Technical Specification

**Technical Specification** 

### PARTICULAR TECHNICAL SPECIFICATIONS FOR DISTRIBUTION TRANSFORMERS

### 1.1 Scope

This chapter covers the particular technical requirements of the medium 24 kV voltage equipment to be procured under this contract. By conflict between the general specification and the particular specifications below the particular specifications shall prevail.

#### **1.2** Applicable Standards

The equipment and the components supplied shall be in accordance with the latest edition of the standards specified below and amendments thereof. However the GEDCO Specification shall supersede these Standards in the event there is a discrepancy:

- a) IEC 60076 (1993) Power Transformers
- b) DIN42500 Three-phase oil-immersed distribution transformers 50 Hz, 50 up to 2500 kVA; general requirements and requirements for transformers Um up to 24 kV; German version HD 428.1 S1:1992
- c) IEC 60156 (1995) Insulating liquids-determination of the breakdown voltage at power frequency – test methods
- d) IEC 60296:3 unused minerals insulating oils for transformers and switch-gear
- e) IEC 60354 (1991) Loading guide for oil-immersed transformers
- f) IEC 60551 (1987) Determination of transformer and reactor sound levels
- g) IEC 60616 (1978) Terminal and tapping markings for power Transformers
- h) IEC 60722 (1982) Guide to the lightning impulse and switching impulse testing
- i) IEC 60815 (1986) Guide for the selection of insulators in respect of polluted conditions
- j) IEC 60137 (1995) Insulating bushing for alternating voltages above 1 kV
- k) BS 5493 (1997) Protective coating of iron and steel structures against corrosion
- I) IEC 60085 Thermal evaluation and classification of electrical insulation

### 1.3 Basic Features

The transformers shall be 22/0.4kv, 3-phase, two winding, liquid immersed, sealed or Breathing type rated for continuous operation under site ambient conditions at full rated power, naturally cooled (ONAN), with off load, manual, operated tap-changer, lockable in all positions on primary side.

#### 1.4 Vector Group

Unless otherwise specified, the transformer shall be connected delta-star in accordance with vector group reference Dyn11.

### 1.5 Impedance Voltage

The impedance voltage at normal tap shall be 4% for transformers up to 800KVA and 6% for 800KVA transformers or greater.

### 1.6 Temperature Rise:

At the rated power, the transformer shall comply with the following maximum temperature rises:

Top oil 45°C Max.

Winding 50°C Max.

Hot Spot 98°C Max.

Avg. temperature to short circuit 250°C Max.

### 1.7 Overload Capacity

After thermal equilibrium has been reached at 75% of rated load, the transformer shall be capable of sustaining the overload conditions listed in the following table without the transformer winding hot spot temperature exceeding 110 °C:

Load Percent of rating (%)	Minimum I Ambient Ter	Duration in Minutes at nperature of Percent of
	30 ºC	40 ºC
133	240	155
150	98	65

The supplier shall demonstrate by test and calculation that these requirements are met.

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### 1.8 Noise Level

In general is to be less than 68 dB at 0.3m for ratings up to 2000 kVA and in accordance with IEC 551.

### 1.9 Transformer Construction

- The primary and secondary windings shall be constructed from high conductivity E.C. grade copper. All turns of windings shall be adequately supported to prevent movement. The high voltage winding shall be of layered winding and the low voltage winding shall be of foil winding using Copper sheets.
- The Windings shall contain minimum two ventilation channels.
- The core and coil assembly shall have the core and coils rigidly connected. The core/coil assembly shall be mounted on the cover plate so that the assembly could be removed from the tank using the suitably placed lugs provided on the cover plate.
- There must be a possibility of easy to take out the windings from the core.
- No material which can be deleteriously affected by the action of oil under the operating conditions of the transformers shall be used in the transformers or leads or bushings.
- To ensure that the core and coils of transformers are seated on the floor of the tank, supporting frames shall be designed to accommodate variations in tank height. The core and coil assembly shall be rigidly connected to the tank and suitably closed lugs shall be provided for removing the core and coil assembly from the tank.
- Construction features shall permit local repairs to be easily carried out in the event of equipment failure.
- ✤ All internal connections shall be made of copper wires.

### 1.10 Transformer Tank

Variable volume steel tank, with corrugated wall design forming integral cooling pockets, heavy rolled and welded steel bottom and base frame and hermetically sealed bolted-on cover. Tank is to be completely filled with insulating liquid drawn in under vacuum. Tank cover is to have provision for two thermometers or temperature sensors, lugs for lifting, four lashing lugs and filler-pipe with valve. Tank is to have drain plug at bottom, earthing bolt on cover and earthing pad on base-frame, and a rating plate.

- The transformer tank shall be fabricated from steel and shall be of robust construction.
   Care should be taken at the manufacturing stage so as not to have leaks during transportation or when the transformer is continuously operated at rated power.
- With the exception of radiator elements, all external joints shall be seam welded. There shall be only one vertical seam weld for the fin radiator and the other three vertical corner edges of the transformer shall be formed by bending. Corner ribs shall be avoided for the fin radiator. The bearing surface of the tank to which bushings are clamped shall be substantially flat.
- All matching faces of joints shall be made oil tight and finished with a smooth surface to ensure that the gasketing materials make a satisfactory joint.
- Flanges and covers of tanks shall be of sufficient thickness to prevent any depression occurring, which would retain water around the bolts. The horizontal edges of the cover plate shall be bent over the tank flange to facilitate water dripping out of the tank. The bent collar width shall be about 10mm to 15mm.
- All the nut and bolts used shall be hot dip galvanized and spaced at sufficiently close intervals to avoid buckling of either flange or covers and shall provide reasonably uniform compression of the gasket.
- Each transformer shall be provided with a minimum of two closed lifting lugs. The minimum diameter of the hole or width of the slot shall be 25 mm. The two lifting lugs shall be located such that there would be a minimum of 50 mm between the lifting chain and the nearest part of the bushings.

#### **1.11** Transformer Sealing / Gasket

- The transformers shall provide with a satisfactory lid sealing gaskets. The gasket shall of the good quality to maintain the sealing effect through its life span and shall prevent seeping of oil due to ageing and extreme operating temperature.
- Gaskets provided with the transformers shall be suitable for making oil tight joints, and there would be no deleterious effects on either gaskets or oil when the gaskets are continuously in contact with hot oil. No gaskets shall be used in which the material of the gasket is mounted on a textile backing.
- Exterior gaskets shall be of rubberized cork material, weather-proof and shall not be affected by strong sunlight.

#### 1.12 Internal and External Finish

#### ✤ SCOPE

The following coating is intended for the protection of the transformer during its service in hard environmental conditions, as: high humidity, high sun radiation, industrial fumes, desert storms, chemicals, and high salty atmospheric conditions.

The finishing coat has a good shade and gloss retention.

### ✤ PROCESS OF CLEANING AND SURFACE PREPARATION

1. Partial mechanical cleaning of weld slags flux, and weld spatters.

2. Sand blast in accordance with grade SA 2.5 – ISO 8501-1, Swedish standard SIS-

055900, . (Similar to American SSPC SP-10).

### ✤ COATING PROCEDURE FOR EXTERIOR SURFACES

### 1. Base coat

Epoxy primer, two components Thickness of dry film: 120 microns.

#### 2. Top coat

Polyurethane-acrylic coating, 2 components Thickness of dry film 30-40 microns. Color: Grey RAL 7023.

3. Total thickness of the coating system: 150 microns.

#### ✤ INTERIOR SURFACES

1. One coat of varnish or epoxy primer at dry film thickness of 15 microns minimum.

#### ✤ REQUEREMENTS

- 1. Adhesion 2 mm Rating 0 (ISO 2409).
- 2. Salt spray (Scribe x on the coating) 500 hrs. (ISO 9227 or ASTM-B 117).

Adhesion test after 24 hrs. drying: Maximum adhesion loss at scribe, 2 mm. Blistering remote from scribe none.

3. UVA Artificial weathering: 1000 hrs. (ISO 4892-3).

Maximum color change: E - <2.6.

Maximum loss of gloss @ 60 degrees: 25%.

### FLANGES

- 1. Sealing surfaces of flanges shall be painted by base coat only.
- 2. All flanges shall be sealed by means of gaskets and metal plates.

### 1.13 Rating Plate

- A brass /stainless steel rating plate shall be fitted to each transformer. The information shall be deeply etched including the diagram of the connections of the windings, the vector diagram showing the general phase relations of the transformer, and a diagrammatic plan of the transformer cover showing the terminal positions and marking and other essential particulars.
- The plate shall be mounted in an accessible position and following information shall be clearly and indelibly marked in English language.
- a) Transformer type
- b) Manufacturer's name
- c) Manufacturer's serial number
- d) Year of manufacture
- e) Number of phases
- f) Rated power
- g) Rated frequency
- h) Rated voltages
- i) Rated currents
- j) Connection symbol (Vector Group)
- k) Mass of insulating oil
- I) Insulation levels
- m) Details regarding tapping
- n) Gross weight
- o) Impedance voltage at rated current
- p) Type of cooling
- q) Total mass

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### 1.14 Bushings

- All bushings shall be of porcelain clad, of the highest quality and comply with IEC 60137.
   They shall be sealed in a manner to prevent ingress of moisture and to facilitate removal.
   The neutral bushings and stems shall be identical to those provided for phase
   terminations. Bushing palms shall be made of brass and be suitable for the bolting of
   conductor compression lugs.
- The palms shall be suitably dimensioned, to suit the bushing rod and the holes spaced sufficiently apart to enable tightening of bolts using standard spanners and to prevent overlap of lugs. The LV bushing palms shall be as indicated in the attached drawings
- The MV bushings shall be labeled U, V, and W by using indelible black color paint. Phase identification by adhesive stickers is not acceptable.
- All Indoor Transformers MV bushings shall be K180 AR3 Type
- All Outdoor Transformers MV bushings shall be 30 NF -250 Type
- All Transformers LV bushings shall be as below bushings type
- The Transformers 160 KVA & 250 KVA LV bushings shall be with drilled hole 2x Ø14 mm
   Brass Flag
- The Transformers 400 KVA, 630 KVA, 800 KVA, 1000 KVA, 1250 KVA, 1600 KVA and 2000
   KVA LV bushings shall be with drilled hole 4x Ø14 mm Brass Flag.

Rating	Installation	Type of b	oushing
(kva)		H.V	L.V
2000	Indoor	K180 – AR3	DT4000
1600	Indoor	K180 – AR3	DT3150
1250	Indoor	K180 – AR3	DT2000
800	Indoor	K180 – AR3	DT2000

800	Outdoor	30 NF -250	DT2000
630	Indoor	K180 –AR3	DT2000
630	Outdoor	30 NF -250	DT2000
400	Outdoor	30 NF -250	DT1000
250	Outdoor	30 NF -250	DT630

### 1.15 Earthing Connections

- Earthing connections shall be provided with connection facilities for 70mm2 copper stranded conductors.
- Three bolts of M12 size shall be located on either side of the tank base (two) and on the cover plate (one).

### 1.16 Off Load Tap Changer

- The Tap changer shall made of stainless steel.
- Voltage tapings shall be provided on the primary side of each transformer. Tapping step shall be ±2.5%. Number of tapings shall be as specified in Technical guarantees.
- The tapings shall be selected by an 'off load' tapping switch with an external hand wheel with provision for locking on to a selected tapping. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service.
- The voltage operating positions, together with tap change positions shall be `clearly and indelibly marked.

### 1.17 Surge Arrester Mounting Bracket/Bracket to fixing the fuse holder

- The surge arrester mounting bracket/ Bracket to fixing the fuse holder made of steel shall be provided on the transformer cover plate.
- The bracket shall be hot dip galvanized and suitable to accommodate three surge arresters/fuse holder as indicated Specifications in the drawings.

### 1.18 Oil

 Generally all transformers shall be filled to the required level with a new, unused, clean, standard mineral oil in compliance with IEC60296.  PCB synthetic liquids (Poly Chlorinated Biphenyls) or other chlorinated hydro carbons are not acceptable and shall not be used.

#### 1.19 Conservator

- For Outdoor Transformers only, the Conservator shall have an adequate sump, a filling cap and a drain valve.
- Level gauge with markings to be provided on conservator. The level gauge to indicate maximum, minimum and normal level.

#### 1.20 Radio Interference

When operated at voltage even up to 10% in excess of the normal system rating, transformers shall be substantially free from partial discharges (i.e. corona discharges in either internal or external insulation) which are likely to cause interference with radio or telephone communication.

#### 1.21 Accessories

All outdoor transformers shall be including below accessories:

- a) Expansion vessel (Conservator)
- b) Oil Filling Opening
- c) Manual Ball Oil Drain Valve with Sampling Devices
- d) Grounding Terminals
- e) Diagram and Name Plate
- f) Thermometer Pocket
- g) Oil Level Indicator
- h) Lifting lugs
- i) Safety Valve (over Pressure Relief Device)
- j) U Base
- k) Dehydrating breather (silica-gel breather)
- I) Buchholz relay with ability to Connection with SCADA System for Indication.
- m) Oil temperature indicator with ability to Connection with SCADA System for Indication.

### All indoor transformers shall be including below accessories:

- a) Oil Filling Opening
- b) Manual Ball Oil Drain Valve with Sampling Devices
- c) Grounding Terminals
- d) Diagram and Name Plate
- e) Thermometer Pocket

f) Oil Level Indicator for indoor transformers ratings up to 630 KVA

g) Oil temperature indicator with ability to Connection with SCADA System for Indication for indoor transformers ratings up to 630 KVA

h) Lifting lugs

i) Safety Valve (over Pressure Relief Device)

j) U - Base with Wheels

k) DGPT (Combined Gas-Pressure Temperature Relay) or R.I.S. (Integrated Safety detector) Including Oil Level Indicator for indoor transformers ratings bigger than 630 KVA.

### 1.22 Characteristics

a.	Rated power:	1600 kVA /1250 kVA /1000KVA/ 800kVA /630kVA
		/400KVA/250KVA/160KVA/100KVA/50KVA

- b. Winding connection: Dyn 11, neutral insulated and brought out
- c. Frequency: 50 Hz
- d. Rated voltage primary: 22 kV
- e. Rated voltage secondary 0.4 kV
- f. Impedance 6% For 800 , 1250, 1600KVA , 4% for 50,100,160,250,400,630KVA
- g. Tap-changer positions: Plus 1x 2.5% Minus 3x 2.5%
- g. Insulation level :
  - Impulse withstand voltage (Peak 1.2/50 µs (kV)): 125

- Power Frequency withstand Voltage (r.m.s 1 minute (kV)): 50

- h. Available fault current of system at location: 20kA
- i. Duration of short-circuit: 3 sec.
- j. Terminal connections:
  - -HV side: Fully insulated with epoxy sealed end, bolted
  - -LV side: LV busbars

### 1.23 Losses, Impedance Voltage and Noise Level

The indicated figures below are the maximum acceptable values with zero Tolerance. Tolerances will not be accepted by PEA, and Transformers with losses exceeding these values will be rejected.

Rating	Losses (Watt)		Impedance	Noise Level
(kVA)	No load	Load	Voltage (%)	(dB)
2000	2050	17500	6	68
1600	1700	14000	6	66
1250	1300	11400	6	64
800	950	7400	6	62
630	900	5100	4	60
400	610	3850	4	58
250	425	2750	4	55
160	300	2350	4	52
100	210	1750	4	49
50	125	1100	4	47

### 1.24 Outline Drawings, Maintenance Manual and Packing

Outline drawings and other necessary drawings baring an effect on customers' installation shall be provided with each transformer and a comprehensive maintenance manual shall also provided.

The Bidder shall furnish the Final Drawings before starting the manufacturing of transformers and must be obtained the final Approve of the PEA's before manufacturing.

#### 1.25 Quality Assurance

The manufacturer shall possess ISO 9001 Quality Assurance Certification for the manufacture of distribution transformers for the plant where the manufacture of distribution transformers is done. Bidders shall furnish a copy of the ISO certificate certified as true copy of the original by the manufacturer, along with the offer.

### 1.26 List of Reference

Bidders shall furnish the list of reference obtained from Electricity Supply Authorities to whom the Bidder have supplied Distribution Transformers of similar type in the past 3 years, the list shall indicate the Type, Rating, Voltage &, Year of Supply, the Quantity Supplied and shall furnish certificates for the last 3 years from the end user (utilities) including full name, address and phone number.

#### 1.27 Factory Visit

GEDCO have the right to send two representatives at the expense of the supplier, for visiting the factory to verify the capability of the manufacturer to produce transformers within stipulated time before or during the manufacturing.

#### 1.28 Routine Tests

The following routine tests as per IEC 60076: 1993 shall be carried out on all the distribution transformers ordered and the routine test reports shall be made available for the observation of the GEDCO representatives at the time of inspection.

- a) Measurement of winding resistance
- b) Measurement of insulation resistance
- c) Separate source voltage withstand test (High Voltage tests on HV & LV)
- d) Induced Over voltage Withstand test (DVDF test)
- e) Measurement of voltage ratio
- f) Measurement of No Load Loss & Current.
- g) Measurement of Load Loss & Impedance. (Efficiency & Regulation)
- h) Vector Group Verification

### 1.29 Type Tests

The following Type tests as per IEC 60076 and shall be witnessed with three GEDCO representatives and must be conducted on Four transformers (one outdoor 630KVA and one 800 KVA as below:

a) Lightning Impulse withstand voltage test.

b) Temperature-rise test.

c) Acoustic Sound Level Measurements.

#### 1.30 Special Tests

#### 1.30.1 Short Circuit Withstand Ability Test

The Bidder shall be furnished with the offer the Short circuit withstand ability test Certificates by an internationally recognized independent testing authority which shall be conducted in the last 7 years.

If the Bidder cannot Furnished the certificate The Bidder Price shall include The Short circuit withstand ability test and the certificate shall offered before any production of tender transformers.

The Short circuit withstand ability test shall have been conducted by a reputed independent laboratory accredited by International Laboratory Accreditation Corporation (ILAC) or International Accreditation Forum (IAF) or other reputed accreditation agencies.

### 1.30.2 Overload Capacity Test

The Overload Capacity Test shall conducted on Four transformers (one outdoor 630KVA and one 800 KVA and shall be witnessed by three GEDCO representatives according the item 1.7 (Overload Capacity) requirements.

#### 1.30.3 Testing the L.V and H.V winding material

The GEDCO representatives will choose one transformer to make sure that the used transformer windings are made of high grade Copper wires by cutting the transformer L.V and H.V windings.

The costs of this process shall be at the Bidder's own expense.

### **1.31** Acceptance /Sample Tests

The following Acceptance/Sample tests conforming to IEC 60076 on 11 transformers (Three outdoor 630 KVA and Two outdoor 800KVA) and shall be witnessed by three GEDCO representatives. Extra copies of these Test Certificates shall also be supplied with the equipment.

- 1. Measurement of winding resistance
- 2. Measurement of insulation resistance
- 3. Separate source voltage withstand test (High Voltage tests on HV & LV)
- 4. Induced Over voltage Withstand test (DVDF test)
- 5. Measurement of voltage ratio
- 6. Measurement of no Load Loss & current.
- 7. Measurement of Load Loss & Impedance. (Efficiency & Regulation)
- 8. Vector Group Verification
- 9. Oil leakage test
- GEDCO will select the transformers before the testing procedures.
- The Place of tests must be in the manufacturer's factory or in specialized laboratories for this tests.
- The No-load losses and Load losses at 75C° shall be according to the technical schedules, if any increases on the losses during the tests the transformers will be rejected.
- If any material is rejected, the supplier shall be obliged to replace it without extra payment.

### 1.32 Information's to be furnished with the Offer

The following Information shall be furnished the offer:

- a) Technical Guarantees.
- b) Constructional features and materials used for components.
- c) Separate explanatory drawings and dimensions of tap changer.
- d) Overall dimensional drawings.
- e) Transformers internal dimensions (core, windings and spaces)

e) Drawing of rating plate to scale incorporating the particulars called for.

f) Certified copy of the quality assurance conforming to ISO 9001.

g) List of Reference for goods and certificates from the end user (utilities) for the last 3 years including full name, address and phone number.

h) The Bidder shall provide clear name and the address of the manufacturers.

#### 1.33 Operating conditions:

- The existing transformers may expose to sudden loads that may reach 150%.
- The loads of the low voltage directly is connected to the transformers through Manual L.V Disconnector with Fuses.
- There is excess voltage levels resulted from the manual disconnecting and connection due to the load shedding program which is applied due to the electricity shortage.

So the manufacturer must design the transformers to be able to withstand such high and sudden loads.

### 1.34 Note:

The transformer shall be designed to resist system fault current due to the short circuit.

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Reference Manufacturing Standards		IEC 60076 or DIN42500			
4	Туре		3 phase oil- immersed Hermetically Sealed			
5	Continuous Maximum Rating (C.M.R)	KVA	1600			
6	Rated Frequency	Hz	50			
7	Cooling method		ONAN			
	Normal Voltage Between Phases at No Load					
8	a) H.V	Volts	22000			
	b) L.V	Volts	400			
	Connection and Vector Group					
q	a) H.V Winding		Delta			
5	b) L.V Winding		Star			
	c) Vector Group		Dyn11			
	Tapping Range on H.V Side					
10	a) Rating of the Tap change		+1x2.5% -3x2.5%			
	b) Type of Tap Changer		Off Load			
	Losses (Low Losses Type)					
11	a) No-load losses	Watts	1700 (Zero Tolerance)			
	b) Load losses at 75C°	Watts	14000 (Zero Tolerance)			
12	Max. Impedance Voltage of Short Circuit at 75 °C	%	6			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Voltage Drop at Full Load					
13	a) at unity Power Factor (Cosφ = 1)	%	1.095			
	b) at 0.8 Power Factor (Cosφ = 0.8)	%	4.38			
	Efficiency at full load					
14	a)at unity Power Factor (Cosφ = 1)	%	98.99			
	b)at 0.8 Power Factor (Cosφ = 0.8)	%	98.74			
	Max Temperature rise at C.M.R					
15	a) Top Oil by Thermometer	°C	45			
15	b) Average Winding by Resistance	°C	50			
	c) Hot Spot Corresponding to (b)	°C	98			
	Insulating Voltage Level					
16	a) Rated lighting – Impulse withstand Voltage 1.2/50 µs (Peak Value)	kV	125			
	b) Rated Duration Power Frequency withstand Voltage 1 min (r.m.s Value)	kV	50			
17	Material thermal class insulation (According IEC 60085)		Class A			
	Overloading					
18	a) Minimum Duration of %133 Overloading at 30C <sup>o</sup> Ambient Temperature and Preload 75% F.L	Min.	240			
	b) Minimum Duration of %150 Overloading at 30C <sup>o</sup> Ambient Temperature and Preload 75% F.L	Min.	98			
	Winding Conductor Material					
19	a) H.V winding		high conductivity electrolytic copper			
	b) L.V winding		high conductivity electrolytic copper			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Type of insulation					
20	a) H.V winding		Diamond pattern Kraft paper			
	b) L.V winding		Diamond pattern epoxy coated Kraft paper			
	Type of Bushing					
21	a) H.V Plug in Bushing		Euromold K180-AR3			
	b) L.V Bushing (with drilled hole 4x Ø14 mm Brass Flag)		DT3150			
22	Installation		Indoor			
23	Noise level at 0.3 m (Lwa)	dB	≤ 66			
	Transformer Oil (as Standard IEC60296:3	.0)				
	a) Kinematic Viscosity , at 40 °C	mm²/s	8			
	b) Density, at 20 °C	kg/dm <sup>3</sup>	≤ 0.895			
24	c) Breaking Voltage before Treatment	κv	≥30			
	d) Breaking Voltage After Treatment	кv	>60			
	e) Environmental Requirements		Polychlorinated biphenyls (PCBs) Free			
	f) Туре		Nytro 10XN or Equivalent			
25	Oil weight	Kg	shall be filled by manufacturer			
26	Total weight	Kg	shall be filled by manufacturer			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
	Internal Dimensions				-			
	a) Winding Length and shape of the windings	mm	shall be filled by manufacturer					
27	b) Space Between the Windings	mm	Bigger than 20 mm					
	c) Space between Windings and Transformer Top Body	mm	Bigger than 40 mm					
	e) Space between Windings and Transformer Side Body	mm	shall be filled by manufacturer					
	Overall Dimensions		-	-				
	a) Height	mm	shall be filled by manufacturer					
28	b) Length	mm	shall be filled by manufacturer					
	c) Width	mm	shall be filled by manufacturer					
	e) Space Between Wheel Centers	mm	shall be filled by manufacturer					
	Accessories							
	a) Oil Filling Opening		Required					
	b) Manual Ball Oil Drain Valve with Sampling Devices		Required					
	c) Grounding Terminals		Required					
	d) Diagram and Name Plate		Required					
29	e) Thermometer Pocket		Required					
29	f) Lifting lugs		Required					
	g) Safety Valve (over Pressure Relief Device)		Required					
	h) Wheels		Required					
	i) DGPT (Combined Gas-Pressure Temperature Relay) or R.I.S. (Integrated Safety detector) Including Oil Level Indicator		Required					
30	Short Circuit withstand ability test Certificates/Reports from internationally reputed testing agency		Required					

### 22/0.4 KV Low Losses , 3 phase , Indoor Distribution Transformer 1600 KVA Rating

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
31	Type, Acceptance, Overload capacity & Routine tests witnessed by Beneficiary		Required			
32	Attached Drawing		Drawing No IDT_1600			

Tenderer's Signature : .....

Date: .....

IDI_IDUU 22/0.4 KV Low Losses , 3 phase , Indoor Distribution Transformer 1600 KVA Rating
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1	L.V Bushing
2	H.V Plug in Bushing
3	RIS
4	Cover
5	Rating Plate
6	Tank
7	1" Drain Valve

- 8 Wheels
- Lifting Lugs  $\bigcirc$

	9 Litting Lugs 10 Safety Valve
$\begin{array}{c c} \\ \hline \\ $	11 Tap Changer 12 Thermometer Pocket 13 Dil Filling Opening 14 Desce Flace Court V/
Prepared by: Eng. Wael Ahmed Ismail Elhefni	14 Brass Flag for L.V Bushing 15 Grounding Terminal

### 36 Kv, 3-phase Outdoor Isolating Switch With Built-In Arc Interruption

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer		ELCO			
2	Country of Origin		ISRAEL			
3	Standards		IEC60129 & IEC60265-1			
4	Rated Voltage	kV	36			
5	Design and Operating		Manual Isolating Switch under load having capability of frequent switching			
6	All Ferrous Parts Material		Hot Galvanized Steel			
7	Pole No.		3			
8	Safe Operating Zone Temperature	°C	-10 to +55			
9	Rated Frequency	Hz	50			
	Arc Interruption					
	Name of Manufacturer					
	Country of Origin					
10	Туре		Heavy Duty			
10	Operating		without an External Arc or Flame Conforming to IEC 60265			
	Installation		Hard Fixed and not Able to Rotate			
	Insulators					
	Name of Manufacturer					
11	Country of Origin					

### 36 Kv, 3-phase Outdoor Isolating Switch With Built-In Arc Interruption

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	a) Material		Polymer			
	b) Creepage Distance	mm	1050			
12	Continuous Current Capacity	A	630			
13	Rated Peak withstand Current	KA	31.5			
14	Rated Short Time Current (1 sec Duration)	KA	12.5			
	Rated Lightning Impulse withstand	Voltage				
15	a) Standard Impulse with Stand Voltage to Earth (1.2/50 μs Full Wave)	kV	170			
	b) Between Poles Across Isolating Distance	kV	190			
	Rated One Minute Power Frequency	/ withsta	nd Voltage in Dry an	d Wet Conditi	ons	
16	a) Power Frequency Test Voltage to Earth	kV	75			
	b) Between Poles Across Isolating Distance	kV	100			
17	Minimum Clearance Between Phase and earth	mm	shall be filled by manufacturer			
18	Minimum Clearance Between Phases	mm	shall be filled by manufacturer			
19	Mechanical Operations	C/O	≥1000			
20	Electrical Operations Under 400A load	C/O	shall be filled by manufacturer			
21	Short Circuit Electrical Operations	C/O	shall be filled by manufacturer			
22	Installation and operating accessories		Required			

### 36 Kv, 3-phase Outdoor Isolating Switch With Built-In Arc Interruption

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
23	Master Key Lock Body		Chrome-plated solid brass			
24	Master Key Lock U-Shackle		Boron-steel alloy			
25	Type Test Certificates/Reports from internationally reputed testing agency (According IEC 694 and IEC 265-1)		Required			
26	Acceptance & Routine tests witnessed by Beneficiary		Required			
27	Switch Parts, Accessories and All Dimensions		As Attached Drawing No IS_36			

Tenderer's Signature : .....

Date: .....

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation
NO	Description	Onic	Requirements	Offered Data	Documentation	Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Design Standards		IEC60502-1 & IEC60228			
4	Test Standards		IEC60230 & IEC60502-1 & IEC60811			
5	Code & Designation		N2X2Y FR1 , L.V Cable with Copper Conductors and XLPE Insulation			
6	Climatic Design		- 5°C to 55°C			
7-	Rated Voltage					
7.1	Between Conductor and Sheath $(U_o)$	kV	0.6			
7.2	Between any Two Conductors (U)	kV	1			
7.3	Max. Service Voltage (U <sub>m</sub> )	kV	1.2			
7.4	Rated Frequency	HZ	50			
8-	Cable Design					
8.1	Cross Section	mm <sup>2</sup>	240			
8.2	Core No.	No	1			
8.3	Material		Copper			
8.4	Class and Form		Class2 - Circular Stranded			
8.5	Minimum No. of wires	No	34			
8.6	Conductor Minimum / Maximum Diameter	mm	17.5 / 19.2			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
8.7	Insulation Material		Cross Linked Polyethylene (XLPE)			
8.8	Nominal Insulation Thickness	mm	1.7			
8.9	Insulation Max Service Temperature	°C	90			
8.10	Outer Sheath Material		LDPE ST7 with Chemical Additives			
8.11	Nominal Sheath Thickness	mm	1.8			
8.12	Overall Diameter of the Cable	mm	shall be filled by manufacturer			
8.13	Max. Rated Temperature for Permanent Load	°C	90			
8.14	Max. Rated Temperature for Emergency Loads	°C	105			
8.15	Max. Rated Conductor Temperature at Short Circuit (1 sec. max. duration)	°C	250			
8.16	Total Weight of the Cable	kg/km	shall be filled by manufacturer			
8.17	DC Resistance (R <sub>dc</sub> )	ohm/km	shall be filled by manufacturer			
8.18	Minimum Bending Radius	mm	shall be filled by manufacturer			
8.19	Continuous Current Carrying Capacity Single Cable Laid Buried in 0.7 m Deep in Soil at 20 <sup>°</sup> C with 1 k.m/w Thermal Resistivity and Load Factor 0.7	A	521			
8.20	Short circuit rating (1 sec) based on an initial conductor temperature of 90 °C and a final temperature of 250 °C	KA	34.3			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
9-	Drum :					
9.1	Method of Cable Delivery		on Drums			
9.2	Length of Cable on Drum	m	500			
9.3	Drum Material		New Wood			
9.4	Cable Protection on Drum		Wooden Batten			
9.5	Max. Gross Weight of Drum with Cable	kg	shall be filled by manufacturer			
9.6	Dimension of Drum	mm	shall be filled by manufacturer			
10	Permissible Pulling Forces	Ν				
11-	Tests :					
11.1	Type Test Certificates /Reports from internationally reputed testing agency		Required			
11.2	Acceptance & Routine tests witnessed by Beneficiary		Required			
			Embedded print, giving :			
12	Marking		2- Cross-section 3- Manufacturer name 4- Nominal voltage			
			5- Length for Each Meter 6- Production year			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Outer Sheath XLPE II	nsulation	Conductor			

Tenderer's Signature :		Date:	
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### Low Voltage Distribution Board 2500A with Main C.B. IZM 2500A and 10 Feeder

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Standard		IEC 60439			
4	Rated Insulation Voltage	V	1000			
5	Rated Operational Voltage	V	690			
6	Rated Frequency	HZ	50			
7	Safe Operating Zone Temperature	°C	-10 to +55			
8	Network System		ТТ			
9	Design		Metal-Enclosed			
10	Туре		Indoor			

### 11- Busbars

11.1	Reference Standards		BS 159		
11.2	Material		made of rectangular high grade electrolytic copper with insulation covering		
11.3	Dimensions		2(100*10mm)+N+E 100*10mm		
11.4	Rated Current at 45 °C	A	3000		
11.5	Rated Peak withstand Current	KA	176		

## Low Voltage Distribution Board 2500A with Main C.B. IZM 2500A and 10 Feeder

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
11.6	Rated Short Time withstand Current	KA	80			
11.7	Main Cable Entry		Bottom			
11.8	Main Busbar		3-phase			
11.9	Earthing Busbar		Required			

### 12-Main Air Circuit Breaker

12.1	Name of Manufacturer		shall be filled		
12.2	Country of Origin		shall be filled		
12.3	Reference Standards		IEC 60947		
12.4	Continuous current rating	А	2500		
12.5	Sensor Rating	А	2500		
12.6	Opening Type		Electronic		
12.7	Pole No		3		
12.8	Ultimate Breaking Capacity (kA)	KA	65		
12.9	Rated Short Time withstand Current (1 sec.)	KA	Minimum 55		
12.10	max. Break time	msec	30		
12.11	max. Closing time	msec	50		
12.12	Terminals Material		Tinned copper		

## Low Voltage Distribution Board 2500A with Main C.B. IZM 2500A and 10 Feeder

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation Committee Comments
12.13	Mechanical Endurance with maintenance	C/O	10,000			
12.14	Electrical Endurance without maintenance	C/O	5,000			
12.15	Type tests report		Required			

### 13- Vertical Low Voltage Disconnector Switch

1					
13.1	Name of Manufacturer		shall be filled		
13.2	Country of Origin		shall be filled		
13.3	Reference Manufacturing Standards		IEC 60947-3, DIN0636-2		
13.4	Number		10 each		
13.5	Rated insulation voltage (Ui)	V	800-1000		
13.6	Rated operational voltage	V	690		
13.7	Conventional free air thermal current	A	400		
13.8	Rated Conventional Free Air Thermal Current With Solid Link	A	shall be filled by manufacturer		
13.9	Pole No		3		
13.10	Switching Type		Three Pole		
13.11	Rated impulse withstand voltage (Uimp)	Kv	8		
13.12	Short circuit making capacity (peak)	KA	shall be filled by manufacturer	 	
13.13	Short time withstand current capability (for 1 second)	KA	shall be filled by manufacturer		

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation Committee Comments
13.14	Mechanical Operations	Operation	≥1000			
13.15	Rated conditional short-circuit current (with fuses)	KA	50			
13.16	HRC fuselink No.		30			
13.17	HRC fuselink Rating Current	A	250			
13.18	HRC fuselink Type		"gG" / Blade Contact fuse-links, NH2			
13.19	Space between the switches	cm	2-3			
	14-Street Lighting					
14.1	Name of Manufacturer		shall be filled			
14.2	Country of Origin		shall be filled			
14.3	Reference Manufacturing Standards		IEC 60947-3, DIN0636-2			
14.4	Number		1 each			
14.5	Rated insulation voltage (Ui)	V	800-1000			
14.6	Rated operational voltage	V	500			
14.7	Conventional free air thermal current	А	160			
14.8	Rated Conventional Free Air Thermal Current With Solid Link	A	shall be filled by manufacturer			
14.9	Pole No		3			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation Committee Comments	
14.10	Switching Type		Three Pole				
14.11	Rated impulse withstand voltage (Uimp)	Kv	8				
14.12	Short circuit making capacity (peak)	KA	shall be filled by manufacturer				
14.13	Short time withstand current capability (for 1 second)	KA	shall be filled by manufacturer				
14.14	mechanical operations	Operation	≥1000				
14.15	Rated conditional short-circuit current (with fuses)	KA	50				
14.16	HRC fuselink No.		3				
14.17	HRC fuselink Rating Current	А	100				
14.18	HRC fuselink Type		"gG"  / Blade Contact fuse-links, NH2				
	15-Panel configuration						
15.1	Frame parts		2 mm – Galvanized chromed sheet steel				
15.2	Surface		Powder-Coated Paint -finish				
15.3	Design		hermetically tight welded, without any sealings				
15.4	Degree of protection		IP3XD				
15.5	Colour		slightly embossed RAL 7035 powder- paint				
1	6-Accessories						
16.1	Lock System		Interlocking				
	Current Transformer						

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to	Evaluation Committee
16.2	Specification : According IEC- CT rating on incoming busbars: 3000/5A Error Co-efficient: Less than 5 Insulation Class: class E,120°C Rated Burden: 10 VA		Required		Documentation	Comments
16.3	Three Maximum demand ammeters :Scale range 0 –		Required			
16.4	One 3Φ voltmeter: Scale range 0 - 500 V, Class 1.5 with a selector switch		Required			
16.5	Three indicating lamps		Required			
16.6	One three-phase 32 A circuit- breaker, Circuit Breaker nominal breaking current not less than 6 KA at 380 V with thermal and instantaneous short-circuit		Required			
16.7	One single-phase, 32 A, 220 V C.B for control circuits with thermal and inst. short-circuit releases. The nominal breaking current of the circuit-breaker shall not be less than 6 KA at 380 V		Required			
16.8	Another Accessories		as Drawing			
17	Safety		The Busbars Should including Separation Covers			
18	Internal Wiring		made of flexible copper cables			
19	Ventilation		Natural			
20	Width	m	shall be filled by manufacturer			
21	Height	m	shall be filled by manufacturer			
22	Depth	m	shall be filled by manufacturer			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
23	Total Weight	kg	shall be filled by manufacturer			
24	Quality Certificate		Required			
25	Dimensions		as Drawing			
### **Technical Guarantees No. LVB\_2500**

#### Low Voltage Distribution Board 2500A with Main C.B. IZM 2500A and 10 Feeder

No	Description	Unit	Requirements	Offered Data	Remarks , Ref to	Evaluation Committee Comments
	ا تیکی	، الڪتررسة	۷ ملم مدهونة بدهان	جافن بسمڪ	ية من العاج الم	اللوحة معينوء
	-		IZM	ىينة الرئيسية	يد نرعية السك كين الفرعية	مطلوب تحد ونوعية الساء

Tenderer's Signature :

Date: .....



## شركة توزيع كهرباء محافظات غزة

## **Gaza Electricity Distribution Corporation**

# TECHNICAL SPECIFICATIONS FOR 24 kV RING MAIN UNIT

March 2012

#### 1 GENERAL SPECIFICATIONS

#### **1.1** Completeness of Contract

- 1.1.1 All apparatus, accessories or fittings which may not have been specifically mentioned, but which are usual or necessary in the respective equipment for the completeness of the finished work in an operable status, shall be deemed to be included in the Contract and shall be provided by the Contractor without any extra charge. All equipment shall be complete in all details, whether or not such details are mentioned in the Specifications. This includes fixation details and connection clamps and/or terminals.
- 1.1.2 Any reference in the quantity and price schedules, the delivery period schedule or in the various clauses and schedules of the text of either the Specification or the Bid, to any equipment shall imply that the equipment is complete with all accessories, apparatus and fittings as outlined in sub-clause 1.1.1 above.
- 1.1.3 The Bidder shall be responsible for ensuring that the equipment supplied is fit for the purpose intended. Available information on the characteristics of the system to which the works will be connected and associated will be supplied on request to the Bidder who shall be responsible for obtaining and determining all applicable knowledge relevant to the works.

#### **1.2 Drawings and Documentation**

The Contractor shall prepare and submit to the Engineer/GEDCO for approval dimensioned general and detailed design drawings and other pertinent information of all the Equipment specified in the Specifications.

The Contractor shall supply detailed instructions for erection, operation and maintenance of all equipment and components in English and preferably Arabic language.

In the event of any difference between the drawings and the Specifications, the latter shall prevail.

Approval of drawings shall not relieve the Contractor of his obligations to supply the Plant in accordance with the Specifications. In the event of any difference between scaled dimensions and figures on the drawings, the figures shall prevail

All text on drawings provided by the Contractor shall be in the English language in addition, if necessary, to that of the country of origin.

All drawings shall be dimensioned in millimeters.

#### **1.3** Time of Delivery and Completion

The guaranteed delivery times shall be stated in the appropriate schedule in this document.

#### **1.4 Quality of Materials**

All materials supplied under this Contract shall be new and of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration in the setting up of undue stresses in any parts and also without affecting the suitability of the various parts of the Works for which they were designed. No toxic material (such as Halon, PCB, and Asbestos) shall be utilized.

#### 1.5 Contractor's Quality Assurance Procedures

The Bidder shall have established a quality assurance system based on ISO 9001 or 9002. The Contractor shall include a documentation of the system with a list of current procedures, an organogram of the quality organization and the name of the quality manager. He shall also submit a list of quality revisions performed the last twelve months with a list of closed and unclosed findings as well planned revisions the coming twelve months.

The Contractor shall submit for approval a program of quality control and inspection procedures to assure that the product during manufacture and on completion complies with the specified requirements. The program shall relate the quality control and inspection activities to the production cycle. In support of the quality control and inspection program the Contractor shall provide details of quality control and inspection procedures available for use in the execution of the Contract. The Contractor shall retain responsibility for quality control and inspection activities made by his sub-contractors and shall indicate on the program, which items are to be sub-contracted.

#### **1.6 Guarantees and Particulars**

The Works shall comply with the technical guarantee data stated in the Bid. The Contractor shall be responsible for any discrepancies, errors and omissions in the particulars and guarantees, whether the Engineer/GEDCO has approved such particulars and guarantees or not.

#### **1.7** Places of Manufacture and Sub-Contractors

The manufacturer's identity and places of manufacture, testing and inspection before shipment for the various portions of the Contract Works shall be specified in the Technical Schedules and shall not be departed from without the agreement of the Engineer/GEDCO.

All Sub-contractors and Sub-suppliers of components and materials shall be subject to the approval of the Engineer/GEDCO. Information shall be given on each Sub-order sufficient to identify the material or equipment, to which the sub-order relates, stating that the material is subject to inspection by the Engineer/GEDCO before dispatch.

All equipment offered shall be the product of recognized and experienced manufacturers and shall be proven equipment of the same basic design and size similar to that which has been in successful continuous operation for at least three years preferably under similar climatic conditions. Proven plant reliability and high availability are of prime importance and the attention of the Bidder is drawn to these particular requirements.

#### **1.8** Inspection and Testing

All materials used in the Contract Works may be to inspection by the Engineer/GEDCO and it is the Contractor's responsibility to advise the Engineer/GEDCO when equipment and materials are available for inspection, at least 1 month in advance.

