever brackets cut and pinned to the walls or screwed to 30mm timber chambered backboards, which shall be plugged and screwed to the walls. They shall be provided with 35mm bottle traps with brass cleaning eye and lining soldered on, or alternatively, a similar PVC fitting. Cistern supporting brackets shall be screwed to 30mm timber chambered backboards, which shall be plugged and screwed to the walls. Overflow pipes from WC cisterns shall be 20mm bore. Glazed ware shall be of best quality and type and manufacture approved by the Employer. Fittings shall be securely fixed in an approved manner. Cisterns shall be plastic wherever possible.

16.15.15. Earthing Installation

The described indoor and outdoor transformer foundations, cable ducts, etc. must be connected to the common earthing system as pointed out under elsewhere in this specification. A steel tape armouring at each crossing, lap welded at a length of about 20 mm, must be placed in all slab and concrete ceilings. Each column shall contain at least one rod welded-up to the lower and upper tape armouring. 30 cm above floor level, a rod of 16 mm shall protrude 20 cm from the concrete for connection to the earthing

system. Squares formed by the in-concrete earthing system shall not exceed 8 x 3.4 m. Protruding connection rods shall be painted red.

16.15.16. Painting and Decorating

Paints for priming, undercoat and finishing shall be ready mixed paints of the best quality for the intended use and comply with BS 6150. Paint for use on concrete or block work shall be of a type specially prepared for this purpose. All work shall be properly cleaned and rubbed won between each coat in a way, and using materials, recommended by the manufacturers of the paints concerned. No coat shall be commenced until the Employer has passed the previous coat a dry, hard and satisfactory. Each coat shall be of a distinct colour from the preceding one and all colours shall be approved by the Employer. Spray painting will not be permitted except for internal faces of walls and ceiling. All other paint shall be thoroughly brushed into and completely cover the surface. All timber required to be built into bedded or fixed against brickwork, masonry or concrete shall be given two priming coats and one undercoat on the concealed surfaces. All woodwork shall have knots treated with two coats of a knotting solution and then painted with aluminium priming paint prior to priming the complete surface. The wood shall then be primed, stopped and painted with two undercoats and one high gloss-finishing coat. Hard wood, which is not required to be painted, shall be made perfectly smooth, prepared and oiled twice with linseed oil. Alternatively, it shall be stained and wash polished, or treated with two coats of an approved varnish. Bitumastic painted surfaces and coated pipes shall be thoroughly cleaned to remove grease, dirt or other deleterious matter, and then painted with one coat of sealer, one coat of leafing aluminium, one coat of undercoating paint and one coat of high gloss finish. When so described or directed, internal surfaces of fair-faced block work, plastered walls and the soffits of concrete roofs shall be prepared and painted with one coat of ant suction primer, followed by one undercoat and two finishing coat of PVA based plastic emulsion paint. Exterior surfaces for fair faced block work walls and concrete columns at the new buildings shall be prepared and painted with two coats of an approved stone paint. At the completion of all works, the Contractor shall clean down the premises; wash paving and steps; wash and leather down wall tiling, etc. Clean all sanitary fittings; touch up paint work; examine all roofs and leave watertight; clean out all pipes and leave the whole of the premises in a clean, sound and perfect condition ready for immediate occupation.

16.15.17. Contractor's Site Facilities

The Contractor shall as a minimum provide for the use on site the following equipment.

- standard metal cube moulds as required
- compacting factor apparatus
- one kango hammer with tools for vibrating cubes
- one set of sieves for aggregates
- one set of scales (100 N)
- graduated measuring vessels
- concrete thermometer, maximum/maximum thermometer, water thermometer.

The cost of such labour, materials and transport which the Employer's Representative may require to assist him in carrying out tests and checks on material shall be included in the billed rates for the permanent work.

16.16. Fencing

16.16.1. Security Fencing

Security fencing where required shall be chain link gauge 8 or equivalent fences and shall be constructed in accordance with BS 1722, Part 10 and shall be of such manufacture that when any one segment is cut, remaining segments within the pattern retain their rigidity. Overall height of the fencing shall be 2.4metrs above ground level, excluding barbed wire. Posts of the fences shall be of steel structure with concrete block foundations. The perimeter fences shall be earthed independently of the main switchyard earthing with an adequate earthing rod at every 5 supporting posts of the fences. The posts shall have cranked tops set at 45o to the posts, to which shall be attached three stands of galvanized barbed wire to BS 4102. Barbed wires shall be strained between straining posts with eyebolts and fixed to intermediate posts with stirrup wires. Intermediate posts shall be provided at centres not exceeding 3 meters. Corner posts and struts shall be provided at all ends, corners, adjacent to gate posts and at intervals not exceeding 35 meters. All fence fittings shall be galvanized.

16.16.2. Gate

A gate where required shall comply with BS 1722, Part 10 and shall be constructed of galvanized chain link mesh on a galvanized extension arms. Separate man gate shall be provided beside the main gate. The gate shall be fitted with a vertical drop bolt on each leaf, a sliding bar lock with padlock eyes and a padlock to prevent movement of the sliding bar lock. All these fittings shall be galvanized. The vertical drop bolts are to drop into galvanized steel tubes cast into the road, to secure the gate when in both closed and open positions. Gateposts shall be made from galvanized steel RHS or tubular section shall be capped and set in concrete in the ground. Gate hinges (pivots) shall be heavily galvanized.

17. DESIGN & INSTALLATION REQUIREMENTS

17.1. General

All detailed design for construction shall be carried out by the Contractor and shall be submitted to the Employer for review and confirmation of compliance before commencement of procurement or construction. The designs shall be submitted at least 7days before commencement of the works.

This section describes Employer's requirements for design and installation of facilities to be supplied under Contract.

17.2. Design Requirements

17.2.1. Fiber Network Design Requirements

Contractor must offer standard products and designs. It should be noted that preliminary design information and quantities specified in the price schedule are indicative only. The Contractor shall verify the design data during the site survey and detailed engineering and finalize the Bill of Quantities (BoQ) as required for ultimate design and system performance.

Contractor's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for enquiries.

The scope of the work includes detailed survey during the Contract execution and the Contractor will be required to visit all sites. The site visit after Contract award shall include all necessary surveys to allow the contractor to perform the design and implementation.

The scope of fiber optic network design will also including planning for the links from the existing junction boxes to the ODF in the proposed telecom hub building. The Contractor will be required to submit design calculations.

17.2.2. Building Services

The building shall be designed to last a lifetime of at least 50years. The Contractor will be expected to carry out and submit the following designs for the review by the Employer:

- a) Preliminary design
- b) Architectural design
- c) Civil/Structural design
- d) Electrical installations
- e) Mechanical (plumbing and air conditioning)
- f) Fire suppression system

17.3. Installation Requirements

17.3.1. Installation Methodology

Prior to commencement of any installation works, the Contractor will be required to submit a method statement for the works for review and approval of the Employer before commencement of the works.

The method statement shall clearly detail the following:

- a) Scope of works
- b) Method for the works including any tests to be performed before and after the works
- c) Number of Interruptions required (if any) and the specific dates requested
- d) The time required for the works including the time planning
- e) Resources available for the works (personnel and tools)
- f) Management of safety
- g) Any other requirements

Except for circumstances where power of fiber interruptions are required, method statements shall be submitted at least one (1) week in advance. Where interruptions are required the method statement must be submitted together with request for interruption at least 21days prior to the commencement of the works.

17.3.2. Live Line Installation

All works under this project shall be installed under live line (fully HOTLINE) condition i.e. with all the circuits of the line charged to their rated voltage.

The installation shall be generally in accordance with the latest version of IEEE Guide to the Installation of Overhead transmission Line Conductor with additional instructions and precautions for live line working and fibre optic cable handling.

Any Interruptions required for the fiber optic system shall be facilitated by the employer upon the request of the Contractor and the same shall have been foreseen and included in the approved method statement for the works.

17.3.3. Optical Fiber Splices

All fibre splices shall be of the fusion type, except where demountable connectors are specified. Fusion splicing shall be carried by trained personnel using automatic fusion splicing equipment designed for the fibre type.

The accurate alignment of fibre cores, prior to splicing, shall be verified using a technique that monitors the optical power transmitted across the splice interface.

Fusion splice optical losses shall average 0.1db per splice. No single splice loss shall exceed 0.15 db. Splices shall be mechanically strengthened and protected from the environment by means of splice sleeves or enclosures. The finished splice shall be supported within the spliced box by means of suitable clips or restraints. It shall be possible to remove and replace the splice in the support device without risk of damage to the splice or fibre. Each fusion splice shall have a spare length of fibre of approximately 1 m associated with it. This excess fibre shall be coiled neatly and clipped (or otherwise retained) within the splice box.

The splicing shall be performed at ground level. Splice boxes conforming to IP 55 of shall be mounted on the poles at least 5 meters above the ground. The cable shall be fastened into the tower structure. In each splicing location at least 15 meters of free cable must be included for future splicing at ground level.

18. INSPECTIONS AND TESTS

18.1. Testing Requirements

All materials to be supplied and all work performed under this Contract shall be inspected and tested. Deliveries shall not be shipped until all required inspections and tests have been completed and all deficiencies have been corrected to comply with this specification and approved for shipment by the employer.

The Contractor shall furnish all man power and materials for tests, including testing facilities, power and instrumentation and replacement of damaged parts. The costs shall be borne by the Contractor and shall be included in the Contract Price.

The entire cost of testing for factory and site acceptance, routine tests, production tests and other test during the manufacture and site activities specified herein shall be included in the Contract Price.

Acceptance or waiver of tests will not relieve the contractor from the responsibilities to furnish material and works in accordance with the specifications and to employer's satisfaction.

All tests shall be witnessed by the employer unless employer authorizes testing to proceed without witness. The employer representatives shall sign the test form indicating approval of successful tests.

Contractor shall ensure to meet the specification failing which contractor has to replace or upgrade on their own expense. The employer reserve rights to require the Contractor expense any other reasonable test(s) at the contractor premises, on site or elsewhere in addition to the specified type, Acceptance, Routine or Manufacturing test to assure the specification compliance.

The plant will be inspected during manufacture and testing by the Employer. Every facility shall be provided by the Contractor to enable the Employer to carry out the necessary inspection of the plant and the cost of all tests during manufacture and preparation of test records shall be deemed to be included in the Contract Price. Apart from the tests specified here in below, other tests mentioned in the Specifications of individual components of the works shall also be performed to the satisfaction of the Employer. The passing of such inspection or test will not, however, prejudice the right of the Employer to reject the Plant and any or all of material, if it does not comply with the Specifications, or give complete satisfaction in service.

The Contractor shall inform the Employer in writing at least thirty (30) days before the equipment or material is planned for testing at manufacturer's works.

Unless otherwise specified in this Contract, selection of test samples, numbers of specimens and acceptance of results shall be in accordance with the terms of the relevant Standards and Codes. Where no terms exist, the Employer is to instruct details in advance of the inspection and tests in response to the request of the Contractor.

As a special requirement for this Project, the contractor should demonstrate and provide test reports to prove the fiber optic cable installation is safe and secure even under direct contact with voltages in respective KPLC substations.

18.2. Type Tests

All the equipment offered by the Bidder shall have been type tested within the past five years (reckoned from the date of Bid Opening) and the Bidder shall submit copies of Type Tests Certificates for all relevant equipment / material offered. If the Type Test Certificates furnished refer to period earlier than five years as indicated above then the Employer reserves the right to seek for repetition of type tests for any / all equipment at his discretion and such testing shall be carried out at the cost of the Contractor.

18.3. Factory Acceptance Tests

Factory Acceptance Tests (FAT) shall be conducted as per relevant Standards and Codes on randomly selected final assemblies of all equipment to be supplied. These tests shall be carried out in the presence of the Employer's authorized representatives unless waiver for witnessing by Employer is intimated to the Contractor.

Unless testing is waived by the Employer, Factory Acceptance Testing shall be shall be carried out on the following:

- Fiber Optic Approach Cable
- Emergency Diesel Generators
- Fire Alarm and Suppression System

Equipment shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, and the Employer has issued Dispatch Clearance, which may be issued after completion of FAT by the Employer or his authorized representatives assigned to carry out the FAT. Successful completion of the factory tests and the Employer approval to ship shall in no way constitute final acceptance of the system or any portion thereof.

The Factory Acceptance Test (FAT) shall demonstrate the technical characteristics of the Fiber Optic cable & associated accessories in relation to this specifications and approved drawings and documents. The list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics, performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

Prior to commencement of the tests, the Contractor shall submit an Inspection and Test Plan (ITP)document which shall detail the specific tests to be carried, test methods, test criteria and forms of reports to be prepared as a record of each test to be performed. The ITP shall be submitted at least 2weeks prior to commencement of the tests.

The Contractor shall include the cost of witnessing the tests by three (3) of Employer's personnel in the Contract price. This shall include economy class return air tickets, at least three (3) star hotel accommodation and daily allowance of USD 200 per day for each personnel for a minimum period of 5days for each trip.

18.4. Site Acceptance Tests

The Contractor shall be responsible for carrying out Site Acceptance Tests (SAT) and inspections for all equipment supplied under Contract as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Optical Fiber cable & Telecom equipment installation.

Prior to commencement of the tests, the Contractor shall submit an Inspection and Test Plan (ITP)document which shall detail the specific tests to be carried, test methods test criteria and forms of

reports to be prepared as a record of each test to be performed. The ITP shall be submitted at least 2 weeks prior to commencement of the tests.

