RURAL ELECTRIFICATION

IN

NORTH-CENTRAL STATE OF NIGERIA

GENERAL SPECIFICATION ON DIESEL POWER STATION AND DISTRIBUTION SYSTEM

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JAPAN INTERNATIONAL COOPERATION AGENCY

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CONTENTS

I. GENERAL

1) This general specification covers electrical, civil and architectual technical conditions required in electrification of rural towns for all towns commonly. Accordingly, for the rating and quantity of the machinery and equipment delivered or constructed for the respective towns, the separate INDIVIDUAL SPECIFICATIONS shall be referred to. Any other matters of requirement not specified in the general specification and individual specifications, including instruction to Contractors, form of bid, form of agreement and conditions of contract, shall be as determined by the Government separately.

2) This general specification provides the special conditions (Chapter II) required for delivery and construction of the machines and equipment, followed by the technical conditions (Chapter III) required for the delivery and construction.

   Further, a schedule of Characteristics is appended for representation in detail of the technical conditions. It specifies the ratings to be observed by the Contractor and shall have the additional ratings of the machines and equipment entered by the Contractor (Chapter IV)

   In Chapter V (Schedule of Components and Unit Price), the composition of the components and units to be delivered in accordance with the characteristics in Chapter IV is shown, and the prices of the components and units shall be entered by the Contractor.

II. SPECIAL CONDITIONS

1. CLIMATIC AND GEOGRAPHIC CONDITIONS

The towns are all situated in the tropical zone. The climatic and geographic conditions are set forth in the following, but they are of general nature. The Contractor is required to investigate the conditions of the specific towns and perform the delivery and construction of equipment in accordance with such conditions.

1.1 TEMPERATURE

Maximum ambient air temperature - Up to 40°C.
Minimum ambient air temperature - Down to 5°C.

1.2 HUMIDITY

Average relative humidity - Up to 70%.

1.3 ALTITUDE

All towns (except) are situated below 1,000 m altitude above sea level.

1.4 RAINFALL

Monthly average rainfall in mm is as follows:

Month	
January	Up to 50
February	Up to 50
March	Up to 50
April	Up to 200
May	Up to 200
June	Up to 200
July	Up to 300
August	Up to 400
September	Up to 400
October	Up to 100
November	Up to 50
December	Up to 50

1.5 WINDS

The wind velocity is up to 120 km/h.

1.6 ISOCERAUNIC LEVEL (I.K.L.)

Severe thunder storms and lightnings are usual. The percentage frequency of the thunder activity decreases to 15.

1.7 EARTHQUAKE

There is no particular earthquake scale to be followed for construction and equipment consideration in this area.

2. CODES, STANDARDS AND UNITS OF MEASUREMENTS

2.1 CODES AND STANDARDS

All design, equipment, materials and workmanship shall comply with and be tested in accordance with the requirements of these specifications, and the latest applicable standards, rules, codes, regulations and recommendations of International Electrotechnical Commission (I.E.C.) and the Laws of the Federation of Nigeria and Lagos (Chapter 57).

The Government will accept materials and equipment which comply with the other National Standards of Contractor who can satisfy the Government that an equal or more severe standard than the above mentioned is ensured.

2.2 UNITS OF MEASUREMENT

All dimensions and units given in the Bids, associated drawings and on all equipment quoted, and references to weights, measures and quantities in all documents and communications are in metric units.

3. SPECIFICATIONS AND DRAWINGS

1) The general specification and appended individual specifications and the accompanying drawings shall have no alterations, revisions or omissions made to their contents except filling the required spaces. Any doubt entertained by the Bidder of the contents of the general specification and separate individual specifications and of the drawings must be

referred to the Government immediately and thus be resolved.

The Contractor shall read the general specification and separate individual specifications well and check the sizes and dimensions in installation of the equipments. Any deviation shall be brought to the attention of the Government for instruction.

Should the Contractor come to believe, upon investigation of the respective towns, that there are better methods available than those set forth in the general specification, separate individual specifications and drawings, he must propose them to the Government immediately for instruction. Particularly, with respect to the distribution route and locations of the power station and substation, he shall investigate them thoroughly for conformance to the local environment (trees, houses, etc.).

2) In execution of the work, any and all items not shown in the specifications but in the drawings or not in the drawings but in the specifications shall be performed under the bid price as if they are written in the drawings as well as specifications. Further, any other items not written in the drawings and specifications but are obviously required to insure efficiency, reliability or safety or for completion of the work shall be worked out as if they are included in the bid price.