Factory tests on equipment shall be made according to the applicable IEC Standards, or as specifically specified or according to standards approved by the Engineer/GEDCO.

Routine tests shall be made on each unit of all equipment.

Type tests shall be made on one unit of each type of different equipment. Instead of carrying out the type tests the Contractor may submit suitable certificates of tests made on equipment of the same type; however, the Employer reserves the right of accepting these certificates or to reject them partially or totally.

The Engineer/GEDCO shall be at liberty to demand any additional testing at the manufacturer's works, at site or elsewhere in order to verify that the equipment complies with the conditions of the Specifications.

A test program shall be submitted to the Engineer/GEDCO for approval at least 1 month ahead of the commencement of testing.

Measuring apparatus shall be approved by the Engineer/GEDCO and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

#### **1.9** Packing, Transportation and Storage

Packing shall give adequate protection to the enclosed materials against mechanical damage during transport to its final destination, including rough handling during sea, rail and road transport and transition from one mode of transport to another.

Packing should be stout close-boarded wooden cases of adequate thickness, suitably braced and banded and lined internally with water-resistant material or equally solid enclosures.

Steelworks sections and similar items may be bundled provided that the ends are adequately protected and the enclosing bands or wires are robust.

Indoor electrical equipment must be enclosed in welded polythene envelopes inside packing cases and the envelopes shall be evacuated or have a desiccant inside.

All items in cases or crates shall be secured so that they are not free to move and cannot work loose in transport. If rotating parts are shipped within their bearings or mountings, they must be adequately braced and restrained to prevent relative movement. Loose items shall be placed in bags in a case, each bag having stitched onto it a label indicating the number and nature of its contents. Where a filler material is used in a case to restrict movement or provide additional protection, it must be inorganic and non-hygroscopic.

All surfaces liable to corrosion shall be thoroughly cleaned and special steps adapted to the nature of the materials and the time interval between packing and unpacking shall be taken to prevent corrosion. These steps may constitute the greasing on surfaces, the application of a protective coat, enclosure of the items in a hermetically sealed container, the addition of vapour phase inhibitor paper to the package or other approved means.

Steps shall be taken to ensure that moisture, moulds, insects or rodents cannot damage insulated materials. Items that include materials liable to be damaged by moisture shall be packed in hermetically sealed containers in which silica gel, or some other approved desiccant has been inserted.

Cases shall be marked with large lettering to show which side of the case is to be up, and if the contents are fragile, marked "FRAGILE" in large letters with the international wineglass symbol. Packages shall be marked with their place of destination in such a way that rough handling or the effect of weather cannot remove or obliterate the marking. Each item shall be marked with its gross weight and, for all lifts over two tonnes, marks on the cases shall show the correct positions for the slings.

Special steps shall be taken to guard against theft during transport. No small items such as padlocks nameplates and so forth that could be torn off or unscrewed shall be accessible.

Cases, crates, barrels and drums shall be banded in such a manner as to obstruct the theft of any of the timber used for packaging and the bands shall be so secured that they are not rendered ineffective by shrinkage of the wood.

A descriptive and fully itemized list shall be prepared of the contents of each packing case. A copy of this list shall be placed in a waterproof envelope under a metal or other suitable plate securely fastened to the outside of one end of the case, and its position indicated by stenciling on the case. Where appropriate, drawings showing the erection markings of the items concerned shall be placed inside the case.

All stenciled markings on cases and crates, or other markings on descriptive metal tabs fixed to cable drums, bundles of structural steel works and so forth, shall be applied in two places with a material which cannot wash off and shall be additional to any erection or other marks or impressions which may be specified elsewhere.

Shipping marks are to be stenciled in oil based paint in block letters and symbols. When unobstructed flat smooth surfaces of sufficient size are not available on the case for the shipping marks they are to be stenciled on marine-ply notice boards of adequate size and of at least 6 mm thickness securely fastened to the packing case.

All packing cases, though not steel containers, shall remain the property of the Employer.

#### 1.10 Tools

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

#### 1.11 Spare Parts

Particulars of spare parts, which may or not from part of the contract at the Purchaser's discretion, shall be agreed. Bidders giving their recommendations should complete the relevant Schedules and prices for spares that they believe should be purchased by Purchaser

#### 2 TECHNICAL SPECIFICATION

#### 2.1 General

This Chapter contains a general technical specification of electrical distribution equipment and may cover equipment not to be procured under this contract. For details about each type of equipment to be procured reference is made to **Particular Technical Specifications.** 

The design shall incorporate every reasonable precaution and provision for the safety of the general public as well as for all those engaged in the operation and maintenance of the Contract Equipment and of associated works supplied under other Contracts.

#### 2.2 Drawings

The Bidder shall in his Bid enclose overall drawings showing dimensions, main working principles, and internal components and fixing methods to a detail level allowing the Employer to evaluate the functionality and completeness of the equipment.

#### 2.3 Standards

Ratings, characteristics, tests and test procedures, etc. for the electrical equipment encompassed by this specification shall comply with the relevant provisions and requirements of the Recommendations of the International Electrotechnical Commission (IEC), unless otherwise expressly stated in Particular Technical Specifications. This applies even where the specific standards are not referred to in the Particular Specifications. Where the IEC Recommendations do not fully cover all provisions and requirements for the design, construction, testing, etc. and for equipment and components that are not covered by IEC Recommendations recognized national standards shall be applied. The rules of CEE (International Commission for the approval of electrical equipment) and the standards of CENELEC (the European Committee for Electrotechnical Standardization) may also be applied.

Can be adopted British Standards Institution (BSI) or German Institute for Standardization (DIN) or French Standards (NF) for specific items of electrical materials.

The latest revision or edition in effect at the time of Bid Invitation shall apply. Where references are given to numbers in the old numbering system from IEC it shall be taken as to be the equivalent number in the new five digit number series.

The Precise Standard, complete with identification number, to which the various equipment and materials are manufactured shall be specifically stated by the Bidder.

In case of conflict or disagreement between the particulars of the Standard adopted by the Bidder and the particulars of this Specification, this Specification shall prevail over the Standard. All conflicts or disagreements, mentioned above, must be clearly stated, failing which the materials and equipment offered shall be deemed to comply in every respect with this Specification both in manufacture and in performance, and compliance thereof be insisted upon without additional cost to the Employer.

#### 2.4 Units

The SI-system (meter, Newton, second) shall be used throughout the works covered by this Specification.

#### 2.5 **Definitions**

Whenever the following terms or words are found in the specifications and/or other documents, they shall have the following meaning:

#### "High Voltage Equipment" (HV):

Mostly used for equipment provided for a maximum operating voltage higher than 36 kV

"Medium Voltage Equipment" (MV):

Equipment provided for a maximum operating voltage higher than 1000 V and up to 36 kV.

#### "Low Voltage Equipment" (LV):

Equipment provided for operation at 1000 V or below. (For transformers the term Low Voltage Winding is used for the side with lowest rated voltage regardless of value, IEC 60076)

Reference to degree of protection (IP) is according to the classification in IEC 60529

#### 2.6 System Characteristics

The basic characteristics of the electrical systems and equipment shall be as follows (not all voltages are applicable to this contract):

#### MV Equipment 33 kV

Maximum operating voltage 36 kV, 3-phase, 50 Hz, delta connected system with neutral solidly earthed via zigzag-star connected Earthing transformer.

#### MV Equipment 22 kV

Maximum operating voltage 24 kV, 3-phase, 50 Hz, delta connected system with neutral solidly earthed via zigzag-star connected Earthing transformer.

#### LV Equipment, 0.4 kV

Maximum operating voltage 420 V, 3-phase, 50 Hz, loaded and effectively earthed neutral TN-C system.

#### 2.7 Phase Relationship

The standard phase colours are Red (L1), Yellow (L2), and Blue (L3) (RYB).

#### 2.8 Design Criteria

The equipment shall be designed to withstand the design stresses given below without damage and disruption of service. All tests shall as a minimum is based on these design parameters.

Itom	Description	I In:t	Nominal voltage level			
Item	tem Description		33	22	0.4	
1	Nominal system voltage phase to phase	kV	33	22	0.4	
2	Highest system voltage phase - phase <sup>1)</sup>	kV	36	24	0.42	
3	System Frequency	Hz	50	50	50	
4	System earth(see above)		Solid	solid	Solid	
5	Minimum Design Short circuit Current (1 sec. arch test) <sup>2)</sup>	kA	25	25	25	
6	Impulse withstand voltage $(1.2/50 \mu \text{ sec wave})^{3)}$	kV peak	170	125	12	
7	Power frequency withstand voltage $(1 \text{ min.})^{3}$	kV	70	50	2.5	
	Min Creepage distance over outdoor insulators (Pollution class 3- severe, IEC 60815/85 - 2.5cm/kV)	cm	90	60	7.5	

#### <u>Note 1)</u>

Ref. IEC 60038

<u>Note 2)</u>

For all current carrying parts the permissible short circuit duration shall be at least 1 second. Indoor equipment shall be arc tested in accordance with IEC 60298 amendments 2. The dynamic or momentary short circuit current on which the equipment design shall be based shall be computed by multiplying the r.m.s. value of the symmetrical short circuit current by the factor  $1.8 \times \sqrt{2}$ .

<u>Note 3)</u>

Ref. IEC 60071

#### 2.9 Ambient Temperatures, Relative Humidity, Wind Pressure

Unless otherwise specifically stated in Particular Technical Specification, any equipment, component and assembly shall be designed for the following service conditions:

ltem	Description	Unit	Value
1	Altitude of site above sea level	m	- 50 to + 200
2	Ambient Temps:- Maximum / Minimum	°C	+55 / - 5
3	Wind Speed	m/s	15
4	Isokeraunic Level		15
5	Pollution Type		Dust
6	Relative Humidity Maximum/ Minimum	%	100 / 50
7	Rainfall Average annual	mm	600
8	Hail		Yes
9	Fog		Yes
10	Sand Storms		Occasional

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

The Contractor shall guarantee these reduced temperature rises.

### 3 PARTICULAR TECHNICAL SPECIFICATIONS FOR 24 kV RING MAIN UNIT

This chapter covers the particular technical requirements of the medium 22 kV voltage equipment to be procured under this contract. By conflict between the general specification and the particular specifications below the particular specifications shall prevail.

#### Scope

This Section covers the manufacture and supply of indoor Ring Main Units, associated equipment and spares.

#### 3.1 Design

- This specification applies to SF<sub>6</sub> insulated switchgear for maximum system voltage 24 kV.
- The switchgear shall be suitable for indoor mounting conditions with natural ventilation.
- ✤ Temperature independent gas pressure gauge marked with green (safe) and red (not safe) zones shall be provided. The safe operating zone shall correspond to a temperature range of −10°C to +55°C. The unit shall continue to work safely even if the gas pressure inside the tank goes down to the atmospheric pressure. Refilling /re-pressurizing inlet valve, if provided, shall be easily accessible for field refilling.
- The switchgear shall be maintenance-free and all the electrical parts including the arcing chamber and the main contacts of the switchgear, as well as the connection busbars are to be mounted in a metal enclosure, hermetically sealed.
- All the external parts of the switchgear shall be protected against corrosion. The switchgear shall be of a self-supporting construction type.
- The cubicles shall be short circuit type tested by an internationally recognized test institution; the switchgear shall consist of cubicles of tropical design. The cubicles shall be metal enclosed, each cubicle shall be provided with test points for capacitive voltage tester.
- Bus-bars shall be of electrolytic high grade copper. It shall withstand the mechanical stresses of the rated short circuit current.
- The surface treatment of the sheet steel is carried out according to the powder coating principle, whereby a thermosetting powder is applied to the sheet steel, electrostatically with an average layer of minimum fifty micrometers. The powder shall be a combination of epoxy and polyester resin, before the powder coating is applied, the sheet steel parts shall be degreased in a spray tunnel and phosphated with 0.4 to 0.8 g/m2 iron phosphate.

#### 3.2 Products

#### 3.2.1 Components:

Components are to include metal enclosed ring main SF6 switchgear unit, comprising two incoming switch disconnectors for ring main network feeders, one transformer protection fuse-switch combination, cable terminal fittings behind dead front panels and front mounted switch gear operating handles, control, indication

#### 3.2.2 Characteristics:

Rated Voltage	24 kV
Normal system voltage	22 kV
Rated impulse withstand voltage (Peak)	125 kV
Rated power frequency withstand voltage (r.m.s )	50kV for I min
Continuous Current	630 Amps
Rated Short Time with stand Current 1s.	20 kA
Rated Short Time with stand Current 3s.	16 kA
Close and Latch Capability	68 kA (Momentary)
Rated Interrupting Time	Five cycles
Rated frequency	50 Hz
Busbar current rating	630 A
Rated peak withstand current	50 kA

3.2.1 Switch-Disconnector: General purpose, 3-pole, load-break, Short-circuit make, category B to IEC 265

3.2.2	Switch-Disconnector Ratings:	
	Rated nominal current	630 A
Rated short-circuit making Capacity (peak)		50kA

- 3.2.3 Ring switches shall be full load break and fault-making type. Ring switches shall be designed for interrupting full rated current as stated in above, small inductive or capacitive currents involved in disconnecting of unloaded transformers, cables or overhead lines. It shall be suitable for full fault-making current.
- 3.2.4 Ring switch shall consist of a moving contact assembly with three positions; 'ON,' OFF' and 'Earth'. Two independent manual operating mechanisms for ring and earth switches are also acceptable. The design shall prevent simultaneous closing of the main switch contacts and the earth switch contacts. The earth switch contacts shall be designed to close into a fault and shall have the same short circuit capacity as the main contacts.
- 3.2.5 Switch-Disconnector Operation: By removable handles at front of unit Switching mechanism is to be manual, spring charge, quick-make, quick-break, with speed of switching independent of operator: Main switch and earth switch operations are to be separated and safety interlocked with the manual handle Inserted in separate access holes for on/off operation of main switch and earth on/earth off operation of earth switch Handle design IS to ensure delay between closing and re-opening of main Switch or Earthing switch, to provide an anti-reflex operation. It is to be Impossible to move earth switch inadvertently into or from earth position except when main switch is in the open position .Indication of switch position is to be mechanical, directly connected to moving contacts each switch IS to have padlocking device in the open, closed and earth positions.

3.2.6 Fuse-Switch Combination: To consist trip-free, load-break, short-circuit make fuse-switch combination, with operational requirements as for switch-disconnector. Fuse is to be separately located in fuse chamber with interlocked earthing switches providing upstream and downstream earthing of the fuse assembly, Automatic trip switching is to be actuated by fuse striker pins which actuate common trip bar in switch mechanism. Once operated, striker pins remain in ejected position, preventing closure of switch until fuses has been replaced. Single phasing is not to be possible. Fuses are to be totally enclosed, current limiting, cartridge type, high-breaking capacity, with striker pins, and with draw able from front of unit

3.2.7 Fuse-Switch Combination Ratings:

Rated normal current	200 A
Rated prospective short circuit breaking current	25 kA to IEC
Rated prospective short circuit making current	63 kA
Rated current of fuse link (to suit)	100 A, 80A, 63A

3.2.8 Incoming/Outgoing Cables: up to 630 mm2 XLPE

3.2.9 Cable Terminal Connectors: Stress-relieving, epoxy sealed end, bolted type, complete with all accessories. Alternative arrangement may be proposed by manufacturer.

Cable Connections in Ring Main Unit Feeders shall be Suitable for RSTI Screened, separable connection system 630 A up to 630 mm2 as EN 50180 and DIN47636

Cable Connections in Transformer Feeders shall be Suitable for Screened Separable Elbow Termination Kit 250A

#### **3.2.10** Accessories: Include the following:

- a. Two N. C and two N. O. auxiliary contact on each switch:
- b. Shunt trip release on fuse-switch combination;

c. Earth fault indicator, operated by core-balance type current transformer, located near and outside cable box/termination's with indicator visible from front and with automatic reset.

d. Padlocking Arrangements: Arrangements shall be provided for locking up with padlocks of size 1" for each of the following:

- Each of the access doors and covers.
- > Each of the operating handle to the frame work.
- Each control position to prevent moving from "OFF" position to the "ON" position and vice versa.
- Each control position to prevent moving from "OFF" position to the "EARTH-ON" position and vice versa.

#### 3.3 QUALITY ASSURANCE

Quality Assurance System conforming to ISO 9001 shall be followed in the manufacture of Ring Main Unit and the manufacturer shall furnish ISO 9001 Quality Assurance Certification Document with the offer.

#### 3.4 Rating Plate markings

Rating plate shall provide the data of the switches and be weather-proof and corrosion-proof. The plate shall be positioned in the front of the unit and be clearly visible from the normal operating location of the device.

Information to appear on the name plate is:-

- Number and year of the standard adapted.
- Manufacturer's identification (Name, country of manufacture etc.)
- Designation of type.
- Class and category.
- Serial number and year of manufacture.
- Rated voltage and frequency.
- Class of insulation.
- Rated pressure of compressed gas for operation, if applicable.
- Rated pressure of compressed gas for interruption, if applicable.
- Weight of equipment without insulating medium and cable terminations.
- Weight and volume of insulating medium.
- Characteristic of switches.

#### 3.5 Applicable Standards

The equipment and the components supplied shall be in accordance with the latest edition of the standards specified below and amendments thereof. However the GEDCo Specification shall supersede these Standards in the event there is a discrepancy

IEC 60694 - Common Specifications for High-Voltage Switchgear and Controlgear Standards

**IEC 62271-105 -** High-voltage switchgear and controlgear - Part 105: Alternating current switch-fuse combinations

IEC 60265-1 - High-voltage switches - Part 1: Switches for rated voltages above 1 kV and less than 52 kV

IEC 60129 - Alternating current (isolators) and earthing switches

**IEC 62271-102 -** High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches

**IEC 60298 -** A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

**IEC 62271-200** - High-voltage switchgear and controlgear - Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

IEC 60640 - CAMAC - Serial Highway Interface System

IEC 60529 - Degrees of protection provided by enclosures (IP Code)

**ISO 2063** - Metallic coatings – protection of iron and steel against corrosion – metal spraying of Zinc and Aluminum

#### 3.6 INFORMATION TO BE SUPPLIED WITH THE OFFER

- 3.6.1 The following shall be furnished with the offer.
  - a) Catalogues describing the equipment and indicating the model.
  - b) Literature describing the operational feature of the equipment.
  - c) Rated values and characteristics of all switches, busbars, fuses, insulating medium etc.
  - d) Constructional features, materials used for components and relevant technical literature and dimensioned drawings.
  - e) Operating mechanism of the switches and associated equipment/ interlocks/access covers and doors including sequence of operation.
  - f) Mechanical characteristic incorporating overall dimensions in open and closed positions, weight with and without insulating medium, foundation layout dimensions, weather shield particulars, anticorrosive preventive measures, padlocking arrangements.
  - g) Drawing of name plate to scale incorporating the particulars called for.
  - h) Details of earthing, earth conductor/strap bonding and termination.
  - i) ISO 9001 Certification.
  - j) Certificate of type tests for the following carried out in accordance to the specified standard.
    - Dielectric Tests
    - Temperature rise Tests
    - Making and Breaking Tests
    - Short-Circuit Current carrying capability
    - Operation and Mechanical endurance
  - 3.6.2 Test certificates, performance curves etc. Furnished shall be based on the type tests confirming to the relevant British Standard. The tests certificates should clearly identify the equipment's concerned, showing the Manufacturer's identity, type number and basic technical parameters. The test certificates referred to shall be issued from an internationally recognized independent testing authority.
  - 3.6.3 Failure to furnish the particulars requested in Clause 6.5.1 will result in the offer being rejected.

#### 3.7 TECHNICAL LITERATURE & DRAWINGS

The selected tenderer along with the equipment should supply relevant drawings, technical literatures, hand-books etc. in order to facilitate installation, operation and maintenance.

#### 3.8 INSPECTION AND TESTING

#### 6.8.1 Inspection

The selected Bidder shall make necessary arrangements for inspection by a Representative of the Purchaser and also to carry out in his presence necessary Routine or Sample Tests of the materials,

equipment offered.

#### 3.8.2 Testing (routine / Sample)

- (i) Dielectric withstand tests
- (ii) Mechanical operation (including interlocks) checks.
- (iii) Leakage test.
- (iv) Power frequency voltage withstand tests
- (v) Measurement of resistance

#### 3.8.3 Routine / Sample Test Certificates

These Test certificates will form a part of the shipping documents. Extra copies of these test certificates shall also be supplied with the equipment.

#### 3.9 PACKING AND SHIPMENT

The switchgear shall be delivered ready for installation.

Switchgear shall be individually packed in non-returnable cases

For container shipment, switchgear bolted on wood pallet is acceptable.

Units shall be supplied complete with all operation and installation accessories.

## 24 kV, 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Two Incoming Switch Disconnectors, one Transformer Protection Fuse Switch Combination (CTC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
	Reference Manufacturing Standa	irds				
	a) Service Condition		IEC60694			
	b) Switch Fuse Combination		IEC62271-105			
	c) Switch endurance & Short time & Peak withstand for Switch		IEC60265-1			
3	d) Short time & Peak withstand for Earth Switch /Disconnector		IEC60129 / IEC62271-102			
	e) Temperature Rise Test & Dielectric Test & Internal Arc Test		IEC60298 / IEC62271-200			
	f) Safety Interlocking		IEC60298/ IEC60640			
	g)Enclosure Degree of Protection		IEC60529			
4	Insulation Medium , Interruption medium		SF6 Gas			
5	Design		Metal-Enclosed			
6	Туре		Indoor			
7	Component		Two Incoming Switch Disconnectors, one Transformer Protection Fuse Switch Combination (CTC)			
8	Rated voltage	kV	24			

## 24 kV, 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Two Incoming Switch Disconnectors, one Transformer Protection Fuse Switch Combination (CTC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
9	Rated Frequency	HZ	50					
10	Safe Operating Zone Temperature	°C	-10 to +55					
	Rated insulation level							
11	a) Rated short-duration power- frequency withstand voltage	KV	50					
	b) Rated lightning impulse withstand voltage	κv	125					
	Rated Normal Current							
	a) for ring-main feeders	A	630					
12	b) for transformer feeders depending on the HV HRC fuse link	A	200					
	c) for Busbar	A	630					
	Rated short-time withstand curre	ent						
13	a) for 1 sec	kA	20					
	b) for 3 sec	kA	16					
	Rated short-circuit making current							
14	a) for ring-main feeder	kA	50					
	b) for transformer feeder	kA	25					
15	Rated Peak withstand Current	kA	50					
16	Pressure values for insulation (Rated filling pressure)	hPa (absolute)	1500					
	Panel configuration							

## 24 kV, 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Two Incoming Switch Disconnectors, one Transformer Protection Fuse Switch Combination (CTC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Switchgear container Design		hermetically tight welded, without any sealings			
	Degree of protection for all high- voltage sections		IP65			
17	Degree of protection for switchgear enclosure		IP3XD			
	Position for isolating/grounding via the Switch Disconnector		three Position			
	Position of switch-disconnector		three Position			
18	Bolted Electrical Joints Design		secured by fasteners of corrosion-proof materials			
19	Clearance between clamp and bushing		Suitable for all type of terminations			
20	Cable Connections in Ring Main Unit Feeders		Interface C , Screw Type , Suitable for RSTI Screened, separable connection system 630 A up to 630 mm2			
21	Cable Connections in Transformer Feeders		24kv interface A, Pin Type , Suitable for Screened Separable Elbow Termination Kit 250A			
	Operating Manually Indicate the	Following	g Positions			

## 24 kV, 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Two Incoming Switch Disconnectors, one Transformer Protection Fuse Switch Combination (CTC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	a) Switch Disconnector		ON and OFF			
22	b) Off-Load Isolator		ON and OFF			
	c) Earthing		ON and OFF			
	Accessories					
	a) Voltage indicator lamps		Required			
23	b) Gas Pressure Indicator		Required			
	c) M.V Porcelain Fuses		Required			
	d) Operating Lever		Required			
24	Width	mm	Shall be filled by manufacturer			
25	Height	mm	Shall be filled by manufacturer			
26	Depth	mm	Shall be filled by manufacturer			
27	Total Weight	kg	Shall be filled by manufacturer			
28	Type Test Certificates /Reports from internationally reputed testing agency		Required			
29	Acceptance & Routine tests witnessed by Beneficiary		Required			

Tenderer's Signature : .....

Date:

### 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6 , Three Incoming Switch Disconnectors, One Transformer Protection Fuse Switch combination (CTCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
	Reference Manufacturing Standa	rds				
	a) Service Condition		IEC60694			
	b) Switch Fuse Combination		IEC62271-105			
	c) Switch endurance & Short time & Peak withstand for Switch		IEC60265-1			
3	d) Short time & Peak withstand for Earth Switch /Disconnector		IEC60129 / IEC62271-102			
	e) Temperature Rise Test & Dielectric Test & Internal Arc Test		IEC60298 / IEC62271-200			
	f) Safety Interlocking		IEC60298/ IEC60640			
	g)Enclosure Degree of Protection		IEC60529			
4	Insulation Medium , Interruption medium		SF6 Gas			
5	Design		Metal-Enclosed			
6	Туре		Indoor			
7	Component		Three Incoming Switch Disconnectors, One Transformer Protection Fuse Switch combination (CTCC)			
8	Rated voltage	kV	24			

#### 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6 , Three Incoming Switch Disconnectors, One Transformer Protection Fuse Switch combination (CTCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
9	Rated Frequency	Hz	50					
10	Safe Operating Zone Temperature	°C	-10 to +55					
	Rated insulation level							
11	a) Rated short-duration power- frequency withstand voltage	KV	50					
	b) Rated lightning impulse withstand voltage	KV	125					
	Rated Normal Current							
	a) for ring-main feeders	А	630					
12	b) for transformer feeders depending on the HV HRC fuse link	A	200					
	c) for Busbar	А	630					
	Rated short-time withstand curre	ent						
13	a) for 1 sec	kA	20					
	b) for 3 sec	kA	16					
	Rated short-circuit making current							
14	a) for ring-main feeder	kA	50					
	b) for transformer feeder	kA	25					
15	Rated Peak withstand Current	kA	50					
16	Pressure values for insulation (Rated filling pressure)	hPa (absolute)	1500					
	Panel configuration							

#### 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6 , Three Incoming Switch Disconnectors, One Transformer Protection Fuse Switch combination (CTCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
	Switchgear container Design		hermetically tight welded, without any sealings						
	Degree of protection for all high- voltage sections		IP65						
17	Degree of protection for switchgear enclosure		IP3XD						
	Position for isolating/grounding via the Switch Disconnector		three Position						
	Position of switch-disconnector		three Position						
18	Bolted Electrical Joints Design		secured by fasteners of corrosion-proof materials						
19	Clearance between clamp and bushing		Suitable for all type of terminations						
20	Cable Connections in Ring Main Unit Feeders		Interface C , Screw Type , Suitable for RSTI Screened, separable connection system 630 A up to 630 mm2						
21	Cable Connections in Transformer Feeders		24kv interface A, Pin Type , Suitable for Screened Separable Elbow Termination Kit 250A						
	Operating Manually Indicate the Following Positions								

#### 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6 , Three Incoming Switch Disconnectors, One Transformer Protection Fuse Switch combination (CTCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
22	a) Switch Disconnector		ON and OFF			
	b) Off-Load Isolator		ON and OFF			
	c) Earthing		ON and OFF			
	Accessories					
	a) Voltage indicator lamps		Required			
23	b) Gas Pressure Indicator		Required			
	c) M.V Porcelain Fuses		Required			
	d) Operating Lever		Required			
24	Width	mm	Shall be filled by manufacturer			
25	Height	mm	Shall be filled by manufacturer			
26	Depth	mm	Shall be filled by manufacturer			
27	Total Weight	kg	Shall be filled by manufacturer			
28	Type Test Certificates /Reports from internationally reputed testing agency		Required			
29	Acceptance & Routine tests witnessed by Beneficiary		Required			

Tenderer's Signature : .....

Date:

## 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Three Incoming Switch Disconnectors (CCCCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
	Reference Manufacturing Standa	irds				
3	a) Service Condition		IEC60694			
	b) Switch Fuse Combination		IEC62271-105			
	c) Switch endurance & Short time & Peak withstand for Switch		IEC60265-1			
	d) Short time & Peak withstand for Earth Switch /Disconnector		IEC60129 / IEC62271-102			
	e) Temperature Rise Test & Dielectric Test & Internal Arc Test		IEC60298 / IEC62271-200			
	f) Safety Interlocking		IEC60298/ IEC60640			
	g)Enclosure Degree of Protection		IEC60529			
4	Insulation Medium , Interruption medium		SF6 Gas			
5	Design		Metal-Enclosed			
6	Туре		Indoor			
7	Component		Five Incoming Switch Disconnectors ((5 ring-main feeders))			

## 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Three Incoming Switch Disconnectors (CCCCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
8	Rated voltage	kV	24					
9	Rated Frequency	Hz	50					
10	Safe Operating Zone Temperature	°C	-10 to +55					
	Rated insulation level							
11	a) Rated short-duration power- frequency withstand voltage	KV	50					
	b) Rated lightning impulse withstand voltage	ΚV	125					
	Rated Normal Current							
12	a) for ring-main feeders	А	630					
	b) for Busbar	A	630					
	Rated short-time withstand current							
13	a) for 1 sec	kA	20					
	b) for 3 sec	kA	16					
14	Rated short-circuit making current for ring-main feeder	kA	50					
15	Rated Peak withstand Current	kA	50					
16	Pressure values for insulation (Rated filling pressure)	hPa (absolute)	1500					

#### 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Three Incoming Switch Disconnectors (CCCCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Panel configuration					
17	Switchgear container Design		hermetically tight welded, without any sealings			
	Degree of protection for all high- voltage sections		IP65			
	Degree of protection for switchgear enclosure		IP3XD			
	Position for isolating/grounding via the switch disconnector		three Position			
	Position of switch-disconnector		three Position			
18	Bolted Electrical Joints Design		secured by fasteners of corrosion-proof materials			
19	Clearance between clamp and bushing		Suitable for all type of terminations			

## 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Three Incoming Switch Disconnectors (CCCCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
20	Cable Connections in Ring Main Unit Feeders		Interface C , Screw Type , Suitable for RSTI Screened, separable connection system 630 A up to 630 mm2						
	Operating Manually Indicate the	Following	g Positions						
21	a) Switch Disconnector		ON and OFF						
21	b) Off-Load Isolator		ON and OFF						
	c) Earthing		ON and OFF						
	Accessories								
	a) Voltage indicator lamps		Required						
22	b) Gas Pressure Indicator		Required						
	c) Operating Lever		Required						
23	Width	mm	Shall be filled by manufacturer						
24	Height	mm	Shall be filled by manufacturer						
25	Depth	mm	Shall be filled by manufacturer						
26	Total Weight	kg	Shall be filled by manufacturer						

## 24 kV , 630 A Switchgear, and 16 kA Short Circuit Current Ring Main Unit SF6, Three Incoming Switch Disconnectors (CCCCC)

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
27	Type Test Certificates /Reports from internationally reputed testing agency		Required			
28	Acceptance & Routine tests witnessed by Beneficiary		Required			

Tenderer's Signature : .....

Date: .....

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
1	Name of Manufacturer								
2	Country of Origin								
3	Design Standards		IEC60502-2 & IEC60228						
4	Test Standards		IEC60230 & IEC60502-2 & IEC60811						
5	Code & Designation		N2XS(F)2Y , Power Cable with Copper Conductors and XLPE Insulation						
6	Climatic Design		5°C to 55°C						
7-	7- Rated Voltage								
7.1	Between Conductor and Sheath $(U_{o})$	kV	12						
7.2	Between any Two Conductors (U)	kV	20						
7.3	Max. Service Voltage (U <sub>m</sub> )	kV	24						
7.4	System Nominal Voltage	kV	22						
8	Rated Frequency	HZ	50						
9	Impulse withstand Voltage 1,2/50 us	kV	125						
10- 0	Cable Design								
10.1 C	Conductor :								
10.1.1	Cross Section	mm <sup>2</sup>	50						
10.1.2	Material		Copper						
10.1.3	Class and Form		Class2 - Stranded Compacted Circular (filled with swelling powder)						
10.1.4	Minimum / Maximum Diameter	mm	8.1 / 8.8						

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
10.1.5	Minimum Number of Strands	No	6			
10.1.6	Weight of Conductor Per Meter	Kg/Km	shall be filled by manufacturer			
10.1.7	Maximum DC Resistance of Conductor at 20°C	Ω/km	0.387			
10.1.8	Max. Rated Temperature for Permanent Load	°C	90			
10.1.9	Max. Rated Temperature for Emergency Loads	°C	105			
10.1.10	Max. Rated Conductor Temperature at Short Circuit (1 sec. max. duration)	°C	250			
10.2 lı	nner Semi Conductive Layer (Cond	luctor Scre	en) :			
10.2.1	Material		Triple Extruded Bonded Thermosetting Semi- Conductive Layer			
10.2.2	Thickness at Any Point	mm	0.3			
10.2.3	Max Service Temperature	°C	90			
10.3- X	(LPE Insulation :					
10.3.1	Material		Triple Extruded Dry Cured (XLPE)			
10.3.2	Nominal Thickness	mm	5.5			
10.3.3	Minimum Thickness at Any Point	mm	4.85			
10.3.4	Diameter Over Insulation	mm	shall be filled by manufacturer			
10.3.5	Max Service Temperature	°C	90			
10.3.6	Weight	Kg/Km	shall be filled by manufacturer			
10.4- C	Outer Semi Conductive Layer (Insu	lation Scre	en) :			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
10.4.1	Material		Triple Extruded Bonded Thermosetting Semi- Conductive					
10.4.2	Thickness at Any Point	mm	0.3					
10.4.3	Max Service Temperature	°C	90					
10.5- S	emi-Conductive Water Swelling Ta	ape :						
10.5.1	Material		Semi Conductive					
10.5.2	Thickness at Any Point	mm	0.3					
10.5.3	Max Service Temperature	°C	90					
10.6- Copper Wire Screen (including Equalizing Tape) :								
10.6.1	Material of Wire and Equalizing Tape		Copper					
10.6.2	Minimum Wires Number		shall be filled by manufacturer					
10.6.3	Wire Geometrical Cross Section	mm²	16					
10.6.4	Equalizing Tape Width	mm	10					
10.6.5	Equalizing Tape Thickness	mm	0.1					
10.7- S	eparation Sheath (Binder Tape) :			-	·	-		
10.7.1	Material		Water Blocking Tape Non- Conductive					
10.7.2	Thickness	mm	0.2 - 0.3					
10.7.3	Max Service Temperature	°C	90					
10.8- 0	Duter Sheath :	-		-	•	-		
10.8.1	Material	mm	LDPE ST7 with Chemical Additives					
10.8.2	Nominal Thickness	mm	1.9					
10.8.3	Minimum Thickness at Any Point	mm	shall be filled by manufacturer					

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
10.8.4	Max Service Temperature	°C	90						
10.8.5	Color		Red						
10.8.6	Weight	Kg/Km	shall be filled by manufacturer						
10.9-	Completed Cable :								
10.9.1	Overall Diameter of the Cable	mm	shall be filled by manufacturer						
10.9.2	Total Weight of the Cable	kg/km	shall be filled by manufacturer						
10.9.3	Minimum Bending Radius	mm	shall be filled by manufacturer						
10.9.4	9.4 Sustained Current Rating in Underground Under Below Conditions :								
10.9.4.1	At <b>Flat</b> Laying Arrangement (Buried in 0.7 m Deep in Soil at 20 <sup>°</sup> C with 1 k.m/w Thermal Resistivity and Load Factor 0.7)	A	250						
10.9.4.2	At <b>Trefoil</b> Laying Arrangement (Buried in 0.7 m Deep in Soil at 20 <sup>°</sup> C with 1 k.m/w Thermal Resistivity and Load Factor 0.7)	A	222						
11	Maximum Short-Circuit Current of Conductor During 1 sec.	KA	≥7.2						
12- D	rum :								
12.1	Method of Cable Delivery		on Drums						
12.2	Length of Cable on Drum	m	500						
12.3	Drum Material		New Wood						
12.4	Cable Protection on Drum		Wooden Batten						

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
12.5	Max. Gross Weight of Drum with Cable	kg	shall be filled by manufacturer						
12.6	Dimension of Drum	mm	shall be filled by manufacturer						
13	Permissible Pulling Forces	Ν	shall be filled by manufacturer						
14- Te	14- Test :								
14.1	Type Test Certificates /Reports from internationally reputed testing agency		Required						
14.2	ptance & Routine tests witnessed by three Engineers		Required						
			Hot Stamping, giving :						
15	Marking		<ol> <li>Type of cable</li> <li>Conductor</li> <li>Cross-section area</li> <li>Beneficiary</li> <li>Name (Gedco)</li> <li>Manufacturer name</li> <li>Nominal voltage</li> </ol>						
			6- Length for Each Meter 7- Production year						


No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments	
1	Name of Manufacturer						
2	Country of Origin						
3	Design Standards		IEC60502-2 & IEC60228				
4	Test Standards		IEC60230 & IEC60502-2 & IEC60811				
5	Code & Designation		N2XS(F)2Y , Power Cable with Copper Conductors and XLPE Insulation				
6	Climatic Design		5°C to 55°C				
7-	7- Rated Voltage						
7.1	Between Conductor and Sheath $(U_{o})$	kV	12				
7.2	Between any Two Conductors (U)	kV	20				
7.3	Max. Service Voltage (U <sub>m</sub> )	kV	24				
7.4	System Nominal Voltage	kV	22				
8	Rated Frequency	HZ	50				
9	Impulse withstand Voltage 1,2/50 µs	kV	125				
10- 0	Cable Design						
10.1 C	Conductor :						
10.1.1	Cross Section	mm <sup>2</sup>	400				
10.1.2	Material		Copper				
10.1.3	Class and Form		Class2 - Stranded Compacted Circular (filled with swelling powder)				
10.1.4	Minimum / Maximum Diameter	mm	23.1 / 24.6				

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
10.1.5	Minimum Number of Strands	No	53			
10.1.6	Weight of Conductor Per Meter	Kg/Km	shall be filled by manufacturer			
10.1.7	Maximum DC Resistance of Conductor at 20°C	Ω/km	0.047			
10.1.8	Max. Rated Temperature for Permanent Load	°C	90			
10.1.9	Max. Rated Temperature for Emergency Loads	°C	105			
10.1.10	Max. Rated Conductor Temperature at Short Circuit (1 sec. max. duration)	°C	250			
10.2 lı	nner Semi Conductive Layer (Con	ductor Scr	een) :			
10.2.1	Material		Triple Extruded Bonded Thermosetting Semi- Conductive Layer			
10.2.2	Thickness at Any Point	mm	0.3			
10.2.3	Max Service Temperature	°C	90			
10.3- X	(LPE Insulation :					
10.3.1	Material		Triple Extruded Dry Cured (XLPE)			
10.3.2	Nominal Thickness	mm	5.5			
10.3.3	Minimum Thickness at Any Point	mm	4.85			
10.3.4	Diameter Over Insulation	mm	shall be filled by manufacturer			
10.3.5	Max Service Temperature	°C	90			
10.3.6	Weight	Kg/Km	shall be filled by manufacturer			
10.4- C	Outer Semi Conductive Layer (Insu	lation Scr	een) :			

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
10.4.1	Material		Triple Extruded Bonded Thermosetting Semi- Conductive					
10.4.2	Thickness at Any Point	mm	0.3					
10.4.3	Max Service Temperature	°C	90					
10.5- S	Semi-Conductive Water Swelling T	ape :						
10.5.1	Material		Semi Conductive					
10.5.2	Thickness at Any Point	mm	0.3					
10.5.3	Max Service Temperature	°C	90					
10.6- Copper Wire Screen (including Equalizing Tape) :								
10.6.1	Material of Wire and Equalizing Tape		Copper					
10.6.2	Minimum Wires Number		shall be filled by manufacturer					
10.6.3	Wire Geometrical Cross Section	mm²	35					
10.6.4	Equalizing Tape Width	mm	20					
10.6.5	Equalizing Tape Thickness	mm	0.1					
10.7- S	Separation Sheath (Binder Tape) :							
10.7.1	Material		Water Blocking Tape Non- Conductive					
10.7.2	Thickness	mm	0.2 - 0.3					
10.7.3	Max Service Temperature	°C	90					
10.8- 0	Duter Sheath :		-					
10.8.1	Material	mm	LDPE ST7 with Chemical Additives					
10.8.2	Nominal Thickness	mm	2.5					

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments				
10.8.3	Minimum Thickness at Any Point	mm	shall be filled by manufacturer							
10.8.4	Max Service Temperature	°C	90							
10.8.5	Color		Red							
10.8.6	Weight	Kg/Km	shall be filled by manufacturer							
10.9-	Completed Cable :									
10.9.1	Overall Diameter of the Cable	mm	shall be filled by manufacturer							
10.9.2	Total Weight of the Cable	kg/km	shall be filled by manufacturer							
10.9.3	Minimum Bending Radius	mm	shall be filled by manufacturer							
10.9.4	4 Sustained Current Rating in Underground Under Below Conditions :									
10.9.4.1	At <b>Flat</b> Laying Arrangement (Buried in 0.7 m Deep in Soil at 20 <sup>°</sup> C with 1 k.m/w Thermal Resistivity and Load Factor 0.7)	A	685							
10.9.4.2	At <b>Trefoil</b> Laying Arrangement (Buried in 0.7 m Deep in Soil at 20 <sup>°</sup> C with 1 k.m/w Thermal Resistivity and Load Factor 0.7)	A	671							
11	Maximum Short-Circuit Current of Conductor During 1 sec.	KA	≥57.2							
12- D	rum :									
12.1	Method of Cable Delivery		on Drums							
12.2	Length of Cable on Drum	m	500							
12.3	Drum Material		New Wood							

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
12.4	Cable Protection on Drum		Wooden Batten						
12.5	Max. Gross Weight of Drum with Cable	kg	shall be filled by manufacturer						
12.6	Dimension of Drum	mm	shall be filled by manufacturer						
13	Permissible Pulling Forces	N	shall be filled by manufacturer						
14- Te	14- Test :								
14.1	Type Test Certificates /Reports from internationally reputed testing agency		Required						
14.2	Acceptance & Routine tests witnessed by Beneficiary		Required						
			Hot Stamping, giving :						
			1- Type of cable						
			2- Conductor Cross-section area						
15	Marking		3- Beneficiary Name <b>(Gedco)</b>						
			4- Manufacturer						
			5- Nominal voltage						
			6- Length for Each Meter						
			7- Production year						

# 12/20 kV Single Core Cable with XLPE Insulation and Copper Circular Stranded Conductor $1\mathrm{x400~mm}^2$



# 250A , 24 kv Indoor Screened Separable Elbow Termination Kit for 12/20 kv XLPE Cable 1x50/16 $\mbox{ mm}^2$

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Standards		ANSI/IEEE386 , IEC540, VDE0278 , VDE0220			
4	Max. Service Voltage (Um)	kV	24			
5	Termination Design		Separable Elbow Connector			
6	Termination Material		Cross linked EPDM			
7	Cable and Conductor Type		Single Core Cable with Copper Wire Shield			
8	Cable Insulation Type / Thickness		XLPE / 5.5mm			
9	Conductor Cross Sectional Area	mm²	50			
10	Application		to Connect with SF6 Switchgear Transformer Side and Transformer H.V Side			
11	Current Carrying Capacity	А	250			
12	Basic Impulse Level	kV	125			
13	AC Dry withstand Voltage Test (1 minute without Flashover and No Breakdown)	Kv	57			

# 250A , 24 kv Indoor Screened Separable Elbow Termination Kit for 12/20 kv XLPE Cable 1x50/16 $\mbox{ mm}^2$

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments				
14	DC withstand Voltage Test (30 minute without Flashover and No Breakdown)	Κv	96							
	Termination Kit Parts									
	a) Screened Body		Required							
	b) Capacitive Test Point		Required							
	c) Stress Cone		Required							
	d) Conductive Cable Entrance		Required							
	e) Earthing eye and Ground Lead		Required							
15	f) Inner Screen		Required							
	g) Lifting Eye		Required							
	h) Pin (Tin Plated Copper Electrode , Tested to carry 250 A Continuous Current)		Required							
	i) Bimetallic Compression Pin- Connector Designed with Locking Ring, to Connect Both Aluminium and Copper Conductor Cables		Required							
	j) Bail Restraint		Required							
16	Type Tests and Routine Tests reports by qualified laboratory according to the international specifications (e.g. ANSI/IEEE 386, IEC 540, VDE 0278,VDE 0220)		Required							

# 250A , 24 kv Indoor Screened Separable Elbow Termination Kit for 12/20 kv XLPE Cable 1x50/16 $\mbox{ mm}^2$

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Bail Restraint	r Screen pression ector	Pin		Lifting Eye Capacitive Test Stress Cone Screened B Conductive Ca	Point Body able Entrance
	Tenderer's Signature :		Date:			

# 630A , 24 kv Indoor Screened Separable Termination Kit for 12/20 kv XLPE Cable 1x400/35 $\mbox{ mm}^2$

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Reference Manufacturing Standards		CENELEC HD629.1 S2, HD506 S1 , DIN47636, EN50180 and EN50181			
4	Max. Service Voltage (Um)	kV	24			
5	Design		Separable Tee Shape Connector			
6	Material		Cross linked EPDM			
7	Cable and Conductor Type		Single Core Conductor Cable with Copper Wire Shield			
8	Cable Insulation Type / Thickness		XLPE/5.5mm			
9	Conductor Cross Sectional Area	mm²	400			
10	Current Carrying Capacity	A	630			
11	Basic Impulse Level	kV	170			
12	Partial discharge at 2 U0		< 10 Pc			

# 630A , 24 kv Indoor Screened Separable Termination Kit for 12/20 kv XLPE Cable 1x400/35 $\mbox{ mm}^2$

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments				
13	AC Dry withstand Voltage Test (5 minute without Flashover and No Breakdown)	Kv	81							
14	DC withstand Voltage Test (15 minute without Flashover and No Breakdown)	Kv	108							
15	Thermal Short Circuit (1 second)	KA	33							
16	Dynamic short circuit	KA	84							
	Termination Kit Parts									
	a) Screened Body		Required							
	b) Inner Screen		Required							
	c) DIN Compression Lug for AL or CU Conductors (400 mm2)		Required							
	d) Stress Cone Adaptor		Required							
17	e) Earthing eye and Ground Lead		Required							
	f) Threaded Pin Together with a Spring Washer and Hex Nut		Required							
	g) Removable Rear Plug with Capacitive Test Point		Required							
	h) Test Point		Required							
	i) Conductive End cap		Required							
18	Type Tests and Routine Tests reports by qualified laboratory according to the international specifications		Required							



630A , 24 kv Indoor Screened Separable Termination Kit for 12/20 kv XLPE Cable  $1x400/35 \text{ mm}^2$ 

Tenderer's Signature : .....