As a minimum, the following inspections and tests shall be included in the ITP:

No.	Test Item	Tests
1.	Fiber Approach Cable Pre-Installation Testing	(a) Optical fiber continuity and fibre attenuation with OTDR at 1550/1310 nm. (b) Physical Inspection of the cable assembly for damage
2.	Fibre Optic Cable Splice Testing	(a) Per splice bi-directional average attenuation with OTDR (b) Physical inspection of splice box/enclosure for proper fibre routing techniques (c) Physical inspection of sealing techniques, weatherproofing, etc.
3.	Fiber Optic Cable Link Testing	(a) Fibre continuity and link attenuation (Bi-directional) between FDT connectors at two ends for each fibre at 1310 and 1550 nm by OTDR. (b) Fibre continuity and link attenuation (Bi-directional) between FDT connectors at two ends for each fibre at 1310 and 1550 nm by Power meter & Laser source. (c) Average fibre attenuation and average splice loss in the link including FDT. (d) Proper termination and labelling of fibre and fibre optic cables at FDT.
4.	Emergency Diesel Generator Tests	(a) Functional Tests including the changeover mechanism

19. SPARES AND TOOLS

19.1. Tools for Service and Maintenance

As a part of the continuing maintenance concept, the Contractor is required to supply the tools and plant for maintenance of the facilities as indicated in the price schedule. However it must be noted that list of Tools and plant given in the price schedule is indicative only. The Contractor shall supply actual tools and plant required for the operation and maintenance by the Employer. The tools shall comprise mandatory tools as indicated in the schedule of prices and any other tools necessary for the normal operation of the plant supplied.

The Contractor shall also supply mandatory spare parts in such quantities as are indicated in the Schedule of Prices in *Volume 1* of the bid documents.

In addition to the mandatory spare parts and tools, the Contractor shall also provide a price list of any other tools and spare parts not listed among mandatory spare parts and tools but which the Contractor considers to be necessary for the maintenance of the plant. The list of such spare parts and tools shall be entered in the Schedule of Prices (*Volume 1* of the bid documents).

Specifications for tools and plant to be supplied are described as follows:

19.1.2. Splicing Machine

The splicing kit shall consist of the basic set of implements necessary to carry out a splicing exercise and shall include the following at the minimum; a fusion type splicing machine, cleavers, strippers, batteries and power cord. The splicing machine shall be single fiber fusion splicer with high versatility. Below are the features desired for the splicing machine:

- i. Rugged construction providing shock, dust and moisture resistance
- ii. Ability to withstand a 30" drop test.
- iii. Dual monitor position with automatic image orientation
- iv. Automatic arc calibration and ribbon fiber identification
- v. Auto-start tube heater
- vi. Color LCD display and anti-reflective coating for excellent visibility in bright sunlight
- vii. Simultaneous battery charge and splicer operation
- viii. Long life battery (up to 90 splice/heat cycles per charge)
- ix. Detachable work table incorporated into the transit case
 - x. Data and video download software and splicer upgrade software to be included; software upgrades through PC application via the internet
- xi. Green friendly – RoHS& WEEE compliant

19.1.2. Termination Kit

The termination kit shall be a standard toolkit that contains a collection of essential tools needed for termination of Single Mode fiber optic cable of all connector styles (SC, LC & ST). The case should be a carry like briefcase that is rugged and compact. The case shall be lined with a foam-padding material that keeps the tools safe, neat and in proper working order.

19.1.3. Fault Locator

The fault locator shall be an easy to use device of portable construction. It shall be of high performance in optical fiber troubleshooting functionalities with capability of locating fiber breaks and high loss events over long distances. It should be able to detect the fiber break location and display the results on an LCD screen. Refer to the Guaranteed Technical Data Sheet for the minimum requirements for the desired Fault Locator.

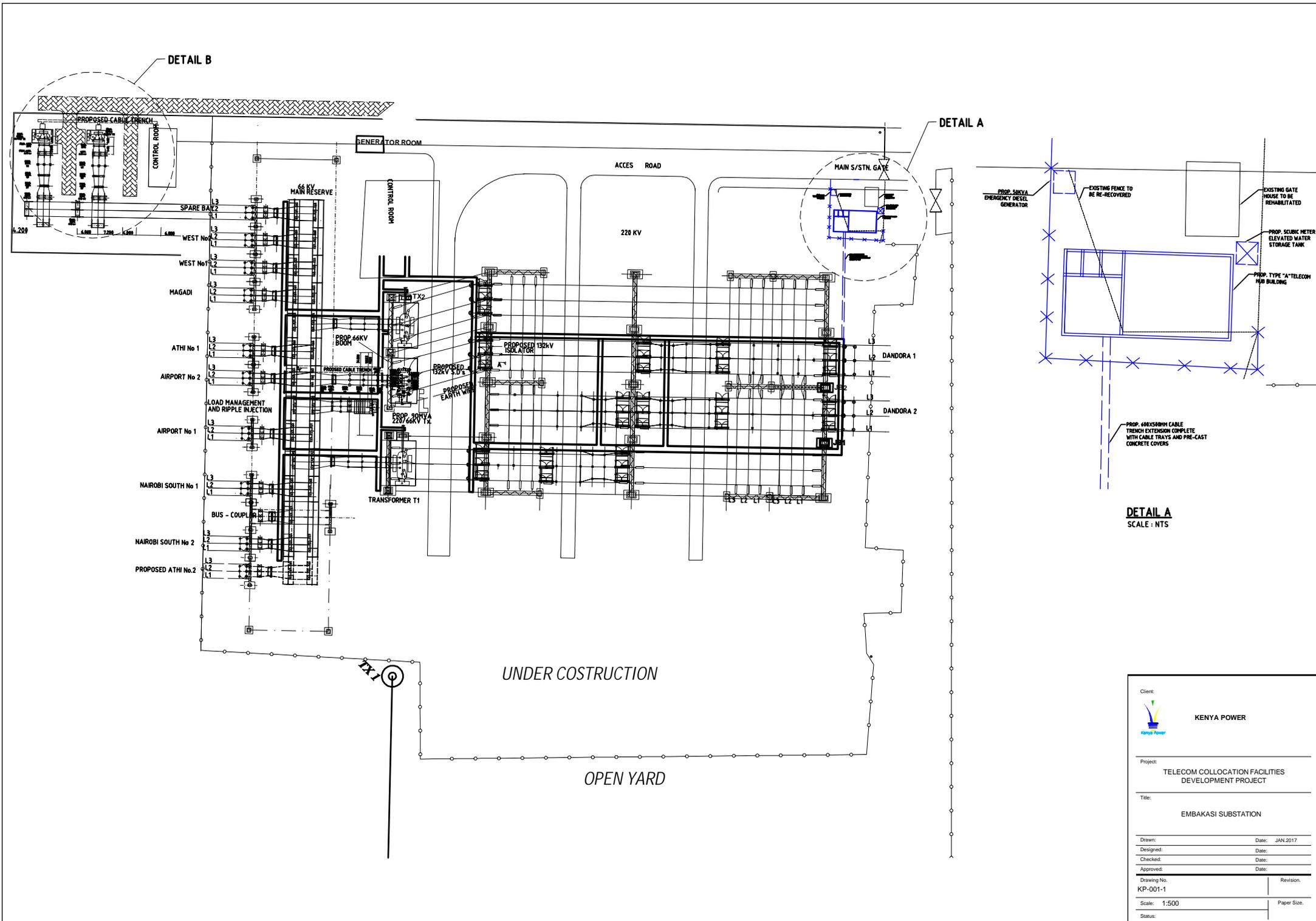
19.2. Spare Parts

The Bidder shall quote for Mandatory Spares detailed as per the relevant schedule provided in the Price Schedule.

The mandatory spares shall be delivered not later than the date of receipt of the last shipment of the associated item of plant/equipment. All spares shall be interchangeable with the original parts. They shall be treated and packed for long term storage under the climatic conditions of site.

Each item shall be clearly and permanently labelled on the outside of its container with its description and purpose. When several items are packed in one case, a general description of the contents shall be given on the outside of the case. Spare parts shall not be shipped in the same cases as components which are used for erection. The cases shall be clearly labelled to indicate that they contain spare parts or tools and each tool or appliance shall be clearly marked with its size and purpose. All cases, containers, or other packages are liable to be opened for inspection and checking on site.

ANNEX 1- TENDER DRAWINGS

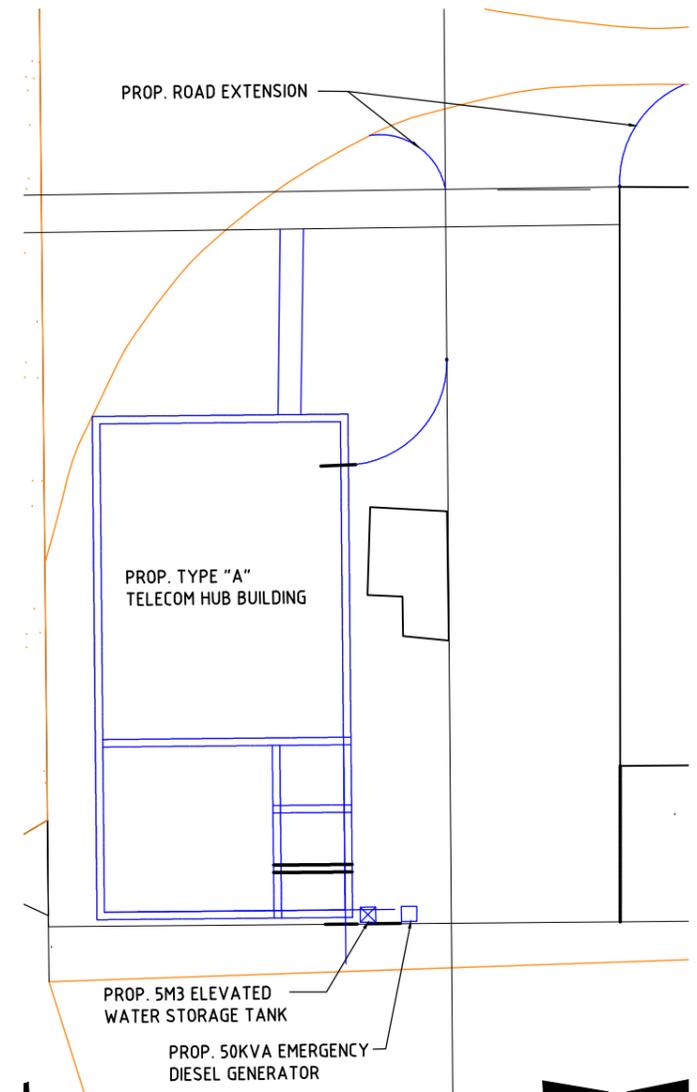
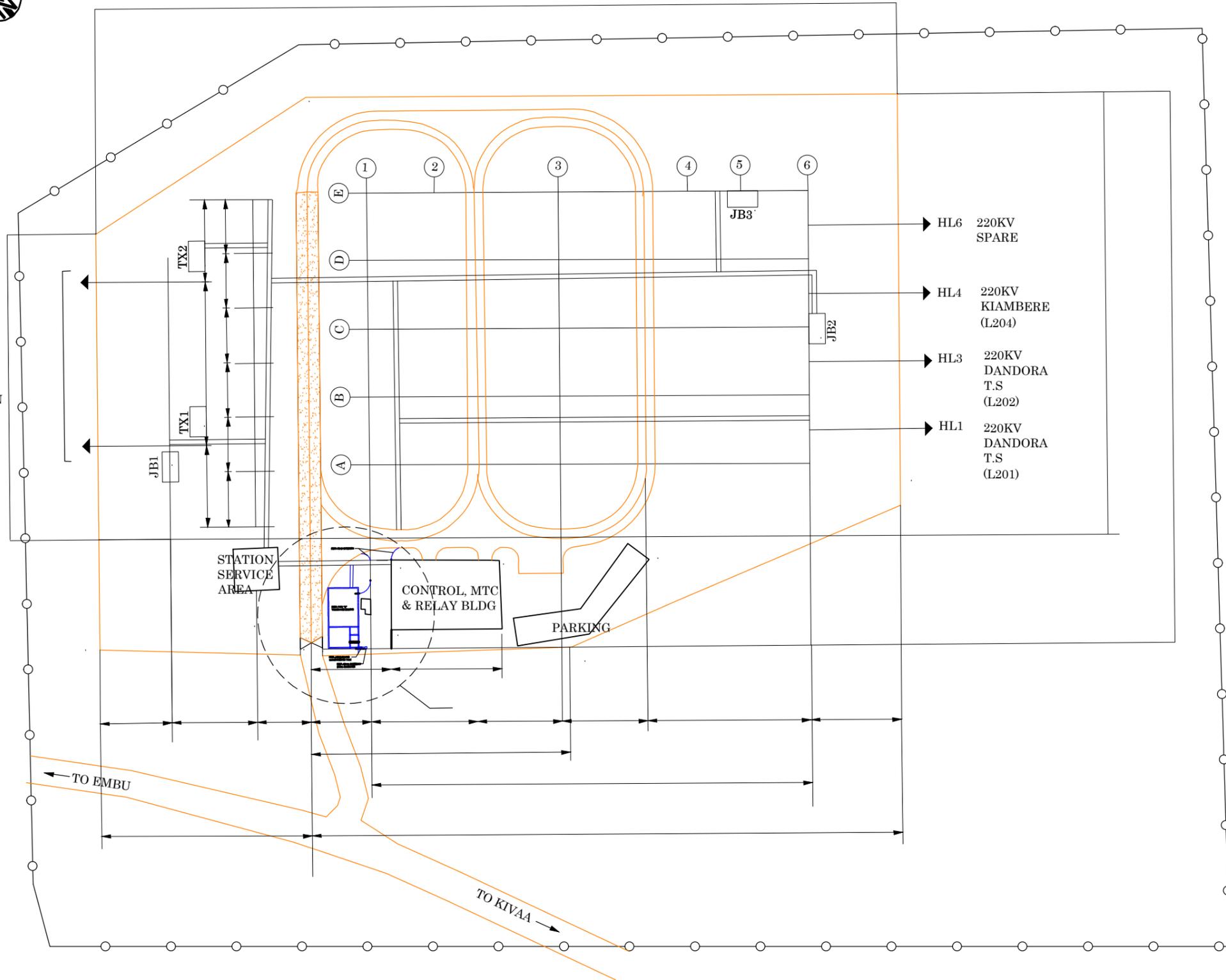