4. MISCELLANEOUS

What is written in this Chapter II SPECIAL CONDITIONS is only a part, and the Government shall determine separately.

1) Transportation to site,
2) Storage of equipments and instruments,
3) Accommodation of living and offices for Contractor's staffs,
4) Site services (supply of electricity, water, etc.),
5) Sanitation,
6) Details and procedure of information of the drawing, method of testing, etc., to be submitted by the Contractor to the Government,
7) Information of any connection to the existing electrical equipments,
8) Handling of the existing public facilities (service water and sewer lines, etc.),
9) Treatment of the Constractor in the case of erection,
10) Cautions in commissioning.

III. TECHNICAL SPECIFICATIONS

1. GENERAL CHARACTERISTICS

The general characteristics of the individual devices and materials specified in this specifications and equipments in combination thereof shall conform to the standards specified in Chapter II-2 and be satisfactorily adaptive in current Nigeria.

Frequency	50 Hz
Generating voltage	415/240V (Y–)
High distribution voltage	11kV (Δ)
Low distribution voltage	415/240V (Y–)

Insulation level for high voltage system

BIL (Peak) ..... Not less than 75kV

One minute power frequency withstand voltage (rms)

... 35kV

Fault level for high voltage line ..... Not less than 50 MVA

Grounding system ..... 240/415V - Multigrounding common neutral system

11kV - Non-grounding

2. MATERIALS AND WORKMANSHIPS

2.1 GENERAL

1) Subject to the requirements of this specification, the Contractor shall be responsible for

   i) The general and detailed design and drawings of the power station and distribution system with detailed calculation,

   ii) Checking on the site,

   iii) Transportation of devices and materials,

   iv) Specifications and quantities of the equipments and materials,

   v) Construction of this specification,

   vi) Testing.

2) All materials and equipments supplied by the Contractor shall have a one calendar year period of guarantee beginning on the date of provisional acceptance. During this period, the Contractor is responsible for all defects and shortage that may appear in the equipment.

2.2 WORKMANSHIP

2.2.1 Survey

The Contractor shall be responsible for detailed survey of site of diesel power station, all overhead lines and routes and detailed design of all overhead line structures. It shall be necessary that the detailed survey shall be completed within specified WEEKS of the acceptance of tender with an approval obtained from the Government.

The drawings submitted for the purposes of this Contract are schematic and the routing for the overhead line construction are only approximate. The Contractor shall ascertain for himself these routes and other site conditions by visiting the site before tendering.

The survey must be conducted by competent and qualified personnel capable of understanding the specification.

2.2.2 Design

The Contractor shall fully grasp the current status of the town, construction site and materials and equipments as required by the specification before study and arrangement with the Government of the processes and details of the construction.

Whenever modification or change of the teams of contract or requirements of the 'pecification is required, the Contractor shall consult with the Government to provide simple, harmonized, economical and satisfactory facilities.

2.2.3 Installation

1) The Contractor shall precisely grasp the details of design and perform proper works.

2) The Contractor shall exert every effort to insure smooth performance of the work in accordance with the work schedule with sufficient time given for preparatory works such as determination of the site, cutting or transfer of hazardous trees and bushes to the construction of distribution lines, ground leveling for diesel power station and substation, as soon approval as possible of the site of construction by the Government, check of the supply materials, preparation of survey instruments, etc.

3) The installation shall be performed by skilled workers with a responsible person stationed normally to insure safety of the work.

4) Contacts with the related parts (headquarters, etc.) of the town shall be established in construction to insure smooth performance of the work.

5) The Contractor shall exert effort to prevent injury to the third persons by a dropping object or hole in the road, and also noise.

6) The Contractor shall forward to the Government at the end of each month during the construction period a report giving full details of the progress of the specification during the preceding month, including progress on drawings, manufacture, delivery and erection.

7) Each worker shall have a safety helmet, working clothes and necessary portable tools furnished.

8) Before commissioning, the Contractor shall inspect the construction site and check any omission in the work. When any pole or equipment has its position changed, the Contractor shall indicate the details of such change in the design specifications and submit the same to the Government. The Contractor shall also clear any cable chips, metals and other remaining materials of the construction site. He shall remove any excessive soil and restore the site to the original form as far as possible and keep the site in good order.