Date: .....

# Technical Guarantees No. OT36\_400

## 36 kv Heat Shrinkable Outdoor Termination Kit for XLPE Cable 1x400/35 mm<sup>2</sup>

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
1	Name of Manufacturer					
2	Country of Origin					
3	Standards		IEC60502 & CENELEC HD629.1 S1			
4	Max. Service Voltage (Um)	kV	36			
5	Outdoor Termination Material , form , Designation		Heat Shrink Tubing and Molded Parts Shall be Flexible, Made from Specially Formulated Cross-Lined Polymeric			
6	Cable and Conductor Type		Single Core Conductor Cable with Copper Wire Shield			
7	Cable Insulation Type / Thickness		XLPE / 5.5 mm			
8	Conductor Cross Sectional Area	mm <sup>2</sup>	400			
9	Wire Screen Cross Sectional Area	mm²	35			
10	Termination Length	mm	550			

# Technical Guarantees No. OT36\_400

## 36 kv Heat Shrinkable Outdoor Termination Kit for XLPE Cable 1x400/35 mm<sup>2</sup>

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments			
11	Rain Shed Diameter	mm	135						
12	Number of Rain Sheds	No	4						
13	Insulating , Electrical Material and Rain Shed Brittle Temperature	°C	<-40						
14	Impulse withstand Voltage Test 1.2 Micro Second Between Conductor & Screen Grounded	kV	170						
15-	15- Test :								
15.1	All Type tests reports by qualified laboratory according to CENELEC HD 629.1 S1		Required						
15.2	Routine test report		Required						
	Heat Shrinkable Outdoor Termin	ation <b>F</b>	(it Parts						
	Bimetallic Terminal Mechanical Lug with 13 mm Hole and 3 each Shear_Head Bolts (for Aluminium or Copper Conductors)		Required						
	Anti-Tracking Sleeve		Required						
16	Rain-Sheds (4each)		Required						
	Stress Control Sleeve		Required						

## **Technical Guarantees No. OT36\_400**

## 36 kv Heat Shrinkable Outdoor Termination Kit for XLPE Cable 1x400/35 mm<sup>2</sup>

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Stress Control Mastic		Required			
	Binding Wire		Required			
	Worm Drive Clamp		Required			
	Copper Braid (Earthlings)		Required			
17	Installation Instruction Documents		Required			



No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments		
1	Name of Manufacturer							
2	Country of Origin							
3	Standards		HD 629.1 S1 , VDE0276 , VDE0620					
4	Max. Service Voltage (Um)	kV	24					
5	Cable and Conductor Type		12/20 kv Single Core Cable with Copper Wire Shield					
6	Cable Insulation Type		XLPE					
7	Conductor Cross Sectional Area	mm²	400					
8	Copper Shield Cross Sectional Area	mm²	35					
9- Tes	st :							
	Below Type tests reports by qualified laboratory according to CENELEC HD 629.1 S1 or IEC 60502-4 :- AC Voltage Withstand							
9.1	Partial Discharge Impulse Voltage Withstand Short Time Current Cyclic Aging DC Voltage Withstand High Voltage Time Shielding		Required					
9.2	Mechanical connectors Test used in joints should pass the requirements in accordance with IEC 61238-1 class A.		Required					
10	Routine test report		Required					
11	Installation Instruction Documents		Required					
	Heat Shrinkable Straight Joint Parts							
	Stress Control Tubing		Required					
	Screened insulating Sleeve		Required					

#### 24 kv Heat Shrinkable Straight Joint for Single Core XLPE Cable 1x400/35 mm<sup>2</sup>

No	Description	Unit	Requirements	Offered Data	Notes, Remarks , Ref to Documentation	Evaluation Committee Comments
	Outer Sleeve (Heat Shrink able Conductive Material)		Required			
	Screened Insulating Tubing		Required			
	Filling Mastic		Required			
12	24kv Mechanical Connector with Shear-Head Bolts and Central Barrier for AL or CU Conductors (400 mm2)		Required			
	Mechanical Connector with Shear- Head Bolts and Central Barrier for Copper Shield (35 mm2)		Required			
	Mastic Wrap		Required			
	Copper Mesh		Required			

#### 24 kv Heat Shrinkable Straight Joint for Single Core XLPE Cable 1x400/35 mm<sup>2</sup>



Tenderer's Signature : ..... Date: .....

Technical Specification for Civil Works

## 1. Scope of works

## 1.1 General

Scope of the work includes, but not necessarily be limited to, the following :

- Preparation of detailed design documents, obtaining approval from Statutory Authorities / Municipalities / Client .
- Civil works, handling, transportation to sites.
- Supply, manufacturing, packing and forwarding, delivery at site, installation and supervision.
- ✤ Installation of electrical equipment as specified in Bill of Quantities.
- Erection of all equipment and materials for the construction.
- Electrical cables and accessories Supplying, laying and installing .
- Locating the cables trenches routes and all cables joints by high accuracy positioning device (GPS).
- Repair all damage caused by excavation and filling own infrastructure or property of others.
- ✤ Coordination with owner to energize installed lines .
- Providing progress reports etc.
- ✤ Statutory approvals.
- Inspection and testing as specified during the contract period.
- Submission of documents as specified.
- Any other items, required to make system complete.

## 1.2 Design conditions

## 1.2.1 Site conditions

The climatic conditions are as follows:

geographic location	:	as abovementioned
altitude	:	from -10 m to 100 m above sea level
mean ambient temperature	:	from plus 5° to 35°C
max and min ambient temperature	:	from 2° to plus 45°C
humidity	:	90%
maximum wind velocity	:	from 10 (normal) to 50 km/h (gale)

	pollution	: light, few sand wind
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## 2. Responsibility of Contractor

- 9.1 In all matters related to installation of electrical equipment and supply of any materials as per Bill of Quantities.
- 9.2 The contractor is responsible for the quality and correctness of workmanship and for the quality and suitability of materials of his supply, in accordance with the relevant contract documents / drawings, specifications, standards, bills of material, etc.
- 9.3 Locating the cables trenches routes and all cables joints by high accuracy positioning device (GPS) .
- 9.4 The work shall comply with the requirements of latest statutory regulations in force but not limited to the Owner Rules & Acts, Relevant Owner Specifications, Local Statutory Regulations and Specifications of this Tender.
- 9.5 The Contractor shall be responsible for assigning the staff and personnel having the necessary competence and experience to carry out the tasks required for the work.
- 9.6 All materials to be provided by Contractor required for the work such as Cables, termination kits, joints, poles, arms, Pipes, Concrete Slabs, Cables Guard, Steel Plates, Cable Ties, Warning Tape, insulation tape, interlock tiles, Asphalt layer, concrete, marble flooring tiles, kurkar, base-coarse and Sand etc., shall be conform to relevant Specifications and Supervisor engineer instructions, and arranged by the contractor at his own cost.
- 9.7 Tools & tackles required for the work shall be arranged by the contractor and shall be kept at his own custody.
- 9.8 All the tools & tackles must be of good specifications and accepted by the supervisor engineer.
- 9.9 The contractor shall draw a detailed programme for the supply of materials and installation work to fit into the overall project programme of the owner.
- 9.10 The contractor shall obtain owner's representatives acceptance of the programme. The contractor shall work to this and provide sufficient labour and tools / tackles / materials to meet the programme dates.

- 9.11 The contractor shall estimate the percentage of work completed on each section of the work each week and shall pass this information to the supervisor engineer. Supervisor engineer will decide whether such percentages are a true record of the actual work carried out.
- 9.12 The supervisor engineer, if required, may instruct the contractor in writing to increase the labour force tools and tackles at site. The contractor shall take action and shall ensure that progress of the works is brought in line with the progress curves and satisfy of the supervisor engineer. No idle time claims shall be applicable under this contract.
- 9.13 The contractor shall arrange for resident Engineer to be available for a weekly site meeting to cover general progress.
- 9.14 The delivery of materials, which are to be provided by the contractor, shall be in accordance with the predetermined programme agreed between the owner representative and the contractor.
- 9.15 All work shall be done and completed in workmanlike manner in accordance to best modern practice of construction, notwithstanding any omissions from this specification or drawings.
- 9.16 The Contractor shall comply with all national and local regulations regarding barricades, detour arrangements and warning signs. Damages to roads, footpaths, bridges, ditches, etc., caused by the Contractor shall be repaired at Contractor's own expense.
- 9.17 No separate payment shall be made to the Contractor on account of building or repairing the access lanes.

### 9.18 Site Supervision:

- 2.14.1 The contractor shall provide adequate number of competent and qualified full time supervisors at site. Owner site engineer shall monitor the work / inspect the materials supplied by the contractor and issue necessary instructions to the contractor when required.
- 2.14.2 The contractor must provide a vehicle to transfer full-time project Supervisor engineer to work place at the expense of the contractor.

- 2.14.3 The contractor shall be supplied with general arrangement, schematic wiring drawings and layout drawings showing the routing of cables, earthing, location of Cables Joints, etc. All Drawings and Points shall be taken by high accuracy GPS.
- 2.14.4 The contractor shall prepare when required detailed working drawings. He must obtain owner supervisor engineer's approval prior to starting the installation.
- 2.14.5 All field corrections shall be marked up on the copy of relevant drawings and such "As Built" drawings shall be submitted to the supervisor engineer on the complete section. Two sets of hardware and software drawings shall be handed over to the contractor.

## 3. Measurements:

- 3.1 The contractor shall inform the supervisor engineer when various sections of the contract works are completed.
- 3.2 Contractor's representative on site shall maintain records and measurement sheets as the work progresses. The summarized measured quantities of each cable size, type of equipment, etc. will be entered on the sheets and initialed by both, contractor's representative and the supervisor engineer in charge weekly. The contractor shall then submit a copy of the summarized sheets to substantiate his claim for payment.
- 3.3 The supervisor engineer's signature on the measurement sheet at the completion of each interim measurement does not commit the owner to pay for the work described.
- 3.4 The signature shall mean that the supervisor engineer and the contractor agree with the measured work. The liability of the owner to pay the contractor for the measured work shall be defined by the terms of the contract.
- 3.5 Contractor shall ensure that the measurement of quantities in case of underground activities will be certified by owner engineer before covering the cables of sand.
- 3.6 Contractor shall raise only one running bill per month for supply & installation.
- 3.7 Measurement Procedure

- a. Cables Measurement shall be from lug to lug.
- b. Excavation Average width and depth shall be considered. Length will be measured along the center line.
- c. Sand layers shall be measured on the basis of drawing average dimensions and according to supervisor engineer instructions.
- d. Backfilling Average width and depth shall be considered. Length will be measured along the center line.

## 4. Extra Items

In the event of any item of work which needs to be carried out for the completion of the work and it is not covered by this specification, such an item of works shall be termed an extra item. The contractor shall first notify with provisional rate and get a written agreement from the site engineer before commissioning the work. In order to facilitate the finalization of the rate for items not covered in the schedule of rates, but which are similar in nature to the items already covered therein, the rates for these items shall be arrived at by extending the rates for similar extra item as applicable. In case, it is not possible to derive rates for extra items as mentioned earlier, contractor shall submit detailed rate analysis with supporting vouchers to substantiate the rate for approval to site engineer.

## 5. Approval of Authorities

The contractor shall coordinate the inspection / approval by the authorities of the work that he carried out for the purpose of compliance with the necessary regulations issued by them.

## 6. Consumables

The contractor shall supply all the consumable materials and installation materials required for complete erection like lubricating oil, insulating tapes, tapes and cords, Warning Markers, connectors, burning / soldering / plumbing materials, numbering ferrules, numbering tags, markers, hardware's, etc. All used hardware's shall be galvanized only.

## 7. Prevention and safety requirements

- 7.1 The contractor shall supply all the prevention and safety materials required for workers, engineers and drivers like worker yellow hard hat, working clothes, ropes, gumboots, gloves, belts and emergency first aid kits.
- 7.2 Contractor assumes full responsibility for the extent of the workers to follow the laws of prevention and safety. Owner Officer will prevention and safety in charge of the

work of daily reports about the extent to follow the laws of prevention and public safety, and in the case of failure to follow these laws the work will be arrested immediately.

- 7.3 it is required taking the required safety and precaution procedures during executing the project such as the closure of the streets, putting the cautionary signals about the drilling or what is required in the site as per supervisor engineer instructions.
- 7.4 it is required submitting the insurance for all the workers and project equipment by the approve insurance company before starting execution.

## 8. Civil Engineering Work

- 8.1 This section is generally to be carried out in compliance with Section " CIVIL WORKS " of this specification.
- 8.2 The contractor's scope of work will include any minor civil work directly connected to his work and in making good all breakages / damages caused in the execution of his work at no extra cost to the owner.
- 8.3 The contractor shall be responsible for the true and proper setting out of the work in relation to original points, lines and levels of reference and for the correctness of levels, dimensions and alignment of all part of the work and for the provision of all necessary instruments appliances and labour in connection therewith. The contractor shall layout one or more permanent bench marks in some central place before starting the work.
- 8.4 The contractor shall check and inform in writing to owner supervisor engineer if any discrepancy is noticed by him in civil work. The supervisor engineer then shall arrange for necessary rectification, if necessary.
- 8.5 Other openings, sleeves, etc. required to be provided in the brickwork / concrete for electrical work shall be carried out by the contractor and shall be made good to the satisfaction of owner at no extra cost.

- 8.6 All damages caused to the foundation due to negligence of the contractor shall be rectified by him at his own cost as directed by the supervisor Engineer.
- 8.7 Excavation of trench for direct burial of underground cables, including supply and spreading of sand, supply and laying of concrete slab / pipes wherever required and backfilling with good earth shall be included in the scope of the contractors work.
- 8.8 The contractor shall also at the end of each day's work, ensure that all the trenches within the work site are properly covered by means of protection covers, wooden planks, steel plates, etc. as temporary measures or cordoned off by barricades. In the case of non-implementation of the foregoing owner will do what is required at the expense of the contractor and will be suspended from work until the contractor's commitment to taking the guarantees of non-repetition.

## 9. Storage

- 9.1 The contractor shall provide and quipped at no extra cost suitable temporary storage facilities and fully equipped site office.
- 9.2 The contractor shall provide the necessary security services to safeguard the materials which shall be his responsibility under the terms of the contract.
- 9.3 When the contractor is established on site, he shall off-load, sort out, store or stack and record to owner's satisfaction all materials, which have been fabricated or ordered by the contractor.
- 9.4 At the end of the contract, the contractor shall completely remove and dispose of all temporary works erected on site and return the place of the store and office to what it was before the start of work.

## 10.Clean-up of work site

The Contractor's scope include cleaning up of the work site and carting away all unnecessary materials from the work site from time to time at no extra cost.

## **11.Receipt and Reconciliation of Material**

- 11.1 The contractor's scope of work includes taking delivery of these equipment / materials packed or unpacked, from owners store, transporting to place of installation or to his Warehouse.
- 11.2 All necessary tools, tackles and facilities required for transporting shall be made available by the contractor at no extra cost.
- 11.3 The contractor shall visually inspect all materials for any defects of workmanship or damage. The contractor shall accept the liability for all the items issued to him till the same are installed, commissioned and handed over to the owner.
- 11.4 On completion of the work, the contractor shall submit material reconciliation Statements for all material issued by owner, in the preform a prescribed by supervisor engineer.
- 11.5 All excess materials and scrap shall be returned after duly accounting for, to the storage points, in good condition, without which contract will be deemed to be incomplete.
- 11.6 If the contractor fails to return the surplus material aforesaid, the owner will charge the contractor for such un-returned materials at rates prevailing in the market.

## **12.Installation of Equipment**

12.1 Prior to start of installation of the electrical equipment, Contractor shall verify that equipment and complete materials have been received. Handling, shifting to required site location, installation and testing of all electrical equipment shall be done by contractor with utmost care. Manufacturer's instructions and the requirements given in their technical manuals shall be strictly adhered. The switchgear room wherein the equipment shall be installed shall be kept clean, dry and free from all debris. Switches not in immediate use shall be suitably covered to avoid any mishap. No

parts shall be subjected to undue strains or sudden stresses which could cause damage to the equipment.

- 12.2 The lifting position mark indicated on packing casing shall be adhered to strictly, for keeping it in required vertical position.
- 12.3 Contractor shall check and report to the Supervisor engineer about any damaged item and / or missing component for getting the same replaced as per specifications. During installation, all accessories and loose items shall also be inspected by the contractor before their assembly/mounting.

## 13.Excavation, cables laying and backfilling works

### **13.1** Excavation works:

- 13.1.1 Contractor shall comply with the conditions for the extension of public services roads.
- 13.1.2 The contractor shall be fully responsible for excavation works towards any authorized side or the owner of the street such as ministries or municipalities. He shall bring all the required documents from them , and call a representative from them before starting excavation or during its period.
- 13.1.3 The contractor shall submit an official letter from the municipality of the initial receipt of the project.
- 13.1.4 The contractor will be liable for any infrastructure in the ground and shall fix it in case of any damage might occur. He shall remove any invisible obstacles, put the solutions in his account which has to be satisfactory for the supervising crew and to commit to replace what is needed.
- 13.1.5 The excavation dimensions shall be in compliance with the given dimensions.
- 13.1.6 The depth & width of the trench shall vary depending upon the number of layers of cables. It is to be ensured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed.
- 13.1.7 The contractor shall support the sides of excavations if it is necessary. In case of reaching to unsuitable soil when reach to excavation level, the contractor shall excavate to level not less than 40 cm depth increase and replace the soil with

suitable soil reaching to the underlay. This occurs in his account without having the right to call for any financial differences .

- 13.1.8 The contractor shall keep excavating waste away from the trench as possible and as instructed by the supervisor engineer.
- 13.1.9 All the notes given by the municipality and owner supervising crew are obligatory.
- 13.1.10 Corrosive soils, ground surrounding sewage effluent etc. shall be avoided for the routes.
- 13.1.11 In unpaved areas, cable trenches shall be identified by means of cable markers.

## **13.2** Cable unwinding:

The cable drum shall be set on stand for this operation. The stand shall be installed in the longitudinal axis and near the open trench. The drum covering battens shall be removed and the cable shall be unreeled. The drum rotation shall be controlled by two (2) operators.

Withdrawing process of the cable shall be from the bottom of the cable drum.

### 13.3 Cable Laying:

- 13.3.1 The contractor must have the pulling cable machine with all the necessary accessories for cable drag and must have suitable cables-grip.
- 13.3.2 The power cables shall be laid in directly buried trenches or in pipe sleeves as detailed in the cable layout drawings.
- 13.3.3 Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with the structures, drains, piping and telephone cables etc.
- 13.3.4 Any change in routing shall be done to suit the field conditions wherever deemed necessary, after obtaining approval from supervisor engineer.
- 13.3.5 The cables shall be separated from each other by adequate spacing and by using non-magnetic material like plastic, wood or concrete spacers as per drawings and according to supervisor instructions.

- 13.3.6 Details of cable routes and cable spacing not shown in these drawings shall be determined by the contractor and approved by the supervisor engineer.
- 13.3.7 The trench bottom shall be filled with a layer of clean, dry sand cushion of not less than 10 cm in depth sand to ensure that no scratches or cutting to the cable would occur. This sand shall be levelled and cables laid over it.
- 13.3.8 The Contractor shall provide suitable cable rollers to be used for pulling of cables, The Contractor shall install the cable rollers every three (3) meters and the angle rollers at each corner of the cable route. Each roller shall be securely fixed to the ground.
- 13.3.9 Before the start of cable laying, the contractor shall prepare cable drum schedule and get that approved by supervisor engineer to minimize/ avoid straight through joints. Then the cables shall be cut to the required lengths, leaving sufficient lengths for the terminations of cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of supervisor engineer to meet contingencies.
- 13.3.10 Sufficient care shall be taken while laying cables to avoid formation of twist, sharp bend etc. in order to avoid mechanical injuries to cables.
- 13.3.11 Cable installation shall provide minimum cable bending radius as recommended by cable manufacturer.
- 13.3.12 The cable men shall be positioned inside and along the trench at convenient intervals so that the portion of cable length can be easily lifted and dragged by each cable man.
- 13.3.13 The contractor shall supply the cables ties which must be made from natural nylon with size 7.5 mm and 1.8 Thickness as required Length of cable outer diameter.
- 13.3.14 When laid the cables in trefoil formation, its shall be braced by suitable cables ties at a distance, not exceeding two (2) meters along the cable routing.
- 13.3.15 Cables shall be neatly arranged in the trenches in such a manner that crisscrossing is avoided and final take off to the switchgear is facilitated.
- 13.3.16 Cable routing between cable trench and equipment shall be taken through UPVC sleeves of adequate size.

- 13.3.17 Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage. The distance between different voltage cables shall be according to supervisor engineer.
- 13.3.18 Cables for road crossings shall be taken through UPVC pipes as shown in the cable layout drawings, Pipes shall be continuous and clear of debris or concrete before cables are drawn.
- 13.3.19 At road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- 13.3.20 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be securely fastened to the cable and wrapped around it. These cable markers shall be placed at location of changes in the direction of cables. At intervals of not more than 30m and also at cable straight through joint locations.
- 13.3.21 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of cables shall be taped with an approved UPVC end cap or rubber insulating tape.
- 13.3.22 The lengths indicated in the cables schedule are only approximate. The contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured.
- 13.3.23 Before covering the cables with sand, the cables shall be tested for continuity of cores and insulation resistance also the cable length shall be measured.
- 13.3.24 The cables end shall be sealed.
- 13.3.25 If the poles or switchgear rooms at the end side, the contractor shall pull 12-15 meters length of the cable from each side and lifted to the steel poles or in switchgear rooms.
- 13.3.26 The cables shall be rolled out for equipment and cutting shall be as per site requirement.
- 13.3.27 The Contractor shall cut all cable length by actual measurement at site as per final route determined. Cable lengths indicated in cable schedules shall be used only to get an idea of length involved.

#### **13.4 Pipes:**

- 13.4.1 Pipes shall be in a special specification, type "SN8", the contractor shall commit with the number and diameters in the bill of quantities.
- 13.4.2 During the execution ,all the pipes shall be connected with each other in order not to enter concrete in the pipes.
- 13.4.3 The contractor shall put suitable ropes inside the pipes to facilitate inserting and pulling the cable .
- 13.4.4 The trench bottom under pipes shall be filled with a layer of clean, dry sand cushion of not less than 10 cm.
- 13.4.5 The contractor shall be ensured that both the ends of UPVC pipe to be sealed with approved weather proof sealing plastic compound after cabling.
- 13.4.6 All wall opening/ pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside lined trench /Switchgear building.
- 13.4.7 As for packaging the pipes with concrete if any , the type of concrete shall be B200. The thickness of this concrete shall be according the drawings and supervisor engineer instructions.
- 13.4.8 The owner have the right to take samples to test the concrete or refuse it by the naked eye or according to the opinion of supervisor engineer .
- 13.4.9 When pipes are laid cutting an existing road, care shall be taken so that the soil filled up after laying the pipes is rammed well in layers with watering as required to ensure proper compaction. A crown of earth not exceeding 10cm should be left at the top.

#### 13.5 Works inside the trenches:

- 13.5.1 The Contractor shall provide amounts of sand, concrete slabs, base course, interlock, concrete and asphalt according to the need before starting the work.
- 13.5.2 These cables shall be covered with a layer of clean, dry sand. The sand shall be watered and lightly compacted.
- 13.5.3 Supplying a sample of the concrete slabs providing that the size not to be less than 45\*45\*5 cm, endurance strength 40 kg/cm2 to be in compliance with the technical specification and according to the approved result of testing. Also

approved by the supervisor engineer before installation. Forbidden to use any sample such as construction materials size 40\*20\*5 cm.

- 13.5.4 The concrete slabs shall be placed breadth-wise for the full length of the cable.Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables.
- 13.5.5 When cast the concrete around the pipes there is no need to put concrete slabs in the trenches.
- 13.5.6 After installation of concrete slabs or casting concrete around and over pipes the contractor shall but clean and dry sand as per drawings and according to supervisor engineer instructions.
- 13.5.7 The cables shall be tested for continuity of cores and insulation resistance again after installation of concrete slabs, and before casting the concrete around the pipes.
- 13.5.8 Over the previous sand layer the contractor shall supply and laid in continuous length warning tapes according to the drawings and supervisor instructions. The warning tape shall be Acid / Alkali Resistant and 150 mm wide in Phosphoric (yellow) color printed with black letters in indelible material. The text is in English and Arabic languages should be:

### **CAUTION CAUTION CAUTION**

### **Electrical Cables Buried Below**

## تحذير تحذير تحذير

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The number of warning types according the drawings.

- 13.5.9 The trenches shall be then back-filled with excavated earth, free from stones or other sharp ended debris, rammed and levelled.
- 13.5.10All previous operations must be punctuated by spraying water and compaction according to the supervisor engineer instructions.
- 13.5.11 All the notes which given by the municipality supervising crew are obligatory for the contractor as the notes which are given by the owner supervision crew.

13.5.12 The supervisor engineer has the right to refuse the sand, backfill, Warning type, concrete slabs, pipes, concrete... etc. if he discovers that the materials are not according the specifications.

## 13.6 Surface layers

### 13.6.1 Interlock:

- a) The contractor must provide samples and take the approval of the supervisor engineer before the supply of the quantity of the interlock .
- **b)** the thickness of the interlock shall be 8 cm or as per the available tiles subjected to the approval of the owner and the relevant municipality in particular the thickness and shape.

## c) The method of interlock installation:

- i. Supply and place of base course 30 cm thickness on 2 layers each layer is 15 cm thickness watering and compacting each layer separately, the contractor shall provide samples of the base course for approval before the use, the supervising committee has the right to inspect the base course at any time, also the supervising committee has the right to take samples of the base course after compacting to make sure of the compacting density which must not be less than 100% according the specifications applied in the ministry of public works and housing.
- ii. Supply and place of 5 cm thickness of clean sand, the supervising committee has the right to reject the sand it has detritus or any other content.
- iii. Supply and tiling interlock provided that the final level of the interlock shall be according to the instruction of the engineers be slightly above the level of the street, then close the side spaces between the interlock and the sidewalk and between the interlock and the concrete then spread yellow sand and use the vibrator to compact the interlock and hand over the final surface in a satisfactory manner to the supervisor engineer.
- iv. All the notes which given by the municipality supervising crew are obligatory for the contractor as the notes which given by the owner supervision crew.

### 13.6.2 Asphalt:

- a) Furnishing two layers of base course each layer is 15 cm with compacting as mentioned above , in regard to the specifications of the base course the compacting ratio should not be less than the compacting ratio of the ministry of public works and housing, the layer shall be cleaned from other substance and dust , then furnishing a layer of MCO using the proper tools in accordance with the ministry of public works and housing in a ratio of 1.7-0.8 kg/m2 which is soak in layer to the base course layer with a temperature of 60 °C.
- **b)** After that furnish a glue layer RC3 or RC2 in a ratio of 0.75-0.3 kg/m2 which is a layer from hot bitumen fast volatilized in accordance to the specification of the ministry of public works and housing , it should be furnished on the soil after being cleaned and then be left to get dry to become sticking with a temperature of 70 ° C , then spread the asphalt mixture and well roll it with rollers , the owner has the right to take samples after rolling and contact the required tests on the taken samples , the temperature of the mixture shall be at 135 °C and shall not exceed 165 °C .

#### 13.6.3 Tile of normal sidewalk:

Furnish of base course layer with 15 cm thickness with watering and well compacting according to specifications, the supervising committee has the right to take samples from the compacted soil, then furnish a 5 cm layer of clean sand after that furnish a 2 cm layer of slurry under the tiles, after that place the tile over the slurry taking into account finishing and fill the spaces between the tiles with slurry.

#### 13.6.4 Concrete in the sidewalk:

Furnish of base course layer with 15 cm thickness with watering and well compacting according to specifications, the supervising committee has the right to take samples from the compacted soil, then furnish a 10 cm layer of concrete B200 taking into account take samples for tests.

#### 13.6.5 The mosaic tiles:

Supplying sample of mosaic tiles to be approved by the supervisor engineer before the installation according to the origins of manufacturing and according to the sample used in the site regarding dimensions and thickness.

#### **13.6.6** The fluted cement tiles:

Supplying sample of the fluted cement tiles provided that to be in compliance with what is available and to be approved by supervisor engineer before the installation and according to the dimensions, thickness and to be installed according to the manufacturing.

#### **13.7** Terminations and Joints:

- 13.7.1 Jointing and termination of electrical cables shall be done by skilled and experienced jointer duly approved by supervisor engineer.
- 13.7.2 The contractor must use the appropriate equipment and machinery to install and fix the joints and terminations.
- 13.7.3 The contractor must open samples of the joints and terminations in front of the supervisor engineer to ensure the safety of the equipment and the absence of any shortage of funds within the joints and terminations.
- 13.7.4 The number of joints shall be restricted to minimize as far as possible.
- 13.7.5 Before laying a cable, proper locations for the proposed cable joints, if any, shall be decided, so that when the cable is actually laid, the joints are made in the most suitable places. As far as possible, water logged locations, carriage ways, road crossings, proximity to telephone cables, water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for locating the cable joints.
- 13.7.6 No joints shall be allowed in hazardous areas without the approval of supervisor engineer.
- 13.7.7 Joint pits shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin or by set up a tent to prevent dust and other foreign matter being blown on the exposed joints and jointing materials.
- 13.7.8 The location of joints shall be identified with permanent markers and the contractor shall take the joints coordinates with high accuracy GPS and then handed over to the owner.
- **13.8** Accessories supplying and installation:
- 13.8.1 The contractor must provide samples and take the approval of the supervisor engineer before the supply of the quantity of the Cable guards, Stainless steel bands, stainless steel buckles and steel plates.
- 13.8.2 When cabling and fixed on steel poles, the contractor shall install cables guards before the process of lifting cables on the pole, and then install the outdoor termination kits.
- 13.8.3 The contractor shall fix the cables by cables ties on cable guards. Then closing the cable guard cover and fix the cable guard by stainless steel band 12.7mm width and 0.76mm thickness, The specifications shall be as per supervisor engineer instructions.
- 13.8.4 The contractor shall fix the cables with the steel poles by using suitable cable ties.
- 13.8.5 The contractor shall fix the cables on the top of poles into cable holders on steel plates as per supervisor engineer instructions.
- 13.8.6 The Contractor shall install surge arrestors as per site engineer instructions and make all necessary earthing as required values.

#### 13.9 Earthing

- 13.9.1 The contractor shall ground the ring main units, surge arrestors and steel structures in switchgear rooms.
- 13.9.2 The contractor shall supply and install earthing units (70 mm2 copper PVC cable, 35mm2 copper wires, earthing rods, earthing joints and earthing clamps)
- 13.9.3 The Contractor shall measure the earth resistance. The value of earthing resistance must be not more than 5  $\Omega$ .
- 13.9.4 All wires shall be handled and installed in a workmanlike manner free from kinks and damage of any kind.
- 13.9.5 Backfill of trenches for earthing shall be thoroughly compacted.

#### **13.10** Other Connections:

The contractor must make all the necessary connections to connect the cables with overhead network, all connections inside the switchgear rooms and cables connections for ring main units as instructed by the supervisor engineer without an extra charge.

#### **13.11** Testing of Cables:

Before energizing, the insulation resistance of every circuit shall be measured from phase to phase, phase to neutral and from phase/ neutral to earth. Where Joints or terminations are required, insulation resistance of each length of cable shall be measured before Joints and/ or terminating. After completion of Joints and/ or terminations measurements shall be repeated. The insulation resistance of directly buried cables shall be measured after laying the cables and before cable trenches are backfilled.

#### **13.12** Coordination:

- 13.12.1 A detailed plan / methodology of the works shall be prepared by the Contractor taking into account that any existing network is to remain operational during the works.
- 13.12.2 The necessary power cut-offs and disturbances for the consumers shall be reduced to minimum level and the contractor shall prepare a time schedule for these temporary shutdowns in close co-operation with the supervisor engineer.
- 13.12.3 The contractor shall anticipate these operations so that sufficient notice of the disturbances shall be given in advance in order to allow owner to inform the public.

#### 13.13 Lines Routes:

- 13.13.1 The routes for the Cables are given in the drawings annexed to the present document.
- 13.13.2The quantities of equipment are resulting from the engineering studies, preliminary site visits and the basis of line length.
- 13.13.3 The final line route will be rechecked by the Contractor and Owner after the contract award.
- 13.13.4The final and detailed line route survey and profile drawings are in the responsibility of the Contractor.

#### **13.14** Inspections:

13.14.1 Inspection by owner engineer or their representative(s) shall be carried out at the following stages of work:

- a. Open trench before laying of cables;
- b. Cables laid in trench before filling the clean sand directly over the cables;
- c. Before and after concrete slabs are laid;
- d. When the Pipes are Laid;
- e. After casting the concrete around and over the pipes;
- f. After warning tape
- g. Before backfilling;
- h. after completed backfilling and cleaning of site
- 13.14.2 Each successive step of work shall be carried out by the contractor only after inspection and approval of the proceeding ones.

**Civil Works** 

# 1. Excavation, Earth Works and Road Works

# 1.1 General

The Contractor shall carry out all excavations, filling, backfilling and all other earthworks required in whatever material may be encountered.

The Works shall be executed accurately to the dimensions, levels, lines and profiles as indicated on the drawings or directed by the Engineer.

The Contractor shall reconstruct to the proper level and profile any filled areas which settle or spread during the execution of the work or during the maintenance period.

The Contractor shall drain and dewater the underground water to a level below the excavation by lowering the water table with a proper drainage and dewatering system approved by the Engineer.

#### **1.2 Soil Information**

The Contractor shall be deemed to have visited the Site of Works and satisfied himself as to the nature of the ground and made him conversant with the local conditions to be encountered during the execution of the Contract. The contractor is requested to perform a soil test to determine the nature and bearing capacity of the soil surface if indicated clearly in the contract documents.

# **1.3 Materials**

#### 1.3.1 Backfill and Fill

Backfill and fill shall be a structurally sound material such as; gravel or native soil free of rocks with size more than 5cm, lumps, vegetables and other organic materials obtained from suitable excavated material and/or from approved borrow pits.

#### 1.3.2 Water

Water shall be clean potable water as specified under "Concrete Work"

#### 1.3.3 Concrete

Concrete used as fill for making up the correct level areas of over-excavation shall be, where required by the Engineer of Class "B" as specified under "Concrete Work".

#### 1.3.4 Hard-core

Hard-core under floor paving, etc. (Where shown on the drawings or as directed by the Engineer) shall consist of tough, sound and durable rubble stones (maximum 150mm), free from coatings, clays, seems or flows of any character. Fine aggregate for blinding the interstices of hard-core bed shall be as described in "Concrete Work".

#### 1.3.5 Agricultural Soils, Gravel and Sand Fill

Agricultural soil shall be first choice top soil rich in organic materials and free from roots, stones and rubbish suitable for plantation and shall be obtained from an approved source. Gravel fill shall consist of graded gravel 50mm down to 20mm and blinded with clean coarse sand.

# **1.4 Site Preparation**

## **1.4.1 Existing Public Utilities**

The Contractor shall ascertain the whereabouts of all existing public utilities on the site, both above and below ground. Such utilities shall be removed, sealed or rerouted in a manner prescribed by the Public Authorities concerned at the Contractor's own expense. The Contractor shall also be held responsible for all damages entailed on any of the public utilities adjacent to the Site resulting from the Works.

#### 1.4.2 Removal of Existing Structures and Other Obstructions

This work shall include, but not be limited to, the removal of existing structures and other obstructions interfering with the works. The salvaging of any of these materials for the use of the GEDCo shall be as directed by the Engineer and unwanted materials shall be disposed off the Site in a satisfactory manner at the Contractor's expense.

#### 1.4.3 Cleaning and Grubbing

The Contractor shall perform the clearing and grubbing (if any) of top soil consisting mainly of loose soil, vegetable and organic matters, drift sand, unsuitable soil and rubbish by scarifying the areas to be excavated to a minimum depth of 300mm from the natural ground level. All materials resulting from the above operations shall be removed from the Site, loaded and transported and off loaded spread and leveled to approved dumps as directed by the Engineer.

# 1.5 Setting-Out

The Contractor shall stakeout the work as shown on the Drawings and secures the Engineer's approval of his stakeout before proceeding with construction. If, in the opinion of the Engineer, modification of the line or grade is advisable before or after stake-out the Engineer will issue detailed instructions in writing to the Contractor for such modification and the Contractor shall revise the stake-up for further approval in accordance with the relevant Clause of the Conditions of Contract.

# **1.6 Excavation**

#### 1.6.1 General

Excavation in any material whatsoever found including rock to reduce levels and to form foundations, bases, trenches, septic tanks, pools, pits and the like to depths shown on the drawings or as directed by the Engineer. Completely remove all existing obstructions in the line of excavations such as wall, slabs, curbs, steps and the like.

When removing any trees and roots with diameter more than 80 mm, should be rooted out to a depth of up to 500 mm then re-filled with approved material in layers. Also when mass rocks and other obstacles are found, the same mechanism of rooting and backfilling should be carried out at the expense of the contractor.

Trimming the sides of excavations to the required profiles and levels as well removing all loose material should be executed prior to consecutive process.

Level and well ram and consolidate surface of ground and bottom of all excavations to receive concrete foundations, beds, etc.

Bottoms of excavations shall be approved by the Engineer's Representative before any concrete is laid. Should the Contractor excavate deeper than is shown on the drawings or required by the

Engineer's Representative, to obtain a solid bottom, he must fill up excavation to the proper level with concrete Class B at his own expense.

#### 1.6.2 Excavation in Rocks

Rock shall be defined as boulders, exceeding 0.25m3 in volume or any kind of stone or rock formation which in the opinion of the Engineer's Representative requires for its removal drilling and blasting wedging, sledging or barring or breaking up with power-operated hard tool..

The definition shall exclude any soft or disintegrated rock which can be removed with a hard pick or mechanical excavator or shovel or loose, shaken or previously blasted rock or broken stone in rock fillings or elsewhere.

Blasting by explosives shall not be permitted without obtaining the written approval of the Engineer. If such approval is given the Contractor shall be solely responsible for:-

1. Obtaining permits, keeping record.

2. Storing permits, keeping record.

3. Taking all necessary precautions in compliance with the regulations pertinent to the use of Explosives.

4. Any damage that may occur due to the blasting operations where rock is encountered it shall be carefully excavated and the Contractor shall not be entitled to additional compensation unless otherwise specified in the Bills of Quantities.