DETAIL A
SCALE : NTS

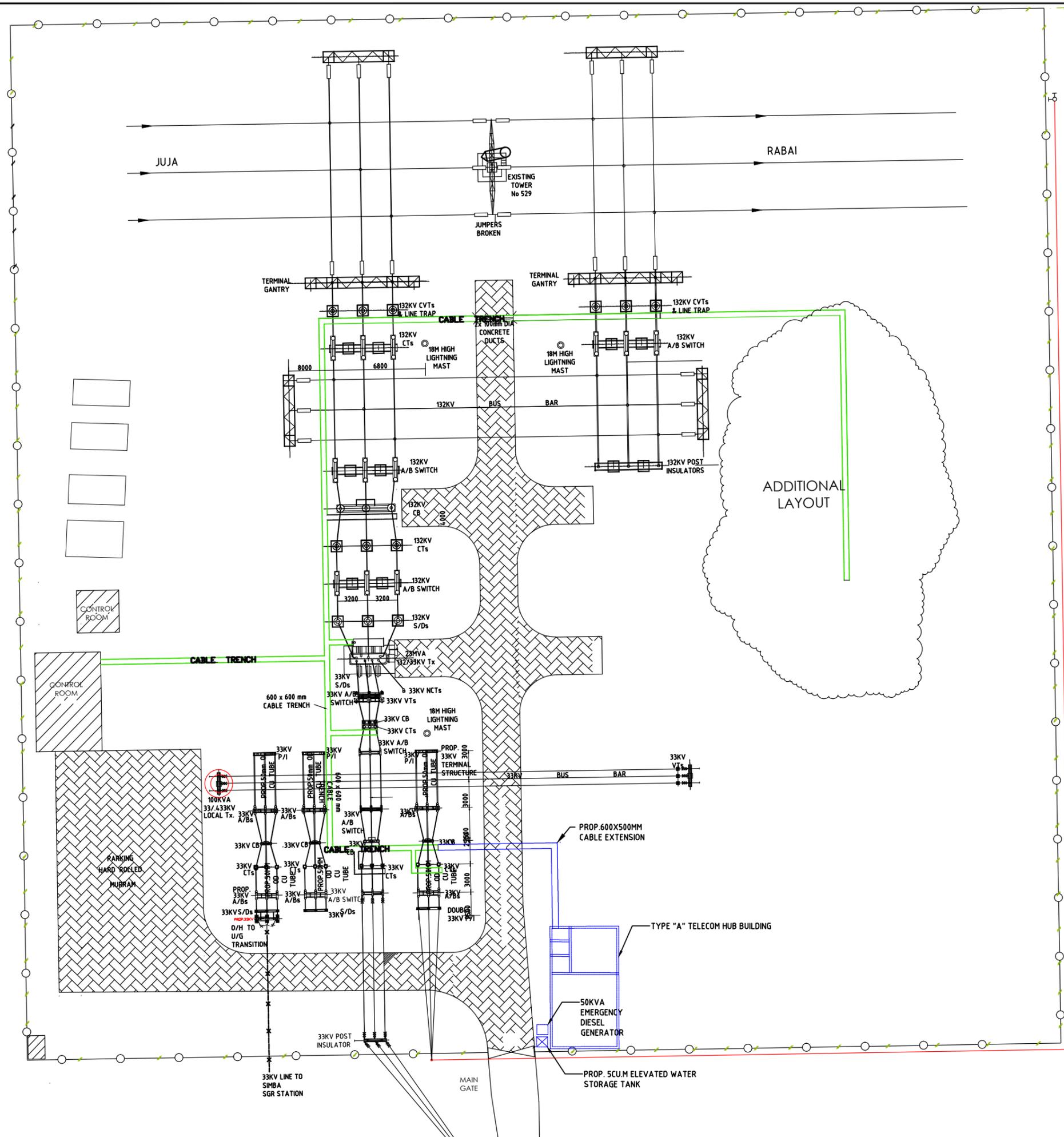
		KENYA POWER	
Project:		TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:		EMBAKASI SUBSTATION	
Drawn:	Date:	JAN 2017	
Designed:	Date:		
Checked:	Date:		
Approved:	Date:		
Drawing No:	Revision:		
KP-001-1			
Scale:	1:500		Paper Size:
Status:			



132KV
YARD
TO KAMBURU
132 S/STATION



Client:	
 KENYA POWER	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
220KV KAMBURU SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No. KP-002	Revision.
Scale: 1:500	Paper Size.
Status:	



Client:	
 KENYA POWER	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
132KV KIBOKO SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No. KP-003	Revision:
Scale: 1:200	Paper Size:
Status:	



TO NYERI

TO CHAKAA

GATE 2

GATE 1

GATE 1

TX 1

JB1

GENERATOR ROOM

JB2

DETAIL A

Client:



KENYA POWER

Project:

TELECOM COLLOCATION FACILITIES
DEVELOPMENT PROJECT

Title:

132KV
KIGANJO SUBSTATION
GENERAL LAYOUT

Drawn: _____ Date: JAN.2017

Designed: _____ Date: _____

Checked: _____ Date: _____

Approved: _____ Date: _____

Drawing No. KP-Q04-A Revision.

Scale: 1:500 Paper Size.

Status: _____



132 KV FROM RABAI

CAR PARKING

CAR PARKING

SECURITY ROOM

DETAIL A

132KV STRUCTURE LAYOUT

CONTROL HSE (11KV)

COMMUNICATION HSE

CABLE TRENCHES

CONTROL HOUSE AT KENGEN

NEW CONTROL ROOM UNDER CONSTRUCTION

DETAIL B

PROP. TYPE "A" TELECOM HUB BUILDING

PROP. 5CUBIC METER ELEVATED WATER STORAGE TANK

PROP. 50KVA EMERGENCY DIESEL GENERATOR

PROP. CABLE TRENCH EXTENSION

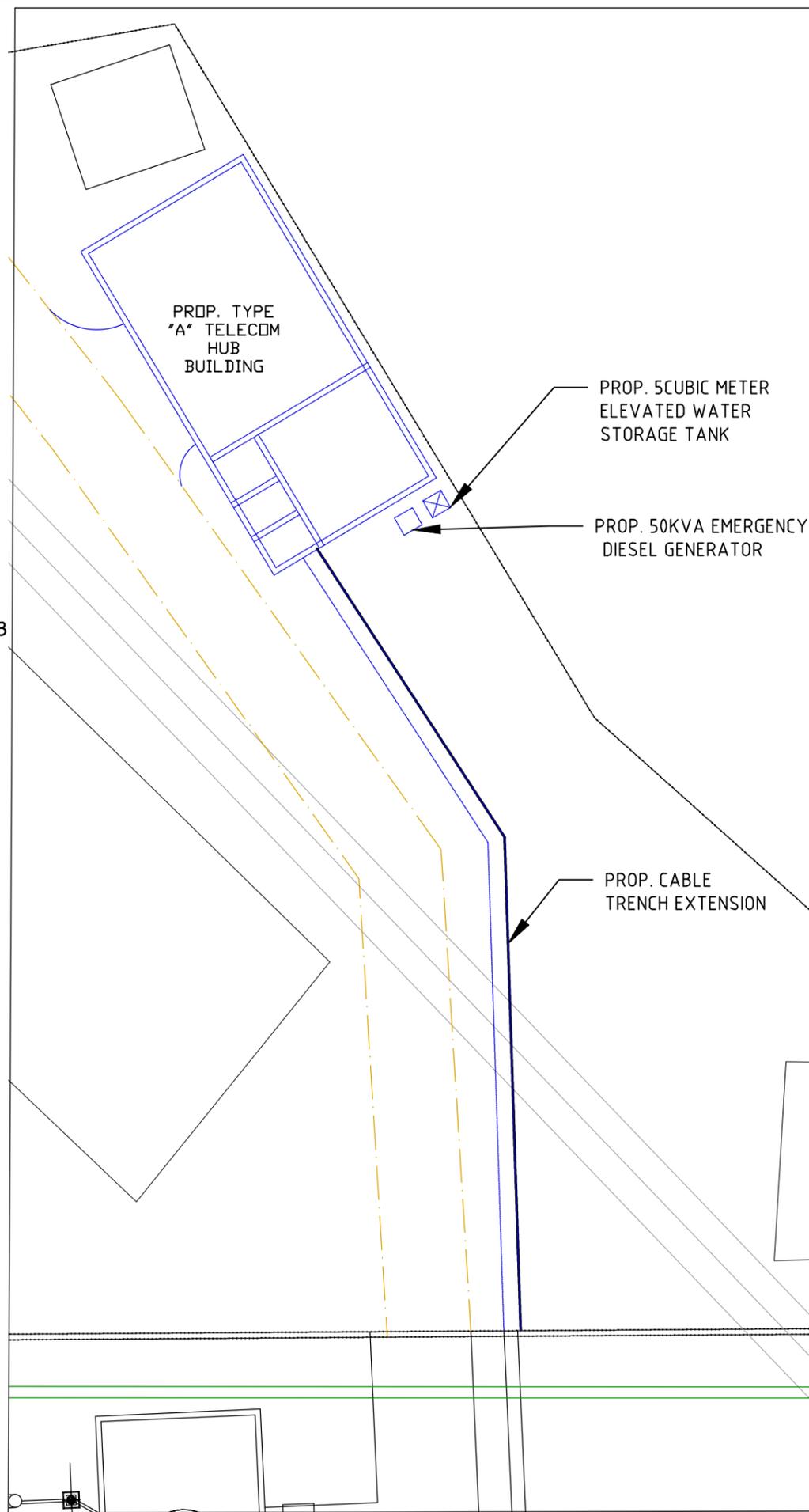
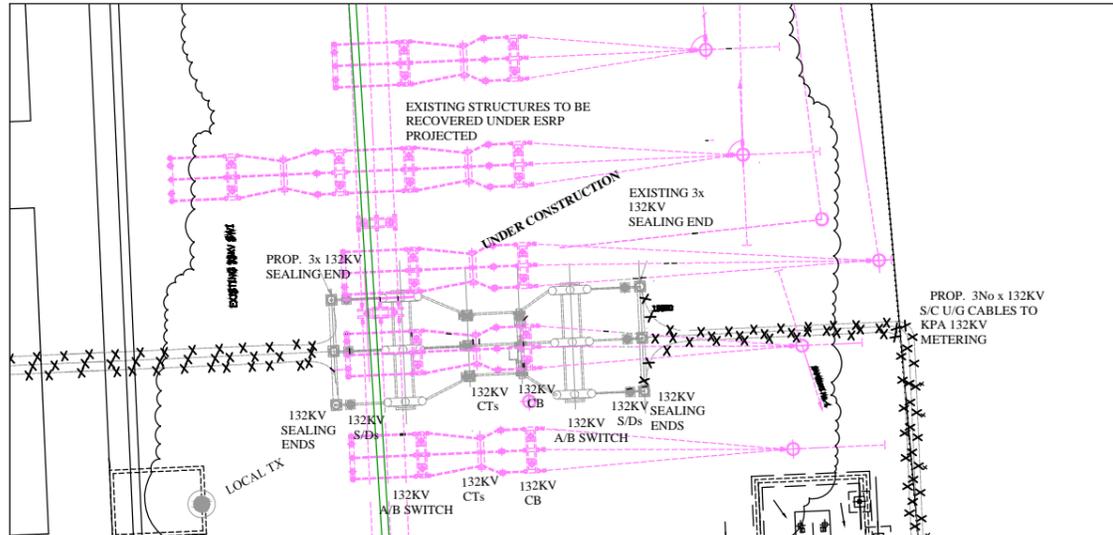
PROP. 3No x 132KV S/C U/G CABLES TO KPA 132KV METERING