9) After commissioning, the Contractor shall perform check of the voltage, phase rotation, etc., to insure that the electricity is fed properly.

2.3 MATERIALS

2.3.1 Guaranty of the Quality

1) All materials used in the contract work shall be of the best quality and shall withstand the changes of temperature and atmospheric conditions encountered under working conditions, without distortion or deterioration or causing undue stress in any part of the equipment.

What is not stated in this specification but is to be provided with as a complete set shall be regarded as included in the specification.

2) Information, characteristics, drawings, etc.

The Contractor shall submit the following:

. Names of manufacturers of all principal items,
. The complete and detailed characteristics of the materials,
. Detailed drawings of each material,
. Detailed program of testing,
. Ancillary equipments and materials required for the work.

2.3.2 Quality Variation

In case that the specification of the manufacturer's equipments does not completely correspond with the required technical specification, the Contractor may propose his own equipment according to the related manufacturer's specification. The Government may or may not accept such proposal.

2.3.3 Using Materials

All materials and parts comprising the units herein specified shall be new and unused, of current manufacture and free from all defects or imperfections affecting performance.

2.3.4 Plates and Labels

Diesel electric generators, switch gears, transformers and other equipments shall have a rating plate of an uncorrosive material fixed at a clearly visible position in a manner durable for a long period. The building fences of diesel power stations, substations and poles shall have attached thereto a plate or label showing the owner, danger indicating and location.

2.3.5 Locks

Where maintenance is required such as the power house and gate of diesel power station, control room and gate of substation shall be provided with locks which can be released by a common key.

Other specific places such as the office and storeroom shall be provided with locks that can be opened by different types of keys.

The locks should be of Yale type or equivalent with no automatic lock mechanism and shall withstand a long period of use.

2.3.6 Lubrication

Oils used for the equipments shall be new and be filtered before use to eliminate any impurities.

Before lubrication, the equipments shall have the inside cleaned thoroughly with a flushing oil.

A check table should be provided for control of the degradation of oil in the respective machines and equipment.

2.3.7 Metal Equipment

a) Bolts, nuts, washers and studs required for assembly of the equipments shall have an adequate strength and structure.

b) The castings shall be free from irregular form or hazardous scars due to improper heat treatment.

c) Welding shall be performed by an experienced worker, with care exercised for selection of a welding machine, adjustment of Co_2 gas and current and selection of a welding rod and also for selection of welded materials and check of the waveform, width, height and length of the weld.

d) All steels shall be protected from corrosion by plating or painting. The outdoor steels shall be of dip brazing.

2.3.8 Operation of Handles and Indication

Operating handles used in equipments for control of an electric circuit shall have an indication made to show the direction of operation.

. With an indication lamp or plate provided to shown the condition of the electric circuit or the equipment as the result of handle operation,
. With care exercised, where two or more handles are provided, for their arrangement to prevent one being taken as another,
. With the applicable standards observed for the color identification, light intensity, sound volume, location and arrangement of the indications.

2.3.9 Defect of Material

No repairs of any kind to defective materials or parts will be permitted.

If defects or imperfections should appear, whether caused by inferior materials, poor workmanship, misalignment, misdesign, poor arrangement or improper storage practices, the Contractor shall replace such equipment or materials with acceptable ones at no additional cost to the Government.

2.3.10 Particular Reference

Particular reference is to be made in the operating and maintenance instructions with respect to

. Diesel power station,
. Substation,
. Overhead line.

For details, the Contractor should concult with the Government.

The instructions must be contained in a flexible covered folder respectively.

2.3.11 Packing

All materials must be packed with care for sea and land transportation.

Each packing shall have the following noted clearly on the surface:

. Country name
. Names of State, Ministry and Project
. Material name
. Specification
. Lot No.
. Sender
. Weight
. Quantity

3. POWER STATION

3. 1 GENERAL

This specification covers the requirements for the supply of power station of unattended operation with complete diesel electric generators (up to approximate 400kW) and relevant equipments (step up transformers, control panels, fuel provision equipments high and low voltage switchgears, D. C. supply system, etc.).

The one line diagram and layout of power station is as shown in the relevant attached drawings (Fig. 1). All designs should be made according to this one line. Generally the design of all power stations shall be such as will permit and facilitate future extensions.

For specification for civil works required for the power station, refer to III-7 "CIVIL WORKS FOR POWER STATION".