# **1.7 Planking And Strutting**

The terms "planking and strutting" will be deemed to cover whatever methods the Contractor elects to adopt for shoring the sides of excavation and also for planking and strutting the excavations against the sides of adjoining buildings, public roadways, etc... The Contractor will be held responsible for shoring the sides of all excavations, adjoining building and the like and no claim for additional excavation, concrete or other material or workmanship will be considered in this respect. In the event of any collapse of the excavations, the Contractor shall re-excavate and re-instate such excavations at his own expense. No additional excavations will be paid or should the Contractor batter the sides of the excavations.

# **1.8 Keeping Excavations Free From Water**

All excavations shall be kept clear of water by pumping or bailing or by well-point dewatering, but the latter system shall not be employed if any danger exists of withdrawing water from the foundations of the adjoining buildings and such water shall be discharged clear of the works and the method adopted shall in no way contravene the regulations of the Local Authorities. The system or systems to be employed shall be approved by the Engineer. Such approval if given shall not waive the Contractor's responsibilities and liabilities under the Contract. Particular attention shall be paid to the installation of sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel and public.

# **1.9 Storing Of Suitable Excavated Material**

During excavation, materials suitable for backfill and fill shall be stockpiled on the Site at sufficient distance from the sides of the excavation to avoid overloading and prevent caverns or mixing with the concrete during the construction of foundations.

# 1.10 Disposal of Unsuitable and Surplus Excavated

# Material

Upon the order of the Engineer, all unsuitable and surplus excavated materials shall be immediately removed.

Loaded and transported off the site area by the Contractor to approved dumps and he shall abide by the relevant local regulations.

#### **1.11 Excavation for Foundations and Sub-Structure**

The Contractor shall excavate to reach a suitable strata accepted by the Engineer or as shown by the Drawings during excavation for foundations, the bottom layer of excavation of minimum 200mm in thickness, shall be left undisturbed and subsequently removed manually only when the concrete in blinding is about to be placed in order to avoid softening or deterioration of the surfaces of the excavation.

Bottom of all excavations shall be formed to correct levels as shown on the Drawings or as directed in writing

# **1.12 Excavation for Trenches**

#### 1.12.1 General

The Contractor shall provide all forms and bracings, and excavate trenches necessary to install all drainage, sewer water supply, electrical and telephone cables to the lines and grades complete in strict conformity with these specifications, applicable drawings and/or as directed by the Engineer.

## 1.12.2 Grading

The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its length, except for the portions of the pipe where it is necessary to excavate for bell-holes and for proper sealing of joints. Bell-holes and depressions for joints shall be dug after the trench has been graded.

Care shall be taken not to excavate below the depths indicated. Where rock shall be excavated to the required depth, uneven surface of the bottom trench shall be excavated 15mm deeper.

Such depth, if in rock, shall be back-filled with concrete Class "B" as specified under

"Concrete Work" and when in earth, shall be back-filled with approved sand at the Contractor's own expense.

Whenever unstable soil, which in the opinion of the Engineer, is incapable of properly supporting the pipe or duct is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench back-filled to the proper grade with sand, fine gravel or other suitable material approved by the Engineer.

The width of the trench for Drainage at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall be 20mm on each side of the pipe. The width of the trench above that level may be as wide as necessary for sheeting and bracing and the proper performance of the work.

Trench for Water Supply System shall be of a depth to provide minimum cover over the top of 300mm and avoid interference of water lines with other utilities. Width of trench shall be a maximum of 200mm on each side of the pipe.

The width of trenches for electrical and telephone cables shall be as specified in their relative section. Banks may be sloped or widened to facilitate placement of cables, but not to an extend that will cause interference with other utilities. Excavation for appurtenant structures for manholes, septic tank, percolating pit and similar structures shall be sufficient to allow a minimum of 300mm of clear space between their outer surfaces shoring timbers which may be used to protect the banks.

# 1.13 Backfill and Fill

Approved suitable excavated material as specified under "MATERIALS" shall be used in the backfilling and filling next to footings, foundations underground structures, under sub-floors, etc... And shall be laid in layers not exceeding 250mm and compacted with compaction equipment, as approved by the Engineer. Moisture content shall be adjusted as directed by the Engineer and 97% of dry weight compaction accordance to ASTM: D1557-70 shall be achieved.

At least one sample of core pit must be taken from each 100 m2 in buildings for each layer of backfill.

Heavy equipment's should not work or pass through within the structural boundary of the building during the backfilling process.

Should the quantity of the excavated material be not sufficient for the process of backfill and fill, the Contractor shall obtain the quantity required of such backfill and fill from approved borrow pits and transport same to the Site of work at his own expense if not itemized in the bills of quantities. No backfill shall be executed until the footings, foundations, etc., have been inspected, measured and approved by the Engineer.

Trenches should be backfilled until all required tests are performed and until the Engineer has verified that the Utility systems have been installed in accordance with the Specifications and the Drawings. The backfill in the pipe zone must be placed and completed so as to provide and maintain adequate and even support around the pipe wall. If mechanical compaction equipment is need, care must be taken to prevent direct contact with the pipe.

# 1.14 Bed of Hardcore

The bed of hardcore where shown on the Drawings or as directed by the Engineer shall be of an approved rubble stone as specified under "MATERIALS" and shall be laid under floor paving. The rubble stone for hardcore shall be hand-packed with sharp edge upward and wider (natural face) lay on the ground. The interstices of hardcore bed shall be filled with approved fines, wetted sufficiently and well consolidated. The thickness of the hardcore bed shall be as shown on the Drawings.

# 1.15 Placing of Agricultural Soil, Gravel and Sand

The agricultural sifted soil as specified under "MATERIALS" shall be spread in the flower boxes and beds to the thickness shown on the Drawings after thorough watering and on a bed of 100mm thick graded gravel blinded with clean coarse sand to the satisfaction of the Engineer.

# 1.16 Excavations of Cuttings in Carriage Ways

1. Hauling of material from cuttings or borrow pits to the embankments or other areas of fill shall proceed only when sufficient compaction plant is operating at the place of disposition to ensure compliance with the requirements of specifications.

2. Any excess depth excavated below formation level tolerance shall be made good by back filling with suitable material of similar characteristics to that removed, compacted in accordance with specification.

3. The slopes of cuttings shall be cleared of rock fragments which move when prized by a crow bar.

4. Construction traffic shall not use the surface of the bottom of a cutting unless the cutting is in rock or the Contractor maintains the level of the bottom surface at least 30cm above formation level. Any damage to the sub-grade arising from such use of the surface shall be made of good by the Contractor at his own expense, with material having the same characteristics as the material which has been damaged.

# 1.17 filling and forming of embankments and other areas of fill

1. Embankments and other areas of fill shall be formed of material defined as "suitable material"

2. All earthworks material placed in or below embankments, below formation level in cuttings or else wherein the works shall be deposited and compacted as soon as practicable after excavation in layers of thickness appropriate to the compaction plant used or as a permitted departure therefore. Embankments shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and a surface sufficiently even to enable surface water to drain readily from them. During the construction of embankments, the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor.

3. In areas of shallow filling where after removal of topsoil the ground level is within 30cm of formation level constructional traffic shall not use the surface unless the Contractor brings up and maintains the surface level at least 30cm above formation level. Any damage to the sub-grade arising from such use shall be made good by the Contractor at his own expense with material having the same characteristics as the damaged materials.

# 1.18 Compaction of embankments and other areas of fill

1. All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition.

2. Variation from the method of compaction stated below or the use of plant not included therein will be permitted only if the Contractor demonstrates at site trials that a state of compaction is achieved by the alternative method equivalent to that obtained using the approved methods. This procedure shall be agreed and approved by the Engineer.

3. The Engineer may at any time carry out comparative field density tests determined in accordance with B. S. 1377 test No. 14 on material, which he considers has been, inadequately compacted. If the test results when compared with the results of similar tests made on adjacent approved work in similar materials carried out in accordance with specification, show the state of compaction to be inadequate and this held to be due to failure of the Contractor to comply with the requirements of the Contract, the Contractor shall carry out such further work as the Engineer may decide is required to comply with the terms of the Contract.

4 The Contractor shall not less than 24 hours before he proposes to carry out compaction processes during periods of overtime, apply in writing to the Engineer for permission to do so.

# **1.19 MEASUREMENTS**

All measurement of cut, backfill and fill of different materials should be using the engineering calculations or otherwise mentioned in the other contract documents or as directed by the Engineer.

# **2 -CONCRETE WORKS**

#### **2.1 SCOPE**

This section describes and specifies work required for plain and reinforced concrete, including formwork intended to be used for the Project under the Contract in accordance with the Drawings, Bills of Quantities and as directed by the Engineer.

At the beginning of each month, the Contractor shall submit to the Engineer his concreting program for that month, stating the pouring dates, so that adequate checking and supervision can be provided

before and during the pouring operation. No pouring shall be allowed unless the Engineer has been given a week-advanced notice of the intention to pour.

# **2.2 APPLICABLE TESTS AND CODES**

Prior to commencement of concrete work, the Contractor shall submit samples to the Engineer before sending them to the laboratories for testing, to establish the probability of the materials passing tests for specified requirements.

After the Engineer is convinced that the samples with their sources are truly representative samples and sufficient materials are available on the Site for the completion of all concrete works under the Contract, the samples shall be approved and sent to the laboratories for testing. Upon the Engineer's request, the Contractor shall have the tests made, at his own expense in the laboratories approved by the Engineer.

All concrete aggregates, cement and water shall be sampled and tested as frequently as deemed necessary by the Engineer. All tests samples shall be obtained in accordance with the latest editions of the American Society for Testing and Material (ACI) Code or any equally approved standard.

# **2.3 MATERIALS**

# 2.3.1 Cement

#### 2.3.1.1 General

Cement shall be Portland Type originating from approved manufacturers in sealed and labeled bags, each 50 kgs. Not capacity, name and brand of the manufacturer shall plainly be identified thereon and delivered to the site in good condition. Cement delivered in bulk shall be accepted only if a central mixing plant is used. The Quality of cement shall conform to the Standard Specification for PORTLAND CEMENT of ASIM Designation: C150-74 Type Ifor use in general concrete construction and Type V- for use when high sulphate resistance is desired.

#### 2.3.1.2 Storage of Cement

All cement shall be stored in suitable weatherproof and approved storage sheds which will protect the cement from dampness. Storage sheds shall be erected in locations approved by the Engineer. Provision for storage shall be ample, and the consignment of cement as received shall be separately stored in such a manner as to provide easy access for the identification and inspection of each consignment. Cement shall be used in the order of its delivery to site, new deliveries shall not be used unless the cement from earlier deliveries has be completely used.

Stored cement shall meet the test requirements at any time after storage when a re-test is ordered by the Engineer all the expense of the Contractor.

The Contractor shall keep accurate records of the deliveries of cement and of its use in the work. Copies of these records shall be supplied to the Engineer in such form as may be required.

#### 2.3.1.3 Rejection

The Contractor shall notify the Engineer of dates of delivery so that there will be sufficient time for sampling the cement either at the mill or upon delivery.

The provisional acceptance of the cement at the mill shall not deprive the Engineer of the right to reject on a reset of soundness at the time of delivery of the cement to the site.

Package of cement varying by 5 percent or more from the specified weight shall be rejected and if the average weight of packages in any consignment, as shown by weighing 50 packages taken at random, is less than that specified, the entire consignment shall be rejected and the

Contractor shall remove it forthwith from the Site at his own expense and replace it with cement of satisfactory quality.

Stale cement or cement reclaimed from cleaning bags shall not be used and cement which for any reason has become partially set, or contains lump or caked cement, shall be rejected.

## 2.3.2 Aggregates

#### 2.3.2.1 General Requirements

All aggregates shall consist of tough, hard, durable uncoated particles. The Contractor shall be responsible for the processing of this material to meet the requirements of the Specifications. Approval of aggregate quality and/or gradation shall not waive the responsibility of the Contractor to provide concrete of having the minimum strength specified.

#### 2.3.2.2 Storage

Coarse and fine aggregates shall be delivered and stored separately on site in such a manner as to prevent segregation and contamination or the admixture of foreign materials. Aggregate which has become segregated or contaminated with foreign matter during storage or handling will be rejected and shall be removed and replaced with material of acceptable quality at the Contractor's expense. Aggregates of the quality and color selected shall be stored in sufficient quantity to avoid interruption of concreting work at any time.

#### 2.3.3 Fine Aggregate

#### 2.3.3.1 General Requirements

All fine aggregate shall conform to Standard Specification for Concrete Aggregates of ASIM Designation: C-33 and also to the detailed requirements give in Table 2-1 (appended here below). It shall not contain harmful materials such as iron pyrites, coal, mica, and shale.

Alkali, coated grains, or similar laminated materials such as soft and flaky particles, or any material which may attack the reinforcement, in such a form and in sufficient quantity to affect adversely the strength and durability of the concrete. Fine Aggregate passing sieve No. 4 shall not contain any voided shells.

Fine aggregates shall be washed thoroughly with de-mineralized water to ensure compliance with the appropriate requirements and limitations of the specifications.

The Contractor shall provide and maintain for this proposes sand-washing plant and equipment. Fine Aggregate from different sources of supply shall not be mixed or stored in one pile nor used alternately in the same class of construction or mix.

Sieve Analysis	
Grading Sieve	Percent of Passing
3/8	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-3
Fineness modulus	2.50-2.15
Organic Impurities	The color shall have an intensity not darker than two-thirds the intensity of the standard color solution. (Not darker than Plate 2 as determined by the Standard Method of Test for Organic Impurities in Sands for Concrete of ASTM Designation C - 40
Chlorides soluble in	Not more than 0.10 percent by weight when expressed as sodium
dilute Nitric Acid	chloride (NACL).
Total Acid soluble	Not more than 0.50 percent by weight when expressed as sulpher
sulphates	trioxide(S03)
Silt	Not more than 2 percent
Mortar strength	Compression ration less than 95 percent
Soundless	Weighted average loss when subjected to 5 cycles of the soundless test using magnesium sulfate, not more than 10 percent

## Table 2-1: Detailed requirements for Fine Aggregate

#### 2.3.4 Coarse Aggregate 2.3.4.1 General Requirements

All coarse aggregate for concrete shall conform to Standard Specifications for Concrete Aggregates of ASTM Destination: C-33 Coarse aggregate shall consist of gravel, crushes gravel, or crushed stone, having hard, strong durable pieces, free from adherents. It shall not contain harmful materials such as iron pyrites, coal, mica, alkali, laminated materials, or any material which may attack the reinforcement, in such a for or in sufficient quantity to affect adversely the strength and durability of the Concrete. Coarse aggregates shall be washed thoroughly with de mineralized water to ensure compliance with the appropriate requirements and limitations of the specifications. The Contractor shall provide and maintain for this purpose approved washing plant and equipment.

#### 2.3.4.2 Deleterious Substances

 The amount of deleterious substances shall not exceed the following limits:

 Max. Permissible Limit Percent by Wt.:

 Soft fragments
 2.00

 Coal and lignite
 0.50

 Clay lumps
 0.25

 Materials passing the No.200 sieve
 1.00

Chlorides soluble in dilute Nitric acid when expressed as Sodium Chloride (NaCL) ...0.05 Total acid soluble sulphates when expressed as sulpher trioxide (S03) .....0.50 2.3.4.3 Percentage of Wear

Coarse aggregate shall conform to the following requirements:

Percentage of wear, Los Angeles test, not more than (30)

#### 2.3.4.4 Grading

Coarse aggregate, when tested according to the requirements of ASTM, shall meet the following graduation and shall be uniformly graded within the limits stated in Table 2-2 here below:

ASTM	Deveentage by Weight Dessing				
ASIM	rei	sing			
	Grading	Grading	Grading		
	(3/4" to No.4)	(1" to No.4)	(2" to No.4)		
2 <sup>1</sup> / <sub>2</sub> inch			100		
2 inch	,		95-100		
1 ½ inch		100			
1 inch	100	95-100	35-70		
<sup>3</sup> / <sub>4</sub> inch	95-100				
<sup>1</sup> / <sub>2</sub> inch		25-60	10-30		
3/8 inch	20- 55				
No. 4	0-10	0-10	0-5		
No. 8	0-5	0-5			
No. 200	0-1	0-1	0-1		

Table 2-2:	Grading	Analysis	for Coarse	Aggregate
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#### **2.3.5** Combined Aggregate

Approved fine and coarse aggregate on each batch of concrete shall be combined in proportions as approved by the Engineer, according to test results giving the required compressive concrete stress as specified per type of Concrete.

The combined aggregate gradation using the <sup>3</sup>/<sub>4</sub> in. to No. 4 gradation shall be used for concrete members with reinforcement to close or permit proper placement and consolidation of the concrete. Change from one gradation to another shall not be made during the progress of the work unless approved by the Engineer. Such changes are admitted only after being proved by test results.

# **2.3.6 Aggregate for Mortar**

#### 2.3.6.1 General Requirements

Aggregate for motor shall conform to the Standard Specification for Aggregate for Masonry Mortar of ASTM Designation: C-144 and shall consist of hard, strong, durable uncoated mineral or rock particles, free from injurious amounts of organic or other deleterious substances.

#### 2.3.6.2 Organic Impurities

Fine aggregate for mortar when subjected to the Calorimetric test for organic impurities and producing a color darker than the standard color shall be rejected.

#### 2.3.7 Water

#### 2.3.7.1 Quality of Water

Water for mixing of concrete shall be fresh, clean and free from injurious amounts of oil, acid, or any other deleterious mineral and/or organic matter. It shall not contain chlorides such as sodium chloride in excess of 700 ppm. It shall not contain any impurities in amount sufficient to cause a change in the time of setting of Portland Cement of more than 10 percent, nor a reduction in compressive strength of mortar of more than 5 percent compared to results obtained with distilled water.

The PH of the water for mixing and curing of concrete shall not be less than PH 4.5 or more than PH 8.5.

#### 2.3.7.2 Tests for Water

When required by the Engineer the quality of the mixing water shall be determined by the Standard Method of Test for quality of water to be used in concrete, as specified in B.S. 3148: 1959 Tests for Water for Making Concrete.

In sampling water for testing, care shall be taken to ensure the containers are clean and that samples are representative.

#### 2.3.7.3 Admixtures

Admixtures in concrete shall be used only when approved by the Engineer and shall conform to the requirements of the ASTM Standard Specifications Designation c-494-68 for Water Reducing and Retarding Admixtures, and C-260-69 for Air entraining Admixtures for Concrete, and waterproofing and watertight.

The Contractor shall ensure that the admixture supplied for use in the work is equivalent in composition to the admixture subjected to test under this Specification. Tests shall be made whenever practicable using the cement, aggregates, admixtures proposed for specific work, because the specific effects produced by chemical admixtures may vary with the properties of the other ingredients of the concrete.

The specific effects produced by chemical admixtures may vary with the properties of the other ingredients of the concrete.

Admixture that contains relatively large amounts of chloride shall accelerate corrosion of reinforcing steel and shall be the cause of rejection.

Water reducing and retarding admixtures shall comply with the physical requirements of ASTM tests and shall be approved in writing by the Engineer.

When the admixture is delivered in packages or containers, the proprietary name of the admixture, the type and the weight or volume shall be plainly marked thereon. Similar information shall be provided in the shipping advises accompanying packaged or bulk shipments of admixtures.

The admixture shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight store that will protect the admixture from dampness.

Costs of such admixtures, sampling and testing shall be at the Contractor's expense.

# **2.4 Composition of concrete**

The cement content, coarse aggregate size, water content, consistency and the approximate weights of fine and coarse aggregate (saturated surface-dry basis) for the class of concrete shall be within the requirements of Table 2-3 (I) and Table 2-3 (II) Below.

The weight of fine and coarse aggregate given in Table 2-3 (II) below is based on the use of aggregates having bulk specific gravities, in a saturated surface-dry condition, 2.65-5%. For reasonably well graded materials of normal physical characteristics, the use of the below indicated proportions, together with specified water content to obtain the required consistency, will result in concrete of the specified cement content, plus or minus two (2) percent.

For aggregate having specified gravities outside the ranges indicated in the Table 2-3 (II) below, the weights shall be corrected by multiplying the weights shown in Table 2-3 (II)below by the ration of the specific gravity of the aggregate and 2.65.

The relative weights of fine and coarse aggregate per sack of cement given in Table 2-3 (II) below are based on the use of natural sand having a fineness modulus within the range of 2.70 and 2.90 and methods of placing which do not involve high frequency vibration. When sharp, angular manufactured sands, or extremely coarsely graded sands are used, the relative amount of fine aggregate should be increased. For finer sands the relative amount of fine aggregate should be decreased. In general, the least amount of sand which will insure concrete of the required workability for the placing conditions involved should always be compensated for by changing the weight of coarse aggregate in the opposite direction by a corresponding amount.

Class of oncrete	Compressi ve strength at 28 days (in Kg/cm <sup>2</sup> )	Minimum cement content (Kg)	Coarse aggregate size	Max. water content (Liter per	Consiste in sl (m	ncy range lump 1m)
	Cube			Bag)	vibrated	non vibrated
A	250	375	<sup>3</sup> / <sub>4</sub> inch or 1 inch- No. 4 as required by the Engineer	27	50-100	75-125
В	200	350	Ditto	27	50-100	33-125
С	150	250	2 inch- No. 4	30	25-50	50-75

able 2-3 (I). Requirements of concrete composition
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T	able 2-3 (II): R	equirements of	í concrete com	position- Continue	

Class of concrete	Cylinder compressive strength at 28 days	Approximate Weight (Saturated Surface-Dry) of Fine and Coarse Aggregate per Sack (50Kgs) of Cement			
	$(kg/cm^2)$	Rounded coarse aggregate		Angular coa	rse aggregate
		Fine (Kg)	Coarse (Kg)	Fine (Kg)	Coarse (Kg)
A	250	40	170	95	150
В	210	95	180	100	160
С	140	140	370	160	340

Table 2-3 (II) is given for indicative purposes and is not binding.

The total sodium chloride content of any materials used for making concrete shall be less than:

For mass concrete..... 1.5 percent

For reinforced concrete...... 0.7 percent

Expressed as a percentage by weight of the cement.

In calculations made under the provisions of this clause, any chloride, other than sodium chloride in the materials shall be converted to the equivalent of sodium chloride and be added to the amount of sodium chloride. The sulphate content shall not exceed 0.03 percent by weight of the cement.

# **2.5 Proportions**

#### 2.5.1 General

After the materials provided by the Contractor have been accepted for the works, the proportions and equivalent batch weights shall be determined which will produce concrete having not less than the strength required.

#### 2.5.2 Trial Mixes

The actual proportions shall be determined on the basis trial mixes made by the Contractor and conducted with the content being determined by means of yield test in accordance with American Society for Testing Material (ASTM) Designation (C-138). The proportions will be such as to required (within a tolerance of plus or minus one (1) percent, the cement content shown in Table I as the minimum cement content, provided, however, that if the materials supplied by the Contractor are of such a nature or are so graded that proportions based on the minimum cement content cannot be used without exceeding the maximum allowable water content specified in Table I, the proportions will be adjusted so as to require the least amount of cement which will produce concrete of the required plasticity and workability without exceeding such maximum allowable water content. No additional compensation will be made for the increase in quantity of cement required.

#### 2.5.3 Contents

The mixes required will be designated in kilograms of fine and coarse aggregate exclusive of free water, per sack (50 Kilograms) of cement and in liters of total mixing water per sack of cement on the basis of the required amount of cement per cubic meter of concrete.

#### 2.5.4 Batch Weights

Since the proportions are designated in terms of aggregate in surface-dry condition, the equivalent batch weights to be used in the work shall be corrected periodically to take into account the actual moisture content of the aggregates at the time of use.

# 2.6 Concrete compression and slump tests

#### 2.6.1 Cubical Test

The Compression Strength of Concrete shall be obtained according to cubical tests locally done. Test cubes made in the field shall have a dimension of 15cm, At least 3 separate batches of concrete shall be made for trial and these shall be tested for compliance with the requirements of the table below, at least 3 test cubes being made from each batch of concrete.

Once a mix is approved no substantial change in the materials or proportions of materials being used shall be made without the approval of the director of works who may then require further trial mixes to be produced. The compressive strength of the concrete will be taken as the arithmetic mean of the strength of all the cubes tested.

The following table 2-4 will be used to compare test results:

# Table 2-4: Compressive Strength results of samples of concrete at 28 days. (Mixed by Weight)

Kind of Concrete	Mean value At 28 days Kg / cm²	Minimum Individual Value at 28 days Kg / cm <sup>2</sup>	Mean value At 28 days Kg / cm <sup>2</sup>	Minimum Individual Value at 28 days Kg / cm <sup>2</sup>
	In case of 3-4 samples taken		In case of 5 sa	mples or more
B - 150	185	130	175	130
B - 200	240	170	230	170
B - 250	300	215	290	215
B - 300	360	255	345	255
B - 350	420	300	405	300

Test at 7 days must not be less than 75% of the required strength at 28 days

#### 2.6.2 Slump Tests

Slump tests shall be carried out periodically to ensure the appropriate water cement ratio in accordance with the Standard Method of Test of Slump of Portland Cement Concrete of the ASTM Designation: C-143.

#### 2.6.3 Test of Hardened Concrete in the Structure

Where the results of specimens indicate that the concrete does not meet specification requirements, core boring tests conforming to the current issue of ASTM Designation: C-42 shall be performed, as directed by the Engineer, all at the Contractor's expense.

1. Hardened concrete is identical to specifications if the results of specimens test follow the conditions:

At least the average compressive strength of samples testing coincides the required design strength for the concrete.

No compressive strength of any of the sample specimens deviates from the required design strength for the concrete by (85%).

Cubes are standard size  $(150 \times 150 \times 150)$  mm and age (28) days mainly to the requirements of comparing strength. The nominal compressive strength is the minimum value of all the values of the testing samples, which does not allow the existence of values lower than more than (5) percent of the number of sample tests.

The contractor to submit to the supervisor written reports from an authorized laboratory for all of the tests carried out according to specifications and within period of not more than (24) hours of the implementation of the testing.

2. If the cube tests fail to pass the above; Core Specimens must be carried out at (3) specimens for each sample of hardened concrete which had not achieved the conditions of the sub-item mentioned above. Note that taking the specimens, water treatment and testing are in accordance with the requirements of American Standard (ASTM -C 42), this is coincided to the concrete specifications if the test results match following conditions:

At least the average compressive strength of the specimens of a sample is (85%) of the strength provided by the design.

At least the compressive strength of an individual specimen from a sample is (75%) of the strength provided by the design.

3. If test results fail to pass the condition stated in item (B) of this section, found not conform to these specifications, and must then be completely removed from the site at the expense of the contractor, as

the same contractor bears full responsibility for any damage that might be caused to the sound elements as a result of the demolition and removal.

4. As exception to what is stated in paragraph (C) of this section, for the slabs and beams only, if the average value of compressive strength of the samples equivalent to the standard cubes (150 \* 150 \* 150) mm is not less than (150 Kg/cm2); loading test might be carried out only upon the client request and at the contractor's expense to ensure the ability of the concrete elements to bear loads according to engineer and the designer. If the elements pass the load test, then the slabs and beams are considered structurally accepted.

#### 5. Loading Test

Load test must be carried out at the site for the slabs and beams of reinforced concrete that are under the age of (56) days by authorized and experienced laboratory in that field. The loads must be equivalent to that part of the actual dead loads and shall be placed on the slabs and beams prior to loading the total loads by (48) hours and remain until the end of the test.

The slabs and beams must be loaded by a total of (0.85) multiplied by (1.4 Dead Load + 1.7 Live Load) Less Dead Load actually performing (48) hours before. Special devices should be placed at the bottom of slabs and beams to measure deflection.

These devices should be installed on fixed frames to ensure the stability of these devices, and the preliminary readings to be taken prior to process of loading. The loads must be placed gradually and systematically for (24) hours, without causing any vibrations or shocks and batches of not less than (4) equal installments, and then taking the readings , which identifies the maximum deflection; that is the difference between this reading and reading pre-loading. Then the loads are lifted and left unloaded for two (24) hours, the readings are taken for the final deflection which determines the value of self-retrieval as the difference between this reading, and reading pre-lift. 6. Passing the test

The structural elements could succeed in passing the test, if not exceed the maximum deflection (D) in mm as per the formula:

$$D = (50 L2) / h$$

Where:

L = Span loaded in meters of the following values: the distance between the centers of supports or clear span loaded plus the height of the structural element which is smaller.

h = height of the structural element (mm)

The slabs and beams fail to pass the test if wide cracks appear or signs of failure during the test, or if they do not achieve the value of deflection (D).

#### 2.7 Measurement of materials

Materials shall be measured by weight, except as otherwise specified or where other methods are specifically authorized by the Engineer. The apparatus provided for weighing the aggregates and cement shall be suitably designed and constructed for this purpose. Each size of an aggregate and the cement shall be weighed separately. The accuracy of all weighing devices shall be such that successive quantities can be measured to within 1% of the desired amount. Cement in standard packages (sack) need not be weighed. The mixing water shall be measured by a measuring device susceptible of control accurate to plus or minus half percent of the capacity of the tank but not exceeding 2 liters. All measuring devices shall be subject to the Engineer's approval. Where volumetric measurements are exceptionally authorized by the Engineer for projects where the amount of concrete is small, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregate.

#### 2.8 Mixing of concrete

#### 2.8.1 General

Unless otherwise authorized by the Engineer, concrete shall be machine mixed.

The mixing of concrete or mortar shall not be permitted when the temperature is above 40 C or when the temperature is below 5 C.

#### 2.8.2 Mixing on Site

Concrete shall be thoroughly mixed in a batch mixer conforming to the requirements of B.S. 1305 Batch type concrete mixers which will ensure a uniform distribution of the materials throughout the mass.

The mixer shall be equipped with adequate storage and a device for accurately measuring and automatically controlling the amount of water used on each batch. Preferably mechanical means shall be provided for recording the number of revolutions for each batch and automatically preventing the discharge of the mixer until the materials have been mixed within the specified minimum time. The entire contents of the mixer shall be removed from the drum before materials for a succeeding batch are placed therein.

All concrete shall be mixed for a period of not less than  $1\frac{1}{2}$  minutes after all materials, including water, are in the mixer. During the period of the mixing the mixer shall operate at the speed for which it has been designed, but this speed shall be not less than 14 nor more than 20 revolutions per minute.

The first batch of concrete material placed in the mixer shall contain sufficient excess of cement, sand and water to coat the inside of the drum without reducing the required mortar content of the mix. Upon the cessation of mixing for a considerable period, the mixer shall be thoroughly cleaned.

#### 2.8.3 Truck Mixing

Truck mixers, unless otherwise authorized by the Engineer, shall be of the revolving drum type, watertight, and so constructed that the concrete can be mixed to ensure a uniform distribution of materials throughout the mass. All solid materials for the concrete shall be accurately measured in accordance with Section C.7 and charged into the drum at the proportioning plant.

Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying mixing water. Only the prescribed amount of water shall be placed in the tank unless the tank id equipped with a device by which the quantity of water added can be readily verified. Truck mixers may be required to be provided with means by which the mixing time can be readily verified by the Engineer.

The maximum size of batch in truck mixers shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and stamped in metal on the mixer. Truck mixing shall be continued for not less than 50 revolutions after all ingredients including the water, are in the drum. The speed shall not be less than 4 r.p.m., nor more than a speed resulting in a peripheral velocity of the drum of 70 meters per minute.

Nor more than 100 revolutions of mixing shall be at speed in excess of 6 r.p.m. Mixing shall begin within 30 minutes after the cement has been added either to the water or aggregate.

When cement is charged into a mixer drum containing water or surface-wet aggregate and when the temperature is above (33 C) is used this limit shall be reduced to 1245 minutes; the limitation on time between the introduction of the cement to the aggregates and the beginning of the mixing may be waived when, in the judgment of the Engineer, the aggregates are sufficiently free from moisture, so that there will be no harmful effects on the cement.

#### 2.8.4 Partial mixing at the Central Plant

When a truck mixer provided with adequate mixing blades is used for transpiration, the mixing time at the mixing plant may be reduced to 30 seconds and the mixing completed in the truck mixer. The mixing time in the truck mixer shall be as specified under the Section C.8.3 for truck mixing.

#### 2.8.5 Plant Mix

Mixing at a central plant shall conform to the requirements for mixing at the Site and shall conform to the applicable requirements of the Standard Specification for Ready-Mixed Concrete of ASTM Designation: C-94.

#### 2.8.6 Time of Hauling and Placing Concrete

If the distance from the mixing plant to the construction Site is so great that between the time of mixing and pouring the concrete, the temperature is below 40 C and the traveling time is more than 30 minutes, truck mixers must be employed.

When truck mixers are used, concrete shall be discharged and placed in its final position in the forms within thirty (30) minutes after water is first added to the mix.

#### 2.8.7 Delivery

The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing and finishing of the concrete. The rate shall be such that the interval between batches shall not exceed 20 minutes. The methods of delivering and handling the concrete shall be such as will facilitate placing with the minimum of re-handling and without damage to the structure of the concrete.

#### 2.8.8 Re-tempering

The concrete shall be mixed only in such quantities as are required for immediate use and any concrete which has developed initial setting shall not be used. Concrete which has partially hardened shall not be re-tempered or remixed.

# 2.9 Handling and placing concrete

# 2.9.1 General

Prior to pouring concrete in any structure, the Contractor shall secure a written order to commence from the Engineer. In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matters shall be removed from the interior of forms, struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the firms and not buried in the concrete. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall not be permitted unless the authorization in writing of the Engineer is obtained. In case an interior quality of concrete is produced by the use of such conveyers, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing. Open troughs and chutes shall be of metal lined and shall be of rounded cross section to avoid the accumulation of concrete in corners. The chutes shall be steep enough (1 vertical to 2 or 2 ½ horizontal) to permit flow requiring a slump greater than specified or required for placement.

All chutes, troughs and pipes shall be kept clean and free from coating of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure. When placing operations would involve dropping the concrete more than 1.50 meter, it

shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial setting of concrete, the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

#### 2.9.2 Hot Weather Concreting

The temperature of concrete when placed shall not exceed 27 °C when the relative humidity is 50 percent or less and shall not exceed 32 °C for values of relative humidity between 50 percent and 70 percent, the max temperature of concrete shall be found by interpolation.

In lieu of above, the temperature of concrete when placed shall not exceed 32  $^{\circ}$  C, regardless of the relative humidity.

The Contractor shall comply with the above requirements by the following procedures:-

Cooling the mixing water and/or replacing 50% of the mixing water by crushed ice.

When crushed ice is used it shall be stored at a temperature that will prevent formation of lumps. The ice shall be completely melted by the time mixing is completed.

Shading aggregate stockpiles and/or keeping moist by sprinkling then with water.

Cement shall not be used if its temperature exceeds 77 °C.

Painting the mixer drum white and spraying it with cool water or shading the mixer from direct sunrays.

Maintaining the mixing time and delivery time to the minimum acceptable.

Sprinkling of forms sub-grade and reinforcement with cool water prior to placement of concrete. Water reducing and retarding admixture shall be used in all concrete work when the temperature of concrete exceeds 27 ° C. The water cement ratio inclusive of free surface moisture on aggregates and any admixtures shall be kept to a minimum.

#### 2.9.3 Vibrating Concrete

Concrete, during and immediately after depositing, shall be thoroughly compacted. The compaction shall be done by mechanical vibration subject to the following provisions:

Vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.

Vibration shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.

The intensity of vibration shall be such as to visibly affect mass concrete of 25mm slump.

Contractor shall provide a sufficient number of the vibrators to properly compact each batch immediately after it is placed in the forms.

Vibration shall be manipulated so as to thoroughly work the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms.

Vibration shall be applied only by experienced operators under close supervision, at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any point to the extent that localized areas of grout are formed.

Application of vibration shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibrations. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

Vibrator shall be supplement by such spading as it necessary to ensure smooth surface and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

The use of implements such as compressors which are likely to disturb or disarrange reinforcement or formwork shall not be permitted.

Concrete shall be placed in horizontal layers not more than 300mm thick as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with preceding layer which has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete after becoming firm enough to retain its form shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible points as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel.

Immediately following an approved discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement bars and the surfaces of forms shall be removed.

Dried mortar chips and dust shall not be puddle into the unset concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete steel bond at and near the surface of the concrete while cleaning the reinforcement bars.

#### 2.9.4 Joints

Expansion joints shall be formed in the positions indicated and to the details shown on the Drawings or otherwise ordered by the Engineer. The expansion joints shall be filled with bitumen impregnated fiberboard to its full depth and width. The filling will be permitted to be used as permanent formwork only for the second casting. Where the fiberboard is exposed, it shall be cut back for a depth of at least 1cm. from the chamfered edges, filled and pointed with a resilient liquid poly sulphide polymer sealant. Whenever the placing of the concrete is discontinued other than at the expansion faces, this discontinuity shall form a construction joint. Construction joints are to be made only along a horizontal or vertical plane except that in the case of inclined or curved members they shall be at right angles to the principal axis.

Care shall be taken to prevent offsetting of the joint and to ensure water tightness. The joints shall in every way satisfy the requirements of the Engineer, and be in accordance with the Drawings. Unless otherwise shown on the Drawings, construction joints will not be allowed in the supported portion slabs, beams and beam like members. At construction joints the laminate film and porous layer of the already set concrete shall be removed and the surface keyed by hacking and then wirebrushed and thoroughly cleaned. Immediately before adding the new concrete, the surface it to be thoroughly wetted and a 1-cm thick coating of a fresh cement/sand mortar (having the same proportion of cement/sand as concrete in the mix) applied to the surface. The new concrete is then to be well compacted into the old.

The number of construction joints should be kept as few as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings.

# **2.10 Precast hollow concrete blocks [hordes] for ribbed slabs: 2.10.1 Material and Manufacture**

Aggregate shall be so sized, graded, proportioned and thoroughly mixed in a batch with such proportions of cement and clean water as to produce a homogeneous concrete mixture.

However, in no case shall the proportion of cement in the mixture be less than five (5) standard [each weighing 50 Kgs] per cubic meter of concrete.

Pre-cast hollow concrete blocks (hourdis) for a ribbed slab shall be manufactured in approved vibrated, machine.

If for any reason the strength requirement is not achieved, cement shall be increased at the Contractor's own expense. The blocks shall be cured for twelve (12) consecutive days and shall be at least twenty-one (21) days old before incorporation in the Works. The blocks shall be of an approved pattern of withstanding a compressive force applied at the ends of 30 kgs/cm2 based on the gross sectional area of the block obtained without deducting voids.

The blocks shall be hard, sound, durable, sharp, clean with well-defined arises, free from cracks and flaws or other defects and of the dimensions shown on the Structural Drawings. The blocks shall be obtained from an approved local factory.

#### 2.10.2 Workmanship

Pre-cast hollow concrete blocks (hourdis) shall be laid exactly in a line with the cells on the long dimensions.

Close edge blocks shall be used at the end; the dimensions of the ribs and size of reinforcing bards shall be exactly according to the Structural Drawings, In narrow width specially made half blocks shall be used and full block shall not be used along their length (with the calls along the long dimensions of the rib.)

The blocks are to be laid on adequate forms. All blocks shall be cleaned and thoroughly wetted with clean water before the concrete is poured and laborers shall not be allowed to walk on them. Any block found to be defective or damaged during concreting operations shall be removed and replaced before pouring the concrete, all at the contractor's expense.

# 2.11 Formwork

# 2.11.1 General

The Contractor shall be responsible for the design and stability of the formwork. The contractor shall submit a full program of work indicating the various phases for the erection and removal of forms and the manner in which he intends to execute all concrete works.

# 2.11.2 Material

All forms shall be of wrought lumber and shall be built mortar 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 lumber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The Contractor shall take into consideration the effect of vibration on the formwork, and shall be responsible for any damage or default resulting thereof.

#### 2.11.3 Workmanship

Forms shall be inspected by the Engineer prior to installation of reinforcement The number of spacing of the form struts and braces shall be such that the forms will be braced rigidly and uniformly lock joints between form sections shall be free from play or movement. The shape, strength rigidity, water tightness and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber must be resized before being re-used. Forms which are unsatisfactory in any respect shall not be re-used.

Metal tie rods or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 40mm from the face within injury to the concrete. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 10mm.

From the face of the concrete with chisels or nippers for green concrete, nippers are necessary. All fittings for metal ties shall be of such design that the cavities produced upon their removal are the smallest possible.

The cavities shall be filled with non-shrinkage material mortar and the surface left sound, smooth, even and uniform in color.

All forms shall be treated with special approved oil and saturated with water immediately before placing the concrete. For members with exposed faces, the forms shall be treated with approval material to prevent the adherence of concrete.

Any material which will adhere to or discolor the concrete shall not be used.

The contractor shall provide means for accurately measuring the settlement of the forms during placement of the concrete and shall make all necessary corrections as directed by the Engineer way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the Contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

#### 2.11.4 Removal of Form-work

In the determining of the time for removal of forms, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete and the materials used in the mix. In general, the forms of any positions of the structure shall not be removed until the concrete is strong enough to prevent injury to the concrete when the forms are removed. Unless otherwise directed by the Engineer forms shall remain in place for the following specified period of time:

Centering under beams: 21 days Floor slabs: 21 days Walls, columns, sides of beams and other vertically formed surfaces: 3 days

Method of form removal likely to cause overstressing of the concrete shall not be used. In general, the forms shall be removed from the bottom upwards. Forms and their supports shall not be removed without the written approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure.

The Contractor shall include in his prices for any formwork which may have to be left in position due to the impossibility of removal of same.

# 2.12 Reinforcement

## 2.12.1 General

The contractor shall prepare for his own use bar bending schedules from the information given on the drawings and in these specifications. These schedules shall be submitted to the Engineer for approval which shall in no way release the contractor of his responsibility for the correctness of these schedules.

All reinforcement shall be placed strictly in accordance with the drawings and as instructed in writing by the Engineer. Nothing shall be allowed to interfere with the required disposition of the reinforcement, and the contractor shall ensure that all parts of reinforcement are placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place. The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

Placed correctly in position and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

The ties, links or stirrups connecting the bars shall be taut so that the bars are properly braced the inside of their curved part small be in actual contact with the bars, around which they are intended to fit.

# 2.12.2 Type and Quality of Steel Reinforcement

1. Hot-Rolled Steel Plain Rods and Bars

Hot rolled steel plain rods and bars shall conform to the strength requirements and minimum elongation of the Standard Specification for Deformed Billet-Steel Bars of Grade 40 with minimum yield strength 2400Kg/cms (35000 psi) for concrete Reinforcement of ASTM Designation (A-615) or equivalent.