GENERAL LAYOUT

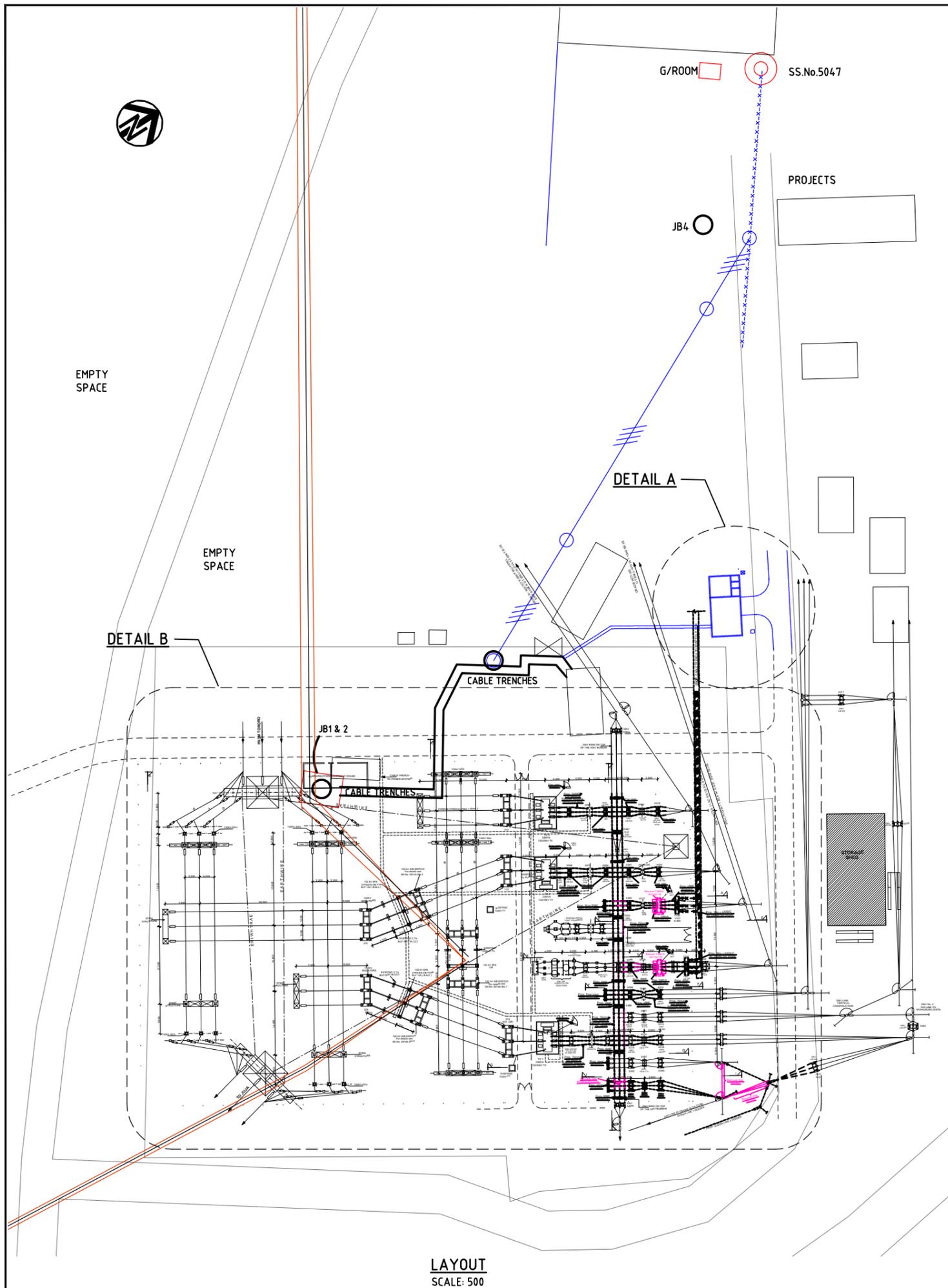
CSA

DETAIL B
SCALE: NTS

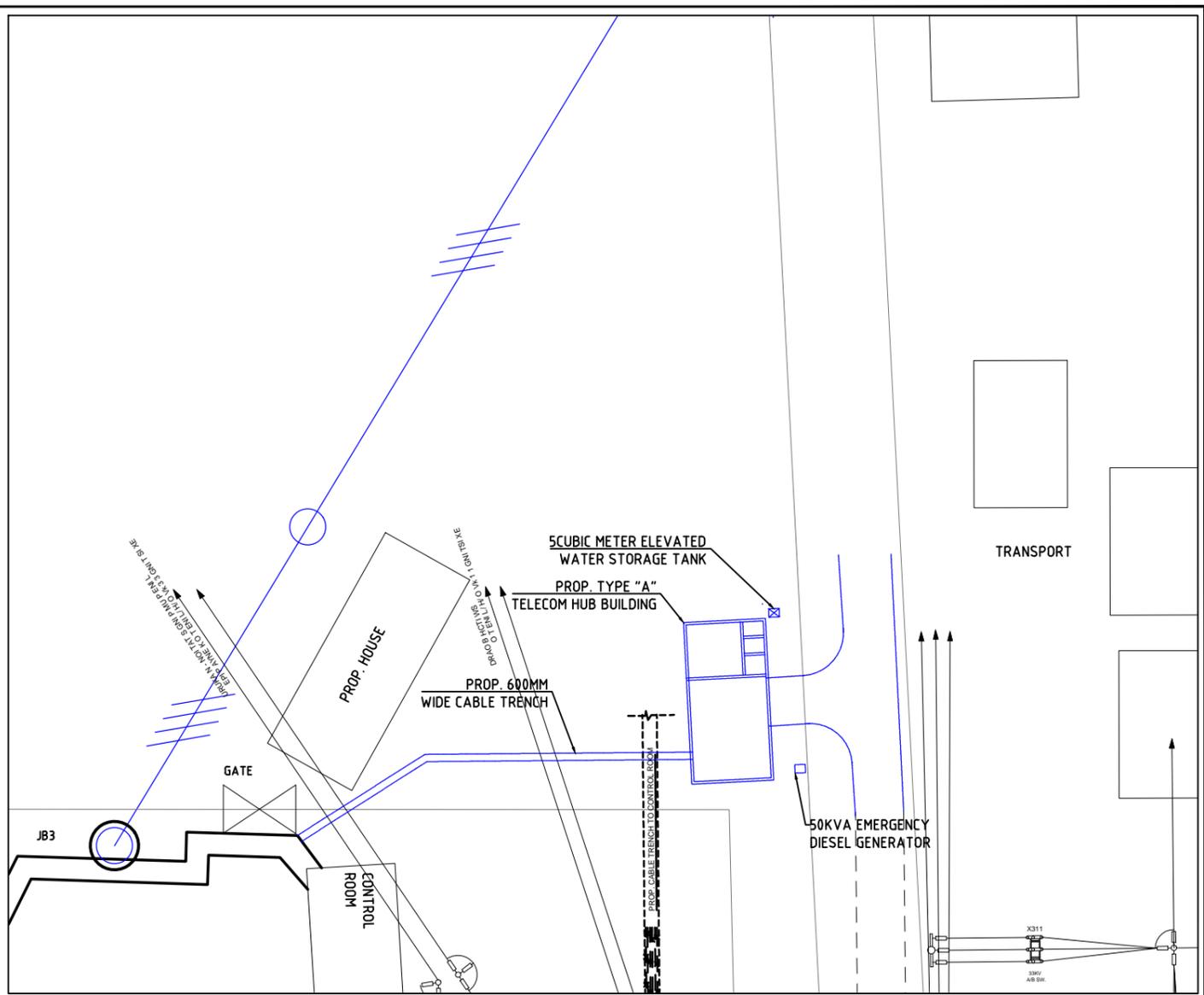
DETAIL A
SCALE: 200



Client:	
 KENYA POWER	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
132KV KIPEVU SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No. KP-005	Revision:
Scale: 1:500	Paper Size:
Status:	

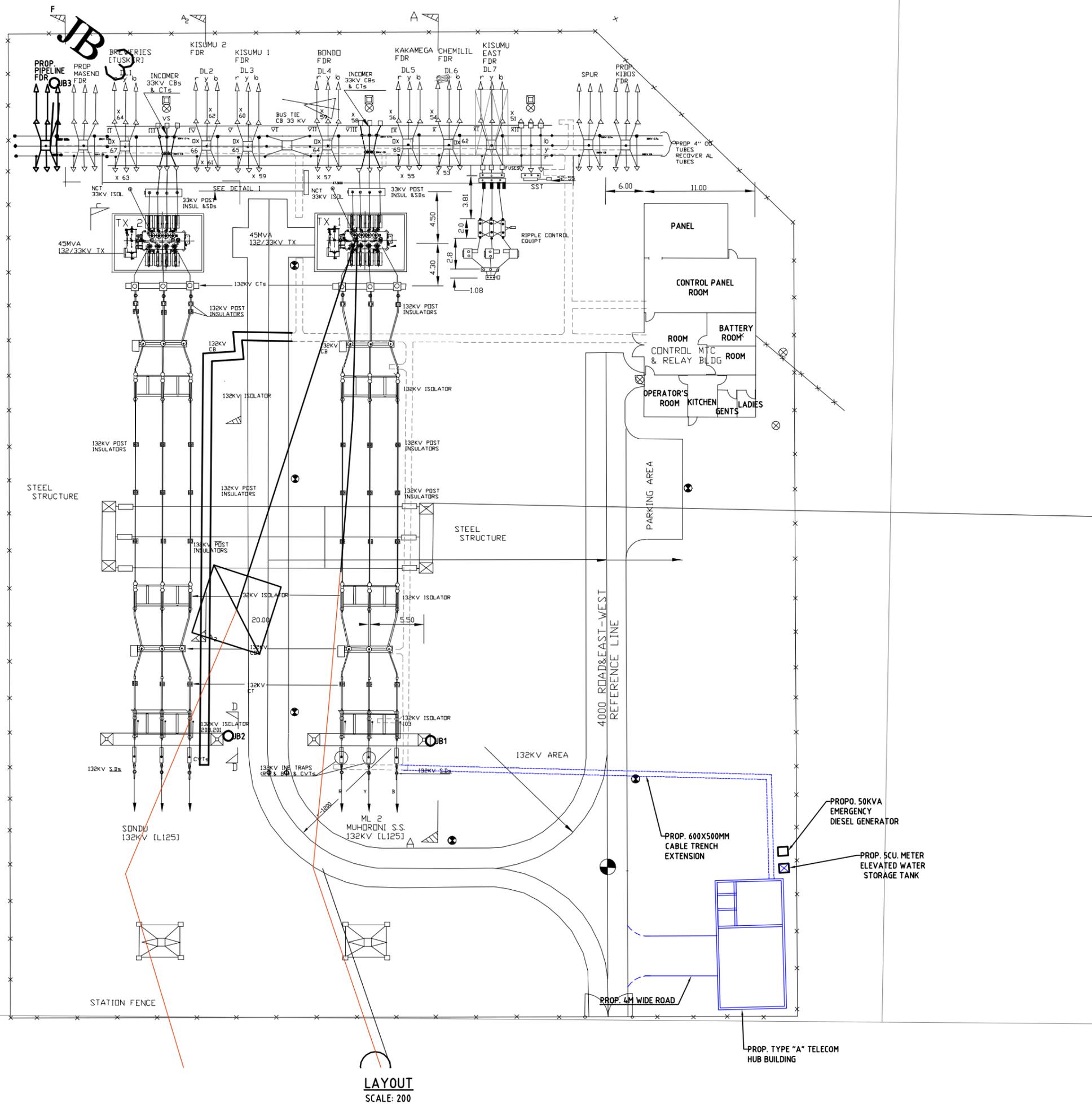


LAYOUT
SCALE: 500



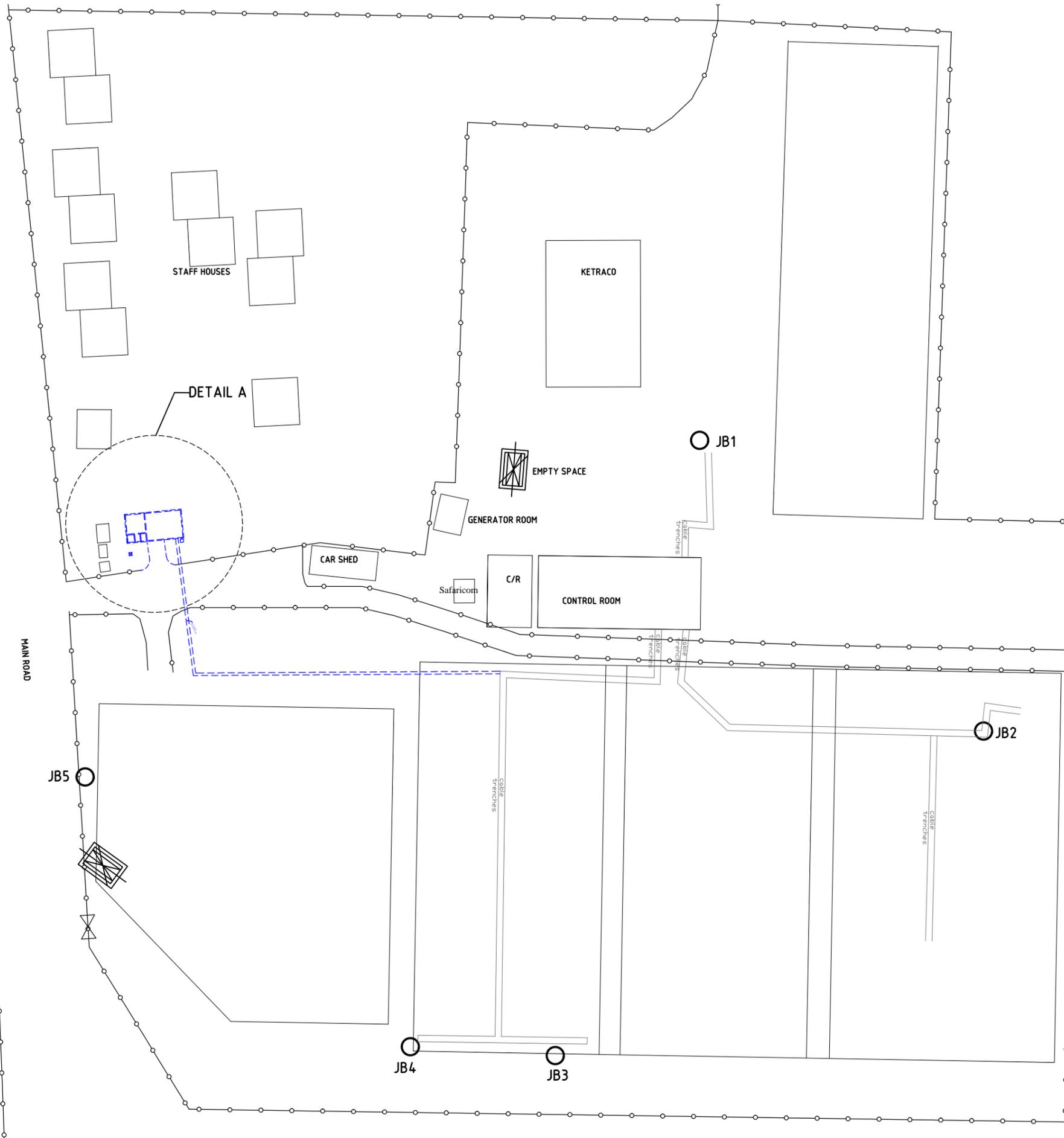
DETAIL A
SCALE: 250

Client:	
 KENYA POWER <small>Kenya Power</small>	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
132KV LANET SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No. KP-006	Revision:
Scale: AS SHOWN	Paper Size:
Status:	