3. 2 DIESEL ELECTRIC GENERATOR

The diesel electric generator units shall be operated in an unattended power plant and shall be completely protected against serious damages due to failures of any parts of the unit or auxiliary equipment.

The unit shall be capable of parallel operation with other diesel electric generating units.

3. 2. 1 Assembly

The diesel electric generating unit shall consist of the following parts plus other accessories as necessary to make the generating unit self contained and complete, capable of functioning independently:

1) Diesel engine
2) Alternator
3) Radiator
4) Base plate with necessary vibration insulators
5) Control panel with synchronizing equipment
6) Excitor
7) Voltage regulator
8) Air starting motor or starting device
9) Unit air tank
10) Daily service tank with fuel transfer pump

11) Speed governor

12) Accessories

13) Tools

14) Spare parts

3. 2. 2 Diesel Engine

The diesel engine shall

have four stroke cycle.

develop sufficient kW to drive the alternator with kW-rating as specified in Schedule I, continuously for 24-hour duty.

be capable of 10% overload for one hour.

run at down to 750 min^{-1}.

be vertical straight (in line) engine.

have supercharger if necessary.

This complete unit and alternator should be mounted on a common base plate.

a) Engine Equipment

Items to be provided include, but not limited to, the following:

1) Heavy duty air cleaner.

2) Fuel oil filters (with replaceable elements).

3) Lubricating oil filters (with replaceable element).

4) Pumps and other accessories as required (Heaters if necessary).

5) Manual and electrical speed control governor with remote controls mounted on generator control panel.

6) Lubricating oil priming pump. Electrically (D. C.) and/or manually operated.

7) Radiator.

8) Protection devices-overspeed trip, low lube oil pressure, high cooling water temperature, emergency push button tripping device.

9) Flywheel.

10) Tachometer including running hour totalizer.

11) Visual flow indicator in lube oil, and cooling water systems.

12) Thermometers on water cooling system and lube oil.

13) Pressure gauge on lube oil, cooling water.

14) Lube oil manometer with stopcock.

15) Lube oil cooler for adequate water inlet temperature of adequate size and type for the specific system it must serve.

16) Exhaust silencer.

17) Dialy fuel oil tank for 8 hours full load capacity, pump, indicator.

18) One electrically driven fuel oil transfer pump plus one hand pump connected in parallel.

19) Lube oil tank, as required.

20) Heat insulation for exhaust piping inside the power house along the total length of the pipes.

21) Complete set of water softening equipment, or water still.

22) Standard spare parts for diesel engine and related equipment.

23) Special tools for erection, operations and maintenance.

24) Supercharger, where requested, complete with spare parts, special tools for maintenance, operating and maintenance manuals and test certificate.

25) Common base plate.

26) Fuel consumption meter for each unit.

b) Fuel

The diesel engine shall operate with the fuel of B. S. Class A or equivalent.

c) Parallel Operation and Vibration

The units shall operate in parallel with each other. This shall include the electrical as well as the mechanical features for transient as well as steady state, real and reactive load conditions. The contractor shall be responsible for the coordination between the engine, generator, and governor vendors and for the satisfactory overall operation of the units and all components thereof.

The units and their foundations shall be designed and installed so that there will be no objectionable or damaging vibration and/or resonance alone or in parallel with each other. Satisfactory freedom from objectionable vibration and/or resonance in the foundation shall be construed as maximum amplitude of vibration or oscillation not exceeding 0. 006 cm in any direction measured at any point on the foundation. If unsatisfactory vibration conditions occur in the complete installation, these conditions shall be corrected at the expense of the contructor.

d) Radiator

Each diesel engine shall be supplied with a radiator of sufficient size and type to maintain the operating temperature within the limits specified by, and guaranteed under the warranty of, the engine manufacturer. The radiator shall be cooled by means of a fan driven by an electric motor or driven mechanically from the shaft of the diesel engine, depending upon the type of radiator furnished.

The radiators are to be liberally rated to permit operation of the engine and associated equipment at ten percent (10%) overload at the maximum ambient temperature at site, location.

This radiator shall be of the pressurized type.