#### 2. Deformed Steel Rod and Bars

Deformed steel and bars shall conform to the requirements of the Standard Specification for deformed Billet-Steel Bars of grade 60 with minimum yield strength 4200 kg/cm2 (60000 psi) for concrete reinforcement of ASTM Designation (A-615) or equivalent.

#### 2.12.3 Wire

Wire for bending reinforcement bars shall be of soft black annealed mild steel wire. The diameter of the Wire shall not be less that 16 S.W.G. (1.6mm) and the binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.

#### 2.12.4 Order Lists

Before ordering material, all order lists and bending diagrams detailed in accordance with the latest revision of AGI Building Code shall be furnished by the contractor for the approval of the Engineer, and no material shall be ordered until such lists and steel bending diagrams have been approved. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the contractor of his responsibility for the correctness of such lists and diagrams.

Any expenses incurred to the revision of material furnished in accordance with such lists and diagrams to make and comply with the design drawings including cut and waste shall be borne by the contractor.

#### 2.12.5 Protection of Material

Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil, loose, rust, grease or other foreign substances.

#### 2.12.6 Fabrication

Bar reinforcement shall be bent to the shapes shown on the Drawings and Steel Bending (Diagrams), bending dimensions and scheduling of bars for the reinforcement of concrete. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be bent except as shown on the plans or specifically permitted by the Engineer.

#### 2.12.7 Placing and Fastening

All steel reinforcement shall be accurately placed in the position shown on the drawings and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing 300mm in each direction, in which case alternate intersections shall be tied. Distance from the forms shall be maintained by means of stays, blocks ties, hangers, or other approved supports. Blocks for holding reinforcement from contract with the forms shall be pre-cast mortar blocks of approved shapes and dimensions or approved metal or plastic chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by pre-cast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal is required.

#### 2.12.8 Splicing

All reinforcement shall be furnished in the full lengths indicated on the drawings.

Splicing bars except where shown on the drawing, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.

Additional splices, other than those shown on the drawings; and allowed by the Engineer, shall be at the contractor's own expense.

The cost of all supports for holding reinforcement bars shall be borne by the Contractor.

# **2.13 CURING AND PROTECTION**

#### 2.13.1 Water Curing

All concrete shall be cured for a period of time required to obtain the full-specified strength but not less than seven (7) consecutive days. Unformed surfaces shall be covered with sand burlap, or other approved fabric mats kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on the uniformed surfaces. When burlap, sand or other approved fabric materials are used, they shall not cause any undesirable finish such as rough surface and discoloring where exposed to light. Unhardened concrete shall be protected from heavy rains or flowing mechanical injury and the Contractor shall submit for the Engineer's approval his construction procedure which is designed to avoid such an eventually. No fire or excessive heat shall

be permitted near or in direct contact with concrete at any time. Water for curing shall conform to Section 2.3.6.

## 2.13.2 Curing with Curing Media

Curing medium shall meet all requirements of the specifications for Liquid Membrane- Forming Compounds for Curing Concrete of ASTM Designation: C-309 and test for water retention by concrete curing materials of ASTM Designation: C-156.

The compound shall be applied to the concrete surface by means of a sprayer, roller or lamb's wool applicator and shall be sprayed on. Ample time shall be allowed for the concrete surface to harden and to prevent any damage. The compound shall give a drying time not to exceed thirty minutes, and shall be applied undiluted directly from the manufacturer's labeled container in accordance with the manufacturer's directions and to the satisfaction of the Engineer.

The compound shall be completely compatible with adhesives, joint sealants and cement grout.

#### 2.13.3 Payment

No separate payment shall be made for curing with water or with curing media. The cost of such curing shall be deemed to be included in the Unit Prices of "CONCRETE WORK".

# 2.14 Concrete [fair face] exposed surfaces

#### 2.14.1 Formwork

Formwork for exposed concrete surface shall conform to the applicable requirements of Section C 14, in addition to those Specifications.

All concrete surfaces that are to be left exposed to view as a finished surface except for precast concrete units, shall be produced by vertical metal shuttering.

The quantity of the surface of concrete exposed to view shall be consistent throughout the project and the following methods shall be adopted to obtain the required finish.

Metal forms of an approved type for pre-cast units The Contractor may submit alternative proposals for the Engineer's approval if he so desires.

The Contractor is to submit to the Engineer for his approval shuttering details and sequence of operation relating to fair face concrete work. Sample panels shall be constructed for all their face concrete finishes and following the Engineer's approval the panels will remain on site and constitute a standard which must be maintained throughout the duration of the Contract.

#### 2.14.2 Coating Forms with Mineral Oil

In addition to the above forms or linings, the forms shall be coated before placing reinforcement with an approved colorless mineral oil free of kerosene.

All surplus oil on form surfaces and any oil on reinforcing steel shall be removed.

#### 2.14.3 Samples and Workmanship

The Contractor shall submit for approval a sample panel not less than 600x1200mm to demonstrate the quantity of the exposed concrete produced by forms at his own expense.

The quantity of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Engineer without any additional cost.

The quality of the finished surfaces shall be uniform in color and consistency, whether in color or in texture, in any of the finished surfaces, the Engineer may order the repair or the demolition of the portion of concrete work and the reconstruction of same at the expense of the contractor and the contractor shall have no right to claim for any expenses or time delay incurred.

Alternatively the Engineer may order the contractor to plaster all exposed surfaces and bush hammer the entire area of, concrete in the project so as to render all exposed surfaces of concrete consistent throughout the project at the contractor's own expense.

# 2.15 Monolithic smooth finish surfaces

All concrete surfaces which are not in acceptance condition and which are required to be surfacefinished as designated herein shall be rubbed to a smooth and uniform texture with a carborundum brick and clear water as soon as the forms are removed and the concrete is ready to hone. The loose material formed on the surface shall be removed as soon as it dries by rubbing the surface with burlap or other approval material. A cement wash shall not be used.

Concrete surface shall be free from honeycombing, air holes, fins and projections arising from defective mixings, placing or formwork. When the formwork has been stuck off, the surface of concrete shall be left untouched until inspected by the Engineer. Any defective concrete work shall at the discretion of the Engineer be demolished completely and rebuilt or cut out and made good with concrete of the same proportions as the original. Such rectifications shall be to the satisfaction of the Engineer and at the Contractor's own expense.

# 3 Sub base and base courses

# 3.1 General

Locating sources and manufacturers of materials are the responsibility of the contractor. Prior to starting quarry or borrow pit operations, the contractor shall obtain written permission from the Authorities or Owner concerned.

The contractor shall submit to the Engineer, 10 days prior to the scheduled beginning of crushing and screening, a statement of origin of all stone and/or gravel aggregates and granular materials. The contractor shall submit for testing and approval, representative samples of all materials needed. Samples shall be taken by the contractor in the presence of the Engineer. Approval of specific sources of materials shall not be considered as final approval.

The contractor may conduct necessary tests in the Field Laboratory in the presence of the Engineer and the contractor's Materials Engineer. Samples shall satisfy all specified test requirements. The contractor shall furnish all necessary labor, transport, tools and equipment required by the Engineer.

# **3.2 Granular Material for Sub-Base**

Granular material for use in sub-base courses shall be naturally occurring gravel, blended as necessary with fine or coarse material and screened to produce the specified gradation. Crushing of natural granular material shall not normally be required, unless for the purpose of meeting the gradation requirements, or when shown on the Drawings (to produce a higher quality sub-base with improved mechanical stability).

Gravel shall consist of hard, durable and sound stones, free from deleterious substances not mentioned below.

Other requirements are:

Crystalline gypsum (expressed as SO3) 5% max. Clay lumps and friable particles 10% max.

Flakey and elongated particles

Crushed rock ......40% max. Each Crushed gravel ......45% max. Each

Maximum dry density

Maximum dry density is 2.05gm/cm3 as min.

Chart content (determined by percentage by weight insoluble in hydrochloric acid) should be specified in special technical specification.

Granular materials delivered to the road site shall meet the requirement of class A or B as shown in Table 3.1, when tested in accordance with AASHTO T-27 after dry mixing and just before spreading and compacting. The Class of granular material to be used shall be as shown on the Drawings or otherwise as selected by the Engineer. The actual gradation shall, in all cases, be continuous ad smooth within the specified limits for each Class. If gradation is tested after compaction, a tolerance of 3% is allowed in the upper limit for the percentage of material passing sieve no. 200. Gradation of Granular Material by Class, shown table 13-1

Table 13-1. Gradation of Granular Material by class				
Siove Designation	Percent by weight passing			
(Square openings)	Class A	Class B		
63 mm (2-1/2 in.)	100			
50 mm (2 in.)	80-100	100		
37.5 mm (1-1/2 in.)	70-95	80-100		
25 mm (1 in.)	55-90	60-95		
12.5 mm (1/2 in.)	45-75	47-80		
4.75 mm (No.4)	30-60	30-60		
2.00 mm (No. 10)	22-48	22-45		
0.425 mm (No.40)	10-30	10-30		
0.075 mm (No. 200)	5-12	5-12		

 Table 13-1: Gradation of Granular Material by class

Sand equivalent

The material shall contain a minimum of 25% sand equivalent at any stage of construction. Loss weight of granular material

The loss weight of granular material shall not exceed 45% after 500 revolution, when tested in accordance with AASHTO T 96 (Los Angelos Abrasion Test).

The ratio of wear loss = 
$$\frac{A brasion after 100 \text{ Re } v}{A brasion after 500 \text{ Re } v}$$
.

Should not be more than twenty percent of the maximum allowed abrasion after 500 revelations.

Soaked CBR

The granular material shall have a 4-day soaked CBR of not less than 30 when compacted at 100% of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

#### Soundness

When tested for soundness in accordance with AASHTO T 104, the material shall not show signs of disintegration and the percentage loss in weight after 5 cycles shall not exceed 12% in the case of the sodium sulphate test and 18% in the case of the magnesium sulphate test.

Portion of granular material

The portion of granular material, including any blended material, passing the 0.425 mm (No. 40) mesh sieve shall have a liquid limit (L.L) of not more than 27and a plasticity index (P.I.)

not grater than 6 when tested in accordance with AASHTO T 89 and T 90. Non-Plastic condition might be accepted if crushed limestone is used provided that angularity test (R) value shall not be less than 8.

#### Additional fine material

If additional fine material is required to correct the gradation of the granular material, or for adjusting the L.L. or P.I. of the fraction passing 0.425 mm (No. 40) sieve, it shall be uniformly blended and mixed with the granular material. Additional fine material for these purposes shall be obtained from the crushing of stone, gravel, or slag, if naturally occurring fine materials not available.

#### **3.3 Aggregate for Base Courses:**

Aggregate for use in base course construction shall be crushed stone, and may be washed, if directed, to remove excessive quantities of clay, silty clay or salts.

It shall consist of hard durable and sound particles or fragments of stone, free from other substance. Other requirements are gypsum, or flaky particles.

Other requirements	
Gypsum content (expressed as SO <sub>3</sub> )	. 2 % max.
Clay lumps and friable particles	. 8 % max.
Elongated and flakey particles for crushed rock	(Determined in accordance with BS 812 Part
1: 1975)	
Granit and Basalt	40 % max each.
Lime stone	35 % max
Minimum dry density (g/cm3)	2.15 % min
Linear shrinkage not exceed	. 3%
Gradation of Base course Aggregate by class, sh	own in table 13-2.

Siovo Designation	Percent by weight passing		
Sieve Designation	Class A	Class B	
50 mm ( 2 in )		100	
37.5 mm (1.5 in)	100	70-100	
25 mm (1 in )	75-100	55-85	
19 mm (3/4 in )	60-90	50-80	
12.5  mm (1/2  in)	45-80		
9.5 mm (3/8 in )	40-70	40-70	
4.75 mm (No 4)	30-65	30-60	
2 mm (No 10)	20-40	20-50	
0.425 mm (No 40)	8-20	10-30	
0.075 mm (No 200)	5-10	5-15	

Table 13-2: Gradation of Base course Aggregate by class

The material shall contain a minimum of 40% sand equivalent at any stage of construction. The loss weight shall not exceed 40 % after 500 revolutions, when tested in accordance with AASHTO T96 (Los Angeles Abrasion Test).

The ratio of wear loss should not be more than twenty percent of maximum allowed abrasion after 500 revolutions.

The crushed aggregate base course material shall have a 4-day soaked CBR of not less than 80 when compacted at 100 % of modified proctor AASHTO (T 180-D) and tested in accordance with AASHTO T 193.

When tested for soundness is accordance with AASHTO -104, the material shall not show signs of disintegration and the loss by weight shall not exceed 12 % in case of the sodium sulphate test, and 18 % in the case of the magnesium sulphate test.

The portion of aggregate, including any blended material passing the 0.425 mm (No. 40) sieve shall have a liquid limit (L.L.) of not more than 25 and plasticity index (P.I) of not more than 6, and not less than 3 when tested in accordance with AASHTO T 89 and T 90.

If additional fine material is required to correct the aggregate gradation or for adjusting the L.L or P.I. of fraction passing the 0.425 mm (No 40) sieve, it shall be uniformly blended and mixed with the aggregate material.

Elongated and flakiness not to exceed 35% for each.

#### **3.4 Granular sub-base courses**

#### 3.4.1 Scope

These Works shall consist of furnishing granular sub-base material of the required Class, mixing, spreading on prepared sub-grade, compacting and finishing, all as and where shown on the Drawings.

#### 3.4.2 Materials

All materials shall conform to the relevant requirements of Section "Materials", in respect of granular material Class A or Class B for sub-base construction.

#### 3.4.3 Sub-grade Surface Preparation

The sub-grade shall have previously been constructed in accordance with the requirements of

Section "Sub-grade Construction and Topping" and properly maintained and kept well drained thereafter.

At all special grade control points, such as at bridge structures, existing pavements, etc. The subgrade shall be lowered to a depth sufficient to permit construction of the sub-base course to the specified elevations and thickness.

Transitions shall be of sufficient length to avoid abrupt change of grade and shall be within plus or minus 3% of the final design grade unless otherwise directed. Surplus material shall be removed and disposed of.

The sub grade shall be inspected and approved immediately prior to commencement of subbase construction. Any soft, yielding material shall be removed and replaced by approved topping material. Holes, depression and other irregularities shall be made good as directed and the sub-grade re-compacted as necessary and finished ready to receive the sub-base course.

#### 3.4.4 Equipment

Equipment used to handle, place, spread, water, compact and finish sub-base shall conform to the requirements of Section "Contractor's Plant and Equipment" and with the Contractor's approved Work Program.

#### **3.4.5** Construction

#### 3.4.5.1 Stockpiling of Granular Material

Stockpiling procedures shall conform to the relevant requirements of Section "Materials". Methods used for stockpiling granular material and removing it from stockpiles shall not result in significant degradation or segregation nor the introduction of significant amounts of foreign materials or extraneous matter.

Granular material adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall be incorporated in the Works regardless of previous approval of such material, until the deficiencies have been rectified in an acceptable manner.

#### 3.4.5.2 Mixing and Spreading

All components of sub-base course material shall be mixed thoroughly and uniformly with water in situ. The amount of water added, as approved by the Engineer, shall be such that the material will be uniform and within the specified moisture content range at the time of compaction. Wetting of granular material in stockpiles or in trucks before or during delivery to the Site will not be permitted. However, water shall be added to the material, if necessary, during placing and compaction of sub-base material.

The sub-base material shall be placed on the subgrade in a uniform two layers each 150 mm thickness (after compaction).

If approved, heavy duty vibratory compaction equipment is used, the sub base may be in one 300 mm layer (after compaction) provided compaction tests with appropriate testing equipment indicate that the specified compaction standard will be attained and uniform throughout the thickness.

The sub-base material shall be placed to the required width using a self-propelled spreader or motor grade equipped with blade extensions. Water shall be applied by approved spraying equipment and thoroughly mixed with the sub-base material.

The material shall not be bundled in such a way as to cause segregation. If the spreading equipment causes segregation in the material, or leaves ridges, or other objectionable marks on the surface which cannot be readily eliminated or prevented by adjustment of the equipment, the use of such equipment shall forthwith be discontinued and it shall be replaced by a spreader or grader capable or spreading the material in proper manner.

All segregated material shall be removed and replaced with well-graded material. "Skin" patching will not be permitted. Only minor surface manipulation and watering to achieve the required surface tolerances will be permitted during the compaction process.

Neither hauling nor placement of material will be permitted when, in the judgment of the Engineer, the weather or surface conditions are such that hauling operations will cause cutting of the subgrade or cause contamination of the sub-base material.

#### 3.4.5.3 Compaction

The Contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces, If the Contractor delays placing of succeeding layers of material to the extent that additional water is required to prevent raveling or excessive drying, the application of such water shall be carried out as directed and at the Contractor's expense.

The sub-base material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass.

Rolling shall continue until the entire thickness of each sub-base layer so thoroughly and uniformly to 100% AASHTO T 180 (Method D) maximum density. Final rolling of the completed course shall be by means of an approved self-propelled roller. Rolling shall be accompanied by sufficient blading, to insure a smooth surface, free from ruts or ridges and having the proper shape. When additional water is required, it shall be applied in an approved manner.

Any areas inaccessible to normal compaction shall be compacted by use of portable mechanical tampers until the required standard of compaction is achieved.

Each layer shall be completely compacted and approved prior to delivery of materials for the subsequent layer.

Prior to placing a subsequent layer, the existing surface shall be made sufficiently moist as directed, to ensure proper bond between the layers.

The edges and slopes of the sub-base course shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the Drawings and to present straight, neat lines and slopes as free of loose material as practicable.

Material which has dried out prior to final compaction, or which has dried and compacted subsequent to final compaction, shall be watered and recompacted using approved equipment and procedure. If the Contractor is unable to return the material to its original or specified condition with respect to compaction, thickness and surface tolerances, the Contractor shall remove the material and reconstruct the sub-base course on a re-approved sub grade.

#### 3.4.5.4 Tolerances

The fully compacted and completed sub-base course shall conform to the lines, grades and cross sections as shown on the Drawings.

The elevations of the finished sub-base course shall be checked by the Contractor in the presence of the Engineer at maximum intervals of 10 m and at intermediate points as directed.

The tolerance on elevations of finished surface shall be plus 10 mm to minus 20 mm, minus tolerance shall be compensating by the proceeding layer.

When the finished surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 10 mm.

All areas which exceed the specified tolerances shall be corrected by removing the defective sections of sub-base and reconstructing them or, if approved, by adding new material mixing and recompacting and finishing to the specified standard.

#### 3.4.5.5 Maintenance of Completed Sub-base

Following completion and acceptance of the sub-base course, it shall be maintained by the Contractor at his own expense. The sub-base shall be bladed, broomed and otherwise maintained, keeping it free from raveling and other defects until such time as the base course is placed. Water shall be applied at such times and in such directed by the Engineer.

#### 3.4.6 Testing

Every 500 linear meter of sub-base material or whenever there is a change in the material source shall be subject to a full set of tests after mixing in situ and, if found satisfactory, shall be approved for compaction. This approval shall not deem to constitute acceptance of the subbase course. Sampling and testing shall conform to the relevant requirements of Section 1.05- "Control of Materials and Standards for Sampling and Testing".

Compaction shall be tested in accordance with AASHTO T 191 or AASHTO T 205. If there is a delay between the construction of any layer and the following layer, if necessary and required by the Engineer the compaction of the lower layer may be recertified to ensure that it has not loosened due to traffic, passage of construction equipment, adverse weather conditions or otherwise.

#### **3.5 Aggregate base courses**

#### 3.5.1 Scope

These works shall consist of furnishing crushed aggregate base course material of class a, mixing, spreading, compacting and finishing, all as and where shown in the Drawings.

#### **3.5.2 Surface Preparation**

The sub-grade surface shall be inspected and approved prior to commencement of base construction, Holes, depressions and other irregularities shall be made good as directed and the sub-grade re-compacted as necessary and finished ready to receive the base course layer.

#### 3.5.3 Equipment

Equipment used to handle, place, spread, water, compact and finish base course in accordance with contractor's Work program approved by the Engineer.

#### **3.5.4** Construction

#### 3.5.4.1 Stockpiling of Base Course Material

Stockpiling method of aggregates and moving them from stockpiles shall not result in significant degradation or the introduction of significant amounts of foreign materials.

Aggregate materials adversely affected, in the opinion of the Engineer, by stockpiling or handling procedures shall not be incorporated in the works regardless of previous approval of such material until the deficiencies have been rectified in an acceptable manner.

#### 3.5.4.2 Mixing and Spreading

Base course material shall be mixed with water to reach the specified moisture content range at the time of compaction. The mixed material shall be handled and placed on subgrade in a uniform layer as to not cause segregation. All segregating material shall be removed and replaced with well-graded material, "Skin" patching will not be permitted and spread to the required width and shall be delivered such that it is ready for compaction without farther shaping.

#### 3.5.4.3 Compaction
The contractor shall plan the sequence of operations so that the least amount of water will be lost by evaporation from uncompleted surfaces.

The base course material shall be compacted by means of approved compaction equipment, progressing gradually from the outside towards the center, with each succeeding pass uniformly overlapping the previous pass. Rolling shall continue until the entire thickness of each base layer is thoroughly and uniformly compacted to 100% AASHTO T 180 (Method D) maximum density: The edges and edge slops of the base course shall be bladed or otherwise dressed to conform to the lines and dimension shown on the Drawings.

Materials which have dried out prior to final compaction, or which has dried and decompacted subsequent to final compaction, shall be watered and recompacted. If the contractor failed to return the material to its original or specified condition with respect to compaction, thickness and surface tolerance the contractor shall scarify the material and reconstruct the base course on a re-approved subgrade surface or to the satisfaction of the Engineer.

## 3.5.4.4 Tolerances

The dully-compacted base course shall conform to the lines, grades and cross sections as shown in the drawings.

The elevations of base course shall be checked at intervals of 20 m on straight and 10 m on curves, the tolerance on elevations of surface shall not exceed +10 mm or -05 mm, and not exceed 12 mm between any two contact points tested with a 4 m long straight edge placed parallel to, or at right angles to center line.

All areas which exceed the specified tolerances shall be scarified and corrected to specified standard.

## 3.5.4.5 Maintenance of Completed Base Course

Following completion and acceptance of base course, it shall be maintained by contractor at his own expense. The surface shall be broomed and rolled keeping it free from defects until such time as the following course is placed. Water shall be applied at such times and in such quantities as directed.

## 3.5.5 Testing

Sub base and base Course material shall be tested in accordance with the table shown below at stock pile and at the mixing plant for control on site tests, and if satisfactory shall be approved for use. This approval shall not be deemed to constitute acceptance of base course for full payment purposes. Required Tests and Minimum Repetition for Base course material, shown in table 13-3.

Source of Materials		Control on Site (The Road)			
Required Test	Repetition Required for all Test	Required Tests	Repetition Required for all Test		
1-Gradation of materials	* Test for each source	1. Proctor	* test for every 500 Lm for each layer		
2- Plasticity Index	* for every 1000 m <sup>3</sup>	2. Gradation of materials	* when materials changed		
3- Abrasion	* When materials changed or every 1000 m <sup>3</sup>	3. Plasticity Index			
4- C.B.R.		4. C.B.R.			
5- Sand equivalent		5. Abrasion			
6-Percentage of Fractured Grains		<ol> <li>6. Sand equivalent</li> <li>7. Clay Lumps &amp; Friable particles</li> <li>8. Field Density</li> <li>9. Thickness</li> </ol>			

Table 13-3: Required Tests and Minimum Repetition for Base course

Compaction test: for every layer at least 3 samples taken for one street or 1000 m<sub>2</sub> from layer area, or 200 linear meter of road which is smaller.

## 3.5.6 Measurement

1. The net area executed must be measured (without the area under the curb stone).

2. The area of manholes and gullies is to be deducted from measurement.

# **4**-Bituminous construction

## 4.1 Material

## 4.1.1 Scope

All material sources and the quality of materials proposed for use in the works shall be approved prior to procurement or processing material from such sources. Inspection, sampling, testing and retesting as necessary, shall be at the contractors expense.

## 4.1.2 Sampling and Testing of Aggregate

In order to ascertain the properties of aggregate materials, the contractor shall submit for testing and approval, representative samples of all materials intended for corporation in the works, prior to starting quarry operations, the samples shall be taken by contractor in the presence of the Engineer. Tests performed by the contractor shall utilize in assessing the locations, extent of deposits and quantities of materials which will conform to the specifications when properly processed. All testing as carried out by the contractor shall in no way obviate the need for further testing by Engineer. Approval of specific sources of materials shall not be considered as final approval and acceptance of materials from such sources.

Unsatisfactory materials whether in place or not, shall be removed promptly from the site. The contractor shall furnish all necessary material, labor, tools, and equipment and transport required by the engineer for such inspections.

## 4.1.3 Aggregates for Bituminous Paving Mixes

1. Aggregate for use in bituminous, binder and wearing courses, shall consist of crushed stone. 2. Course aggregate shall be the fraction of crushed aggregate material retained on 4.75 mm (No. 4) sieve. Fine aggregate shall be the fraction of crushed aggregate material passing 4.75 mm (No. 4) sieve. Mineral filler shall be added when the combined grading of course and fine aggregates is deficient in material passing 0.075 mm (No. 200) sieve.

3. The material from hot bins passing the number 40 sieve (0.425 mm) when tested in accordance with AASHTO T90 shall be non-plastic.

4. Aggregate shall not contain gypsum more than 1% and the course fraction of the aggregate shall not contain more than:

5% chert and flint for aggregate to be used in the Wearing course.

5% chert and flint for aggregate to be used in the Binder course.

5. Aggregates shall be of uniform quality, free from decomposed stone, organic matter, shale.

6. The percentage by weight of friable particles, clay lumps, and other deleterious matter shall not exceed 1% as determined by AASHTO T112.

7. Aggregate particles shall be clean, hard, durable and sound. Crushing shall result in a product such that, for particles retained on 4.75 mm (No. 4) sieve, at least 90% by weight shall have 2 or more fractured faces.

8. The flakiness index and the elongation index test should be conducted in accordance with

BS 812, the flakiness and elongation index must be less than 30.

9. Aggregates shall be washed if directed, to remove any clay lumps, organic matter, adherent dust or clay films or other extraneous or deleterious matter that may prevent or detract from proper adhesion of bitumen to the aggregate particles.

10. Material filler shall consist of finely divided mineral matter such as limestone dust if added separately; hydrated lime; other non-plastic mineral filler, free from clay and organic impurities; or Portland cement, conforming to AASHTO M17.

11. Combined course and fine aggregates for bituminous mixes, including mineral filler, when tested in accordance with AASHTO T27 and T11, shall conform to gradations shown in Table shown below (Table 14-1):-

Birth and a second seco						
Sieve Designation	Binder Course Percent Passing	Wearing Course Percent Passing				
1" (25.0mm)	-	-				
3/4" (19.0mm)	100	100				
1/2 " (12.5mm)	82±9	89±9				
3/8" (9.5 mm)	72±9	82±9				
No. 4 (4.75mm)	54±9	66±9				
No. 8 (2.36mm)	41±9	53±9				
No. 16 (1.18mm)	32±9	41±9				
No. 30 (0.600mm)	24±9	31±9				
No. 50 (0.300mm)	17±7	21±8				
No. 80 (0.150mm)	12±5	13±6				
No. 200 (0.75mm)	5±2	4.5±2.5				

Table 14-1: Gradation of Aggregates for Bituminous Mixes

12. The loss in weight of aggregate after 500 revolutions, when tested in accordance with AASHTO T96, shall not exceed 35%.

Ratio of wear loss = is less than or equal 25.

13. When tested for soundness in accordance with AASHTO T104 the course aggregate (retained on No. 4 sieve) shall not show signs of disintegration and the loss by weight after 5 cycles shall not exceed 9% in the case of the sodium sulphate test and 12% in the case of the magnesium sulphate test.

14. When tested for resistance to stripping in accordance with the AASHTO T-182 at least 95% coated particles should be achieved. Scandinavian test shall be carried out and at last 60% of the coarse aggregate surfaces area shall remain coated with a bitumen film especially for exposed surfaces otherwise anti stripping agent must be added to achieve the required coating. 15. The material shall contain minimum 50% sand equivalent. Test sample shall be taken from hot bins.

16. Minimum Dry Specific Gravity (g/cm3) 2.55 min

17. Water absorption not exceed 2%

## 4.1.4 Heating of Bitumen

1. Heating equipment shall be of an approved type. Any method of heating that introduces free steam or moisture into the bitumen will not be approved.

2. Bitumen shall not be heated more than 170degrees C. materials heated in excess of this temperature will be rejected and shall not be used in the works.

3. Heating of bitumen shall be uniform and under control at all times, to the specified temperature. The circulation system shall be of adequate size to insure proper and continuous circulation of bitumen during the entire operating period.

4. Thermometers of adequate range (calibrated in 2 degrees c increments) for accurately measuring the temperature of the bitumen, shall be located so as to be readily visible and shall be kept clean and working order at all times.

# 4.2 Bituminous prime and tack coats

## 4.2.1 Scope

This work shall consist of furnishing and applying and MC cutback bitumen prime coat to a previously constructed aggregate base course and applying tack coat on Asphalt or concrete surfaces all as and where shown on the Drawings.

## 4.2.2 Medium Curing Cutback Bitumen

1. MC-70 cutback bitumen for prime coat shall be used as recommended by ASTM D2399-83 for open and tight surface, and RC-70 should be used as tack coat.

2. All surfaces to receive either prime or tack coats shall conform to the specified tolerances and compaction requirements and shall be properly cleaned and finally approved before applying any bitumen material.

3. Application of prime and tack coats shall be performed only when the surface to be treated is sufficiently moist and atmospheric temperature is above 15 C. There should be no fog, rain, strong winds, dusty conditions, or dust storms.

4. The surface of all structures shall be protected in an approved manner during the equipment operation. The contractor shall be responsible for making good any staining or damage of the structures to the satisfaction of the Engineer.

5. Traffic shall not be permitted to surfaces after they have been cleaned and prepared for prime coat application.

6. The contractor shall maintain prime or tack coats until it is covered by the subsequent pavement course.

7. Any area where the coats have been damaged shall be cleaned of all loose material and re-applied at the contractor's expense.

8. Applying temperature of MC- 70 shall be 45-80C.

9. Areas to be primed shall be including 200 mm widths outside the edge of the permanent line.

10. Application rate for prime coat shall be 1 lit/sq.m and tack coat application shall be 0.7 lit/sq.m.

11. Asphalt pavement shall not be placed on prime coat before 24 hours, and no traffic is allowed to pass on prime coat.

12. The minimum solid residue by evaporation by weight must exceed 50 % when tested according to ASTM D 1461-85.

13. The Ash content of residue by weight must not exceed 7 % when tested according to AASHTO T-83(2000).

14. The drying time for prime coat must not exceed 24 hour.

15. The density range from 990 to 1010 gm/l when tested according to ASTM D 70

# 4.3 Bituminous courses

4.3.1 Scope

This work shall consist of the general requirements of furnishing materials, mixing at a central mixing plant, spreading and compacting bituminous courses.

## 4.3.2 Job Mix and Project Mixes

1. The contractor shall submit certificate of origin of all material used in the mix for approval of the engineer, the material must be of best kinds.

2. The contractor shall submit his proposed Job Mix Formula for approval, at least 30 days prior to beginning production so that the life of the submitted Job Mix should not exceed 6 months from the date of submission for small size projects but to be furnished particularly for large size projects. Therefore, samples from materials use in the preparing mix design (aggregates and bitumen) shall be sent to specialized laboratories to be tested for final approval of mix design.

3. The Job Mix Formula is established by the contractor, under the supervision of the engineer, in the field laboratory mix design procedures shall conform to the Marshall method of mix design. All trial mixes shall be prepared and tested by the contractor in the presence of the Engineer.

4. The Job Mix Formula shall specify a combination of mineral aggregates including filler and bitumen in such proportions as to produce a Job Mix which is within the limits of the specified gradation and bitumen content ranges and which meets the Marshall Test requirements. It shall also stipulate the mixing temperature at discharge from the mixer which, unless otherwise directed, shall be 170 degrees C.

5. The Marshall Test procedure shall be used to determine the percentage of bitumen to be incorporated in the mix. The Job Mix Formula shall take into consideration the absorption of bitumen into the aggregates. Air voids shall be calculated in accordance with the procedure given in the Asphalt Institute Manual, MS-2.

6. When compacting specimens on accordance with the Marshall Test procedure, the number of blows applied with the compaction hammer shall be 75 on each side.

7. In order to meet the requirements, an approved additive such as Portland cement, hydrated lime or liquid antistrip agent, may be required in the Job Mix. Portland cement shall meet the requirements of ASTM M 85. Hydrated lime shall meet the requirements of ASTM C207, Type N. Cement or hydrated lime will normally be required in the approximate range of 2-3% by weight of the aggregates and shall be added at the cold feed in dry or slurry form as directed. Liquid antistriping agent, if needed will normally be required in the approximate range of 0.6-1.0% by weight of the bitumen, or according to the manufacturers specifications.

8. Upon receipt of approval of the Job Mix Formula, the Contractor shall adjust his mixing plant to proportion the individual aggregates, mineral filler and bitumen to produce a final project mix within the limits given in Table shown (14-2) with respect to the Job Mix gradation

Sieve Designation	Specified Tolerances
(square openings)	
9.5 mm (3/8 in.) and above	± 5.0%
4.75 mm (No. 4)	$\pm 4.0\%$
2.36 mm (No. 8)	$\pm 4.0\%$
1.18 mm (No. 16)	± 4.0%
0.600 mm (No. 30)	± 4.0%
0.300 mm (No. 50)	± 4.0%
0.150 mm (No. 100)	$\pm 4.0\%$
0.75 mm (No. 200)	± 1.5%
Bitumen Content	$\pm 0.3\%$
Temperature of Mix on discharge	$\pm$ 5 C of the specified mixing
temperature	

#### Table 14-2: Maximum Variations of Project Mix from Approved Job Mix

9. Conformance to graduation requirements will be determined on the extracted aggregate in accordance with AASHTO T 30. The bitumen content shall be determined in accordance with AASHTO T 164.

10. The participation of the Engineer in the preparation of the Job Mix Formula shall in no way relieve the Contractor of responsibility for producing project mixes meeting the specified requirements.

## 4.3.3 Spreading and Finishing Equipment

1. Bituminous course shall be spread and finished using approved type, self contained, powerpropelled pavers of sufficient capacity. Pavers shall be provided with electronically controlled vibratory screed or strike-off assembly and shall be capable of spreading and finishing the course of bituminous mix to the proper thickness and in lane widths applicable to the typical cross sections shown on the Drawings.

2. The pavers shall employ mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices, to maintain trueness of grade and confine the edges of the mix to true lines without the use of stationary side forms. Joint leveling devices shall be provided for smoothing adjusting longitudinal joints between lanes.

3. The paver shall be equipped with receiving hopper having sufficient capacity for a uniform spreading operation. The hopper is equipped with a distribution system to place the mix uniformly in front of the full length of the screed.

4. The screed or strike-off assembly and extensions shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mix.

5. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mix. Speed shall be fully adjustable

6. The Contractor shall make available, for reference by the engineer, the manufacturer's instruction and operating manuals for each paver intended for use.

#### **4.3.4 Surface Preparation**

1. When the bituminous mix is to be placed on a base course, the surface shall be prepared to meet the appropriate specified compaction and surface tolerance requirements. The surface shall hen be primed as specified "Bituminous Prime Coat". No bituminous mix shall be laid on a prime coat until it has been inspected and approved.

2. Broken, soft, or unstable areas of aggregate base course shall be removed and replaced. The areas shall be excavated to a depth as directed and refilled with the specified bituminous mix.

#### 4.3.5 Delivery, Spreading and Finishing

#### 4.3.5.1 Delivery of Mix to Site

1. A sufficient number of haul vehicles shall be provided so that adequate supplies of mix are delivered to ensure that continuous paving will be achieved.

2. Hauling equipment for aggregates and bituminous mixes shall consist of vehicles having dump bodies suitable for dumping materials in a windrow or in spreader boxes. The bodied shall be so constructed that their volume measurement can be accurately determined. They shall be constructed and maintained such that loss of materials during hauling operations will not occur.

3. Dump controls shall be capable of operation from the driver's seat.

4. Hauling equipment for hot bituminous mixes shall have tight, clean, smooth metal beds which are periodically thinly coated with a lime solution or other approved material to prevent adherence of the mix. All hauling units shall be equipped with a canvas or other approved type cover which shall be used to cover the hot material upon loading at the mixing plant and shall not be removed until the mix is discharged into the paver.

5. The dispatching of the hauling vehicles to the site shall be so scheduled that all material delivered is placed at least 90 minutes before sunset to allow sufficient time for compaction.

6. Delivery of material shall be at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

7. The mix delivered to site must have a temperature range from 139° to 163°.

8. Each haul vehicle shall be weighed after each loading at the mixing plant and accurate records shall be kept of the gross weight and net weight of each load, for each vehicle dates and time of loading.

#### 4.3.5.2 Setting out Reference Line

1. The Contractor shall survey the centerline profile and crown of the existing surface or base and determine a reference grade line which will be submitted for approval. A reference line of wire or suitable cord shall be installed at a uniform grade parallel to the approved reference grade line such that conformance with the required geometrics, surface tolerance and minimum thickness requirements shall be ensured.

2. The reference line shall be maintained taut and free from sags at all times during spreading and initial compacting operations.

3. A wire or cord reference line shall be installed on both sides of the paver for the initial bituminous course being laid. Thereafter only one reference line will normally be required, if the paver is equipped with adequate automatic super elevation control.

#### 4.3.5.3 Spreading and Finishing

1. Bituminous mixes shall be laid only when the air temperature is at least 5 degrees C or above when the existing surface is free from moisture, and when the weather is not foggy, rainy, dusty or excessively windy (particularly at low temperatures).

2. After completion of surface preparation, the bituminous mix shall be spread and finished true to crown and grade by approved automatically controlled bituminous pavers. The mix may be spread and finished by approved hand methods only where the engineer determines that machine methods are impracticable. Hand methods include heated hand tampers of at least 10 kg weight and approved type mechanical (vibratory) tampers.

3. The paver shall spread the bituminous mix without tearing the surface and shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugations and other irregularities.

4. The paver shall be operated at a speed which gives the best results for the type of pavers being used and which coordinates satisfactorily with the rate of delivery of the mix to the paver. A uniform rate of placement shall be achieved without repeated intermittent operation of the paver.

5. The mix shall be delivered to the paver in time to permit completion of spreading, finishing and compaction of the mix during daylight hours.

6. If during laying, the paver is repeatedly delayed because of lack of mix or if the paver stands at one location for an extended period, resulting in the (unrolled) mat under and adjacent to the rear of the spreader falling below the minimum temperature for breakdown rolling, the affected portion of

mat shall be cut out and discarded and a transverse joint shall be constructed. Paving shall not recommence until the engineer is satisfied that paving will proceed without interruptions.

7. Contact surfaces of curbing, gutters, manholes, and similar structures shall be painted with a thin, uniform coating of tack coat material. The bituminous mixture shall be placed uniformly high near the contact surfaces so that after compaction it will be 10 mm above the edge of such structure.
8. If during the paving operations, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities that are not satisfactorily corrected by the scheduled operations, the use of the equipment shall be discontinued, until faults are corrected to the approval of the engineer. If this is not possible, other satisfactory spreading and finishing equipment shall be provided by the contractor.

9. Transverse joints in succeeding layers shall be offset by at least 2 m. Longitudinal joints shall be offset at least 150 mm.

10. Bituminous mix shall be spread in one or more layers so that, after rolling, the nominal thickness of each layer of the compacted bituminous material does not exceed 2 to 3 times maximum size of aggregate. This maximum thickness may be increased slightly when such increase is more appropriate to total pavement thickness and provided the engineer determines that such increased thickness will not be detrimental to the quality of the finished bituminous course, and the contractor can show that the required density is attained throughout the layer thickness.

11. Transitions and structure approaches shall meet the design criteria for geometrics, the surface tolerance specifications, and shall not be visually discontinuous or abrupt in appearance. **4.3.5.4 Joints and Edges** 

1. All joints between old and new pavements or between successive days' work shall be as to ensure thorough and continuous bond between the old and new material.

2. Before placing fresh mix against previously laid, the contact surface shall be cut back to a near vertical face, and shall be sprayed or painted with a thin uniform coat of tack coat material. Longitudinal joints shall be made by overlapping the paver screed on the previously laid material (cut back as necessary) and depositing a sufficient amount of fresh mix so that the joint formed will be smooth and tight.

3. Unsupported edges of bituminous layers shall be rolled immediately following the rolling of the longitudinal joint. The material along the unsupported edge may, if approved, be raised slightly by hand methods, to ensure that the full weight of the roller will bear fully on the edge material 4. On completion, the longitudinal edges of bituminous pavement shall be true to the width and alignment as shown on the drawings. The edges shall be cut back if necessary prior to rolling,

additional mix placed manually in a longitudinal strip adjoining each pavement edge, and the edge rolled down to a neat 3:1 (H:V) slope.

5. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight-edged and string-lined to assure smoothness and true alignment

#### 4.3.5.5 Compaction

1. After spreading and strike-off, and as soon as the mix conditions permit the rolling to be performed without excessive shoving or tearing, the mixture shall be thoroughly and uniformly compacted, using approved types, sizes and number of rollers. Rolling shall not be prolonged to the point where cracks appear or shoving or displacement occurs.

2. All rollers shall be self-propelled vibratory steel wheel, 2-axle tandem steel-tired and pneumatictired types, in proper operating condition, capable of reversing without backlash or tearing of the surface, and shall be operated at numbers of rollers required is 3, of which one must be pneumatic type. The Contractor shall select a suitable method and pattern of rolling that will achieve the required compaction, to engineers approval. 3. Prior to use on site of pneumatic-tired rollers, the contractor shall furnish, for reference and retention by the engineer, manufacturers' charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of tire loadings for each type and size of compactor tire to be used. The contractor shall ensure that tire pressures are maintained at all times in conformity with such charts or tabulations. The maximum allowable tolerances shall be plus or minus 35 KN/sq.m (5psi).

4. Rollers should move at a slow but uniform speed, generally with the drive roll or wheels nearest the paver.

5. Breakdown rolling shall be consist of 3 complete coverage unless otherwise directed.

Rolling shall be longitudinal, and overlapping on successive trips by at least one half the width of the rear wheels.

6. To prevent adhesion of the mix to the rollers, the wheels shall be kept lightly moistened with water. Excessive use of water will not be permitted.

7. The initial or breakdown rolling shall be followed by intermediate rolling involving 3 coverage with pneumatic-tired rollers unless otherwise specified.