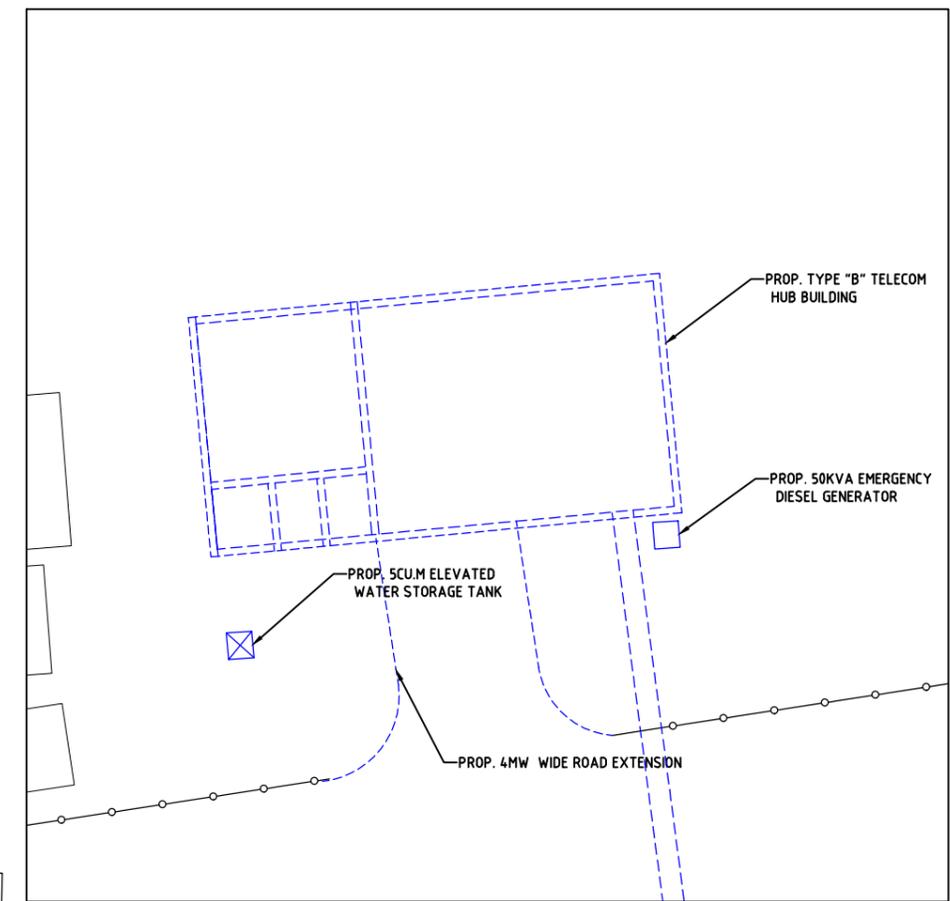


LAYOUT
SCALE: 200

Client:		KENYA POWER	
Project:		TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:		132KV KISUMU MAMBOLEO SUBSTATION	
Drawn:	Date:	JAN.2017	
Designed:	Date:		
Checked:	Date:		
Approved:	Date:		
Drawing No.	Revision:		
KP-007			
Scale:	AS SHOWN	Paper Size:	
Status:			



LAYOUT
SCALE: 200



DETAIL A
SCALE: 100

Client:



KENYA POWER

Project:

TELECOM COLLOCATION FACILITIES
DEVELOPMENT PROJECT

Title:

220-132KV
LESOS SUBSTATION

Drawn:

Date: JAN.2017

Designed:

Date:

Checked:

Date:

Approved:

Date:

Drawing No.

KP-008

Revision:

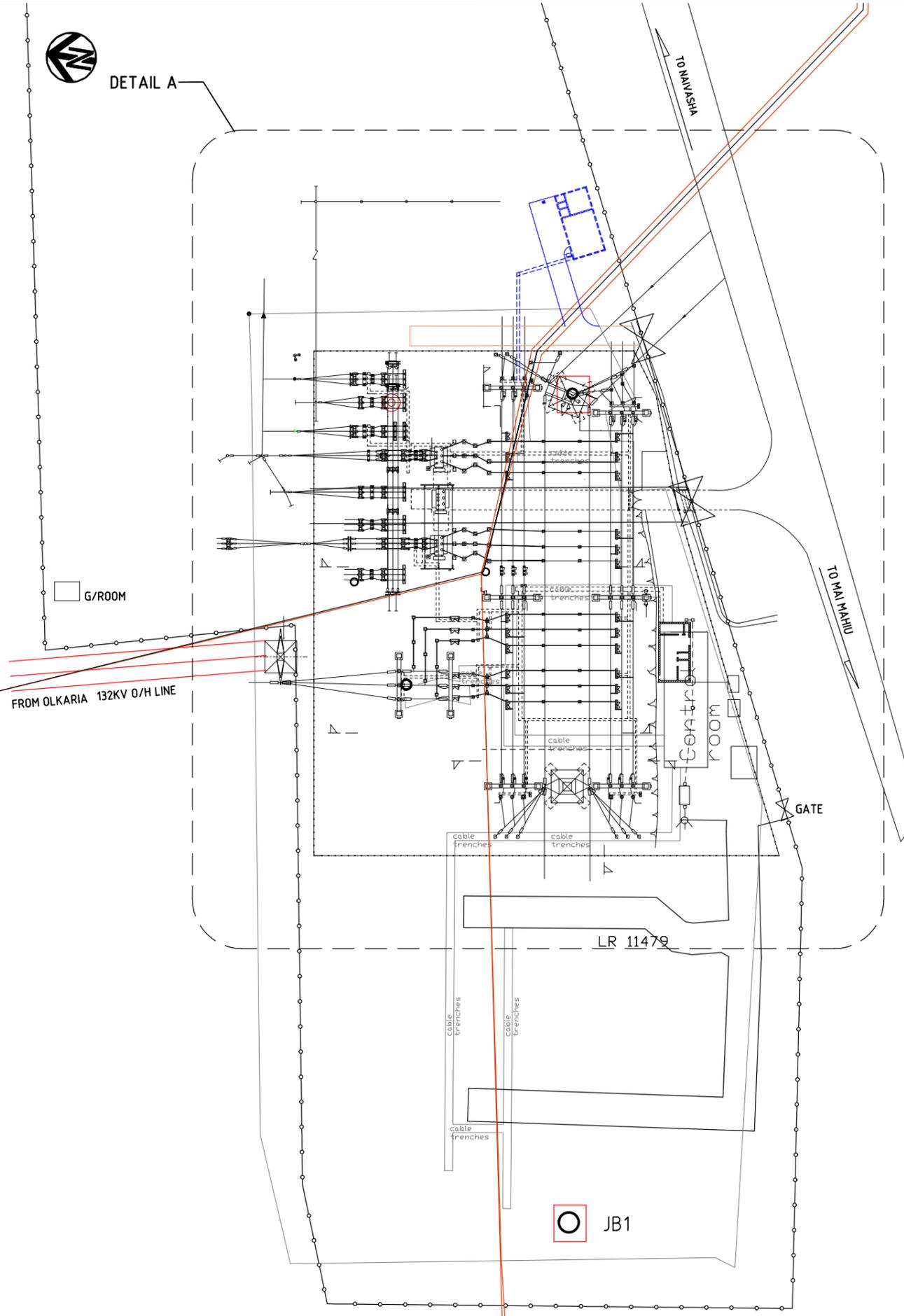
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Paper Size:

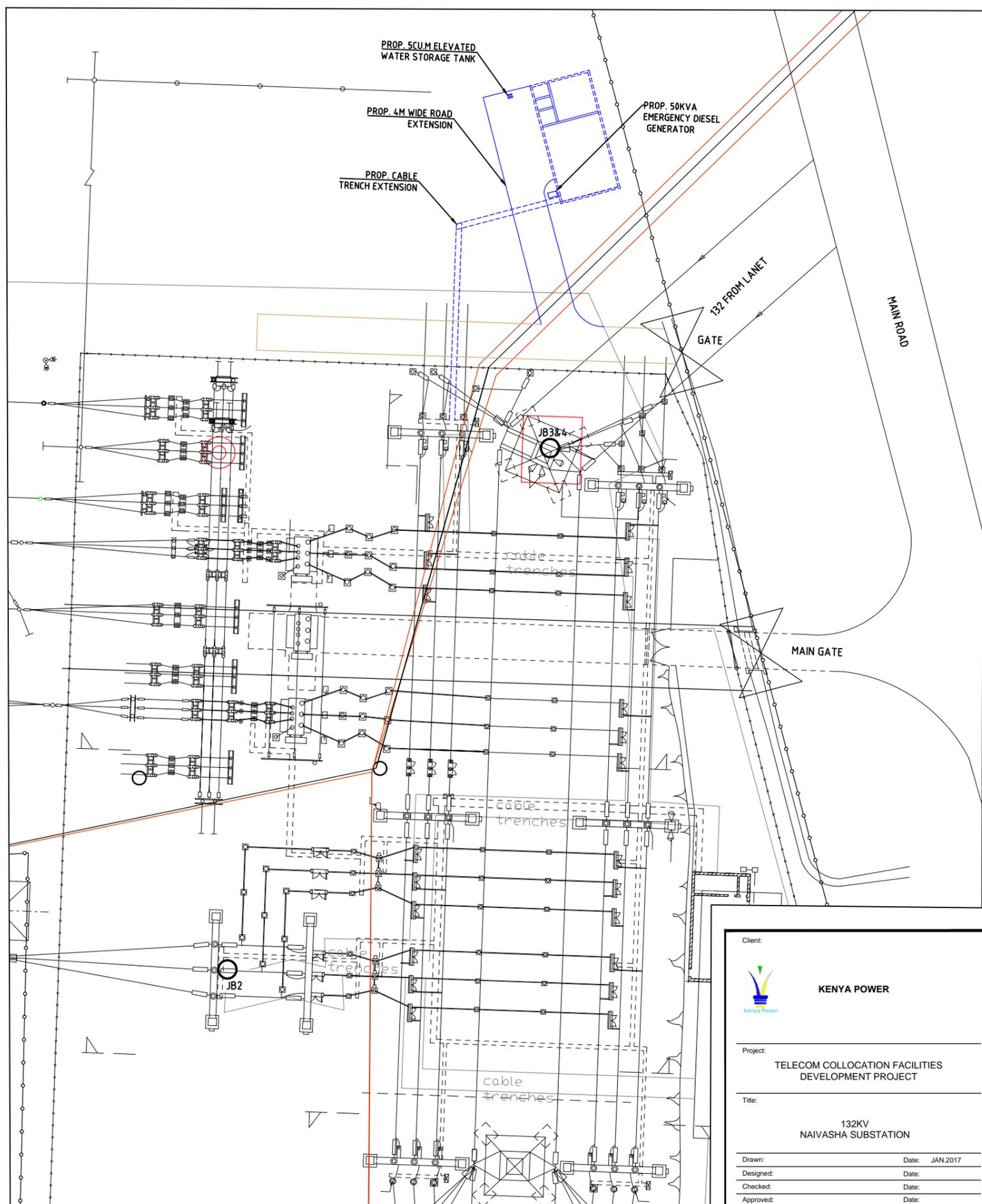
Status:



DETAIL A



LAYOUT
SCALE: 500



DETAIL A
SCALE: 250

Client:	
 KENYA POWER	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
132KV NAIVASHA SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No. KP-010	Revision.
Scale: AS SHOWN	Paper Size.
Status:	

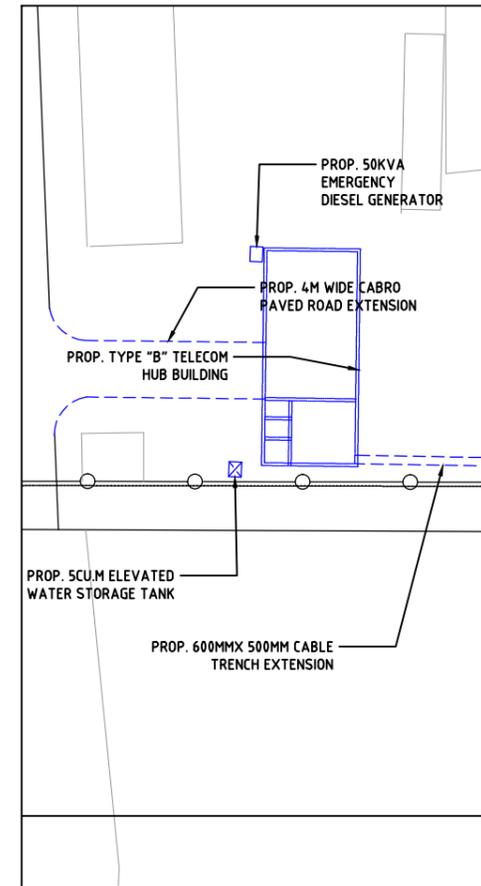
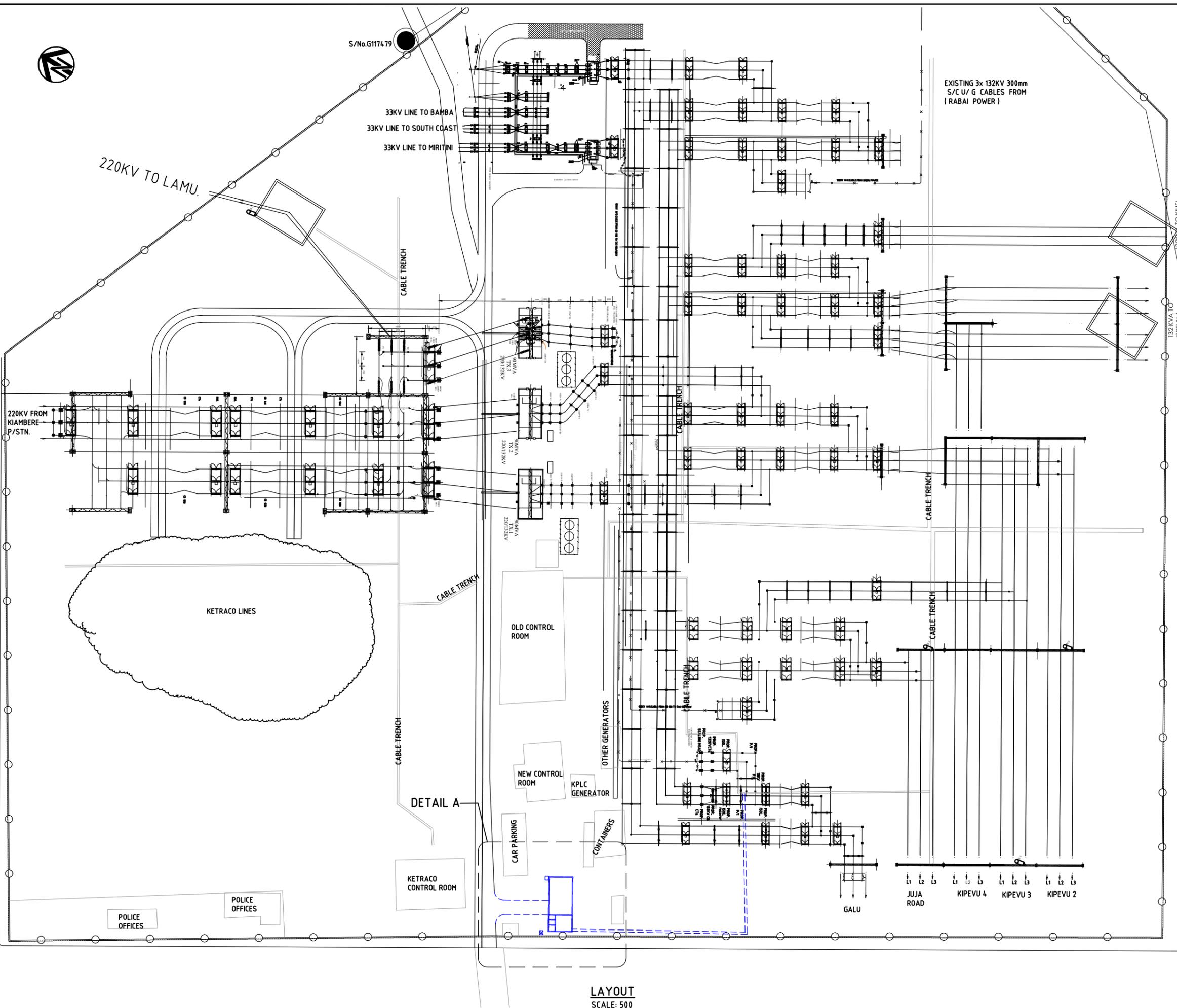