This unit shall be complete with all piping, fittings, isolating valves, non-return valves, and all other equipment and accessories necessary to provide a complete and efficient cooling system. For any requirements the cooling system shall meet and comply with, refer to Fig. 4.

e) Lubricating System

The lubricating system of the engine shall be complete and positive in action. All bearings shall be supplied with lubricating oil direct from the lubricating pump through a suitable strainer and an oil cooler for each engine. This lubricating oil shall be carried under pressure to all major wearing parts. When a separate force feed cylinder lubricator is furnished for the lubrication of the cylinder walls, it shall be built on the liquid sight feed principles and shall meter accurately measured quantities of lubricant delivered to points of lubrication.

An efficient oil filtering system shall be incorporated in the engine system and it shall be possible to clean the filter or replace the filtering element without interrupting the flow of oil while the engine is operating. This shall be a full flow type filter with a by-pass or a change-over valve to enable maintenance while engine is running.

For reference purposes, a lubricating system is shown in Fig. 5 by way of example. It is to be pointed out, however, that the requirements illustrated there should be met and complied with.

f) Air Starting System

The diesel engine shall be equipped with an air starting system for compressing and delivering high pressure air to the air starting motor or starting device. The equipment furnished shall include an air starting motor, similar starting device, unit air tank, shut off valves, pressure reducing valve if required, indicating pressure gauge, water draining facilities, and safety relief valves.

The unit air tank shall have a total capacity sufficient to enable the engine to be started three times under normal starting conditions without being recharged. The tank shall be tested at a pressure of 50% above the required starting pressure and a test sheet submitted. The tank shall be supplied complete with pressure gauge, safety relief valve, isolating valve, and water draining facilities.

In this connection, the high pressure air will be supplied by a storage air tank separately to be installed. Compressed air system comprising, among others, the storage air tank and air compressors shall conform to the provisions specified in III-3. 4.

g) Fuel System

1) The injection pumps and injection valves shall be of a type not requiring adjustment in service. The injection pumps to be either separate pump for each cylinder, or rotary type. The system shall be of the pump-timed type, with the amount of fuel being controlled by the governor. The injection valves shall be of the automatic plunger type with approved type of nozzles to insure correct distribution of the fuel oil and efficient combustion.

The fuel system shall have a fuel filter with replaceable elements which may be easily removed without breaking any fuel line connections or disturbing fuel pumps or any other engine parts. It shall be located in an accessible housing ahead of injection pumps so fuel will have been thoroughly filtered before reaching the pumps. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies.

The vent valves shall be installed in accessible locations to rid the entire system of air.

The fuel filters shall be provided with diesel engine and also at the discharge of each fuel oil transfer pump. Filters will be complete with change-over valves so elements may be replaced without interrupting the flow of oil. Filters shall have replaceable type filtering elements.

2) Daily service tank

The diesel engine shall be provided with a daily service tank having a capacity equal to the amount of fuel required to operate the engine under full load condition for a minimum period of 8 hours.

The tank will be totally enclosed and fitted with a suitable cover to give access into the tank for cleaning and maintenance purposes. The tank will be drilled and provided with the necessary fittings to receive the fuel oil inlet, outlet, vent, overflow and drainage connections. A single glass or float level indicator shall be provided.

A fuel oil level indicator of approved design shall be fitted to each daily service fuel oil tank. Level indicator should be plainly marked to be checked from a distance.

The Contractor shall furnish all piping, fittings valves, mounting brakets, etc. required between the fuel transfer pump and the daily service tank and from the daily service tank to the engine.

An electrically driven fuel transfer pump will be provided by the contractor to transfer fuel oil from the storage tank to the daily service tanks. An automatic level control switch shall be installed to maintain the proper level of fuel in the daily service tank.

The fuel oil will be supplied by the storage tank as specified in III-3. 3 "FUEL STORAGE TANK".

h) Governor

An effective governor of an approved design shall be fitted to diesel engine. The governor shall be of the enclosed mechanical type and shall be gear driven either from the camshaft or the crankshaft or electrical type. Governing must be close enough that synchronization with any other set can be easily and quickly performed. The governor is to be provided with a hand and a reversing synchronizing motor capable of adjusting the engine speed to a minimum of 4 % above and below the rated speed. The speed regulation from no load to rated continuous load shall be not greater than 5%.

Under constant load there shall be no hunting. Under fluctuating loads there shall be no persistent movements.