8. Finishing rolling shall then be carried out by means of tandem power steel rollers unless otherwise designated. If specified density is not achieved, changes shall be made in size and number of rollers being used to ensure the compaction requirements are met.

9. The compacted density shall be equal to or more than 97% and 98% for binder course and wearing course, respectively, of average Marshall bulk specific gravity for each day production unless otherwise directed by the engineer.

10. If after re-testing the density achieved is 0.5% or less below the specified density, the asphaltic layer will be accepted in the works subject to a 10% reduction to the billed rates.

If on the other hand the density achieved is greater than 0.5% below the specified density the asphaltic material shall be removed and new materials laid to the specification at the contractor's cost.

#### 4.3.5.6 Test for Bituminous Pavements

1. Minimum Tests required as shown in table 14-3 below:

Table 14-3: Minimum Test Required for Bituminous

Work item	Tests at Source of material	Frequency of tests	Tests at road site	Frequency of tests
1- Materials used in Asphalt mix (at Batching plant)	Specific gravity and water absorption 2- Abrasion test     Gay lumps and friable materials     S- Flaky and elongated particles     Soundbase	<ul> <li>Test for each source</li> <li>When materials quality changes</li> <li>As requested</li> </ul>		
2- Materials used in Asphalt mix ( from hot bins)	I- Gradation 2- Specific gravity and water absorption 3- Plasticity index 4-Sand equivalent 5- Stripping with asphalt	<ul> <li>Test for each source</li> <li>when materials quality changes</li> <li>As requested</li> </ul>		
3- Asphalt mix design (At batching plant)	1. Complete mix design in accordance with American Asphalt Institute (MS2) 2. Loss of stability	-For each project -When materials quality changes -When results are not consistent with the mix design		

			results - As requested		
	4- Asphalt	At Batching plant 1- Stability 2- Flow 3- Extraction (binder content and gradation) 4- Air voids 5- Voids in mineral aggregates 6- Daily Marshall	<ul> <li>- As requested</li> <li>- Test each 3 working days</li> <li>- Test for each batching plant</li> <li>- As requested</li> </ul>	Behind spreader 1- Stability 2- Flow 3-Extraction (binder content and gradation 4-Air voids 5- Voids in mineral aggregates 6-Marshall	-Test each working day - Test for each batch - As requested
		density 7-Loss of	- Once a week	density 7- Road	- Test each 200
2. The		Stability	- As requested	density and thickness (after final compaction	lin.m. per lane - As requested
specific determined in				8-Loss off stability	- Once a week - As requested

Marshall Bulk gravity shall be accordance with

AASHTO T 166 or AASHTO T 275. The Marshall specimens shall be prepared from the same material used in construction, taken from samples of fresh bituminous mix at the mixing plant or from trucks delivering mix to the site. Oven heating for up to 30 minutes to maintain the heat of the sample is permissible.

3. The bulk specific gravity of the mix as placed and compacted in situ shall be determined from 100 mm nominal diameter core samples, or slab samples cut from compacted layer on the road at locations designated by the engineer who may require additional tests to determine limits of areas deficient in density, or for recheck.

4. Samples for in situ bulk specific gravity determinations shall be taken in sets of 2 from each pavement location. Minimum frequency of sampling for each bituminous layer shall be one set/lane/500 m, with a minimum of one set per day of placing bituminous layers.

5. The contractor shall, cut the samples with an approved core drill in the presence of the engineer. The equipment shall be capable of cutting the mixture without shattering the edges or otherwise disturbing the density of the specimen. The contractor shall fill and compact all test holes at his own expense.

## **4.3.6 Surface Tolerances**

1. The fully compacted and completed bituminous course shall conform to the lines, grades and cross sections as shown on the drawings.

2. The elevations of the finished course shall be checked by the contractor in the presence of the engineer at maximum intervals of 25m and at intermediate points as directed.

3. When the finished surface is tested with a 4 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the test edge between any 2 contacts points shall not exceed the tolerances specified 6.0 mm.

4. All areas which exceed the specified tolerances shall be corrected by removing the defective sections of bituminous course and reconstructing them or, if approved, by adding new material and recompacting and finishing to the specified standard or increasing the thickness of the succeeding course.

5. The tolerances specified for evenness of finished surfaces for all types of bituminous course, shall not invalidate the tolerances specified for construction thickness and elevations of such courses.

## 4.3.7 Determination of Thickness of Course

Cylinder core samples shall be taken as specified for in situ bulk specified gravity core samples.
 Thickness of bituminous course shall be determined by average caliper measurement of cores, rounded upwards to the nearest mm.

3. Paved sections to be measured separately shall consist of each 200 lin.m section in each traffic lane. The last section in each traffic lane shall be 200 m plus the fractional part of 200 m remaining. Other areas such as intersections, entrances, etc. shall be measured as one section and the thickness of each shall be determined separately. Small irregular unit areas may be included as part of another section.

4. One core shall be taken from each section by the contractor at approved location and in the presence of the engineer. When the measurement of the core from any paved section is not deficient by more than 3 mm from the specified thickness, the core will be deemed to be off the specified thickness as shown on the drawings.

5. When the measurement of the core from any paved section is deficient by more than 3 mm but not more than 15% from specified thickness layer, 2 additional cores spaced at not less than 100 m shall be taken and used together with the first core to determine the average thickness of such section, if it failed again, 15% will reduction from unit price.

6. When the measurement of the core from any paved section is less than the specified thickness by more than 15% from specified thickness layer, the average thickness of such section shall be determined by taking additional cores at not less than 5 m intervals parallel to the centerline in each direction from the affected location until, in each direction, a core is taken which is not deficient by more than 15% from specified thickness layer, Exploratory cores for deficient thickness will not be used in average thickness determinations, if it failed again, Asphalt layer will remove or replacement.

7. Any deficiencies in the total thickness of bituminous courses shall be subject to a proportional reduction in the area of (wearing) course measured for payment.

Alternatively, the contractor shall construct all at his own expense, a wearing course overlay, if practicable in the judgment of the engineer. Any such overlay shall be a minimum of 30 mm compacted thicknesses and to the specified standard of the course it is overlaying.

8. If the deficiency in total asphalt layers thickness is from 0 -3 mm, full payment will be made, on condition that deficiencies are not found in more than 10% of the total project.

Deficiencies exceeding 3 mm shall be left to the substantial handing -over procedure.

## 4.3.8 Measurement

1. Bituminous course shall be measured by sq.m for furnished, paved compacted, tested and approved areas placed according to drawing.

2. Any correction, tests, samples, etc. shall not be measured for direct payment.

## 4.4 Bituminous binder and wearing courses

## 4.4.1 Scope

These works shall consist of furnishing materials, mixing at mixing plant, spreading and compacting bituminous binder and wearing course on an approved aggregate base course as and where shown in the drawings.

## 4.4.2 Materials

1. Materials shall conform to relevant requirements of section" Materials" mentioned before.

2. Unless otherwise shown on drawings, bitumen for binder and wearing course construction shall be 60/70 penetration graded bitumen.

## 4.4.3 Job Mix and Project Mix

1. The Job Mix formula shall be established by the contractor in accordance with the procedure and requirements of section "Bituminous Course" mentioned before.

2. The Job Mix for bituminous binder and wearing courses shall conform to the following composition limits, as shown in Table 14-4:

Property Medium-Light						
	Binder	Wearing				
Marshall Stability at 60c	900	900				
(kg)						
Flow (mms)	2-4	2-4				
Voids in Mineral aggregate	13.5	14.5				
0/_						
Property Medium-Light						
Voids in total mix (%)	3-7	3-5				
Stiffness (kg/mm)	500 (Min)	400 (Min)				
* Loss of stability (%)	25(Max)	25(Max)				
Asphalt Content (% in	4.5-6	5-7				
weight)						

Table 14-4: Job Mix Requirements to Bituminous Courses

This test to be carried out in accordance with AASHTO T 165-82.

After the Job Mix Formula has been established and approved, all subsequent mixes shall conform to it within the allowable tolerances.

## 4.4.4 Equipment

Plant and equipment for mixing, hauling, placing and compacting bituminous binder course and wearing course materials, shall conform to the relevant requirements of section "Bituminous Course".

## 4.4.5 Surface Preparation:

Preparation of surface upon which bituminous binder course and the bituminous wearing course mixes are to be laid, and the use of prime coat, shall be appropriate to type and condition of such surface and shall conform with the relevant requirements of section "Bituminous Courses".

## 4.4.6 Delivery, Spreading and Finishing

#### 4.4.6.1 General

The delivery, spreading and finishing of bituminous mixes for binder and wearing courses shall conform with the relevant requirements of Section "Bituminous Course" and to the following particular requirements.

## 4.4.6.2 Rollers

1. Initial breakdown rolling shall be carried out by use of 2 dual-drum steel-wheeled rollers each of minimum weight 7,000 kg. These rollers shall be purpose made for compaction of hot bituminous courses.

2. Intermediate rolling shall be carried out by of at least 2 self-propelled, tandem pneumatic smoothtired rollers each capable of exerting contact pressures of up to 690 kN/sq.m (100 psi) and ballastadjustable to ensure uniform wheel loadings.

3. Final rolling shall be carried out by use 2, 2-axle tandem, steel-tired rollers each of minimum weight 10.000 kg, capable of exerting contract pressures of up to 65 kg/cm (350 lb/in.)

## 4.4.6.3 Standard of Compaction

The compacted density of the bituminous wearing course shall be not less than 98% of the average Marshall Bulk density for each day's production.

## 4.4.7 Sampling and Testing

Sampling and testing shall conform to the relevant requirements of Section "Bituminous Course". **4.4.8 Surface Tolerances** 

1. Surface tolerances shall conform with the relevant requirements of Section "Bituminous Course", and to the following particular requirements.

2. The tolerances on elevations of the final bituminous wearing course surface shall not be greater than 10 mms.

3. When the finished wearing course surface is tested with a 3 m long straightedge, placed parallel to, or at right angles to the centerline, the maximum deviation of the surface from the testing edge between any 2 contact points shall not exceed 5.0 mm.

## **4.4.9 Determination of Thickness**

1. Procedures for determining the average compacted thickness of bituminous binder and wearing course shall conform with the relevant requirements of Section "Bituminous Courses" and the following particular requirements.

2. Cores for thickness measurements of binder course shall be used to determine if changes are necessary in the constructed thickness of the wearing course to rectify and thickness deficiencies in the binder course.

## 4.4.10 Measurement

1. Bituminous binder course and bituminous wearing course shall be measured by sq.m. of mix finished, spread, compacted, completed and accepted; measurements shall be of the areas and thickness as shown on the drawings.

2. Deficiencies in thickness of wearing course shall, unless an overlay is constructed at contractor's expense, result in proportion only of the wearing course area being measured for payment. Proportions shall be determined in accordance with the thickness deficiencies and area proportions mentioned in section "Bituminous Course".

3. All other items shall not be measured for direct payment and their cost shall be included in bituminous binder course and bituminous wearing course price.

## 4.5 Pavement markings for traffic

## 4.5.1 Scope

1. These Works shall consist of the furnishing and application, of the traffic markings and to highway pavements for the guidance, control and safety of vehicular and pedestrian traffic.

2. White (Class A) and yellow (Class B) painted markings shall include centerlines, lane lines, border (edge) lines, pedestrian crossing lines, stop lines, directional arrows, lettering and symbols using the following materials as appropriate and as on the Drawings.

## 4.5.2 Paint and thermoplastic materials

## Reflective Paint (RP)

1. RP shall consist of a mixture of binder, white or yellow pigment and filler specifically compounded for cold application and adhesion to finished paved areas. Paint shall be reflective by adding reflective spheres before adhesion the film dries or sets.

2. White and yellow RP shall conform to AASHTO M248 Type III. The surface application glass spheres shall conform to AASHTO M247, Type I.

## 4.5.3 Application

## 4.5.3.1 Equipment for Pavement Marking

1. The equipment used for pavement marking shall consist of approved types of truck-mounted units, or motorized equipment, or manually operated equipment, depending on the type of marking required. The truck-mounted or motorized unit for centerlines, lines, and edge lines shall consist of a mobile, self-contained unit carrying its own material and capable of operating at a maximum speed of 10 km/h while applying paint. The hand applicator equipment shall be sufficiently maneuverable to install centerlines, lane lines; edge lines gore striping, run lines, crosswalks, stop lines, arrows, and legends

2. Spraying equipment shall be capable of satisfactorily applying the paint under pressure with a uniformity of feed through nozzles spraying directly on the pavement. Each paint tank shall be equipped with cut-off valves which will enable broken (skip) lines to be sprayed automatically. Each nozzle shall have a mechanical bed dispenser that will operate simultaneously with the spray muzzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides and shall provide a method for cleaning the surface of dust just prior to paint application.

3. The spray machine for application of reflective paint lines and other markings shall have an attachment to accurately regulate the rate of application and a tachometer or other approved device to ensure uniform paint application at the designated rate. It shall be adjustable to enable the painting of 1 or 2 adjacent lines simultaneously along the centerline. The paint shall be properly agitated while in operation.

4. An automatic glass sphere dispenser with synchronized automatic cut-off shall be attached to the applicator machine. The dispenser shall utilize pressure type spray guns which will embed the spheres into the surface to at least 0.5 times the sphere diameter. The dispenser shall also be equipped with an automatic cut-off synchronized with the cut-off of the thermoplastic material.

5. Hand equipment shall be used only for painted markings, including arrows, crosswalks, stop lines, symbols and legends, and it shall hold a minimum of 25kg and not more than 100kg of molten material unless otherwise agreed between the Engineer and the supplier.

#### 4.5.3.2 Setting Out and Pavement Preparation

1. The Contractor shall set out all control points necessary for locating paint lines and markings. On irregular widths of roads, the locations of boarder (edge) lines shall be adjusted so as to fall continuously on the pavement.

The locations of all painted markings shall be accurately established and shall be subject to approval before application commences. Markers shall not be located over longitudinal or transverse pavement joints.

2 The area of road surface on which marking is to take place shall be free of dirt, grease, oil, moisture, lose or unsound layers, and any other material which could adversely affect the bond. The areas shall be thoroughly cleaned to the satisfaction of the Engineer before proceeding with painting. 3. Pavement marking shall not proceed when there is moisture on the pavement surface or the air is misty; or the surface temperature of the pavement is below 10 degrees C; or when wind or other conditions may cause a film of dust to be deposited on the surface, or in other conditions that, in the opinion of the Engineer, could displace, damage, or adversely affect the bonding of the material to the pavement surface. Any markings damaged due to water or rain within 20 minutes after application, shall be removed and replaced at the Contractor's expense.

## 4.5.3.3 Painting and Adhesive Film Application

1. The use of Class A (white) paint or Class B (yellow) paint and the type of paint material shall be in accordance with the design standards and as shown on the drawings.

2. Application of the various categories of point to the pavement surface shall be carried out in accordance with the equipment manufacturer's recommendations and as shown on the drawings and directed by the engineer.

3. Painting applications may include centerlines, border (edge) lines, 'no passing' lines, intersection markings chevron striping (in gross areas), pedestrian crossings, letters, arrow, symbols and other special purpose pavement markings.

4. Preformed reflective thermoplastic film shall be utilized only where specified for markings such as intersection markings, lettering, arrows, symbols and other special purpose markings. Application shall be in accordance with the manufacturer's recommendations and shall be carried out in the presence of the Engineer.

#### 4.5.3.4 Reflective Paint (RP) Application

1. Traffic paint shall be thoroughly mixed in the shipping container before placing in the machine tank. The paint machine tanks, connections, and spray nozzles shall be thoroughly cleaned each day with thinner before starting any spraying.

2. The minimum wet film thickness for all painted areas shall be 0.4 mm.

The minimum rate of application for 100 mm width paint lines shall be as follows:

a- Continuous (solid) paint lines: 40 ltr/km for smooth surfaces and 50 ltr/km for rough surfaces.

b-Broken (skip) paint lines: 14 ltr/km for smooth surfaces and 17.5ltr/km for rough surfaces (assuming gap length is double the length of paint line).

Rates shall be modified proportionately for other widths of traffic lines.

The measured application rate shall not vary from the approved rate by more than 5% in any 1/km. At any point where a check indicates a variation in exceeds of 5% painting shall be stopped and the equipment adjusted or replaced. Identifiable areas of deficiency shall be corrected as directed.
 Immediately following the application of paint, a uniform application of glass beads shall be applied at the rate of 0.6-0.7 kg/ltr of paint.

#### 4.5.3.5 Protection of Markings

1. Immediately following the application of paint lines and other markings on pavement open to traffic, traffic cones and other devices shall be placed alongside or over the paint at intervals not exceeding 10 m and shall remain on place until the paint has dried.

2. Traffic shall be prevented from crossing wet paint lines and the Contractor shall use sufficient numbers of flagmen, barricades, or other protection, particularly at crossings to prevent traffic from

crossing wet paint. Section of paint which have been damaged by traffic before the paint has cured, shall be repaired and pavement outside the painted area cleaned at the contractor's expense.

## 4.5.4 Sampling and Testing

1. All material shall be shipped to the job site in undamaged, sealed, original packaging clearly identifying each material as to name, color, manufacturer, batch number, and date of manufacture. All material shall be accompanied by certified test results verifying compliance with all specified physical and chemical requirements.

2. All paint products and other materials designated by the engineer shall be sampled for testing. Sampling shall be performed by the contractor in the presence of the engineer.

Materials shall be sampled in their original containers. All samples shall be packaged for shipment as approved by the engineer. Samples shall be transported to the mobile field laboratory or to an approved independent laboratory, as directed by the engineer. Paint materials shall not be used until approved by GEDCo.

## 4.5.5 Measurement

Painted pavement lines and painted pavement markings shall be deemed to be included in the price of the painted surfaces.

## 4.6 Concrete curbs and sidewalks

## 4.6.1 Scope

This work shall consist of furnishing and constructing concrete curbs and concrete paving to sidewalks as and where shown in the Drawings.

## 4.6.2 Materials and Precast Manufacture

## 4.6.2.1 Concrete

Portland cement concrete shall be class B 300 for all in situ and precast concrete unless otherwise indicated.

#### 4.6.2.2 Mortar

Mortar shall consist of cement and fine aggregate having the same proportions used in the concrete construction.

#### 4.6.2.3 Precast Concrete Units

1. All precast units shall be manufactured to the dimension shown on the drawings. Manufacturing tolerances shall be 3mm in any one dimension. End and edge faces shall be perpendicular to the base.

For horizontal curves of radius less than 10m, curb units shall be manufactured to the radius shown and in such circumstances where straight elements or portions of straight elements shall not be used.
 Precast units shall be cast upside down in approved steel molds under conditions of controlled temperature and humidity. The engineer's approval of the samples will not be considered final and the engineer may reject any precast units delivered to the site which do not meet the required standards.

#### 4.6.3 Precast Concrete Curbs

1. The sub-grade shall be excavated to the dimensions as shown in the drawings, and the surface of sub-grade shall be leveled and compacted to at least 95% AASHTO T180 maximum density.

2. The Base Coarse under the curb is to be placed to the required level and compacted and tested according to the base course specifications.

3. Forms for the concrete base shall be approved wood or steel. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, lines and grade required. Forms shall be cleaned and oiled before each use.

4. Concrete shall be placed, compacted and shaped to the sections shown on the drawings taking in account expansion joints. Concrete shall be compacted with an approved internal type vibrator or if approved, by hand spudding and tamping.

Edges shall be rounded if necessary by the use of wood molding or by the use of an edger as applicable. The concrete base shall be finished to a true and even surface with a wood float. Concrete shall be membrane or water cured for at least 7 days before precast units are placed thereon.

5. Precast units from approved factory shall be set accurately in position in mortar on the concrete base. Joints pattern precast units shall not be mortared unless otherwise shown on the drawings. Units shall be closely spaced and every 10 m run shall be provided with an expansion joint.

6. Where curbs or gutters are installed on existing concrete pavement and using epoxy resin adhesive, the installation procedures shall conform to those specified for raised pavement markers in Section "Pavement Markings for Traffic".

7. After curbs have been installed, forms shall be erected and concrete backing, shall be placed as shown on the drawings.

Pavement courses shall not be laid against curbs until the concrete backing has membrane or water cured for at least 14 days.

8. The tolerances on alignment of completed precast shall be as specified for in situ concrete construction.

3. The area adjacent to completed and accepted curbs shall be backfilled with approved material to the top edges of the curbs to 95 % AASHTO T180 maximum density.

10. The curb to be painted by white, red, and black colors according to traffic requirement, the paint must be after cleaning the curb, with one prime coat and two faces colored approved road paints. 11. Test: 5 curbs must be tested for every 1000 curbs

# Technical Specifications For Distribution Materials And Equipments

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## **1 GENERAL SPECIFICATIONS**

## 1.1 Completeness of Contract

- 1.1.1 All apparatus, accessories or fittings which may not have been specifically mentioned, but which are usual or necessary in the respective equipment for the completeness of the finished work in an operable status, shall be deemed to be included in the Contract and shall be provided by the Contractor without any extra charge. All equipment shall be complete in all details, whether or not such details are mentioned in the Specifications. This includes fixation details and connection clamps and/or terminals.
- 1.1.2 Any reference in the quantity and price schedules, the delivery period schedule or in the various clauses and schedules of the text of either the Specification or the Bid, to any equipment shall imply that the equipment is complete with all accessories, apparatus and fittings as outlined in sub-clause 1.1.1 above.
- 1.1.3 The Bidder shall be responsible for ensuring that the equipment supplied is fit for the purpose intended. Available information on the characteristics of the system to which the works will be connected and associated will be supplied on request to the Bidder who shall be responsible for obtaining and determining all applicable knowledge relevant to the works.

## **1.2 Drawings and Documentation**

The Contractor shall prepare and submit to the Engineer/GEDCO for approval dimensioned general and detailed design drawings and other pertinent information of all the Equipment specified in the Specifications.

The Contractor shall supply detailed instructions for erection, operation and maintenance of all equipment and components in English and preferably Arabic language.

In the event of any difference between the drawings and the Specifications, the latter shall prevail.

Approval of drawings shall not relieve the Contractor of his obligations to supply the Plant in accordance with the Specifications. In the event of any difference between scaled dimensions and figures on the drawings, the figures shall prevail All text on drawings provided by the Contractor shall be in the English language in addition, if necessary, to that of the country of origin. All drawings shall be dimensioned in millimeters.

#### **1.3** Time of Delivery and Completion

The guaranteed delivery times shall be stated in the appropriate schedule in this document.

## 1.4 Quality of Materials

All materials supplied under this Contract shall be new and of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion or deterioration in the setting up of undue stresses in any parts and also without affecting the suitability of the various parts of the Works for which they were designed. No toxic material (such as Halon, PCB, and Asbestos) shall be utilized.

## 1.5 Contractor's Quality Assurance Procedures

The Bidder shall have established a quality assurance system based on ISO 9001 or 9002. The Contractor shall include a documentation of the system with a list of current procedures, an organigram of the quality organization and the name of the quality manager. He shall also submit a list of quality revisions performed the last twelve months with a list of closed and unclosed findings as well planned revisions the coming twelve months.

The Contractor shall submit for approval a program of quality control and inspection procedures to assure that the product during manufacture and on completion complies with the specified requirements. The program shall relate the quality control and inspection activities to the production cycle. In support of the quality control and inspection program the Contractor shall provide details of quality control and inspection procedures available for use in the execution of the Contract. The Contractor shall retain responsibility for quality control and inspection activities made by his sub-contractors and shall indicate on the program, which items are to be sub-contracted.

#### **1.6 Guarantees and Particulars**

The Works shall comply with the technical guarantee data stated in the Bid. The Contractor shall be responsible for any discrepancies, errors and omissions in the particulars and guarantees, whether the Engineer/GEDCO has approved such particulars and guarantees or not.

#### **1.7** Places of Manufacture and Sub-Contractors

The manufacturer's identity and places of manufacture, testing and inspection before shipment for the various portions of the Contract Works shall be specified in the Technical Schedules and shall not be departed from without the agreement of the Engineer/GEDCO.

All Sub-contractors and Sub-suppliers of components and materials shall be subject to the approval of the Engineer/GEDCO. Information shall be given on each Sub-order sufficient to identify the material or equipment, to which the sub-order relates, stating that the material is subject to inspection by the Engineer/GEDCO before dispatch.

All equipment offered shall be the product of recognized and experienced manufacturers and shall be proven equipment of the same basic design and size similar to that which has been in successful continuous operation for at least three years preferably under similar climatic conditions. Proven plant reliability and high availability are of prime importance and the attention of the Bidder is drawn to these particular requirements.

## **1.8** Inspection and Testing

All materials used in the Contract Works may be to inspection by the Engineer/GEDCO and it is the Contractor's responsibility to advise the Engineer/GEDCO when equipment and materials are available for inspection, at least 1 month in advance.

Factory tests on equipment shall be made according to the applicable IEC Standards, or as specifically specified or according to standards approved by the Engineer/GEDCO.

Routine tests shall be made on each unit of all equipment.

Type tests shall be made on one unit of each type of different equipment. Instead of carrying out the type tests the Contractor may submit suitable certificates of tests made on equipment of the same type; however, the Employer reserves the right of accepting these certificates or to reject them partially or totally.

The Engineer/GEDCO shall be at liberty to demand any additional testing at the manufacturer's works, at site or elsewhere in order to verify that the equipment complies with the conditions of the Specifications.

A test program shall be submitted to the Engineer/GEDCO for approval at least 1 month ahead of the commencement of testing.

Measuring apparatus shall be approved by the Engineer/GEDCO and if required shall be calibrated at the expense of the Contractor at an approved laboratory.

## **1.9 Packing, Transportation and Storage**

Packing shall give adequate protection to the enclosed materials against mechanical damage during transport to its final destination, including rough handling during sea, rail and road transport and transition from one mode of transport to another.

Packing should be stout close-boarded wooden cases of adequate thickness, suitably braced and banded and lined internally with water-resistant material or equally solid enclosures.

Steelworks sections and similar items may be bundled provided that the ends are adequately protected and the enclosing bands or wires are robust.

Indoor electrical equipment must be enclosed in welded polythene envelopes inside packing cases and the envelopes shall be evacuated or have a desiccant inside.

All items in cases or crates shall be secured so that they are not free to move and cannot work loose in transport. If rotating parts are shipped within their bearings or mountings, they must be adequately braced and restrained to prevent relative movement. Loose items shall be placed in bags in a case, each bag having stitched onto it a label indicating the number and nature of its contents. Where a filler material is used in a case to restrict movement or provide additional protection, it must be inorganic and non-hygroscopic.

All surfaces liable to corrosion shall be thoroughly cleaned and special steps adapted to the nature of the materials and the time interval between packing and unpacking shall be taken to prevent corrosion. These steps may constitute the greasing on surfaces, the application of a protective coat, enclosure of the items in a hermetically sealed container, the addition of vapour phase inhibitor paper to the package or other approved means.

Steps shall be taken to ensure that moisture, moulds, insects or rodents cannot damage insulated materials. Items that include materials liable to be damaged by moisture shall be packed in hermetically sealed containers in which silica gel, or some other approved desiccant has been inserted.

Cases shall be marked with large lettering to show which side of the case is to be up, and if the contents are fragile, marked "FRAGILE" in large letters with the international wineglass symbol. Packages shall be marked with their place of destination in such a way that rough handling or the effect of weather cannot remove or obliterate the marking. Each item shall be marked with its gross weight and, for all lifts over two tonnes, marks on the cases shall show the correct positions for the slings.

Special steps shall be taken to guard against theft during transport. No small items such as padlocks nameplates and so forth that could be torn off or unscrewed shall be accessible.

Cases, crates, barrels and drums shall be banded in such a manner as to obstruct the theft of any of the timber used for packaging and the bands shall be so secured that they are not rendered ineffective by shrinkage of the wood.

A descriptive and fully itemised list shall be prepared of the contents of each packing case. A copy of this list shall be placed in a waterproof envelope under a metal or other suitable plate securely fastened to the outside of one end of the case, and its position indicated by stencilling on the case. Where appropriate, drawings showing the erection markings of the items concerned shall be placed inside the case.

All stencilled markings on cases and crates, or other markings on descriptive metal tabs fixed to cable drums, bundles of structural steelworks and so forth, shall be applied in two places with a material which cannot wash off and shall be additional to any erection or other marks or impressions which may be specified elsewhere.

Shipping marks are to be stencilled in oil based paint in block letters and symbols. When unobstructed flat smooth surfaces of sufficient size are not available on the case for the shipping marks they are to be stencilled on marine-ply notice boards of adequate size and of at least 6 mm thickness securely fastened to the packing case.

All packing cases, though not steel containers, shall remain the property of the Employer.

#### **1.10 Tools**

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

# 1.11 Spare Parts

Particulars of spare parts, which may or not from part of the contract at the Purchaser's discretion, shall be agreed. Bidders giving their recommendations should complete the relevant Schedules and prices for spares that they believe should be Purchased by Purchaser

## 2 GENERAL TECHNICAL SPECIFICATION

#### 2.1 General

This Chapter contains a general technical specification of electrical distribution equipment and may cover equipment not to be procured under this contract. For details about each type of equipment to be procured reference is made to Section 3-8 -Particular Technical Specifications.

The design shall incorporate every reasonable precaution and provision for the safety of the general public as well as for all those engaged in the operation and maintenance of the Contract Equipment and of associated works supplied under other Contracts.

## 2.2 Drawings

The Bidder shall in his Bid enclose overall drawings showing dimensions, main working principles, internal components and fixing methods to a detail level allowing the Employer to evaluate the functionality and completeness of the equipment.

#### 2.3 Standards

Ratings, characteristics, tests and test procedures, etc. for the electrical equipment encompassed by this specification shall comply with the relevant provisions and requirements of the Recommendations of the International Electrotechnical Commission (IEC), unless otherwise expressly stated in Particular Technical Specifications. This applies even where the specific standards are not referred to in the Particular Specifications. Where the IEC Recommendations do not fully cover all provisions and requirements for the design, construction, testing, etc. and for equipment and components that are not covered by IEC Recommendations, recognized national standards shall be applied. The rules of CEE (International Commission for the approval of electrical equipment) and the standards of CENELEC (Comite Europeen de Normalisation Elecrotechnique) may also be applied.

The latest revision or edition in effect at the time of Bid Invitation shall apply. Where references are given to numbers in the old numbering system from IEC it shall be taken as to be the equivalent number in the new five digit number series.

The Precise Standard, complete with identification number, to which the

various equipment and materials are manufactured shall be specifically stated by the Bidder.

In case of conflict or disagreement between the particulars of the Standard adopted by the Bidder and the particulars of this Specification, this Specification shall prevail over the Standard. All conflicts or disagreements, mentioned above, must be clearly stated, failing which the materials and equipment offered shall be deemed to comply in every respect with this Specification both in manufacture and in performance, and compliance thereof be insisted upon without additional cost to the Employer.

## 2.4 Units

The SI-system (meter, Newton, second) shall be used throughout the works covered by this Specification.

#### 2.5 Definitions

Whenever the following terms or words are found in the specifications and/or other documents, they shall have the following meaning:

#### "High Voltage Equipment" (HV):

Mostly used for equipment provided for a maximum operating voltage higher than 36 kV (generically also used for voltages down to 1000 V).

#### "Medium Voltage Equipment" (MV):

Equipment provided for a maximum operating voltage higher than 1000 V and up to 36 kV.

#### "Low Voltage Equipment" (LV):

Equipment provided for operation at 1000 V or below. (For transformers the term Low Voltage Winding is used for the side with lowest rated voltage regardless of value, . IEC 60076)

Reference to degree of protection (IP) is according to the classification in IEC 60529

## 2.6 System Characteristics

The basic characteristics of the electrical systems and equipment shall be as follows (not all voltages are applicable to this contract):

#### MV Equipment 33 kV

Maximum operating voltage 36 kV, 3-phase, 50 Hz, delta connected system with neutral solidly earthed via zigzag-star connected Earthing transformer.

<u>MV Equipment 22 kV</u> Maximum operating voltage 24 kV, 3-phase, 50 Hz, delta connected system with neutral solidly earthed via zigzag-star connected Earthing transformer.

<u>MV Equipment 11 kV (also to be used for 6.6 kV net)</u> Maximum operating voltage 12 kV, 3-phase, 50 Hz, neutral solidly earthed.

<u>MV Equipment 6.6 kV</u> Maximum operating voltage 7.2 kV, 3 phase 50 Hz, neutral solidly earthed.

<u>LV Equipment, 0.4 kV</u> Maximum operating voltage 420 V, 3-phase, 50 Hz, loaded and effectively earthed neutral TN-S system.

#### 2.7 Phase Relationship

The standard phase colours are Red (L1), Yellow (L2), Blue (L3) (RYB).

## 2.8 Design Criteria

The equipment shall be designed to withstand the design stresses given below without damage and disruption of service. All tests shall as a minimum is based on these design parameters.

Item	Description	Unit	Nomina	Nominal voltage level			
	_		33	22	11	6.6	0.4
1	Nominal system voltage phase to phase	kV	33	22	11	6.6	0.4
2	Highest system voltage phase - phase	kV	36	24	12	7.2	0.42
3	System Frequency	Hz	50	50	50	50	50
4	System earth(see above)		Solid	solid	Solid	Solid	Solid
	Minimum Design Short circuit Current (1 sec. arch test) <sup>2)</sup>	kA	25	25	25	25	25
5	Impulse withstand voltage $(1.2/50 \ \mu \ sec wave)^{3}$	kV peak	170	125	75	75	12

6	Power frequency withstand voltage (1 min.) <sup>3)</sup>	kV	70	50	28	28	2.5
	Min creepage distance over outdoor insulators (Pollution class 3- severe, IEC 60815/85 - 2.5cm/kV)	cm	90	60	31	31	7.5

<u>Note 1)</u> Ref. IEC 60038

#### <u>Note 2)</u>

For all current carrying parts the permissible short circuit duration shall be at least 1 second. Indoor equipment shall be arc tested in accordance with IEC 60298 amendment 2. The dynamic or momentary short circuit current on which the equipment design shall be based shall be computed by multiplying the r.m.s. value of the symmetrical short circuit current by the factor 1.8 x  $\sqrt{2}$ .

<u>Note 3)</u> Ref. IEC 60071

## 2.9 Ambient Temperatures, Relative Humidity, Wind Pressure

Unless otherwise specifically stated in Particular Technical Specification, any equipment, component and assembly shall be designed for the following service conditions:

Description	Unit	Value
1 Altitude of site above sea level	m	- 400 to + 900
2 Ambient Temps:- Maximum / Minimum	°C	45 / - 5
3 Wind Speed	m/s	15
4 Isokeraunic Level		15
5 Pollution Type		Dust
6 Relative Humidity Maximum/ Minimum	%	100 / 10
7 Rainfall Average annual	mm	600

8 Hail	Yes
9 Fog	Yes
10 Sand Storms	Occasional

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

The Contractor shall guarantee these reduced temperature rises.

## 2.10 Power Cables

The following assumed values	of soil thermal	Resistivity, soil and air		
temperatures are for Tender evaluation purposes only.				
Maximum ground temperature	°C	30		
Soil thermal Resistivity	°C m/W	1.8		
Max. ambient shade temperature	°C	30-40		

The underground cables shall be designed to withstand a short circuit current of 30 kA for 1 sec.

## 2.11 Technical Data Schedules

## 2.11.1 Preamble

- 1.1 All the Technical Schedules shall be filled in and completed by the Tenderer, and submitted with the Tender.
- 1.2 All documentation necessary to evaluate whether the equipment offered is in accordance with this Specification shall be submitted with the Tender.
- 1.3 All data entered in the Schedules of Technical Data are to be regarded as values guaranteed by the Tenderer and shall not be deviated from unless approval to do so is obtained from the Engineer.
- 1.4 All data entered in the Schedules of Informative Data are also to be regarded as values guaranteed by the Tenderer. These data may only be deviated from if approval to do so is obtained from the Engineer.
- 1.5 Necessary copies of the schedules format shall be used if necessary to provide space to submit data on all the equipment offered.
- 1.6 Equipment or Systems offered which are not in accordance with the Specification shall be listed and described in Schedule 'B' Deviations from Specifications. If there are no deviations, this shall also be stated in Schedule 'B'.

# 2.11.2 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 m	nean 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
I <sub>N</sub>	shall mean rated (nominal) current
U <sub>N</sub>	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 m	nean minimum
(prefix)	shall mean micro
rms	shall mean root mean square
p.u.	shall mean per unit
p/p	shall mean peak to peak
Т	shall mean Tesla
kg	shall mean kilogram
N	shall mean Newton
s or sec.	shall mean second
No.	shall mean number
dB	shall mean decibel
Amp	shall mean amperes
F	shall mean Farad
°С	shall mean centigrade
K <sub>2</sub>	shall mean degree Kelvin
m <sup>2</sup> <sub>3</sub>	shall mean square metre $(mm^2 \text{ for millimetre, etc})$
m	shall mean cubic metre (mm <sup>3</sup> for millimetre, etc)
m <sup>3</sup> /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
% D	shall mean percentage
Pascal	l N/m <sup>2</sup>
cst	shall mean centistoke

# 2.11.3 Schedule 'A' - National Standards for Equipment not Complying with IEC Standard Recommendations

<u>Equipment</u>	National Standard	English Title

Tenderer's Signature:\_\_\_\_\_ Date:\_\_\_\_\_

## 2.11.4 Schedule "B" - Deviations From The Requirements Of The Specification

It will be assumed that the equipment offered will conform to the Specification in all respects, unless departures are mentioned in this Schedule.

No	Description of deviation	Advantage or result of deviation

Tenderer's Signature:\_\_\_\_\_ Date:\_\_\_\_\_

## 2.11.5 Schedule 'C' - Price Schedules

## Preamble

The Price Schedules shall be read in conjunction with the Instructions to Tenderers, General and Special Conditions of Contract and the Technical Specifications.

The rates and prices tendered in the Price Schedules shall, except insofar as it is otherwise provided under the Contract, include all materials, insurance, profit, together with all general risks, liabilities and obligations set out or implied in the contract.

A price shall be entered against each item in the Price Schedules, whether quantities are stated or not. The cost of Items against which the Supplier has failed to enter a rate or price shall be deemed to be covered by the Contract Price.

The whole cost of complying with the provisions of the Contract shall be included in the Items provided, the Price Schedules, and where no Items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items.

In the Price Summary, Total Amount of Tender, the provisional sums of 5% shall be added to cater for any additional equipment that may be required.

Tenderer's Signature:	Date:
<i>u</i>	
## **3** PARTICULAR TECHNICAL SPECIFICATIONS FOR CABLES

## 3.1 Low Voltage Cables

#### 3.1.1 General

All low voltage cables shall be in compliance with relevant IEC-Standards. The low voltage cables for the 400/230 V voltage level are to consist, according to requirements, of single, two, three and four-core low voltage power cables.

The standard phase colors shall be Red (L1), Yellow (L2), Blue (L3) (RYB), unless otherwise specified by IEC 60173. The IEC Standard will be mandatory with regards to cable colors.

The neutral of the 400/230 V system is solidly earthed (TT-S system).

All cables accessories and materials shall be in accordance with the latest editions (including all amendments) of CENELEC HD 620 IEC and ISO recommendations.

The manufacturer shall have established a quality control system based on regularly accelerated test of production samples according to CENELEC HD620. This system shall be described in the Bid.

## 3.1.2 Conductors

All conductors shall be stranded copper or aluminium as specified in the schedules. The conductor shall be clean, uniform in size, shape and quality, smooth and free from scale, spills, splits, sharp edges and other harmful defects.

They shall be circular, shaped, stranded, as required, to suit the cable specification and shall comply with the requirements of IEC 60228 where applicable.

Where joints are permitted in individual wires, formed into a conductor, they shall be made in the manner prescribed in the appropriate standard and the frequency shall conform to the limiting dimensions stated therein. No joints shall be made in the conductor after it has been formed.

#### 3.1.3 Insulation

Power cables shall be XLPE insulated except if specified otherwise. Only dry processes shall be used in vulcanizing and cross linking of the XLPEinsulation, special precautions shall be taken to avoid ingress and spreading of moisture and development of water- treeing. The Bidder shall document the construction measures used to achieve these requirements. The Supplier can propose an alternative treatment to prevent the possibility for treeing.

## 3.1.4 Laying up and fillers

The cores of all twin and multicore cables shall be laid-up together with suitable fillers, wormed circular and binding tapes applied overall. The fillers for XLPE cables shall be non-hygroscopic. The direction of lay of the cores shall be right- hand for all twin and multicore power cables. The term "right-hand" has the same meaning as for screw threads. All cables shall be circular.

## 3.1.5 Identification

The manufacturer's identification shall be provided on outer sheath throughout the length of the cables by means of a tape under the sheath printed with the manufacturer's name. Alternatively the manufacturer's identification may be embossed on the outer PVC sheath together with the identification and voltage markings. The cables shall be marked for each meter.

## 3.1.6 Testing

Notwithstanding that cables are manufactured to an approved National Standard, all cables accessories and materials shall be subjected to and withstand satisfactorily the test requirements detailed in this specification subject to any exceptions stated therein. All materials shall withstand such routine tests as are customary in the manufacture of the cables and accessories included in the Contract.

## 3.1.7 Sealing and drumming

The cable shall be wound on strong non-returnable drums arranged to take a round spindle of a section adequate to support the loaded cable drum installation and handling. The drum shall be lagged with strong closely fitting battens that shall be securely fixed to prevent any damage to the cable. Wooden drums shall be constructed of seasoned timber to prevent shrinkage of drums during shipment and subsequent storage on site. Each drum shall be clearly marked in a manner that cannot be obliterated with the particulars of the cable including voltage, length, conductor size, number of cores, type of protective covering, section number, gross and net weight, together with the direction of rolling.

The ends of cables shall be suitably sealed to prevent the ingress of moisture. The end of the cable left projecting from the drum shall at all times be securely protected against damage by mishandling during transport or storage.

Voltage	Cable Type	Maximum Length (m)
600/1000V	4-core cables	500
600/1000V	2-core cables	500
600/1000V	1-core cables	500
600/1000V	ABC Cables	1000
600/1000V	concentric cables	1000

Drum lengths of cables shall not exceed the following:

#### 3.1.8 Current Carrying Capacity and Design Parameters

The maximum continuous current carrying capacity and maximum permissible continuous conductor temperature, and the factors for determining such rating and temperature shall be based on IEC Recommendation and all conditions prevailing on Site.

## 3.2 Low voltage aerial cables

#### 3.2.1 General

The Aerial bunch cable shall be 600/1000V grade cross-link polyethylene and shall be of the types and construction stated in the schedules. All cables shall be manufactured and tested to the CENELEC HD 626. Cables shall be designed for a maximum continuous conductor temperature of 90°C and for operation on a system with the neutral solidly earthed.