S/No.G117479

33KV LINE TO BAMBA
33KV LINE TO SOUTH COAST
33KV LINE TO MIRITINI

220KV TO LAMU.

EXISTING 3x 132KV 300mm
S/C U/ G CABLES FROM
(RABAI POWER)

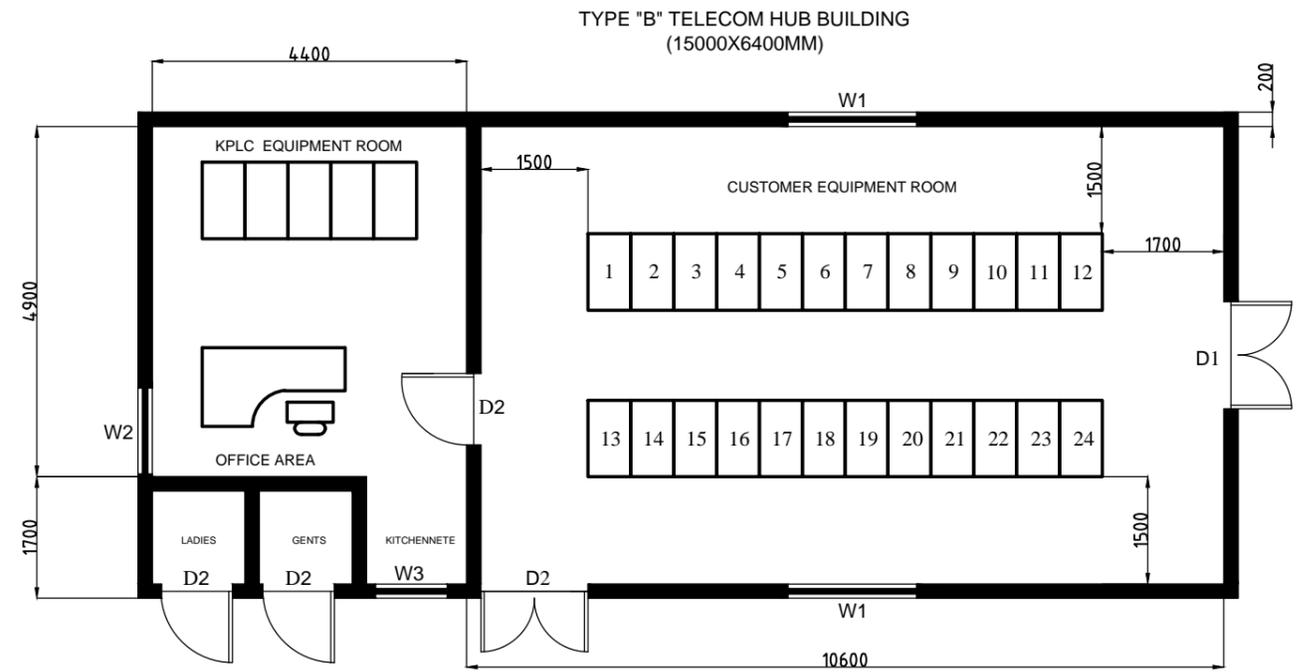
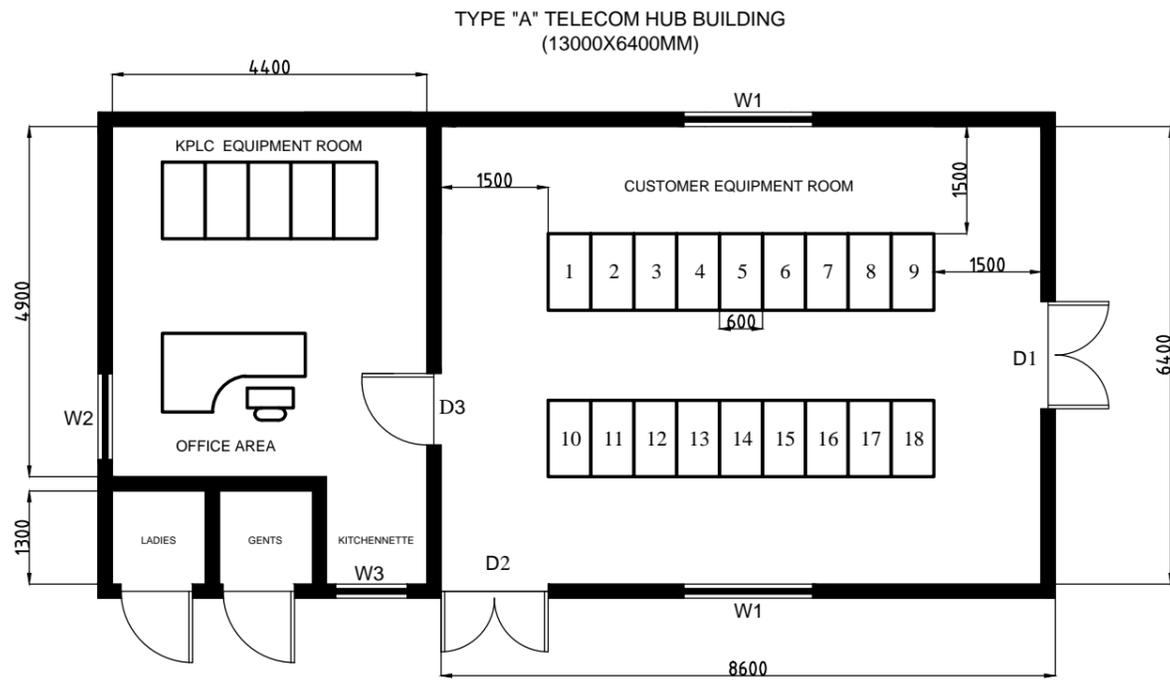


DETAIL A
SCALE: 250

DETAIL A

LAYOUT
SCALE: 500

Client:	
 KENYA POWER	
Project:	
TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT	
Title:	
RABAI SUBSTATION	
Drawn:	Date: JAN.2017
Designed:	Date:
Checked:	Date:
Approved:	Date:
Drawing No.	Revision.
KP-011	
Scale: AS SHOWN	Paper Size:
Status:	



SCHEDULE FOR DOORS & WINDOWS

W1	ALUMINIUM/PVC SLIDING WINDOW (1800X1500MM)
W2	ALUMINIUM/PVC SLIDING WINDOW (1200X1500MM)
W3	ALUMINIUM/PVC SLIDING WINDOW (1000X1500MM)
D1	EMERGENCY DOOR (1500 WIDE)
D2	STEEL DOOR (1500 WIDE)
D3	ALUMINIUM FRAMED DOOR (1000 WIDE)



Project: TELECOM COLLOCATION FACILITIES DEVELOPMENT PROJECT

Title: TELECOM HUB BUILDING DESIGN

Drawn: _____ Date: JAN.2017
 Designed: _____ Date: _____
 Checked: _____ Date: _____
 Approved: _____ Date: _____

Drawing No. KP-013	Revision.
Scale: AS SHOWN	Paper Size.
Status:	

ANNEX 2-TECHNICAL DATA SHEETS

**GUARANTEED
TECHNICAL DATA SHEETS**

DEFINITIONS AND ABBREVIATIONS

The following terms may be met in these Technical Schedules and shall be interpreted as follows:

Hz	shall mean hertz
kW	shall mean kilowatt
MW	shall mean megawatt
VA (kVA, MVA)	shall mean volt-ampere (kilo-, mega-)
A (kA)	shall mean ampere (kilo-)
V (kV)	shall mean volt (kilo-)
W/m	shall mean watt per metre
AC	shall mean alternating current
DC	shall mean direct current
IN	shall mean rated (nominal) current
UN	shall mean rated (nominal) voltage
Ah	shall mean ampere-hours
lm	shall mean lumen
lm/w	shall mean lumen per watt
min	shall mean minute
min.	shall mean minimum
(prefix)	shall mean micro
rms	shall mean root mean square
p.u.	shall mean per unit
p/p	shall mean peak to peak
T	shall mean Tesla
kg	shall mean kilogram
N	shall mean Newton
l	shall mean litre
s or sec.	shall mean second
No.	shall mean number
dB	shall mean decibel
Amp	shall mean amperes
F	shall mean Farad
°C	shall mean centigrade
K	shall mean degree Kelvin
m ²	shall mean square metre
m ³	shall mean cubic metre (mm ³ for millimetre, etc)
m ³ /s	shall mean cubic metres per second
m	shall mean metre
cm	shall mean centimetre
mm	shall mean millimetre
joules	shall mean joules per hour
tonne	shall mean metric tonne
%	shall mean percentage
Pascal	shall mean 1 N/m ²
cst	shall mean centistoke

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Table 1: 96 Core Single-Mode Optical Fiber Approach Cable

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
1.	Manufacturer		(*)	
2.	Country of Origin		(*)	
3.	Reference Standard		ITU G.652D	
4.	Attenuation Coefficient			
	@ 1310nm	dB/km	0.35	
	@1550nm	dB/km	0.21	
5.	Attenuation Variation with Wavelength (+ 25nm) Temperature	dB/km	(*)	
6.	Attenuation at water peak (1383nm)	dB/km	0.4	
7.	Normal Mode Field Diameter			
	@1310nm	μm	8.6	
	@1550nm	μm	9.5	
8.	Mode field diameter deviation			
	@1310nm	μm	0.6	
	@1550nm	μm	0.6	
9.	Mode field non-circularity	%	(*)	
10.	Chromatic Dispersion Coefficient			
	@1310nm (1288-1339)nm	Ps/nm ² km	3.5	
	@1310nm (1271-1360)nm	Ps/nm ² km	5.3	
	@1550	Ps/nm ² km	18	
11.	Zero dispersion Wavelength	Nm	1302 - 1322	
12.	Zero dispersion slope	Ps/nm ² km	0.092	
13.	Polarization Mode Dispersion	Ps/nm ² km	≤0.2	
14.	Cut-off wavelength	Nm	1260	
15.	Refractive index		(*)	
16.	Refractive Index profile		(*)	
17.	Cladding Design		(*)	
18.	Numerical aperture		(*)	
19.	Bandwidth Distance Product	MHz.km	(*)	
20.	Bend Performance (37.5mm radius, 100turns)		(*)	
21.	Fibre Manufacturer(s)		(*)	
22.	Fibre production method		(*)	
23.	Core diameter (nominal + deviation)	μm	(*)	
24.	Core non-circularity	%	6	
25.	Cladding diameter (nominal + deviation)	μm	125±1	
26.	Core clad concentricity error	μm	0.6	
27.	Cladding non-circularity	%	1	

(*) means to be specified by bidder

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
28.	Protective Coating type & material		(*)	
	Primary		(*)	
	Secondary		(*)	
29.	Protective Coating diameter (nominal + deviation)	mm	(*)	
30.	Protective removal method		(*)	
31.	Coating Concentricity			
32.	Colour coding scheme compliant with EIA/TIA 598 or IEC 60304 or Bellore GR-20		Yes	
33.	Colouring material compliant with technical specs?		Yes	
34.	No. of Fibres in cable		96	
35.	Cable Diameter			
36.	Nominal	mm	(*)	
	Tolerance	mm	(*)	
	Cable Weight	kg/km	(*)	
37.	Max. Tensile Strength	kN	(*)	
38.	Max. Pulling Tension			
	During installation	kN	(*)	
	During service	kN	(*)	
39.	Minimum bending radius			
	During installation	mm	(*)	
	During service	mm	(*)	
	Maximum continuous length	km	(*)	
40.	Temperature range			
	Operation	°C	(*)	
	Installation	°C	(*)	
	Shipping & Storage	°C	(*)	
41.	Crush strength			
	Impact Resistance	kN/m ²	(*)	
	Torsion resistance	kN/m ²	(*)	
42.	Outer jacket thickness			
	Nominal	mm	(*)	
	Tolerance	mm	(*)	
43.	Outer jacket material			
44.	Description of outer jacket coatings/additives			
	Inner jacket material			
	Inner jacket thickness	mm	(*)	
	Inner jacket coating/additives		(*)	
	Binder	mm	(*)	