One set of remote controls shall be provided and mounted on each generator control panel for the remote operation of each governor motor.

i) Safety and Protection Equipment

The diesel engine will be fitted with mechanically or electrically operated automatic shut down device of approved design which will automatically operate and shut off the fuel supply to the engine on occurrence of low lubricating oil pressure, or engine overspeed, or engine cooling water high temperature. The device shall be fitted with a separate set of normally open electric contacts to trip the generator fuse free breaker when the automatic shut down device operates.

An overspeed trip shall be provided to cut off the fuel supply when a speed of 10% in excess of the normal speed is reached.

An automatic alarming device shall be provided to actuate visible and audible alarms in the event of low lubricating oil pressure or excessive cooling water temperature.

Safety guards around the flywheel and all exposed drives.

j) Exhaust System

The exhaust system should be equipped with an exhaust silencing equipment which is suitable for the unit and its operation in residential areas. The silencer shall be finished with a high temperature resistant paint and rust prevention against corrosion and oxidation.

The Contractor shall furnish and install all necessary exhaust piping through the building enclosures and necessary flexible connections. The piping shall conform to the requirements of the engine and the system. The piping shall be provided with approved insulation necessary for thermal and acoustical insulations, supports and hangers. An extra set of gaskets should be supplied for all exhaust system.

k) Protective Paint

The piping shall be thoroughly cleaned and painted.

All fuel oil tanks shall be cleaned and coated with an oil resistant paint, varnish, or other approved oil resistant material.

All piping and fittings shall be free from all slag or obstruction that would cause resistance to flow.

l) Cylinder Liners

The cylinder liners shall be constructed of an approved material compatible for use with the metal selected for the piston and rings and they shall also be easily renewable.

m) Flywheel

The flywheel should be statically and dynamically balance and equipped with manually operated barring facilities. The flywheel shall be permanently marked for each cylinder "Top Dead Center" and fuel injection timing marks.

n) Crankshaft

The design must avoid undesirable torsional oscillation at or near the designated running speed. If required by the Government, the eingine manufacturer shall carry out torsion graph tests at the factory at his own expense in the presence of the Government.

o) Bearings

All crankshaft bearing shall be of precision type, steel backed, lined with shells or inserts of high strength and wear resistant material, guaranteed for long life and trouble free service.

3. 2. 3 Synchronous Alternator

a) General

The alternator and related equipment shall be supplied with a nominal output voltage of 415/240 volts. In this case the alternator neutral will be brought to the control panel.

Continuous rated power factor, lagging	0. 85
Connection	3 phase, 4 wire, star
Nominal frequency	50 Hz
Normal speed	according to the engine speed.
Rotor and stator insulation	B or better

The alternator shall be direct coupled to the diesel engine. ' It will be horizontal axle type and self-ventilating. It shall be provided with amortisseur windings to minimize hunting, and to run satisfactorily in parallel with similar generators. Where necessary the alternator shaft bearings shall be insulated to isolate them from shaft currents which could result in bearing damage.

The manufacturer shall supply all curve sheets and data of the alternator and accessories.

The alternator shall be given standard factory electrical tests according to IEC standards.

b) Exciter

Brushless exciters may be offered. Exciter shall have class B sealed insulation. The capacity of the exciter shall be adequate for maximum possible alternator output at low ambient temperature.

The contractor shall take particular care in shipping the alternator to protect against moisture. This precaution is required to avoid having to dry out the alternator insulation in the field.

The exciter shall be given standard factory electrical tests according to IEC standards.

c) Automatic Voltage Regulator

An automatic and quick acting voltage regulator shall be provided for each alternator. It may be either of the electromechanical or the static type. In either case it must be provided with hand/auto change-over switch and hand operated voltage adjusting rheostat for manual operation in case of regulator failure. If this feature cannot be supplied with a brushless exciter, the manufacturer (Contractor) should offer a dynamic type exciter.

It shall be capable of single or parallel operation with other units, and of maintaining the steady state terminal voltage of the machine constant within $\pm 2\%$ of rated voltage from no load to full load, between power factors from 0.85 to unity.

Adjustment should be available for proper division of reactive KVA when operating in parallel with other alternators, including cross-current compernation.