The cable shall be of self supporting type where all conductors share the load; i.e. no messenger wire or reinforced neutral conductor shall be used alone for suspension of the cable.

#### 3.2.2 Conductors

The conductors shall be hard drawn stranded aluminium and shall comply with all the requirements of IEC 60228.

#### 3.2.3 Insulation

The materials used in the manufacture shall be black weather-resistant crosslinked polyethylene with a high resistance to ultra violet radiation. The insulation shall fit closely on but shall not adhere to the conductors.

#### **3.2.4** Cable identification

Identification of individual cores of the cable shall be by longitudinal ridges on the insulation and shall be provided throughout the length of all cables.

## 3.2.5 Testing

All cables, accessories and materials shall be subjected to and satisfactorily withstand the test requirements specified herein. All materials shall withstand such routine tests as are customary in the manufacture of the cables and accessories included in the contract.

## 3.2.6 Sealing and drumming

The cable shall be wound onto a strong non-returnable drum with enclosed flanges and barrel arranged to take a round spindle of a section adequate to support the loaded cable drum during installation and handling. The drum shall be lagged with strong closely fitting battens which shall be securely fixed to prevent damage to the cable. Wooden drums shall be constructed of seasoned timber to prevent shrinkage of drums during shipment and subsequent storage on site. Each drum shall be clearly marked in a manner that cannot be obliterated with the particulars of cable, including voltage, length, conductor size, number of cores gross and net weights, together with direction for rolling.

The ends of the cables shall be sealed by enclosing them in approved caps, tight fitting and adequately secured to prevent the ingress of moisture The ends of the cable left projecting from the drum shall at all times be securely protected against damage.

## 3.2.7 Single-phase split concentric cable

Single phase, split concentric, Cu conductor, for households and street lighting services, incorporates separate neutral wire, suitable for overhead installation.

## **3.3** Medium Voltage Cable

## **3.3.1** The conductor shall be covered with:

- Conductors as specified in 3.3.2 to be with swelling powder to prevent axial ingress of water along the conductor
- An extruded semi-conducting layer
- A layer of dry vulcanised cross-linked polyethylene (XLPE) insulation
- An extruded vulcanised semi-conducting layer
- A layer of swelling tape to prevent axial ingress of water along the screen
- A layer of earthing screen of stranded copper with copper tape.
- Water blocking tape.
- A black outer LDPE (Low Density polyethylene) sheath, or P.V.C.

## 3.3.2 Conductors

All conductors shall be stranded copper or aluminium as specified in the Schedules. The conductor shall be clean, uniform in size, shape and quality, smooth and free from scale, spills, splits, sharp edges and other harmful defects.

They shall be circular, shaped, stranded, bunched and multiple stranded, as required, to suit the cable specification and shall comply with the requirements of IEC 60228 where applicable.

Where joints are permitted in individual wires, formed into a conductor, they shall be made in the manner prescribed in the appropriate standard and the frequency shall conform to the limiting dimensions stated therein. No joints shall be made in the conductor after it has been formed.

## 3.3.3 Conductor Screening

Conductor screening shall be employed at rated voltages above 1.8/3.0 kV for cables insulated with XLPE, and shall consist of a layer of extruded semiconducting material having a smooth even surface in intimate contact with the cable insulation and the conductor, but easily strippable from the conductor surface.

## 3.3.4 Insulation

Power cables shall be insulated with one of the following materials EXCEPT where the type of cable is definitely specified in detail in the Schedules:-

• Cross-linked polyethylene (XLPE) for 22kV cables.

Only dry processes shall be used in vulcanising and cross linking of the XLPE-insulation. Special precautions shall be taken to avoid ingress and spreading of moisture and development of water-treeing. The Bidder shall documents the construction measures used to achieve these requirements. The Supplier can purpose an alternative treatment to prevent the possibility for treeing.

## 3.3.5 Core Screening

Core screening shall be employed at rated voltages above 1.8/3.0 kV for cable insulated with XLPE, and shall consist of a layer of semi-conducting material having a smooth even surface in intimate contact with the cable insulation and a concentric screen of copper wires and tape applied overall. Full details of the method used for stripping the screen shall be provided with the Tender.

#### **3.3.6** Identification of Cores

The cores of all twin, three and four core power cables shall be identified by numbers or colours in accordance with IEC standard or approved National Standard.

## 3.3.7 Laying-up and Fillers

The cores of all twin and multicore cables shall be laid-up together with suitable fillers, wormed circular and binding tapes applied overall.

The fillers for XLPE cables shall be non-hygroscopic. The direction of lay of the cores shall be right-hand for all twin and multicore power cables. The term "right-hand" has the same meaning as for screw threads. All cables shall be circular.

#### 3.3.8 Manufacturer's Identification

The manufacturer's identification shall be provided on outer sheath throughout the length of the cables and the name of GEDCO by means of a tape under the sheath printed with the manufacturer's name. Alternatively the manufacturer's identification may be embossed on the outer PVC sheath together with identification and voltage markings. The cables shall be marked for each meter.

### 3.3.9 Testing

Notwithstanding that cables are manufactured to an approved National Standard all cables, accessories and materials shall be subjected to and withstand satisfactorily the test requirements detailed in this specification subject to any exceptions stated therein. All materials shall withstand such routine tests as are customary in the manufacture of the cables and accessories included in the Contract.

## 3.3.10 Sealing and Drumming

The cable shall be wound on strong non-returnable drums arranged to take a round spindle of a section adequate to support the loaded cable drum during installation and handling. The drum shall be lagged with strong closely fitting battens that shall be securely fixed to prevent damage to the cable. Wooden drums shall be constructed of seasoned timber to prevent shrinkage of drums during shipment and subsequent storage on site. Each drum shall be clearly marked in a manner which cannot be obliterated with the particulars of the cable including voltage, length, conductor size, number of cores, type of protective covering, section number, gross and net weight, together with the direction for rolling.

The ends of cables shall be suitably sealed to prevent the ingress of moisture. The end of the cable left projecting from the drum shall at all times be securely protected against damage by mishandling during transport or storage.

Drum lengths of cables shall not exceed the following:

22 kV, 1-core cables, maximum length 1000m

## 3.3.11 Current Carrying Capacity and Design Parameters

The maximum continuous current carrying capacity and maximum permissible continuous conductor temperature, and the factors for determining such rating and temperature shall be based on IEC Recommendation No. 287 and subsequent amendments and all conditions prevailing on the Site.

## 3.4 Cables And Accessories

#### 3.4.1 Cable Joints

The Tenderer shall submit with his Tender drawings showing the types of joints proposed for each of the cables included in the Contract.

The joints shall be of a watertight, pull-over heat shrink type (Raychem or similar) without moulding, free from sharp points or ridges, thoroughly clean internally and externally. The sleeves shall be of sufficient diameter and length to permit colour-to-colour jointing without undue bending, handling or deformation of the cores.

## 3.4.2 Terminations

Detailed drawings showing the types of cable sealing ends, terminal boxes and glands and overhead line terminations shall be submitted to the Engineer/GEDCO for approval.

Stress cones or other approved means shall be provided for grading the voltage stress on the core insulation of screened cables.

Terminations for all HV cables shall be of an appropriate heat shrink design incorporating a suitable arrangement of stress control, and rain-sheds for outdoor use

Termination kits shall include suitable heat shrink tubing to effectively shroud, seal and insulate the exposed cable conductor and connector, and shall include a heat shrink glove to effectively seal the crutch of the cable to prevent ingress of moisture into the interstices of the cable. Suitable arrangements shall be provided to earth the cable screen and armour (if specified).

Terminations into cable boxes shall include brass compression glands and back nuts of the correct size, which shall secure the cable outer sheath and ensure effective electrical continuity between the cable armouring wires and the metal enclosures on which the cable is terminated. At all rising terminations the cable inner sheath shall pass through the gland to terminate not less than 6 mm above the gland.

Provision shall be made for earthing all sealing end baseplates, cable boxes, glands and armour clamps.

## 3.4.3 Instructions

As soon as possible after the commencement of a contract and before materials are despatched, copies of the jointing and termination instructions applicable to the joints, sealing ends and terminations to be supplied shall be submitted in English to the Engineer/GEDCO for approval, together with details of the physical and electrical characteristics of the filling medium proposed.

## 3.4.4 Materials

Sets of jointing materials for terminating cables shall be complete with all miscellaneous jointing materials to complete the termination. One set of materials shall be sufficient for terminating one end of the cable or cables specified into one joint box. Each set of jointing materials shall be packed as one complete self-contained unit package for direct issue to a jointer at a work site.

## 3.4.5 Heat Shrink Materials

Heat shrink tubing and moulded parts shall be flexible, flame retardant, polyolefin-based material of electrical insulating quality, and shall be obtained from an approved manufacturer. They shall be suitable for use indoors or outdoors in the conditions prevailing on site.

Each part shall bear the manufacturer's mark, part number and any other necessary markings to ensure correct identification for use on the correct size and type of cable. Each set of parts shall be packed as one unit with full and complete installation instructions and clearly marked to show the application.

The material shall reduce to the predetermined size and shape when heated above 120°C. The components shall also be provided with an internal coating of hot melt adhesive compound that shall not flow or exude at temperature below 85°C. All parts and materials shall be tested to a programme of tests to be agreed with the manufacturer.

## **3.5** WORKS TESTS

## **General Requirement**

As provided in the Conditions of Contract, the whole of the materials used in the Works shall be subject to such inspection and test at the manufacturer's works as the Engineer/GEDCO may direct from time to time as the work proceeds. The cost of such inspection and tests, including the provision and use of test equipment, shall be included in the Contract.

Not less than three weeks notice of all tests shall be given to the Engineer/GEDCO in order that he may be present if he so desires. As many tests as in the opinion of the Engineer/GEDCO are possible shall be arranged together. Three copies of the Contractor's records of all tests shall be furnished to the Engineer/GEDCO.

The approval by the Engineer/GEDCO of the results of such inspection and tests shall not relieve the Contractor of his obligations under the Contract for the satisfactory performance of the plant and materials.

If, due to the Contract Works and/or component materials not complying with this specification, further tests are necessary, the Contractor shall pay all additional costs which may be incurred in re-testing.

During the execution of the Contract, test specimens, if required by the Engineer/GEDCO shall be taken from the materials for the purpose of check tests or analyses by Independent Authorities. Such specimens shall be prepared for testing and forwarded at the expense of the Contractor to the Testing Authorities selected by the Engineer/GEDCO.

The Engineer/GEDCO reserves the rights to call for further tests which are in his opinion necessary to confirm satisfactory performance. Tests shall as far as possible simulates site conditions.

The Contractor shall submit certified type test certificates for all equipment covering the type tests detailed in this section. Evidence to this effect shall be submitted at the time of bidding.

Type tests will normally only be required when certified test certificates are not available for identical equipment.

Routine tests will be required on all equipment as described in this Section. High voltage tests shall be to IEC 60060 unless otherwise indicated.

Except where otherwise indicated all electrical tests shall be carried out at rated frequency with an approximately sinusoidal waveform.

All instruments shall be approved by the Engineer/GEDCO and if required shall be calibrated at the Contractor's expense.

## **3.6** Tests For PVC Or XLPE Insulated Power Cables

## **3.6.1** Routine Tests

Routine tests shall be carried out on completed cable lengths of PVC or XLPE insulated power cables in accordance with IEC 60502 and supplements, and shall include the following:

- (a) Measurement of electrical resistance of conductors
- (b) High voltage test
- (c) Partial discharge test (XLPE insulated cables only)

## **3.6.2** Special Tests

The Contractor shall carry out the special tests detailed in IEC Recommendation No. 60502 and supplements as appropriate to the type of cable under test, and shall include the following :-

- (a) Conductor examination
- (b) Check of dimensions
- (c) Electrical test for cables of rated voltage above 3.6/6 kV
- (d) Hot set test for XLPE insulation
- (e) Tests at low temperature for PVC

#### 3.6.3 Type Tests

The Contractor shall carry out the type tests detailed in IEC Recommendation No. 502 (1978) and supplements as appropriate to the type of cable under test. These type test requirements may be waived on production of documentary proof that samples of similar cable manufactured in the same works with the equivalent or larger conductor section have passed identical or more onerous tests which have been witnessed by an approved electricity authority or their duly appointed representatives. Failure by the Contractor to provide such documentary proof in advance of cable manufacture commencing will render the Contractor liable to carry out the full type test programme in entirety.

## 3.7 Schedules

All schedules shall be filled in and submitted with the Tender. The Tenderer may copy or modify the schedules, if necessary, in order to provide sufficient space for all the equipment and relevant data.

## 3.7.1 Schedule 'A' - Time Periods To Complete Delivery

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Cables and Accessories:	

Date:\_\_\_\_\_ Signature of Tenderer:\_\_\_\_\_

## 3.7.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection

Item	Manufacturer	Place of Manufacture	Place of Inspection
<b>Cables and Accessories</b>			
24 kV XLPE single core cables			
LV Cables			
ABC cables			
Joints			
Terminations			
Other:			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

## 3.7.3 Schedule 'C1' - Technical Guarantees, Power Cables L.T (0.6/1 kV)

Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

# 3.7.4 Schedule 'C2' - Technical Guarantees, Power Cables M.V (12/20-24 kV)

Tenderer'sSignature:	Date:

## 3.7.5 Schedule 'D' - Drawings

## **3.7.5.1** Drawings to be Submitted with the Tender

24 kV, XLPE insulated cable cross-sections

LT Cables (UG-ABC Cables)

Drawings of joints and terminations

All conductors and wire cross-sections

Type test reports are to be submitted for all equipment.

## 3.7.5.2 Drawings to be Submitted for Approval after Award of Contract

24 kV, XLPE insulated cable cross-sections

LT Cables (UG-ABC Cables)

Drawings of joints and terminations

Type test reports are to be submitted for all equipment.

## 4 PARTICULAR TECHNICAL SPECIFICATIONS FOR DISTRIBUTION TRANSFORMERS

This chapter covers the particular technical requirements of the medium 22 kV voltage equipment to be procured under this contract. By conflict between the general specification and the particular specifications below the particular specifications shall prevail.

4.1 Transformers

Sealed or Breathing Liquid Immersed Power Transformer

- **4.1.1 Type:** 3-phase, two winding, liquid immersed, sealed or Breathing type rated for continuous operation under site ambient conditions at full rated power, naturally cooled (ONAN), with off load, manual, operated tap-changer, lockable in all positions on primary side.
- **4.1.2** Transformer shall comply with: IEC 76, 354 and 404-2.
- **4.1.3 Construction:** Variable volume steel tank, with corrugated wall design forming integral cooling pockets, heavy rolled and welded steel bottom and base frame and hermetically sealed bolted-on cover. Tank is to be completely filled with insulating liquid drawn in under vacuum. Tank cover is to have provision for two thermometers or temperature sensors, lugs for lifting, four lashing lugs and filler-pipe with valve. Tank is to have drain plug at bottom, earthing bolt on cover and earthing pad on base-frame, and a rating plate.
- **4.1.4** Noise Level: In general is to be less than 75 dB at 0.3m for ratings up to 1600 kVA and in accordance with IEC 551.
- 4.1.5 Windings: Copper.
- **4.1.6 Bushings:** Plug-in, tank-cover mounted, or tank-side mounted to manufacturer's standard, and as approved.
- **4.1.7** Finish: Surfaces are to be steel grit blasted, caustic washed and phosphatized, primed with waterproof primer and finished with weather-resistant enamel and final coat of air-drying enamel. Alternative finish may be used subject to approval.

## 4.1.8 Characteristics:

a.	rated power:	1600 kVA /1250 kVA / 800kVA /630kVA
	/-	400KVA/250KVA/160KVA/100KVA/50KVA
b.	winding connection:	Dyn 11, neutral insulated and brought out
c.	frequency:	50 Hz
d.	rated voltage primary:	22 kV
e.	rated voltage secondary	0.4 kV
f.	impedance 6%	6 For 800 , 1250, 1600KVA ,
	- 49⁄	6 For 50,100,160,250,400,630KVA
g.	tap-changer positions:	Plus 1x 2.5% Minus 3x 2.5%
ĥ.	Insulation level :	
	- Impulse with Stand voltag	e (Peak 1.2/50 μs (kV)) 125
	- Power Frequency with Sta	and Voltage (r.m.s 1 minute(kV)) 50
i.	available fault current of s	system at location: 20kA
j.	duration of short-circuit:	3 sec.
k.	terminal connections:	

-HV side : fully insulated with epoxy sealed end, bolted -LV side : LV busbars or cables to LV compartment

## 4.1.9 Accessories are to include the following:

	Conservator	Sealed
	type	type
- Expansion vessel (Conservator )	Yes	No
- Oil Filling opening	Yes	Yes
- Oil drain valve	Yes	Yes
- Grounding terminals	Yes	Yes
- Diagram and name plate	Yes	Yes
- Dehydrating breather (silica-gill breather)	Yes	No
- Thermometer pocket	Yes	Yes
- Oil level indicator	Yes	Yes
- Lifting lugs	Yes	Yes
- Safety valve (over pressure relief device)	Yes	Yes
- U – base	Yes	Yes
- DGPT(Combined Gas-Pressure Temperature Relay ) for indoor transformer (800-1600 kVA)	No	Yes
- Buchholz relay for indoor transformer (800- 1600 kVA)	Yes	No

Remark: Rollers for all indoor transformers

## 4.1.10 INSTALATION AND TYPE OF BUSHING

Rating (kva)	Installation	Type of b	Type of bushing	
		H.V	L.V	
2000	Indoor	K180 –AR3	DT4000	
1600	Indoor	K180 – AR3	DT3150	
1250	Indoor	K180 – AR3	DT3150	
800	Indoor	K180 –AR3	DT2000	
800	Outdoor	30 NF -250	DT2000	
630	Indoor	K 180 –AR 3	DT1000	
630	Outdoor	30 NF -250	DT1000	
400	Outdoor	30 NF -250	DT1000	
250	Outdoor	30 NF -250	DT630	
160	Outdoor	30 NF -250	DT400	
100	Outdoor	30 NF -250	DT250	
50	Outdoor	30 NF -250	DT160	

Remarks:

**H.V Bushing** 

- For indoor type: plug type, 24 kV, 250A, Euromold 200 series
- For out door type: insulator(hard porcelain brown )

Rating	Losses (Watt)		Impedance Voltage (	Noise Level
(kVA)	No load	Load	- %)	(dB)
2000	2050	17500	6	68
1600	1700	14000	6	66
1250	1300	11400	6	64
800	950	7400	6	62
630	900	5100	4	60
400	610	3850	4	58
250	425	2750	4	55
160	300	2350	4	52
100	210	1750	4	49
50	125	1100	4	47

## 4.1.11 LOSSES, IMPEDANCE VOLTAGE AND NOISE LEVEL

#### 4.1.12 limits of temperature rise:

The temperature rise shall be limited and guaranteed to the following values:

- Oil temperature measured by thermometer at top level 50 °C.
- -Winding temperature measured by resistance 60 °C.

The above temperature rises shall be based on a peak value of the ambient temperature of 45  $^{\circ}$ C.

## 4.1.13 Over load capacity:

Transformers are to be capable of working at 110% of their continuous rated output at least one hour after being running continuously at 90% of rated output without causing danger or other bad effects to the windings and core, and without exceeding the permissible limit of temperature rise.

### 4.1.14 Insulating Outdoor Transformer Oil :

- Viscosity ..... 11 mm<sup>2</sup>/s

(NYTRO 10 GBXT or Similar)

## 4.2 Schedules

## 4.2.1 Schedule 'A' - Time Periods To Complete Delivery

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Section – Transformers:	
Item: 1600kVA Transformers	
Item: 1250kVA Transformers	
Item: 800kVA Transformers	
Item: 630kVA Transformers	
Item: 400kVA Transformers	

Date:\_\_\_\_\_

Signature of Tenderer:\_\_\_\_\_

Item	Manufacturer	Place of Manufacture	Place of Inspection
Transformers:			
Item: 1600kVA Transformers			
Item: 1250kVA Transformers			
Item: 800kVA Transformers			
Item: 630kVA Transformers			
Item: 400kVA Transformers			

## 4.2.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 4.2.3 Schedule 'C' Technical Guarantees, Power Distribution Transformers 22/0.4 Kv – 3phases

1		1

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

## 4.2.4 Schedule 'D' - Drawings

## Drawings to be Submitted with the Tender

General Dimension - Layout

Name plate

Protection devices

Type test reports are to be submitted for all equipment.

## Drawings to be Submitted for Approval after Award of Contract

General Dimension - Layout

Name plate

Protection devices

# 5 PARTICULAR TECHNICAL SPECIFICATIONS FOR 24 kV RING MAIN UNIT

This chapter covers the particular technical requirements of the medium 22 kV voltage equipment to be procured under this contract. By conflict between the general specification and the particular specifications below the particular specifications shall prevail.

### 5.1 General

This Section covers the manufacture and supply of indoor Ring Main Units, associated equipment and spares.

### 5.2 Delivery on Supply Basis

The Supply shall cover Engineering, design. manufacture. testing before shipment and packing sea worthy or otherwise as required, delivery DDP

### 5.3 Design

This specification applies to  $SF_6$  insulated switchgear for maximum system voltage 24 kV.

The switchgear shall be suitable for indoor mounting conditions with natural ventilation.

The switchgear shall be maintenance-free and all the electrical parts including the arcing chamber and the main contacts of the switchgear, as well as the connection busbars. are to be mounted in a metal enclosure, hermetically scaled.

All the external parts of the switchgear shall be protected against corrosion. The switchgear shall be of a self-supporting construction type.

The cubicles shall be short circuit type tested by an internationally recognised test institution The switchgear shall consist of cubicles of tropical design. The cubicles shall be metal-enclosed

Each cubicle shall be provided with test points for capacitive voltage tester.

Internal H. V connection shall be made of copper or aluminium alloy.

#### 5.4 **Products**

5.4.1 Components: Components are to include metal enclosed ring main SF6 switch gear unit, comprising two incoming switch-disconnectors for ring main network feeders, one transformer protection fuse-switch combination, cable terminal fittings behind dead front panels and front mounted switch gear operating handles, control, indication

5.4.2	Characteristics:	
	Rated Voltage	24 kV
	Normal system voltage	22 kV
	Rated impulse withstand voltage(Peak)	125 kV
	Rated power frequency withstand voltage (r.m.s)	50kV for I min
	Continuous Current	630 Amp
	Rated Short Time with stand Current 1s.	20 kA
	Rated Short Time with stand Current 3s.	20 kA
	Close and Latch Capability	68 kA (Momentary)
	Rated Interrupting Time	Five cycles
	Rated frequency	50 Hz
	Busbar current rating	630 A
	Rated peak withstand current	50 kA
	*	

5.4.3 Switch-Disconnector: General purpose, 3-pole, load-break, Short-circuit make, category B to IEC 265

Switch-Disconnector Ratings:	
Rated nominal current	630 A
Rated short-circuit making	
Capacity (peak)	50kA
	Switch-Disconnector Ratings: Rated nominal current Rated short-circuit making Capacity (peak)

- 5.4.5 Switch-Disconnector Operation: By removable handles at front of unit Switching mechanism is to be manual, spring charge, quick-make, quick-break, with speed of switching independent of operator: Main switch and earth switch operations are to be separated and safety interlocked with the manual handle Inserted in separate access holes for on/off operation of main switch and earth on/earth off operation of earth switch Handle design IS to ensure delay between closing and re-opening of main Switch or earthing switch, to provide an antireflex operation. It is to be Impossible to move earth switch inadvertently into or from earth position except when main switch is in the open position .Indication of switch position is to be mechanical, directly connected to moving contacts Each switch IS to have padlocking device in the open, closed and earth positions.
- 5.4.6 Fuse-Switch Combination: To consist trip-free, load-break, short-circuit make fuse-switch combination, with operational requirements as for switch-disconnector. Fuse is to be separately located in fuse chamber with interlocked earthing switches providing upstream and downstream earthing of the fuse

assembly, Automatic trip switching is to be actuated by fuse striker pins which actuate common trip bar In switch mechanism. Once operated, striker pins remain in ejected position, preventing closure of switch until fuses has been replaced. Single phasing is not to be possible. Fuses are to be totally enclosed, current limiting, cartridge type, high-breaking capacity, with striker pins, and withdrawable from front of unit

5.4.7	Fuse-Switch Combination Ratings:	
	rated normal current	200 A
	rated prospective short circuit breaking current	25 kA to IEC
	rated prospective short circuit making current	63 kA
	rated current of fuse link (to suit)	100 A, 80A, 63A

- 5.4.8 Incoming/Outgoing Cables: AL or Cu 3\* 1 \*400mm<sup>2</sup> XLPE
- 5.4.9 Cable Terminal Connectors: Stress-relieving, epoxy sealed end, bolted type, complete with all accessories. Alternative arrangement may be proposed by manufacturer.
- 5.4.10 Accessories: Include the following:
  - a. Two N. C and two N. O. auxiliary contact on each switch:
  - b. Shunt trip release on fuse-switch combination;

c. Earth fault indicator, operated by core-balance type current transformer, located near and outside cable box/termination's with indicator visible from front and with automatic reset.

## 5.5 Schedules

5.5.1 Schedule 'A' - Time Periods To Complete Delivery (RMU)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Section – Ring Main Unit	
Items: 24 kV Switchgear CTCC	
Items: 24 kV Switchgear CTC	

Date:\_\_\_\_\_

Signature of Tenderer:\_\_\_\_\_

= = 2	$\mathbf{C} \cdot \mathbf{L} \cdot \mathbf{J} \cdot \mathbf{L} \cdot \mathbf{D}$	N <i>T</i> C 4	<b>DI</b>	OCM	A J T		
5.5.2	Schedule 'B' -	· Manufacturers,	Places	Of Manufacture	And Ins	pection(RN	1U)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Section – Ring Main Unit :			
Items: 24 kV Switchgear CTCC			
Items: 24 kV Switchgear CTC			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_


Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

			Sheet 1	of 2
2	4 kV Ring Main Units		Guarante	ed Data
Item	Particulars	Unit	Guar.	Tolera
			Fig	nce
1	Test data			
-	- State of type test			
	-Certificate	Yes/no		
	-Report of performance	Yes/no		
	-Sate with what standard the SF6 insulated Switch			
	gear Complies			
	- Does the Switchgear comply to all test duties as required in this specification	Yes/no		
	-Is routine test program attached	Yes/no		
	-Additional test			
	-Test for arcing due to internal fault of 20 kA/sec	Yes/no		
	-Partial discharge test	Yes/no		
2	Design data	N7 and an a		
	-Is the enclosure made of stanless steal?	Y es/no		
	- Thickness of steal plats	111111		
	elements			
	-Cable connectors which may be installed			
	-For cable units			
	-For transformer units			
	-Is the operating mechanism of the spring load type	Yes/no		
	-Is it possible to provide the cable unit with quick	Ves/no		
	making and breaking mechanism?	1 05/110		
	-Is the transformer unit provided with a fuse-tripping device via the striker pin?	Yes/no		
	-Is it possible to provide the transformer with a tripping device via fuse striker pin and trip coil at the same time ?	Yes/no		
	- Is it possible to provide all cable units with breaking mechanism via the trip coil?	Yes/no		
	- Interlock between switch and earthing switch?	Yes/no		
	- Interlock between earthing switch and cable	Yes/no		
	connection cover? Is the isolator provided with gas inspection device?	Yes/no		
	- Are each or the main contacts of the switches	1 05/110		
	enclosed separately in hermetically scaled SF6 gas filled chambers?	Yes/no		

#### 5.5.4 Schedule 'D' -Informative Data, Ring Main Units

Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

## Sheet 2 of 2 Guaranteed Data

## 24 kV Ring Main Units

-Is the indicating device on the load isolator and Yes/no eathing switch position installed directly on the operation system of the load isolator and on the earthing switch contacts? Please attach drawing and explanations -Coating material (if any) of the main contacts	Item	Particulars	Unit	Guar. Fig	Tolera nce
-Is the indicating device on the load isolator and eathing switch position installed directly on the operation system of the load isolator and on the earthing switch contacts? Please attach drawing and explanations -Coating material (if any) of the main contacts				5	nee
-are the HV fuses air insulated? - maximum rated current of the HV fuse - maximum outer diameter of the HV fuse Maximum power dissipation of the HV fuse W		<ul> <li>-Is the indicating device on the load isolator and eathing switch position installed directly on the operation system of the load isolator and on the earthing switch contacts?</li> <li>Please attach drawing and explanations</li> <li>-Coating material (if any) of the main contacts</li> <li>-are the HV fuses air insulated?</li> <li>- maximum rated current of the HV fuse</li> <li>- maximum outer diameter of the HV fuse</li> <li>Maximum power dissipation of the HV fuse</li> </ul>	Yes/no Yes/no A mm W		

## 5.5.5 Schedule 'E' - Drawings

## Drawings to be Submitted with the Tender

Details and dimensions of Ring Main Units

Type test reports are to be submitted for all equipment.

Drawings to be Submitted for Approval after Award of Contract

Details and dimensions of Ring Main Units

# 6 PARTICULAR TECHNICAL SPECIFICATIONS FOR L.V DISTRUBUTION BOARDS

## 6.1 Indoor Panels

- 6.1.1 Construction: dead front type, consisting of main circuit breaker, busbars, outgoing circuit breakers or fuses, where shown on the drawings, instrumentation and accessories.
- 6.1.2 Main circuit breakers shall have solid state unit with long-time short-time and ground-fault pick up and time-delay adjustments and with high instantaneous over-current trip, to correspond with transformer rating and LV interrupting capacity at location, time and current coordinated with MV protection on primary side and circuit breakers or protective devices downstream.
- 6.1.3 Main circuit breaker shunt trip device shall be provided, operated by pressure relief device and thermometer.
- 6.1.4 Busbar assembly shall comprise fully insulated set of 3-phase and neutral copper busbars. Neutral is to be fully rated. Earth bar is to be provided at lower end of compartment.
- 6.1.5 Outgoing circuit breakers shall be moulded case type and must be rated for three phases, 380V A.C, 50 Hz to IEC 157-1 and BS EN60947-2:1992 specifications.
- 6.1.6 Moulded case circuit breakers shall be suitable to accommodate auxiliaries and under-voltage release. They shall be of the thermal magnetic or solid state type with a short circuit capacity withstand of not less than 50 KA at 380V and shall be suitable for the ambient temperature operation within the prevailing enclosure condition. Pad locking facility for the MCCB shall be provided. The exposed incoming terminals shall be provided with a suitable insulated cover up to the equipment mounting plate in order to allow no access to the live incoming terminals. There shall be minimum clearance of 300mm between the incoming glanded cable and input terminals of the MCCB.
- 6.1.7 Bus bars shall be provided throughout the main power circuit. All bus bars are to be silver plated copper and colour sleeved according to phase.
- 6.1.8 The capacity of the Terminal sockets for MCCB shall be 300 sq.mm stranded Cu/A1 cables through suitable terminal silver plated copper bars.

## 6.2 Low Voltage Distribution Pillars (Feeder Pillars)

## 400 Volt 3 phase Distribution Pillar (Feeder Pillar) Weatherproof Housing

The weatherproof housing (IP 54) shall be manufactured from sheet steel or other approved material. The pillar shall be rigid and self-supporting, designed for ground mounting on a flat base or pier or for fixing to standard lattice steel towers at accessible height. Fixing holes in the bottom and on the back shall be provided complete with M16 foundation or fixing bolts. The pillar shall consist of at least two compartments. The bottom cable entrance compartment to be with removable shield plates in bottom and back (depending of direction of cable entrance).

Cable glands or cable muffs shall be used where cables enter/exit the waterproof housing. The bottom cable entrance compartment must be prepared for such arrangement. It shall be possible to maintain sufficient dust proofing (IP54) as specified, without all glands or muffs being installed. Necessary glands or muffs shall be delivered in accordance with the table below and be designed so they, after installation satisfy the requirements (IP54). It shall be possible and simple to install glands or muffs independent of each other. The placing of glands/muffs must be logical in relation to attachment/contact clamps, so that crossing of cables and unnecessary bending of cables is avoided.

The table shows number and sizes of cable glands, for which the housing bottom shall be prepared:

Feeder Pillar	Glands for cable diameter 20-65mm	Glands for cable diameter 15-45mm	Glands for cable diameter 8-12mm
2 way	2	4	1
4 way	4	4	1
6 way	6	8	1

There shall be an arrangement that allows for temporary attachment of cables between housing entrance and electrical connections, in order to avoid mechanical stress directly on the electrical connections during cable laying. Relevant attachments shall be delivered in accordance with the above table.

The upper, equipment compartment shall be arranged for front access only by means of side hinged doors that shall be fitted with an internal document holder and a locking bar to secure them top and bottom. The locking bar shall be operated by a central handle that shall be lockable by means of a padlock having a 10 mm or larger diameter hasp.

The equipment compartment shall be dust and vermin proof, but adequate ventilation shall be maintained to permit circulation of filtered air. The compartment shall be at least

IP 2X with doors open. Provision shall be made for the installation of an electrical heating device to prevent condensation within the housing. Such heaters shall be of the metal clad convection type, and shall be continuously rated complete with fuses and control switch. It shall be possible to switch on/off. When the heating device is on, it shall be controlled by a thermostat with minimum regulating range 0-30 degrees Celcius.

Incoming Cables, Links, Busbars and Conductors Links, busbars and conductors shall be manufactured from hard drawn copper and arranged for access from the front only. The busbars must be fully shrouded.

Busbar support insulators shall be capable of withstanding rated short circuit conditions without undue stress and be resistant to mechanical shock and vibration however caused.

The pillar shall be equipped with internal ammeter and voltmeter allowing measurements in all phases on the incomer.

The pillar shall be equipped with ample dimensioned earth and neutral bars interconnected by a removable link.

Busbars shall be dimensioned for not less than 1200 Amps. The busbars shall have identification codes as per Clause 2.7. The standard phase colours are Red (L1), Yellow (L2) and Blue (L3) (RYB).

**Distribution Circuits** 

Each feeder pillar shall be equipped for the number of 3 phase, 4 wire distributor circuits as specified in the Schedules. Each switch-circuit shall have a circuit breaker (C.B.) for disconnecting all 3 phases simultaneously. The circuit breaker shall de designed to disconnect at highest load. Each phase circuit shall be controlled by a moulded case circuit breaker (MCCB). The nominal rating of the C.B. shall be one of the standard values within the range 160 A to 630 A with min. I.C. 35KA for 160 A M.C.C.B. and increases according to M.C.C.B. current rating .

The installation shall fulfil the requirements for c.b. replacement stated in the general technical specifications.

Auxiliary circuits 63 A and below shall be protected by miniature circuit breakers.

And each pillar should have two spare spaces for extra feeders with all needed internal connections.

#### 6.3 Low Voltage Manual Load Break Disconnectors

Manual Load Break 3-Pole Disconnectors Combined With Fuse Base

6.3.1 Weather proof housing

The weather proof housing (IP54) shall be manufactured from sheet steel, thickness shall not be less than 2mm.

The box shall be rigid and self-supporting designed for fixing to standard lattice steel tower at accessible height.

Cable gland or cable muffs shall be used where cable enter exit the water proof housing .

6.3.2 General Characteristics

The manual load break disconnectors combined with fuse switch shall be designed to provide compact, instantly opening-closed with rolling contact. They have a breaking feature from same phase and four different points. Load break switches shall be manufactured with fuses according to the IEC standard.

6.3.3 Opening- Closing Mechanism

Opening- closing mechanism shall be provided to operate the poles altogether and very rapidly. Speed of opening and closing is independent from hand moving .

- 6.3.4 Safety
  - -Off position both fuse terminal will not be alive, so the fuses can be changed, safety
  - -On position the handle will be locked mechanically, so the box can not be opened while energized.
  - -The isolation distance between the phases is rather wide to prevent arc jumping
  - -Additional fuse protection shields are used for better isolation and protection and switch fuses.
  - -Arc separator are used for arc extinguishing between contacts whish occur during closing or breaking process.
# 6.4 Schedules

# 6.4.1 Schedule 'A' - Time Periods To Complete Delivery

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Section – Low Tension Distribution Panel:	
Items: LTDB with MBC 2500 A	
Items: LTDB with MBC 2000 A	
Items: LVD pillars	
Items: LV Manual Load Break 3-Pole	
Disconnectors Combined With Fuse Base	

Date:\_\_\_\_\_

Signature of Tenderer:\_\_\_\_\_

**6.4.2** Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection (Low Tension Distribution Panel)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Section - Low Tension Distribution			
Panel:			
Items: LTDP with MBC 2500 A			
Items: LTDP with MBC 2500 A			
Items: LVD pillars			
Items: LV Manual Load Break 3-Pole			
Disconnectors Combined With			
Fuse Base			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 6.4.3 Schedule 'C'-Technical Guarantees, (Low Voltage Distribution Pannels)

Tenderer'sSignature:	Date:
----------------------	-------

Item	Particulars	Unit	Guar. Fig	Tolera nce

Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

	Guaranteed Data			
Item	Description	Unit Guaranteed Data		
			Gedco	Bidder

Sheet 1 of 2

# 6.4.4 Schedule 'D'-Technical Guarantees: L.V Manual Load break 3-Poles disconnectors combined with Fuse Base 500V/630A

Tenderer'sSignature:\_\_\_\_\_\_Date:\_\_\_\_\_

	6.4.5 Schedule 'E'	'-Informative Data,	Low Voltage	Distribution	pannels
--	--------------------	---------------------	-------------	--------------	---------

Item	Particulars	Unit	Guar. Fig	Tolerance

Tenderer'sSignature:\_\_\_\_\_

Date:\_\_\_\_\_

Item	Particulars	Unit	Guar. Fig	Tolerance

Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

# 6.4.6 Schedule 'F' - Drawings

## Drawings to be submitted with the Tender

Details and dimensions of Low tension distribution Panel / Pillar/Box (Manual Load break 3-Poles disconnectors combined with Fuse base)

Type test reports are to be submitted for all equipment.

# Drawings to be submitted for Approval after Award of Contract

Details and dimensions of Low tension distribution Panel/Pillar(Manual Load break 3-Poles disconnectors combined with Fuse base)

# 7 PARTICULAR TECHNICAL SPECIFICATIONS FOR OVERHEAEAD LINE MATERIALS

#### 7.1 Conductors and Accessories

#### 7.1.1 Standards

Aluminium clad steel reinforced aluminium conductor (ACSR/AW) aluminium alloy conductor (AA) and copper conductors shall comply with IEC standards or such other equivalent recognised national standard which the Bidder shall define.

## 7.1.2 Manufacture of ACSR and Aluminium Conductor

The manufacture of the ACSR/AW and AA conductor shall be carried out in a portion of the works specially set aside for such purposes. Precautions shall be taken during the manufacture and storage of ACSR conductor to prevent the possibility of contamination by copper or other materials that may adversely affect the aluminium. In the event of any machinery used for conductor manufacture being used for materials other than aluminium or steel strand the Supplier shall furnish the Engineer with a certificate that the machinery has been thoroughly cleaned before use on aluminium or steel wire and the conductor supplied under this Contract is free from contamination.

The aluminium shall be of the highest purity commercially obtainable and the Supplier shall submit certificates of analyses giving the percentage and nature of any impurities in the metal of which the aluminium wires are made.

There shall be no joints in steel wires forming the core of composite conductors, excepting those made in the base rod or wire before drawing, unless the core consists of seven or more wires. In the latter case joints in individual wires are permitted, additionally to those made in the base rod or wire before drawing, but no two joints shall be less than 15 m apart in the complete steel core.

The steel strands shall be performed so that they remain inert and do not move relative to each other when the conductor is cut.

The steel core wires shall be uniformly covered with approved grease. In addition the inner aluminium wires shall be similarly treated. The grease shall fill all internal spaces except that excess grease shall be removed from the conductor before the application of the final layer of wires.

The outermost layer of all conductors shall be stranded with the right-hand lay.

#### 7.1.3 Mechanical Properties

#### Steel Core

The steel core shall be comprised of stranded aluminium covered steel wire in accordance with ASTM B-416, Concentric-Lay-Stranded Aluminium-Clad Steel Conductors. The covering on each individual wire shall achieve a continuous dependable weld with the steel core and shall provide a uniform guaranteed minimum thickness of aluminium of 10 percent of the wire radius. The zone of diffusion shall be clearly defined.

#### Grease

The grease to be used in the conductor shall be chemically inert, shall not flow within nor exude from the conductor when at a temperature of 90oC nor shall its characteristics be impaired after heating to 20oC above its drop point for 150 hours. The grease shall be suitable for service temperatures in the range  $-10^{\circ}$ C to  $+75^{\circ}$ C. The suitability of the grease shall have been proven by tests acceptable to the Engineer.

## 7.1.4 Copper Conductors

The Copper Conductors shall consist of concentric-lay stranded conductors made from uncoated annealed round soft drawn copper wires.

The direction of lay of the outer layer shall be right hand and shall be reversed in successive layers.

No Joints in the finished copper wires, Joints may be made in the base wire before drawing, Joints shall be not closer than 15m to another or to either end of the wire, no more than two such Joints shall be present in any reel length of the conductor. The surface of the wire shall be smooth and free from

imperfections not consistent with good manufacturing practice.

#### 7.1.5 Conductor Characteristics

The conductors shall have the following mechanical and physical properties.

## 7.1.5.1 ACSR /AW Conductor

Code Name	Unit	Dingo	Dog	Rabbit
Nominal Cross-sectional area	$mm^2$	150	100	50
Approx. Overall diameter	mm	16.75	14.15	10.05
Stranding Aluminium	No/mm	18/3.35	6/4.75	6/3.35
Steel Wire	No/mm	1/3.35	7/1.57	1/3.35
Maximum d.c. resistance at	ohms/km	0.1815	0.2733	0.5426
20°C				
Nominal breaking load	Kgf	3640	3335	1876
Approx. Weight	kg/km	506	394	214

# 7.1.5.2 Stranded Copper Conductors

Code Name	Unit					
Nominal Cross-sectional area	$mm^2$	120	95	70	50	35
Approx. Overall diameter	mm	14	12.5	10.5	9	7.5
No of Strands X Diameter	No X mm	19X2.8	19X2.5	19X2.1	19X1.8	7X2.5
Maximum d.c. resistance at 20°C	ohms/km	0.1578	0.198	0.2806	0.3819	0.5337
Approx. Weight	kg/km	1150	858	605	463	314

#### 7.1.6 Conductor Drums

#### 7.1.6.1 General

Conductor shall be supplied on drums of sufficient sturdiness to withstand shipment and transportation, and the drums shall be securely battened to prevent damage to the conductor. Each drum shall be marked with the type, size and length of conductor on the drum, and with the direction of rolling. Conductors shall be supplied in lengths as long as can be conveniently handled, and placed only on drums appropriate to its particular size.