(*) means to be specified by bidder

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
	Wrapping tape	mm	(*)	
	Lay direction	mm	(*)	
45.	Central strength members description			
	Material	mm	(*)	
	Diameter	mm	(*)	
	Cylindrical or Slotted type	mm	(*)	
46.	Peripheral strength member description			
47.	Central Fiber optic unit	Yes/No	Yes	
48.	Loose tube dia & material		(*)	
49.	Loose tube lay direction		(*)	
50.	Max No. of fibers per tube	No	12	
51.	Total No. of tubes and number of empty tubes.	No	8	
52.	Identification/numbering of individual tubes		Tube and fiber coding	
53.	Filling compound within tube		(*)	
54.	Filling compound in cable core Interstices.		(*)	
55.	Ripcord(s) provided?	Yes/No	Yes	
56.	Cable design life	Years	50	
57.	Describe cable termite proofing measures		(*)	
58.	Describe cable anti-rodent measures		(*)	
59.	Cable construction drawing enclosed?	Yes/No	Yes	
60.	Cable drum construction	Type	(*)	
61.	Size of drum			
	Height	mm	(*)	
	Width	mm	(*)	
	Diameter	mm	(*)	
62.	Weight of empty drum	Kg	(*)	
63.	Cable Drum drawing enclosed?	Yes/No	(*)	

(*) means to be specified by bidder

Table 2: 48 Core Single-Mode Optical Fiber Approach Cable

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
1.	Manufacturer		(*)	
2.	Country of Origin		(*)	
3.	Reference Standard		ITU G.652D	
4.	Attenuation Coefficient			
	@ 1310nm	dB/km	0.35	
	@1550nm	dB/km	0.21	
5.	Attenuation Variation with Wavelength (+ 25nm) Temperature	dB/km	(*)	
6.	Attenuation at water peak (1383nm)	dB/km	0.4	
7.	Normal Mode Field Diameter			
	@1310nm	μm	8.6	
	@1550nm	μm	9.5	
8.	Mode field diameter deviation			
	@1310nm	μm	0.6	
	@1550nm	μm	0.6	
9.	Mode field non-circularity	%	(*)	
10.	Chromatic Dispersion Coefficient			
	@1310nm (1288-1339)nm	Ps/nm ² km	3.5	
	@1310nm (1271-1360)nm	Ps/nm ² km	5.3	
	@1550	Ps/nm ² km	18	
11.	Zero dispersion Wavelength	Nm	1302 - 1322	
12.	Zero dispersion slope	Ps/nm ² km	0.092	
13.	Polarization Mode Dispersion	Ps/nm ² km	≤0.2	
14.	Cut-off wavelength	Nm	1260	
15.	Refractive index		(*)	
16.	Refractive Index profile		(*)	
17.	Cladding Design		(*)	
18.	Numerical aperture		(*)	
19.	Bandwidth Distance Product	MHz.km	(*)	
20.	Bend Performance (37.5mm radius, 100turns)		(*)	
21.	Fibre Manufacturer(s)		(*)	
22.	Fibre production method		(*)	
23.	Core diameter (nominal + deviation)	μm	(*)	
24.	Core non-circularity	%	6	
25.	Cladding diameter (nominal + deviation)	μm	125±1	
26.	Core clad concentricity error	μm	0.6	
27.	Cladding non-circularity	%	1	

(*) means to be specified by bidder

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
28.	Protective Coating type & material		(*)	
	Primary		(*)	
	Secondary		(*)	
29.	Protective Coating diameter (nominal + deviation)	mm	(*)	
30.	Protective removal method		(*)	
31.	Coating Concentricity			
32.	Colour coding scheme compliant with EIA/TIA 598 or IEC 60304 or Bellore GR-20		Yes	
33.	Colouring material compliant with technical specs?		Yes	
34.	No. of Fibres in cable		48	
35.	Cable Diameter			
36.	Nominal	mm	(*)	
	Tolerance	mm	(*)	
	Cable Weight	kg/km	(*)	
37.	Max. Tensile Strength	kN	(*)	
38.	Max. Pulling Tension			
	During installation	kN	(*)	
	During service	kN	(*)	
39.	Minimum bending radius			
	During installation	mm	(*)	
	During service	mm	(*)	
	Maximum continuous length	km	(*)	
40.	Temperature range			
	Operation	°C	(*)	
	Installation	°C	(*)	
	Shipping & Storage	°C	(*)	
41.	Crush strength			
	Impact Resistance	kN/m ²	(*)	
	Torsion resistance	kN/m ²	(*)	
42.	Outer jacket thickness			
	Nominal	mm	(*)	
	Tolerance	mm	(*)	
43.	Outer jacket material			
44.	Description of outer jacket coatings/additives			
	Inner jacket material			
	Inner jacket thickness	mm	(*)	
	Inner jacket coating/additives		(*)	
	Binder	mm	(*)	

(*) means to be specified by bidder

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
	Wrapping tape	mm	(*)	
	Lay direction	mm	(*)	
45.	Central strength members description			
	Material	mm	(*)	
	Diameter	mm	(*)	
	Cylindrical or Slotted type	mm	(*)	
46.	Peripheral strength member description.			
47.	Central Fiber optic unit	Y/N	Yes	
48.	Loose tube dia & material		(*)	
49.	Loose tube lay direction		(*)	
50.	Max No. of fibers per tube	No	12	
51.	Total No. of tubes and number of empty tubes.	No	4	
52.	Identification/numbering of individual tubes		Tube and fiber coding	
53.	Filling compound within tube		(*)	
54.	Filling compound in cable core Interstices.		(*)	
55.	Ripcord(s) provided?	Yes/No	Yes	
56.	Cable design life	Years	50	
57.	Describe cable termite proofing measures		(*)	
58.	Describe cable anti-rodent measures		(*)	
59.	Cable construction drawing enclosed?	Yes/No	Yes	
60.	Cable drum construction	Type	(*)	
61.	Size of drum			
	Height	mm	(*)	
	Width	mm	(*)	
	Diameter	mm	(*)	
62.	Weight of empty drum	Kg	(*)	
63.	Cable Drum drawing enclosed?	Yes/No	(*)	

(*) means to be specified by bidder

Table 3: Optical Fiber Joint Box

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
1.	Manufacturer		(*)	
2.	Model Number		(*)	
3.	Dimension H*W*D	cm	(*)	
4.	Weight	kg	(*)	
5.	Colour and finish		(*)	
6.	Cable Glanding		(*)	
7.	Construction materials and gauge		(*)	
8.	Type		(*)	
9.	Total number of optical couplings	No.	(*)	
10.	Suitable for use in man-holes and direct tube	Y/N	(*)	
11.	Degree of protection	IP	IP68	
12.	Describe sealing method			
	Optical Fibre Cable Accommodation			
13.	Cable Glanding			
14.	Max. number of cables that can be accommodated	No.		
15.	Describe Cable entries			
	Cable Termination Splice Accommodation			
16.	Maximum number of splice trays	No.		
17.	Number of splice per tray	No.		

(*) means to be specified by bidder

Table 4: Optical Fiber Distribution Frame (ODF)

No	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Manufacturer		(*)	
2.	Model Number		(*)	
3.	Dimension H*W*D	cm	(*)	
4.	Weight	kg	(*)	
5.	Colour and finish		(*)	
6.	Cable Glanding		(*)	
7.	Construction		(*)	
8.	Locking arrangements		(*)	
9.	Installation Clearances		(*)	
	Front Access	cm	(*)	
	Rear Access	cm	(*)	
	Top*Bottom*Sides	cm	(*)	
10.	Total number of optical couplings	No.	48	
11.	Methods for mounting		19'' Rack mounted	
12.	Connector type		FC- APC	
13.	Cable Management tray		(*)	

(*) means to be specified by bidder

Table 5: Splicing Machine

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Manufacturer		(*)	
2.	Type		Fusion Splicer	
3.	Applicable Fibers		Single-mode ITU-T G.652D	
4.	Fiber Count		Single	
5.	Cladding Diameter		125µm	
6.	Coating Diameter		Single: 250µm and 900µm	
7.	Fiber Cleave Length		900 µm: 10-20mm 250 µm: 16-20mm	
8.	Typical Average Splice Loss		0.05dB with SM, measured by cut-back method relevant to ITU-T and IEC standards	
9.	Splicing Time		20 seconds with standard single-mode fiber	
10.	Arc Calibration Method		Automatic with option of manual arc calibration function	
11.	Splicing Modes		100 preset and user programmable modes	
12.	Storage of Splice Result		Last 2000 splice results	
13.	Fiber Display		Both X and Y simultaneously with option of rear monitor display with automatic image orientation	
14.	Magnification		90X	
15.	Viewing Method		Dual cameras with 4.1 inch TFT color LCD monitor with anti-reflective coating	
16.	Operating Condition		0 to 5,000m above sea level, 0 to 85% RH, -10 to 50°C respectively	
17.	Mechanical Proof Test		1.96 to 2.25N	
18.	Tube Heater		Built-in tube heater with 30 heating modes complete with auto-start function	
19.	Tube Heating Time		50 seconds with FP-5 sleeve, 40 seconds with FP3 (40	
20.	Protection Sleeve Length		60mm, 40mm, micro	
21.	Splice/Heat with Battery		90 cycles with power save functions activated	

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
22.	Power Supply		Auto voltage selection from 100 to 240V AC or 10 to 15V DC	
23.	Terminals		USB 2.0 (USB-B type) for PC communication	
24.	Wind Protection		Maximum wind velocity of 50m/s.	
25.	Dimensions		136W x 161D x 143H (mm) / 5.3W x 6.3D x 5.6H (inches)	
26.	Weight		<3 kg with AC adapter	
27.	Laser Safety		Class 1 Enclosure Auto Laser Shut off	

(*) means to be specified by bidder

Table 6: Fault Locator

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Fiber Type		9/125 μ m Single Mode	
2.	Wavelength	nm	1550 \pm 20	
3.	Emitter Type		LD	
4.	Connector Type		SC	
5.	Pulse Width (ns)		10/20/40/80/160/320 /640/1280/2560/5120 /12400/24800 (auto-switch)	
6.	Max Output Power	mW	\leq 100	
7.	Max Measurement Range	km	\geq 130	
8.	Distance Accuracy		+/- (0.8m + 0.001% x Distance)	
9.	Data Storage	measurements	999	
10.	Event Dead Zone	m	\leq 3	
11.	Power Supply		AC/DC adapter & Rechargeable NiHM Batteries	
12.	Battery Life	uses	15,000	
13.	Operating Temp.	$^{\circ}$ C	-10 to 55	
14.	Storage Temp	$^{\circ}$ C	-20 to 60	
15.	Humidity	%	<85 (non-condensing)	
16.	Communication Port	Type	USB/Serial	
17.	Dimension (mm)		(*)	
18.	Net Weight	g	\leq 250	

(*) means to be specified by bidder

Table 7: Camera Type 1

The 5Megapixel Environmental IP Outdoor/Indoor Fixed Mini-Dome IR Camera

No	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Max Resolution	Megapixel	2048x1536	
2.	Image Sensor		1/3.2-inch CMOS	
3.	Lens	mm	3-9, varifocal	
4.	IR Illumination		Integrated Adaptive IR Illumination	
5.	Focus		Autofocus Motorized Remote Zoom Lens	
6.	Compression		H.264 and MJPEG Compression Capability	
7.	Frames per second		Up to 30 Images per Second (IPS) at 1080p	
8.	Day/Night		Day/Night Capability	
9.	Illumination	Lux	0.03 @ f/1.2	
10.	Video Streams		configurable streams	
11.	Analytics		Motion detection/ camera sabotage	
12.	Local Storage	GB	32 with microSDHC or SDXC, record video	
13.	Power Input		PoE (IEEE 802.3af, Class 3), 24 Vac	
14.	Warranty	Years	3	
15.	ONVIF		Profile S Conformant	

Table 8: Camera Type 2

Description -5 Megapixel IP Environmental Bullet Outdoor/Indoor Fixed Cameras complete with Integrated Lens and Infra-red Illumination

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Max Resolution	Megapixel	2048x1536	
2.	Image Sensor		1/3.2-inch CMOS	
3.	Lens	mm	3-9, varifocal	
4.	IR Illumination		Integrated Adaptive IR Illumination	
5.	Focus /Zoom		Auto focus, remote zoom	
6.	Day/Night		Day/Night Capability	
7.	Wide Dynamic Range	dB	65	
8.	Illumination	Lux	0.03 @ f/1.2	
9.	Max IPS at Max Resolution	IPS	12	
10.	Video Streams		configurable streams	
	Audio		Bidirectional	
	Analytics		Simple motion detection/ camera sabotage	
11.	Local Storage	GB	32 with microSDHC or SDXC, record video	
12.	Power Input		24 PoE (IEEE 802.3af, Class 3), 24 Vac	
13.	Warranty	Years	3	
14.	ONVIF		Profile S Conformant	

Table 9: Camera Type 3

Description -12- Megapixel H. 264 WDR 1800 Panoramic Day/ Night Indoor/Outdoor Dome IP Camera