3.2.4 Control Panel

a) General

The control panel shall be free standing and totally enclosed. The construction of the panel shall be of best quality cold rolled sheet steel or equivalent. The panel door shall be in front and rear. The following instruments - controls, switches and annunciation light, shall be installed in the door; but not limited to:

Controlling

AC - ammeters

AC - voltmeter

Voltmeter switch

Frequency meter

Watt meter

Watt hour - demand meter

Power factor meter

Generator start - stop push buttons with light

Voltage regulator off - manual - automatic switch

Parallel - single unit operation switch

Voltage adjustable rheostat

Compensating rheostat

Annunciation lights for:

high cooling water temperature shut down.

low lubrication oil shut down.

overspeed shut down

long starting time.

Synchronizing

Synchroscope

Synchronizing switch

Frequency meter

AC - voltmeter (2 sets)

Removable synchronizing plugs shall be provided on all generator control panels.

The following main items shall be installed inside the control panel, but not limited.

Fuse free breaker

Current transformers

Auxiliary potential transformer

Voltage regulator complete with paralleling unit and manual operating unit.

Relays (short circuit, reverse power, differential overload, etc.)

Terminal blocks

Surge absorbor

All items shall be located and installed in such a way that they are easily accessible for servicing and maintenance and shall be clearly marked for quick reference.

The unit protection, control and annunciation circuit shall be "DC" and supplied by the 110V battery.

b) Wiring

All control cables shall be of copper and of CVV and of extra flexible type with high temperature, flame retarding insulation of ample capacity and voltage rating for the circuits involved, but in no case shall the wiring be less than 1.5 mm^2. All wiring shall be numbered and tagged where terminated. The terminal blocks shall be installed on an easily accessible terminal strip with at least 6 spare terminal blocks. All terminations shall be of the clamp or screw type. All terminations, conduits, ducts and trays shall be furnished by Contractor.

3.2.5 Spare Parts

The supplier shall include in his quotation standard set of spare parts for the diesel electric generator for one year of operation (about 6,000 operation hours).

3. 2. 6 Tools

The Contractor shall furnish a complete set of tools for servicing and maintenance of the diesel electric generator. The Contractor shall work out a list of all the tools required and apply for approval thereof by the Government.

3. 2. 7 Test

a) General

All materials are to be tested according to ICE Recommendation or better method in the presence of the Government at the Manufacturer's works. Copies of certified tests of a prototype unit should be furnished for all major equipment. The units shall be designed to have optimum efficiency at base load output at the continuous maximum rating.

b) Field Tests

1) When the Contractor considers the units to be complete and ready for provisional acceptance tests, be will notify the Government in writing for the acceptance tests. The Contractor shall make such tests on the engine, alternator and associated equipment as set forth in this specification plus any other as may be necessary, to make operation all equipment is functioning properly and that all guarantees are fully met. All tests shall be made in the presence of the Government. The Contractor shall furnish all special instruments and equipment and materials necessary to perform the tests. The Government shall furnish the fuel oil for the tests.

2) Should these tests indicate that the equipment fails in any manner to fulfil the requirements of these specifications and guarantees, the Contractor shall make such changes and adjustments as his own expense as may be required to fulfil the specification and performance guarantee. After the corrections and adjustments are completed, the Contractor shall make a second series of tests in the same manner as the first.

3) If the second series of tests indicate that the equipment covered by this specification fails to meet the guarantee or fails to operate satisfactorily, the Government shall have the right to operate the equipment until the defects have been corrected and the guarantees met. In the event that defects necessitate rejection of any portion of the equipment, the Government shall have the right to operate the equipment until such time as new equipment is provided to replace the equipment rejected. In the event the equipment furnished by the Contractor fails to fulfil the contract agreement of the Performance Guarantee, the Contractor shall replace the faulty equipment or materials at no additional cost to the Government. Should this cause a delay in the commissioning date by the Government and the Contractor, the Contractor will be assessed a penalty in accordance with the conditions of the contract.

4) The equipment covered by this specification will not be accepted by the Government until the tests and operation have thoroughly demonstrated that the equipment fulfile the specifications and the performance guarantee. Under no conditions will a part of the equipment to accepted pending the completion of erection or replacement of defective parts or materials. The contract must be completed as a whole and functioning satisfactorily before the Contractor is released from his initial obligations. The acceptance test shall be carried out as follows:

5) The diesel electrical generator and all auxiliary equipment will be tested under full load conditions for twenty four (24) consecutive hours or under conditions of equivalent testing.

Test period will be 24 consecutive hours of full load plus one hours of 10% overload. This overload will be interpreted as one hundred and ten percent (110%) of the rated capacity of the unit being tested under site conditions. The hours of overload shall be continuous, not broken into segments of an hour.