The Bidder shall submit with his Bid, drawings showing the general details and dimensions of the drums to be offered for approval.

#### 7.1.6.2 Materials

All wooden components shall be manufactured from sound defect-free seasoned softwoods and suitable for prolonged storage without deterioration. The wood shall be planed or finely sawn to facilitate accuracy in assembly and clear stencilling. The thickness of the boards of each ply or component part shall be of reasonable uniformity.

#### 7.1.6.3 <u>Design</u>

The flanges of drums shall be constructed from two plies of wood, laminated in such a manner as to give cross grain to each other. The boards shall be close butted to provide maximum support. Fastening of the flanges shall be with suitable bright nails with the heads countersunk on the inside of the flange.

A flange conductor hole of sufficient diameter for the free passage of the conductor shall be cut in one flange. A suitable sheet metal plate shall protect the exposed end of the conductor.

The spindle hole shall be round and cut through the centre of the board of each flange ply. The spindle holes, of not less than 80 mm diameter, shall be reinforced by a 6 mm mild steel plate bolted to each flange.

The drum barrel shall be of the segmental type, with supports and cross struts. The barrel lagging shall be closely butted and shall provide a smooth external surface to the conductor. The barrel and flanges shall be securely clamped together.

Drainage holes shall be provided through each flange as close as possible to the underside of the barrel lagging.

Circumference battens shall enclose the conductor space completely. They shall fit flush with the outer flanges. Battens shall be securely fixed in an approved manner.

#### 7.1.6.4 End Fixing of Conductors

The inner end of the conductor shall be brought through the drum flange and secured by staples. The outer end shall also be secured to the inner face of the flange in a similar manner.

# 7.1.6.5 Protection of Conductors

The drum barrel shall be covered with a layer of waterproof sheet plastic or wax paper or in the case of aluminium conductors shall be painted with aluminium flake paint. The inner cheeks of the drum shall be painted with a bitumen-based paint or in the case of aluminium conductors with aluminium flake paint. The outer layer of conductor on the drum shall be covered by a layer of sheet plastic or waxed paper secured immediately under the circumference battens so that it is not in contact with the conductor.

All bolts and nuts on insulator string fittings shall be galvanised as specified and shall be locked in an approved manner.

# 7.1.7 Schedules

All schedules shall be filled in and submitted with the Tender. The Tenderer may copy or modify the schedules, if necessary, in order to provide sufficient space for all the equipment and relevant data.

# 7.1.7.1 Schedule 'A' - Time Periods To Complete Delivery

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Conductors and Accessories:	

Date:\_\_\_\_\_ Signature of Tenderer:\_\_\_\_\_

# 7.1.7.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection

Item	Manufacturer	Place of Manufacture	Place of Inspection
Conductors and Accessories			
ACSR/AW Conductor			
Copper Conductor			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

Item	Particulars	Unit	Guaranteed Data	

# 7.1.7.3 Schedule 'C'-Technical Guarantees for O.H.L Conductors (ACSR/AW and AA)

Technical Guarantees for O.H.L Conductors (Copper	')
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Item	Particulars	Unit	Guaranteed Data	

Tenderer'sSignature:\_\_\_\_\_Date:\_\_\_\_\_

## 7.1.7.4 Schedule 'D' - Drawings

# Drawings to be Submitted with the Tender

ACSR/AW conductor cross-sections

Copper conductor cross-sections

Type test reports are to be submitted for all equipment.

# Drawings to be Submitted for Approval after Award of Contract

ACSR/AW conductor cross-sections

Copper conductor cross-sections

Type test reports are to be submitted for all equipment.

## 7.2 Medium Voltage Drop-Out Fuse, Line Isolators and Switch Isolators

#### 7.2.1 MV Drop-Out Fuse Switch

All Drop-out Fuse Switch shall be of 3 separate, single pole, verticalmounting, channel base pattern drop out fuse switch with fuse holder complete for erecting on standard lattice towers and all the conductor straps, nuts, bolts , and washers necessary to mount and electrically connect the isolators, together with all auxiliary equipment, on their supports shall be provided

All Drop-out Fuse Switches shall be supplied complete with necessary pole coupling rods, operating rods, operating handles and all accessories. Contacts shall be the high pressure, self aligning type made of metal not subject to corrosion. The design of the contacts shall be such that periodic lubrication of their surface is unnecessary for efficient operation under the atmospheric and climatic condition existing at site.

The fuse switch shall have load breaking capacity and in open state fulfil the requirements for circuit isolation (isolator function). Switching and fuse replacement shall be done from the ground. A number of insulated operation rods shall be supplied.

The fuse elements shall be of the current limiting double tail button head type.

#### 7.2.2 Line Isolators and Switch Isolators

#### 7.2.2.1 Isolators

All isolators shall be of the triple pole, gang operated open type, suitable for outdoor installation designed in accordance with IEC 60129 The isolators shall be for horizontal or vertical mounting in standard lattice towers and shall be supplied complete with base plates, pole coupling rods, operating rods, angels and triangular plates for operating rods, operating handles and all accessories, including items such as guide plates or mounting brackets. Facilities shall be incorporated in the design for aligning the main contacts and adjusting the linkages during erection and maintenance, and all the conductor straps, nuts, bolts, and washers necessary to mount and electrical connect the isolators, together with all auxiliary equipment, on their supports shall be provided.

Provision shall be made for adjusting the insulator posts in the vertical axis.

Contacts shall be of the high pressure; self-aligning type made of metal not subject to corrosion, for example hard drawn copper or phosphor bronze. If silver plating is applied the plating shall be in accordance with BS 2816 applying a coating that has a specified silver content of at least 95.0 % by mass, and a thickness of at least 25  $\mu$ m.

The design of the contacts shall be such that periodic lubrication of their surfaces is unnecessary for efficient operation of the switch. Service conditions require that isolating switches shall remain live, and in service without being operated for periods of up to two years. The contacts will therefore be expected to remain capable of carrying their rated load, and short circuit currents without overheating or welding for this period under the atmospheric and climatic conditions existing at site. The advantage of the electromechanical forces created by a fault current to increase the contact pressure where most needed at the contact shall be incorporated in the design.

Isolators shall be designed and tested such that the isolator cannot be opened by forces due to short circuit currents passing through it, and shall be self locking in both the "open" and "closed" positions.

The stationary contacts shall be backed by stainless steel pre-stressed compression springs with multi finger contacts to provide the required contact pressure, resulting in minimum electrical clearance.

Provision shall be included for locking the switches in either the open or closed positions by means of padlocks that will be provided by the Employer.

Where "outboard" bearings are required they shall be suitable for mounting at either end of the isolator.

All roller or ball type bearings shall be grease packed and efficiently sealed to prevent the ingress of dust and moisture. Completely enclosed, weatherproof type bearings that require no maintenance is preferred.

When made of steel or malleable iron, operating boxes, handles, rods, tubes and other fittings for outdoor equipment shall be hot dip galvanised.

Bidders shall state in the Technical Schedules the load current, line charging current and transformer magnetising current which they guarantee that all isolators offered will break without damage to the contacts. Bidders shall declare in their Bid whether special contacts are required to achieve any of the current breaking conditions; details of any such contacts shall be given.

Full details of all heavy current carrying contacts which incorporate moving parts shall be submitted with the tender together with associated electrical and mechanical type test reports.

#### 7.2.2.2 On Load Switch Isolators

All isolators shall be prepared for extension with load breaking heads allowing breaking of minimum 630 A when operating the isolator. The isolator functions shall be retained when the load break head is mounted.

#### Load Interruption

The load interruption shall take place within the interrupter head without an external arc or flame conforming to IEC 265, Category A. Electronic controlled arc

interrupters are not acceptable.

The load interruption shall be achieved by providing a parallel circuit for re-directing the load current path from the main isolator contacts at the instant of their separation. The design of the equipment shall allow the replacement of load interrupter head after a specified number of operations. The manufacturer shall indicate the number of load break operation possible without changing the interrupter head.

The inner layer of the arcing chamber shall be suitable for generating arc-quenchinggas. The generated deionized gas shall extinguish the arc and be dissipated through a rear exhaust chamber, well clear of the switch.

The internal contacts shall be spring loaded and be of such design as to provide a positive and independent tripping action.

The interrupter contacts shall not be in the main current path when the main contacts are in a fully closed position.

The load interrupter head shall be designed to prevent leakage of water to the arcing chamber (where the control mechanism including the spring for opening and closing is housed ) and be made of non corrosive materials.

#### **Operating Handle**

Operating mechanisms shall be designed so that all three poles close simultaneously and be arranged so that any mechanism may be mounted at either end of the supporting structure. All operating handles shall be securely earthed.

#### **Remote Control**

It shall be possible to equip the isolators and switch isolators with a motor driven mechanism connecting to the normal operation rod. The switches must be so designed that such installation also can be done at a later stage. Where the motor operated mechanism is specified it shall be designed to provide electrically initiated opening and closing of the isolator from local or remote switches or relays. Local manual tripping shall also be provided together with manual closing of the isolator; the manual closing operation shall reset a spring or weight operated mechanism.

Provision shall be made for locking the local tripping device with a padlock to be supplied by the Employer. The mechanisms shall be totally enclosed in weatherproof and vermin proof metal panel with padlock hasp.

Automatic operating mechanisms shall be provided with an auxiliary switch to isolate the trip or operating coil when the switch is opened. Auxiliary contacts should clearly indicate the position of the switch.

#### **Rating Plate**

The rating and data of the load break switch shall be engraved or embossed on a weather and corrosion proof metal plate. The rating plate containing the following information shall be positioned at the base supporting frame of the post insulator and

shall be prominently visible.

- a) Manufacturer's Identification (Trade Mark)
- b) Country and Year of Manufacture.
- c) Number and the Year of the standard adopted.
- d) Designation of Type, Class etc.
- e) Rated voltage and frequency (kV & Hz)
- f) Rated 1 minute power frequency withstand voltage (kV) wet.
- g) Rated lightning impulse withstand voltage (kV) dry.
- h) Rated continuous current (A)
- i) Rated short circuit making current (kA)
- j) Rated short time (1 sec.) current (kA)
- k) Total net weight (kg.)
- l) Serial No. CEB/LB/.....

#### Tests

Equipment shall be routine and type tested in accordance with IEC 60129

# 7.2.3 Schedules

# 7.2.3.1 Schedule 'A' - Time Periods To Complete Delivery (Drop-out fuse and On load switch isolator)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Items: Drop-out fuse	
Items: On load switch isolator	

Date:\_\_\_\_\_

Signature of Tenderer:

7.2.3.2 Schedule 'B' - Manufacturers, Place	ces Of Manufacture And Inspection (Drop-
out fuse and On load switch isolat	or)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Items: Drop-out fuse			
Items: On load switch isolator			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 7.2.3.3 Schedule 'C'-Technical Guarantees for 24kV or 36kV -Drop-Out Fuse and Load Switch Isolator

		Load
		Isolator

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 7.2.3.4 Schedule 'D' - Drawings

# Drawings to be Submitted with the Tender

Details and dimensions of 24kV or 36kV -Drop-Out Fuse and Load Switch Isolator

Type test reports are to be submitted for all equipment.

# Drawings to be Submitted for Approval after Award of Contract

Details and dimensions of **24kV or 36kV** -Drop-Out Fuse and Load Switch Isolator

# 7.3 Lightning Arresters

## 7.3.1 Design

This section covers the design, manufacture and testing of lightning arresters for outdoor service.

The arresters shall be capable of protecting the following equipment:

- Transformers which are directly connected to a line
- Transformers which are connected to a line via cables
- Capacitors
- Cables
- Autoreclosers and sectionalisers
- Circuit breakers and isolators
- Instrument transformers

The outdoor lightning arresters shall be of the metal oxide gap-less type, complying with IEC 60099-4.

The lightning arresters shall have the following characteristics:

Description	Unit	<b>Guaranteed Data</b>
Rated Voltage	kV	24
Maximum continues operating voltage (M.C.O.V)	kV	19.5
Nominal discharge current (8/20 µs)	kA	10
Class Distribution Min. protective ratio		1.2

The arresters shall be designed horizontally or vertically (standing or hanging) in standard lattice towers. The arresters shall be supplied complete with fixing materials and connection clamps.

The lightning arresters shall be fitted with a pressure relief device.

All arresters shall be fitted with in corrodible metal nameplates which are visible when the arrester is completely mounted and which clearly indicate the data specified in IEC in engraved or embossed characters.

All external ferrous parts shall be hot-dip galvanised.

# 7.3.2 Protection Characteristics

This is a combination of the following:

- Maximum residual voltage for steep current impulse (1/20 µs)
- Maximum residual voltage for current impulses with waveform (8/20 µs) and 0.5, 1.0 and 2.0 times nominal current
- Maximum residual voltage for switching impulse (30-100/60-200 µs)
- The protection level for lightening impulse is the highest of
- maximum residual voltage for steep current impulse divided by 1.15 and
  - maximum residual voltage at nominal current and 8/20 μs
    The protection level for switching impulse is the maximum residual voltage at the specified switching impulse current.
    The protection level shall have at least a margin of safety of 30 %

compared to the BIL of the arrester housing.

# 7.3.3 Energy Requirements

The lightning arresters shall be designed to minimum line discharge class 1 according to IEC 60099-4 for heavy duty arresters.

# 7.3.4 Housing

The outer housing shall be of a silicone rubber material offering high resistance to pollution. The specific creepage distance for any arrester shall be greater than 31mm/kV system voltage, corresponding to heavy pollution according to IEC. Established practice in Gaza is 800 - 1050mm for 24kV, which shall be complied with.

# 7.3.5 Tests

Lightning arresters offered or supplied to this specification shall comply with the tests detailed in IEC 99-4 including wet tests and any additional tests specified. Tests shall include requirements set out in the following:

Certified copies of type test reports shall be submitted with the bid and shall include calibrated oscillogram demonstrating that each type of arrester offered complies with the minimum specified requirements. The catalogue numbers applicable to each arrester shall appear on the oscillogram. The time to spark-over applicable to each test involving spark-over of the series gap shall be clearly shown.

Bidder should state what routine tests are carried out to prove the effectiveness of the seals of the arresters.

# 7.3.6 Schedules

7.3.6.1 Schedule 'A' - Time Periods To Complete Delivery (Lightning Arresters)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)	
Items: Lightning Arresters		

Date:\_\_\_\_\_

Signature of Tenderer:

7.3.6.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection ((Lightning Arresters)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Items: Lightning Arresters			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

Item	Particulars	Unit	Guaranteed Data

# 7.3.6.3 Schedule 'C'-Technical Guarantees for Lightning Arresters

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 7.3.6.4 Schedule 'D' - Drawings

# Drawings to be Submitted with the Tender

Details and dimensions of Lightning Arresters

Type test reports are to be submitted for all equipment.

# Drawings to be Submitted for Approval after Award of Contract

Details and dimensions of Lightning Arresters

# 7.4 Overhead Line Insulators

#### 7.4.1 General

Pin, post and reel type insulators shall be brown glazed porcelain or epoxy resin and shall comply with the requirements of adequate IEC publications.

Tension insulators shall be either of strings of toughened glass disc insulators or comprise epoxy resin long rod type units. The design of insulators and fittings shall be such as to avoid local corona formation and no significant radio interference shall be exhibited. The insulator units and the complete insulator sets shall conform to the electrical and mechanical design criteria given in General Technical Specification of this Specification.

## 7.4.2 Pin Insulators for Over Head Lines

Pin type insulators for use on 22 kV lines shall have as a minimum the electrical characteristics required in Section 2 of this Specification and they shall be fitted with galvanised mild steel spindles having a minimum failing load of 10kN.

Spindles for pilot insulators must have a minimum failing load of 700N. Conductor sizes to be accommodated shall vary from 6.0mm to 19.0mm diameters with Preformed Distribution Ties.

## 7.4.3 Tension Insulators

Tension insulator sets shall be either made up of strings of toughened glass disc insulators of 254mm diameter and fixing centres at 140mm of 16mm ball and socket couplings, or of epoxy resin long rod type insulators of equivalent electrical and mechanical performance.

Complete tension insulator sets, including fittings, shall have a minimum withstand factor of 2.5 based upon the ultimate mechanical strength.

The ultimate mechanical strength of an insulator set shall be the load at which any part of the insulator string fails to perform its function of providing a mechanical support without regard to electrical failure.

Individual insulator units shall have a minimum withstand factor of 2.5 based upon the combined electro-mechanical strength of the insulator unit. This is defined as that load at which any part of the insulator fails to perform its function either electrically or mechanically when voltage and mechanical stresses are applied simultaneously.

## 7.4.4 Marking of Insulators

Each insulator shall have marked upon it the manufacturer's name or trade

mark, the date of manufacture or firing, and indication of the guaranteed electro-mechanical strength and other such marks as may be required to denote each batch for the purpose of sample tests.

Unless otherwise approved the insulators submitted, as a batch for a test shall bear the same marks.

These marks shall be imprinted and not impressed. For porcelain, the marks shall be imprinted before glazing. When a batch of insulators bearing a certain identification mark has been rejected no further insulators bearing this mark shall be submitted and the Supplier shall satisfy the Engineer that adequate steps will be taken to mark or segregate the insulators constituting the rejected batch in such a way that there shall be no possibility of the insulators being re-submitted for test or supplied for the use of the Employer.

# 7.4.5 **Porcelain Insulators**

All porcelain shall be sound, free from defects and thoroughly vitrified. The glaze shall not be depended upon for insulation. The glaze shall be smooth, hard, of a uniform shade and shall cover completely all exposed parts of the insulator. Insulators and fittings shall be unaffected by atmospheric conditions due to weather, proximity to the coast, fumes, ozone, acids alkalis, dust or rapid changes of air temperature between minus 40°C and plus 75 °C under working conditions.

# 7.4.6 Insulator Caps and Pins

The caps of insulator units shall be of malleable cast iron or other suitable material having the necessary strength to enable the complete unit to comply with this Specification. The pins shall be made of steel or other suitable material of such quality that the finished unit shall comply with this Specification.

The design of the unit shall be such that stresses due to expansion and contraction of any part of the insulator shall not lead to deterioration.

The porcelain shall not engage directly with hard metal. Cement used in the construction of an insulator shall not fracture by virtue of expansion, or loosen by contraction and proper care shall be taken to locate the individual parts correctly during cementing. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.

# 7.4.7 Fittings

Ball and socket connections shall be provided with specially designed "W" clips, which effectively locks the connection against accidental uncoupling without detracting from its flexibility. The "W" clip shall be of stainless steel.

The design shall be such as to permit easy removal for replacement of insulator units under live line conditions without the necessity of removing the entire string from the cross-arm. All split pins for securing the attachment

of fittings of insulator sets shall be of stainless steel and shall be backed by washers. Plated split pins shall not be used.

All clamps, ties, joints, lugs and all other fittings to be supplied under this contract shall be of proven standardised design in compliance with internationally recognised Technical Standards and practices and shall be suitable for the specified equipment to be supplied. The electrical and mechanical properties shall match the equipment to which the fittings shall be connected. The Supplier (Contractor) shall be responsible for proving to the satisfaction of the Engineer, the adequacy of the fittings to be supplied.

#### 7.4.8 Ferrous Metal Parts

All ferrous metal parts except those of stainless steel shall be hot dipped galvanised to give an average coating of zinc equivalent to 610 grams per square metre.

# 7.4.9 Schedules

7.4.9.1 Schedule 'A' - Time Periods To Complete Delivery (O.H.L Insulators)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Section: O.H.L Insulators and Fittings	
Items: Tension Insulators	
Items: Pin Insulators	

Date:\_\_\_\_\_

Signature of Tenderer:

#### 7.4.9.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection ( O.H.L Insulators)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Section: O.H.L Insulators and Fittings			
Items: Tension Insulators			
Items: Pin Insulators			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_
		S	heet 1 of 2
Item	Particulars	Unit	Guaranteed Data

# 7.4.9.3 Schedule 'C'-Technical Guarantees for O.H.L Insulators and fittings

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

		S	Sheet 2 of 2
Item	Particulars	Unit	Guaranteed Data
	a) a)		

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 7.4.9.4 Schedule 'D' - Drawings

# Drawings to be Submitted with the Tender

Details and dimensions of O.H.L Insulators and fittings

Type test reports are to be submitted for all equipment.

# Drawings to be Submitted for Approval after Award of Contract

Details and dimensions of O.H.L Insulators and fittings

#### 7.5 Wood Poles And Accessories

#### 7.5.1 Wood Poles

#### 7.5.1.1. GENERAL

#### 7.5.1.1.1. Scope

This specification covers the technical characteristics and inspection methods and tests as basis for acceptance of wood poles which are to be purchased for use in medium voltage (MV) and low voltage (LV) electric power overhead lines.

# 7.5.1.1.2. StandardsBS 144-1973BS 913-1973BS 913-1973BS 1990:Part-1:1984Coal Tar Creosote for the Preservation (Impregnation) of Timber.Wood Preservation by means of Pressure Creosoting.BS 1990:Part-1:1984Wood Poles for Overhead Power and Telecommunication Lines.Part-1. Specification for Softwood Poles . (Medium Poles)BS 4072-1975Compositions.NWPC1,4,1,1/70Nordic Wood Preparation Council

#### 7.5.1.2. CHARACTERISTICS

#### 7.5.1.2.1. Type of Wood

The impregnated wood poles shall be PINE tree and preferably PINUS SYLVESTRIS. The English and Latin names of the type of wood, the country of origin and the felling year shall be submitted properly. The raw wood poles to be provided from local forests shall be PINE tree.

#### 7.5.1.2.2. Dimensions of Wood Poles

The lengths, top diameter and Minimum Diameter at 1.5 m from butt end of the wood poles are given below.

Heights	Тор	Diameter	Minimum Diameter at 1.5 m
Treights	min.	max.	from butt end
m	cm	cm	cm

8.5	15	17	21.5
10	16	18.5	23
12	17	19	25
14	20	22	30

#### 7.5.1.3. PRESERVATIVE IMPREGNATION SUBSTANCES

The impregnating substances to be used on wood poles shall be one of and preferably pure Creosote with properties as per English standard BS 144/1993 obtained by distilling hard coal at high temperature or soluble salts like Copper/Chromium/Boron (CCB) and

Copper/Chromium/Arsenic (CCA) preparatus or soluble mixed preparatus with the same or better qualities and soluble mixed preparatus to receive a solution with required density or other impregnating substances used for wood poles and proved with the applied procedure.

#### 7.5.1.4. IMPREGNATION OF RAW POLES

#### 7.5.1.4.1. Impregnation with Creosote

The wood poles shall impregnated as per empty-cell Rueping process and as per conditions stipulated at English Standard BS 913:1973. During application of this, periods of pressure and vacuum numbers and repeating numbers shall be stated clearly.

- Creosote detained shall be 115 kg. per m<sup>3</sup> of pole.

- Creosote shall penetrate completely into the live wood.

#### 7.5.1.4.2. Measuring the depth of penetration of Creosote

Samples for the test shall be taken with a test auger from minimum 1.5 meter distance from any end of the pole. It shall be seen at the received sample that the live wood part is covered with Creosote. Immediately after the test the auger bore shall be closed with a wood plug impregnated with Creosote. If the live wood part of the pole cannot be easily recognized visually, chemical method shall be applied instead of it. If non-impregnation is seen in one ore more poles samples are taken these poles (ones found non-impregnated) shall be subject to new impregnation. From this same group same number of sample shall be taken again. If

complete live wood of all of these poles are seen impregnated the rest of this group shall be accepted as impregnated.

- If non-impregnation is seen in the samples taken for the second time, these poles (ones found non-impregnated) shall be subject to new impregnation, and this procedure shall go on like this. The poles impregnated again shall be tested in the same way.

#### 7.5.1.4.3. Determining the Creosote quantity left in the Poles

The total volume of the poles put into the tank and the total weight of it is determined. Total weight of the poles is measured after the impregnation. By subtracting the first weight from the second the weight of creosote left inside the poles is calculated. This weight is divided by the total volume of the poles and the creosote quantity left in the poles per m3 is calculated. This figure shall be  $115 \text{ kg/m}^3$ .

The deduction for the missing creosote quantity shall be calculated from  $usd/m^3$  price, no payment shall be made to the exceeding quantity.

#### 7.5.1.4.4. Impregnation with Salts Soluble in Water

#### 7.5.1.4.4.1. Impregnation method

The poles shall be impregnated by 'Vacuum / Pressure and Full Cell Treatment' method This operation shall be continued until deep impregnating is provided.

Deep impregnating shall be accepted as provided if:

- more than 5 liters per m<sup>3</sup> is deeply impregnated in 15 minutes inside the tank,

- after this, the pressure is kept for 30 minutes

- only when minimum pressure continues for 45 minutes.

#### 7.5.1.4.4.2. Preparation of the Impregnation Solution

The impregnation salt shall be added by introducing slowly into the water in the mixing tank and shall be agitated continuously to provide the melting of the salt. This stirring shall go on for at least 45 minutes. When the mixed preparatus is being prepared the temperature of the water shall be minimum 20°C.

#### 7.5.1.4.4.3. The temperature of Impregnation Solution

The temperature of the impregnation solution shall never exceed 30°C while impregnation. *7.5.1.4.4.4. Impregnation process* 

First vacuum shall be increased to 63.5 cm. mercury in a longer period than 60 minutes. If 63.5 cm. mercury pressure is reached in a shorter time, the vacuum shall be kept until 60 minute time duration is completed.

While this first vacuum is continuing the pressure vessel shall be filled with the impregnation solution. After this vacuum shall be stopped and pressurizing shall start.

Pressure shall be 10.545 kg/cm<sup>2</sup> for Pine.

The last vacuum is the sending of the solution back to the storage tank while taking the poles out from the tank after the impregnation operation and this time duration is 5 to 10 minutes.

The impregnated poles shall not be left inside the solution in the tank for more than 12 hours.

Samples shall be taken with a test auger after the impregnation operation is completed from 10 ea. of the poles of one charge, if the number of poles with inadequate impregnation solution is more than one the whole charge, if the number of pole with inadequate impregnation solution is equal to one that special pole shall be impregnated again.

# 7.5.1.4.4.5. Net Dry Salt Quantity to be used at the Impregnation of Poles and Solution Percentages

For pines the salt preparatus with Copper/Chromium/Boron (CCB) in its composition with % 4 concentration , 350 litre/m<sup>3</sup> and with Copper/Chromium/Arsenic (CCA) in its composition with % 3

concentration, 350 litre/m<sup>3</sup> mixture shall be absorbed.

For pine poles the net average salt quantity to be absorbed with Copper/Chromium/Boron (CCB) shall be  $14 \text{ kg/m}^3$ , with Copper/Chromium/Boron (CCB) shall be  $14 \text{ kg/m}^3$ .

#### 7.5.1.4.5. Impregnation with other Chemicals

If other impregnation materials other than salts of Copper/Chromium/Boron (CCB) and Copper/Chromium/Boron (CCB) is proposed the commercial name, chemical formula and national and international standard shall be given.

- The impregnation material shall be especially appropriate for wood electric poles and average weather conditions.

- The impregnation method shall be explained in details and national and international standard shall be given.

- The net quantity of the chemical material to be used per m<sup>3</sup> or per pole and its resisting duration shall be given clearly and international standard about these shall be given too.

- The country of origin and places used and places being used at present, the institutions/establishments used, the quantities used and obtained results of the proposed chemical impregnation material and the reports and documents of government and private institutions/establishments and research centers shall be given.

- Certificates and results showing the poisoning limit against harmful fungus and insects and penetrating ability.

#### 7.5.1.5. OTHER SUBJECTS

The wooden poles shall fulfil the requirement in Standard B.S 1990 Part 1 or other equivalent internationally recognised Standard. Relevant documentation shall be submitted with the Bid. The Pole shall be good quality, few knots, free from twists, cracks and per formations by insects. Big knots are to be hewn and smoothed.

The first 2 meters from the top of the pole shall not contain more than 3 middling knots. The Poles shall be straight so that straight-line dram between the centre of the top and centre of the bottom shall at no time fall outside the pole and no pole shall have curvature in more than one direction.

The final length of poles shall not exceed the specified length by more than 25 mm for each 3 m of pole. The poles shall not be shorter than the specified length by more than 25 mm for any poles.

If so required by the Employer or the Engineer, representative samples of poles selected at random among lots ready for dispatch, shall be subject to tests in order to verify their conformity with the specification

#### 7.5.1.6. THE MARKING OF THE WOOD POLES

The wood poles shall be marked firmly by aluminium labels, which will contain the following information:

- Type of the tree

- Length (m)
- Top diameter (cm)

- Impregnation material

- Impregnation year

- The Abbreviation of the Firm

Such marked aluminium plackets shall be nailed at 4 meter high measured from the base of the Pole.



#### 7.5.2 Stay Wire

The stay wires shall be hot dip zinc-coated and manufactured from steel. They shall be in accordance with internationally recognised Standard. Such information shall be submitted with the Bid.

The wire shall have the following dimensions and strength:

Nominal area	$52 \text{ mm}^2$
Calculated approximate diameter	9.2 mm
Rated breaking strength	70 kN
Number of strands	19

#### **Stay Wire Accessories**

The following accessories shall be delivered, as specified in the price schedules.

Stay wire tension adjusting device, of the U-bolt type, complete sets with necessary nuts and fittings.

Stay wire attachment devices for attachment to wood or steel pole. The attachment may be preformed grip or clamp type. The device shall be as complete sets suitable for the specified stay wire and its rated strength.

Suitable and matching stay wire anchors for soil and rock shall be supplied as per price schedules.

# 7.5.3 Schedules

# 7.5.3.1 Schedule 'A' - Time Periods To Complete Delivery (Wood Poles and Accessories)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Section: Wood Poles and Accessories	
Items: Wood Poles	
Items: Stay wire and Accessories	

#### 7.6 Works Tests

#### Conductors

Conductors shall be tested in accordance with the following requirements:

#### (a) <u>Samples</u>

Samples of individual wires shall be taken from each length of conductor before stranding and a sample from each length of finished conductor shall be taken at the option of the Engineer.

#### (b) <u>Failure</u>

If a sample should fail, a second and third sample shall be taken from the same length and if one or other of these additional samples fails under tests, the entire length of conductor from which the sample wires are taken shall be rejected.

# (c) <u>Tensile Tests</u>

Tensile tests shall be carried out as detailed in the relevant Standard.

# (d) <u>Wrapping Tests</u>

Wrapping tests shall be carried out as detailed in the appropriate Standard.

#### (e) <u>Resistance Tests</u>

Electrical resistance tests shall be carried out in accordance with the details in the appropriate Standard.

#### **Overhead Line Insulators**

#### General

Type, routine and sample tests shall be carried out in accordance with IEC 60383 on all insulators and insulator string fittings.

#### **Type Tests**

The tests shall prove the required parameters laid down in the Specification. In addition type tests shall be carried out in accordance with IEC 60383 and the following minimum test values shall be obtained for 33 kV:-

	Post		Tension	l
Transverse (pin only) Min Failing Load	10kN			
(Tension)			70kN	
Impulse Withstand Voltage		200kV		300kV
Wet 1 minute power frequency withstand	d			
Voltage	90 kV	r	135 kV	

# **Sample and Routine Tests**

Insulators shall pass the sample and routine tests set out in IEC 60383. In the event of failure under the retest procedure the whole of the batch or batches from which the selection was made will, except at the discretion of the Engineer, be rejected.

# 8 PARTICULAR TECHNICAL SPECIFICATIONS FOR STEEL STRUCTURE

#### General

Steel structures shall be of lattice steel self-supporting, bolted construction.

The structures shall be designed with main dimensions and electrical clearances according to the Employer's standard design.

The structures shall be designed in accordance with BS, ASCE or other recognised standard to the approval of the Engineer.

#### 8.1 Structure types

The types and sizes of structure shall be as described in the schedule of quantities and prices. The types and design shall comply with GEDCo. and Israeli standard practice.

#### **8.2** Accessories to structures

All accessories, such as cross-arms, transformer arms, brackets, bases, bolts, nuts, washers and all other parts necessary for completeness of supply shall be included in the supply and be suitable to the structures as described in the schedule of quantities and prices. All accessories shall be compliance with GEDCo. and Israeli standard practice

#### **8.3** Corrosion Protection

#### 8.3.1 General

All parts of the work shall be protected against corrosion under service conditions. The protection shall also prevent corrosion during transport, handling, storage and erection.

Damage to the protection during transport, handling, erection etc. and jointing shall be repaired to the same quality as specified for the object.

#### 8.3.2 Galvanizing

Except where otherwise specified all ferrous parts shall be galvanized.

Galvanizing shall be applied by the hot-dip process and shall consist of a continuous coating to minimum thickness as follows:

	Average of Specimens tes $\mu m (g/m^2)$	Any ] sted Speci بالم (ع	Individual men tested g/m <sup>2</sup> )
Rolled steel exposed to			
the atmosphere only	t<5 mm	87 (610)	79 (550)
	t <u>≥</u> 5 mm	95 (685)	87 (610)
Rolled steel under ground			
Surface and in contact with ground	215 (1550)	190 (	1370)
Cast iron and malleable iron	87 (610)	70 (	500)
Bolts, nuts and washers	45 ( 3	305)	45 ( 305)

The zinc coating shall meet the requirements according to ASTM A123, A153, A239 and A385, or relevant BS.

All steel shall be fully fabricated before galvanizing, no machine or shop work, boring, punching etc. will be allowed after galvanizing. Minor damage to the galvanizing resulting from transportation and the like shall be repaired at site in an approved manner, e.g. by painting with an approved zinc-rich paint, containing at least 92 weight per cent zinc powder.

After galvanizing all members shall be dipped in a dichromate solution bath to avoid formation of white rust during storage and transportation.

Prior to bundling of towers, after galvanizing, all members shall be completely dry.

Underground parts shall be coated with one layer of bitumen after installation on site.

#### 8.4 Structural Steel

Structural steel shall be made by the open hearth basic oxygen or electrical furnace process, and shall comply in quality with the requirements for ST37-2 in DIN17100 or Grade 43 A in BS 4360. Steel of higher tensile grade if offered, shall comply with relevant DIN or BS Standards.

Only two strength classes may be used, low tensile steel (yield point 220-250

N/mm<sup>2</sup>) and a high tensile steel (yield point 300-350 N/mm<sup>2</sup>).

Steel shall comply with the requirements of ASTM A143 and embitterment tests shall be made in accordance with that specification.

If the Contractor intends to use more than one quality of steel, he will be required to take every precaution to the satisfaction of the Employer or the Engineer against any possible intermixing of different qualities during transport, storage, handling, manufacture and installation.

Cast iron shall have a tensile strength of at least 140 N/mm<sup>2</sup>. It shall be made from the best grey pig and scrap iron and shall be close-grained, tough and uniform in character.

Malleable iron shall be of the black hearth type with a tensile strength of not less than  $330 \text{ N/mm}^2$ .

#### 8.5 Bolted Connections

Bolts shall conform to the requirements of clause **8.6** below Bolted connections may have one bolt only. Minimum bolt spacing is equal to two point five (2.5) times the bolt diameter.

The distance from the centre of a fastener hole to the end and any connected part shall not be less than two (2.0) times the bolt diameter minus five (5.0) mm and the distance to the adjacent edge shall not be less than one point five (1.5) times the bolt diameter.

The distance from the centre of a bolt to the face of the out standing flange of an angle or other members shall be such as to permit the use of a socket wrench, in tightening the nut.

The bolt hole diameter shall be equal to the bolt diameter plus one point five (1.5) mm.

Allowable ultimate bearing stress for bolts as well as members are equal to one point zero (1.0) times the ultimate stress  $F_u$  of the steel.

Allowable ultimate shearing stress for bolts and members is equal to zero point six (0.6) times the ultimate stress  $F_u$  of the steel.

#### 8.6 Bolts, Nuts and Washers

Bolts in poles shall be high strength with M-threads. Connection bolts, step bolts and nuts shall be high strength bolts conforming to ASTM - A325 or equivalent, except as specified herein.

Bolts and nuts shall be of standard design. Nuts shall be tapped after galvanising and the threads of the nuts left bare and greased. Washers shall be used under the nuts. Bolt lengths shall be such as to ensure that bearing is upon the shank and not upon the thread of the bolt. The threaded part shall end within the washer. When installed, the bolt shall project through the nut not less than three (3) mm and not more than ten (10) mm. Taper washers shall be used where required.

An extra 5% bolts, nuts and washers shall be delivered to compensate for loss during construction. The cost of the extras shall be included in the appropriate unit prices in the Prices Schedules.

#### 8.7 Splices

Splices in all members shall be of the butt-splice or lap-splice type. Splices of the main members shall be located immediately above horizontal members or diagonal brace connection.

#### 8.8 Cutting

Members shall be cut, drilled or punched and shaped to jig or by other means ensuring a proper fit. Arris formed by sawing or shearing shall be removed. Cracks and unevenness or sheared surface shall be removed by suitable means. Burrs shall be removed.

#### 8.9 Holes

Final hole diameter may not exceed the corresponding bolt diameter by more than 1.5 mm. Holes may be punched to full size in steel not exceeding 13 mm in thickness provided that the diameter of the hole exceeds the thickness of the material. Holes in steel thicker than 13 mm may be punched to a diameter 3 mm less than final and centre drilled to full size. Steel thicker than 16 mm must not be punched.

Incorrectly drilled or punched holes shall not be refilled by welding.

Cutting and punching may not be carried out at lower steel temperature than  $0^{\circ}$ C.

Detail design shall be such as to avoid as far as possible eccentricities of joints. Pockets or depressions which would hold water shall be avoided. Tubes and similar profiles shall be properly drained.

#### 8.10 Welding

#### **8.10.1** Qualifications for Executing the Welding Work

The welding work on the structures, if employed, shall be performed with a labour management experienced in welding and with skilled welders. The qualifications shall be testified by a certificate.

#### **8.10.2** Execution of the Welding Work

The sequence of welding shall be such as to cause as small deformations and welding stresses as possible.

The welding shall be performed with equipment and in premises suitable for the purpose.

Equipment shall be well suited to the type of weld to be performed so that the right quality shall be attained.

No gaps or hollows may appear in the welding into which acid may penetrate during the pickling procedure preceding galvanising.

The weld shall be ground flush to the surface in such places where the welding bulge prevents a perfect fitting of components together.

A high bulge or uneven weld surface may be levelled out by chiselling or grinding.

#### 8.10.3 Filler Metals for Welding

Standard filler metals shall be used and the strength class and quality shall be chosen to correspond to the base material.

# 8.11 Schedules

# 8.11.1 Schedule 'A' - Time Periods To Complete Delivery (Lattice Steel Poles)

Time Periods shall be stated in weeks from the date of Contract Commencement Date (which is the date of Contractor's receipt of advance down payment against bank guarantee) to the complete delivery.

Section of the works	Time Period (Weeks)
Lattice Steel Poles	

Date:\_\_\_\_\_

Signature of Tenderer:\_\_\_\_\_

8.11.2 Schedule 'B' - Manufacturers, Places Of Manufacture And Inspection (Lattice Steel Poles)

Item	Manufacturer	Place of Manufacture	Place of Inspection
Lattice Steel Poles			
Galvanising			

Date:\_\_\_\_\_\_Signature of Tenderer:\_\_\_\_\_

# 8.11.3 Schedule 'C' - Technical Data for Lattice Steel Poles

The Tenderer shall complete in full all of the information required in these Schedules. Partially completed Schedules will not be accepted.

	Description		
1.	Thickness of zinc coating, steel members	μm	
2.	Thickness of zinc coating, nuts and bolts	μm	
3.	Type of steel for members, lattice structures		
4.	Strength class of steel		
5.	Yield point	N/mm <sup>2</sup>	
6.	Type/class of bolts and nuts		

# 8.11.4 Schedule 'D' – Drawings

The following drawings shall be submitted with the Tender:

Lattice steel poles – standard design 70/80, 80/90, 90/110, 120/130, 140/150 Channel steel pole U14 for MV, 12 m Cross-arms with accessories Anti-climbing devices Channel steel pole U14 for LV, 9 m

8.11.5 Schedule 'E' – Deviation from the Requirements of the Specifications

It will be assumed that the equipment offered will conform to the Specification in all respects, unless departures are mentioned in this Schedule.

No	<b>Description of Deviation</b>	Advantage or result of deviation

# 9 SUBMITTALS

# 9.1 Equipment Data:

Submit full technical data of equipment including, but not limited to, the following:

- 1. Manufacturer's catalogues, detailed description of construction, provisions for extension, compliance with the Standards, dimensions and weights, operating characteristics, operating curves and error curves (PT, CT) for all switchgear, control gear, protective gear, metering gear etc.
- 2. Details of miscellaneous items including pilot lights, cabling or wiring, incoming and outgoing feeder terminal fittings, supports, labels, interlocks, bracing, etc.
- 3. Equipment ratings including:
  - i. Short-circuit rating
  - ii. Voltage
  - iii. Continuous current
  - iv. Basic impulse level for equipment over 600 volts

# 9.2 Shop And Construction Drawings:

Submit drawings for approval including, but not limited to, the following:

- 1. Plans and elevations, with indication of equipment mounted components, dimensions and weights arrangements of equipment and general layouts.
- 2. One-line diagram of power system
- 3. Schematic and elementary diagrams of control circuits.
- 4. Foundation details, grouting holes, base-frames and installation details etc.
- 5. Physical arrangement of incoming and outgoing feeders, terminal fittings and cable terminal sizes, etc.
- 6. Schedule of selected equipment, relays and control gear, with complete identification of each component and its characteristics.
- 7. Protection coordination scheme, including pick-up settings and time-grading, together with time-current curves and range of adjustments etc. as required to coordinate with upstream and downstream protective devices of the complete system.
- 8. Key interlock scheme drawings and sequence of operations.

# 9.3. Operation and Maintenance Manuals:

- 1. Technical description of equipment to ensure that the Employer's staff fully understand the scope and facilities provided.
- 2. Diagrammatic drawings of equipment.
- 3. Schedules (system by system) of equipment installed giving manufacturer, catalogue list numbers, model, rating, capacity and operating characteristics:
- 4. Manufacturer's service manual for each maior item of equipment, assembled including specifically for the project. detailed drawings. illustration, circuit details, operating and maintenance instructions, modes of

operation, control provisions, sequence and interlocks and preventative maintenance program.

- 5. Troubleshooting procedures where applicable
- 6. Manufacturer's lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items which may involve extended deliveries. Instruction books and equipment catalogue cut-sheets.