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Image Sensor		4 x 3MP CMOS WDR	
	Optical Format		1/3.2" Progressive Scan	
	Pixel Pitch	µm	2.2	
2.	Lens		M12 small size lens, true 3MP lens	
3.	Minimum Illumination	Lux	Day/Night 0.025 Lux, IR sensitive	
4.	Full Field of View (FOV) Resolution		Per Sensor 2048 H x 1536 V; Total = 4096 H x 768 V	
	Dynamic Range	dB	100	
5.	Compression Type		H.264 and MJPEG Compression Capability	
6.	Multi- Streaming		8 non-identical streams (2 per sensor)	
7.	Electrical		Power Over Ethernet; PoE 802.3af, Class 3 Auxiliary Power; 12–48V DC and 24V AC	
8.	Video Frame Rates		Max 5.2fps (8192 x 1536); 16.7fps (4096 x 768)	
9.	Programmability			
9.1	Auto adjustment between WDR modes		Yes	
9.2	Flexible Cropping LDR +/-5° Digital Vertical Alignment to adjust images;		Yes	
9.3	Electronic pan,		Yes	
9.4	tilt		Yes	
9.5	zoom (PTZ) On-camera real-time motion detection with up to 1024 detection zones (per sensor)		Yes	
9.6	Bandwidth and storage savings by running at 1/4 resolution;		Yes	
9.7	Bit rate and bandwidth limit control modes,		Yes	
10.	Compliance		Industry Standard; ONVIF Conformant Listings; UL (CB) FCC Compliance; 47 CFR 15 Class A	
11.	Mechanical		Protection Ratings; IK-10 vandal-resistant polycarbonate dome; IP66 water/dust protection rating	
12.	Warranty	Years	3	

Table 10: Camera Type 4

Description- The 12-Megapixel H.264 WDR All In One Directional User- Configurable Multi-Sensor True Day/Night Indoor/Outdoor Dome IP Camera

No	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Image Sensor		4 x 3MP CMOS WDR	
	Optical Format		1/3.2" Progressive Scan	
	Pixel Pitch	µm	2.2	
2.	Lens		8mm, F/1.6", H-FOV = 33°	
3.	Minimum Illumination	Lux	Color-0.5 Lux Color Binning -0.15 Lux Day/Night -0 Lux, IR sensitive	
4.	Full Field of View (FOV) Resolution		Total:8192 H x 1536 V	
7.	Power Over Ethernet		PoE 802.3af, Class 3	
8.	Video Frame Rates		5.2fps (8192 x 1536)	
9.	Gimbal		Easily adjustable, 2-axis w/360° pan and 90° tilt Up to 4 Individual Camera Gimbals can be Independently Placed in Any Orientation Around a 360° Track with Extra Positions for Looking Straight Down	
10.	WDR	dB	100	
11.	Day/Night		True Day/Night Functionality with Mechanical IR cut filter	
12.	Binning Mode		Binning mode for strong low light performance	
13.	Casing	(*)		
14.	DATA transmission		Compression Type:H.264 (MPEG-4, Part 10)/Motion JPEG 21 levels of quality	
15.	Environmental	(*)	IP66, IK -10	
26.	Operating Temperature	°C	-40 to +50	
27.	Humidity	%	0to 90(non-condensing)	
28.	Stable image Temperature	°C	0 to +50	
29.	Storage Temperature	°C	-40 to +60	

(*) means to be specified by bidder

Table 11: Technical Specification for LCD MONITOR

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Resolution	pixels	1920 x 1080	
2.	LED Backlight Technology	included	Must use energy saving LED backlighting rather than cold cathode fluorescent lights (CCFL)	
3.	Type PIP	Included	Must provide picture-in-picture (PIP) for any combination of 2 inputs.	
4.	Energy Star certified	Included	Must be energy Star certified, ensuring reliability in a 24/7 security installation environment	
5.	Design	included	Must be constructed of a lightweight aluminum frame composition for desktop or wall-mount installations.	

Table 12: Biometric Card Reader

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Fully Integrated Biometric and card reader access control system The reader must serve as a controller, biometric reader, card reader as a single module in one device.	Included	Yes	
2.	Onboard Card reading Support onboard card reading technologies for 125KHZ proximity and 13.56MHZ Mifare, i-class (16K and 32K bits), DESFire and dual technology (i.e. Proximity and Mifare). Allow other support to external technology using Wiegand connections.	included	Yes	
3.	Communications Onboard 10/100mps Ethernet using CAT5/6 cable. Allow direct communication with Host server without a controller	included	Yes	
4.	Enrollment Allow fast finger print enrollment using TCP/IP. Enroll finger print and card holder at the same time without the need for separate finger print/card holder enroller. This shall be done directly through the access control system	included	Yes	
5.	Support Messages The reader Must have Large graphical LCD screen to allow users messages to be legible e.g. access denied, card expired etc. The messages must be editable into local language from the control software.	included	Yes	
6.	Database Structured database to Support at least 123,000 card holders and support at least 8,000 transactions in offline operations. Must have internal rechargeable Lithium back up battery.	included	Yes	

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
7.	Offline Operating Mode The reader must contain an up-to-date information offline. Finger prints and card holder templates must be stored from the control computer and frequent updates downloaded on to the reader.	included	Yes	
8.	Configurations Allow configuration through the Control computer and also via the keypad on the reader.	included	Yes	
9.	Input/Output At least four inputs to monitor alarms and two changeovers relay outputs to activate door or other equipment.	included	Yes	
10.	Scan Parameters Offer high resolution scanning detecting conductivity of living tissues beneath the skin which Must match FBI requirements and shall be FIPS201 certified.	included	Yes	
11.	Housing Flame retardant polycarbonate with fully encapsulated electronics. Must be small and light and approved by client.(attach brochure)	included	Yes	

Table 13: Client Workstation Computer for CCTV Surveillance

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Processors Intel® Xeon® Processor E3-1200 v3 Family; 4th generation Intel® Core™ i7 and i5; Turbo Boost Technology 2.05 and Intel Integrated HD Graphics on select processors; optional Intel vPro™ technology	included	Yes	
2.	Operating Systems Windows® 10 Pro (64-Bit) Windows® 8 Pro (64-Bit) Genuine Windows® 7 Ultimate 64-Bit; Genuine	included	Yes	
3.	Chipset Intel® C226 Chipset	included	Yes	
4.	Memory 2,4 Up to 32GB 1600MHz ECC; up to 16GB 1600MHz non-ECC DDR3 memory; 4 DIMM slots	included	Yes	
5.	Graphics 4 Mini tower: one PCI Express® x16 Gen 3 graphic card up to 150W (total for graphics) (some cards available in dual config): Small form factor: one low profile PCI Express® x16 Gen 3 graphic card up to 50W (total for graphics):	included	Yes	
6.	Storage Options Mini tower: up to two 3.5" or four 2.5" SATA drives; Small form factor: one 3.5" or two 2.5" SATA drives; Both: Intel Smart Response Technology (SRT)®, Intel Rapid Start Technology (RST)®, Smart Connect Technology (SCT)® with select drives	included	Yes	
7.	Storage Controller Integrated: Intel Rapid Storage Technology supporting SATA 6Gb/s and host based RAID 0/1/5/10	included	Yes	
8.	Communications Integrated: Integrated Intel 82579 Gigabit Ethernet controller with Remote Wake UP, PXE and Jumbo frames support Optional: Broadcom NetXtreme 10/100/1000 Gigabit Ethernet controller (PCI Express card)	included	Yes	

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
9.	Audio Controller Integrated Realtek ALC269Q High Definition Audio	included	Yes	
10.	Storage Devices Up to two optional optical drives: DVD-ROM; DVD+/-RW; Optional 19-in-1 media card reader (installed in 5.25" bay)	included	Yes	
11.	Environmental and Regulatory ENERGY STAR® 5.2 configurations available including optional 80 PLUS® registered Gold power supplies; EPEAT® registered (see epeat.net for specific registration rating/status by country); China CECP; GS Mark. For a complete listing of declarations and certifications, see Dell's regulatory and compliance homepage at dell.com/regulatory compliance.	included	Yes	
12.	Security Options Trusted Platform Module 1.2 (TPM 1.2); Intrusion switch; Setup/BIOS Password; I/O Interface Security; Kensington® lock slot, Padlock ring, lockable power supply; Dell Data Protection (DDP): DDP Security Tools for advanced authentication; DDP Protected Workspace for malware; DDP Encryption for data protection.	included	Yes	
13.	Chasis HxWxD: 14.17" x 6.89" x 17.13" / 360mm x 175mm x 435mm Bays: Two internal 3.5" bays; two external 5.25" optical bays Slots: One PCIe x16 Gen 3; one PCIe x16 Gen 2 wired x4; one PCIe x1; One PCI 32bit/33MHz Power Supply: 365W 90% efficient (80 Plus® Gold Certified); 290W 65% efficient.	included	Yes	
14.	Monitor Capability UltraSharp series - high-performance monitors with PremierColor (on select models) and ultrawide viewing: 21.5"-30";	included	Yes	
15.	Keyboard; Mouse; Speakers Smartcard Keyboard; Multimedia Keyboard; USB Optical Mouse; Laser USB 6-Button Mouse; 2.0 and 2.1 stereo speaker systems available; sound bar for select flat-panel displays	included	Yes	
16.	Warranty and Support Services 1-year	included	Yes	

Table 14: Switch

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	Manufacturer	Name	Cisco	
2.	Model	Number	SG 300-28	
3.	General Jumbo frames Frame sizes up to 10 KB supported on 10/100 and Gigabit interfaces MAC table Up to 8000 MAC addresses	Included	Yes	
4.	Ports 26 Gigabit Ethernet RJ45, 2x RJ45/SFP Combo Ports	Included	Yes	
5.	Power Over Ethernet (PoE) Maximum power of 15.4W to any Gigabit Ethernet base port. Total power 180W	Included	Yes	
6.	Security Secure Shell (SSH) Protocol, Secure Sockets Layer, IEEE 802.1X (Authenticator role) Layer 3 isolation, Port security: Locks MAC addresses to ports, and limits the number of learned MAC addresses	Included	Yes	
7.	Flash; CPU memory; Packet Buffer 16 MB; 128 MB; 4MB	included	Yes	
8.	Cable Type Unshielded twisted pair (UTP) Category 5 or better for 10BASE-T/100BASE-TX; UTP Category 5 Ethernet or better for 1000BASE-T	Included	Yes	
9.	Power Power saving mode: Energy Detect, Short Reach Maximum Consumption 110V = 30.1W / 220V = 30.3W, Heat Dissipation (BTU/hr) 103.4 , Power Supply: 100–240V 47–63 Hz, internal, universal	included	Yes	
10.	Certification UL (UL 60950), CSA (CSA 22.2), CE mark, FCC Part 15 (CFR 47) Class A	included	Yes	

Table 15: Low Voltage AC Distribution/Metering Panel

No.	Description	Minimum Requirements		Data offered by Bidder
		Unit	Data	
1.	General			
2.	Manufacturer's name	name	(*)	
	Type		metal clad, outdoor, air insulated	
3.	Installation	type	outdoor	
4.	Rated Voltage	V	400/230	
5.	Rated frequency	Hz	50	
6.	Busbar			
	Rated currents	A	160	
	Material		copper	
	Short-circuit current (1 s.)	kA	10	
	Number of 3-phase outgoing		20	
	Number of 1-phase outgoing		0	
	Protection		IP 4X	
7.	Equipment/Accessories			
	Main 3-phase 4-poles moulded case circuit breaker for incoming feeder		(*)	
	AC current Meter		(*)	
	AC volt meter		(*)	
	3-phase 4-pole MCBs for outgoing feeders		(*)	
	outlet socket 220 V, 50 Hz, 10 A		(*)	
	Heater		(*)	
	Humidity & Temperature Controller		(*)	
8.	Dimensions			
	length	mm	(*)	
	height	mm	(*)	
	depth	mm	(*)	
	Weight	kg	(*)	
9.	Applicable standard(s)		IEC 60364, IEC 60439, VDE 0100	

(*) means to be specified by bidder

Table 16: 70mm² LV 4/C AL XLPE Service Cable

Description	Minimum Requirements		Data offered by Bidder
	Unit	Data	
Applicable standards		IEC 60228, IEC 60502	
Manufacturer		(*)	
Country of Origin		(*)	
Main Conductor Material		Stranded Aluminium	
Number of Cores		4	
Code number		(*)	
Cable size	mm ²	70	
Insulation Material		XLPE	
Type of Armour		Steel Wire	
Rated Voltage	V(rms)	0.6/1.2kV	
Operating frequency	Hz	50	
Highest Temperature rating	°C	90	
Nominal insulation thickness	mm	(*)	
Nominal overall diameter	mm	33	
Linear mass	kg/m	(*)	
Current Rating (Laid in Ground)	A	220	
Short Circuit Rating (1sec)	kA	10	
DC Resistance @ 20°C	Ohm/km	0.268	

(*) means to be specified by bidder

Table 17: Laptop Computers

No.	Description	Minimum Requirements		Data Offered by Bidder
		Unit	Data	
1.	Intel Core i7-6200U Processor	GHz	2.3	
2.	DDR3L 1600 MHz RAM	Gigabytes	16	
3.	Windows 8.1 pro or 10.1 pro operating system	bits	32	
4.	Optical Drive Super Multi DVD burner	included	yes	
5.	7200 rpm Optical Hard Disk Drive	Terabytes	1	
6.	FHD LED Glossy Display Panel with Camera(1920X1080)	inch	15.6	
7.	Intel HD 5500 Graphics Card	included	yes	
8.	Integrated Intel Gigabit network connection modem(10/100/1000 NIC)	Kilobytes	56	
9.	802.11 ac Wireless WLAN and Bluetooth	included	yes	
10.	Security Lock Slot plus steel cable with a combination lock	included	yes	
11.	USB 3.0 port, VGA, MiniDP, Ethernet(RJ 45),Dock connector	included	yes	
12.	Touch pad with scroll zone, two pick buttons, or point stick point, two pick buttons	included	yes	
13.	Six row, spill-resistant, multimedia Fn keys, optional LED backlight, TrackPoint pointing device AND buttonless Mylar surface touchpad, multi touch	included	yes	
14.	External wireless optical mouse	included	yes	
15.	HD, low light sensitive, fixed focus camera	pixels	720	
16.	Smart card 4-in-1 media reader(MMC,SD,SDHC,SDXC)			
17.	3 year/1 year battery limited onsite service warranty	IWS	17	
18.	Li-Ion 6-cell External Battery	Wh	72	
19.	240V AC power supply with British plugs	Hz	50	
20.	Leather Carrying Case	included	yes	