The engine and auxiliary equipment protection devices must be demonstrated. This will include, but not limited to, the following:

i) overspeed trip; ii) overload; iii) high cooling water temperature; iv) low lubricating oil pressure.

This will include all alarms, both visual and audible, and shut down devices.

All electrical equipment shall be demonstrated. This will include, but not limited to, the following:

i) earth fault relay; ii) reverse current relay; iii) overcurrent relay; iv) differential relay.

3. 2. 8 Miscellaneous

Each Contractor shall include the following, but not limited to:

1) A detailed description and specification of the diesel engine, alternator and auxiliary equipment.

2) Location in Africa or elsewhere, where similar units are installed and used for pow power generation.

3) Calculations of unit power output.

4) Fuel consumption figures.

5) Description of lubrication oil system

6) A representative sample of technical literature and specifications in English.

7) Description of fuel system.

8) List of spare parts to be supplied with unit.

9) List of tools to be supplied with unit.

10) A detailed description of test facilities available at his factory to test the diesel electric generator.

11) A description of service facilities in Nigeria.

12) A description of special features.

13) A list of optional accessories, other than those specified, which may be available for the engine, indicating current selling price of each accessory.

The Government reserves the right to reject any bid in the event that the above information or any part thereof, is not furnished with the tender.

3. 2. 9 Name Plates

Name plate to be furnished shall include, but not limited to, the following information:

Engine

Make
Type
Serial Number
R. P. M.
Model or Date of Manufacture.
Horse Power

Generator

Make
Type
Serial Number
K. V. A.
R. P. M.
Frequency
Phase
Volts
Amps.
Power Factor
Class of Insulation
Type of Connection
Model or Date of Manufacture

Excitor

Make
Type
Serial Number
KW
Volts
Amps.
Model or Date of Manufacture

3. 2. 10 Capacity of Diesel Electric Generator

Should the Diesel electric generator the Contractor may intend to supply have a rated output different from the nominal value (with tolerance allowed from -10% to +15%), the supplier shall apply for approval thereof by the Government. In such a case, the Contractor shall furnish such electrical equipment as shall correspond to the generator unit.

3.3 FUEL STORAGE TANK

The tanks shall be complete with connections for filling and supply headers, drain and recirculation lines. The tanks shall have an upper manhole, remote level indicator and vent connection. The piping between the fuel storage tank and fuel transfer pump of each daily service tank shall be supplied and installed by Contractor.

For reference purposes, the fuel system is shown in Fig. 2 by way of example. It is pointed out, however, that the requirements illustrated there should be met and complied with.

3.4 COMPRESSED AIR SYSTEM

3.4.1 General

As shown in Fig. 3, the compressed air system shall consist of two (2) motor driven compressors and as engine driven compressor for use in case of outage of the power station, as well as a storage air tank.

Valves, indicators and safety devices shall comply with the provisions specified in III-3. 2. 2-f) "Air Starting System".

The electrically driven compressor shall operate automatically.

3.4.2 Compressed Air System Panel

The panel shall be free standing and totally enclosed. The following instruments controls, switches shall be installed in the door and inside, but not limited:

- Magnetic Switches (2 sets or more)
- Voltmeter
- Ampermeter (2 sets)
- Control Switches
- Automatic starting and stopping equipment
- Others

The detailed specifications of panel and wiring shall conform to the specifications given in III-3. 2. 4 "Control Panel".

3.5 L. V. DISTRIBUTION BOARD

3.5.1 General

The board shall be metal clad, free standing, floor mounted and totally enclosed. The board shall be indoor type suitable for use in an ambient air temperature of 40°C. The board as specified, is required for installation in the power house.

The board as described above shall consist of, but not limited to, the following equipment.

- Busbar
- Fuse free breakers

- Knife switches
- Ampermeter
- Current transformers
- Aux. potential transformers
- Others

3. 5. 2 Bus Bar

Three phase and neutral copper bus bar 415/240V 50Hz shall carry rated current continuously with down to 10kA short circuit capacity.

3. 5. 3 Fuse Free Breaker for Distribution Board

Refer to III-3. 11. The detailed specifications of panel and wiring shall conform to the corresponding specifications given in III-3. 2. 4 "Control Panel".

3. 6 STEP UP TRANSFORMER

L. V. bus is connected with the step up transformer. More details see III-5. 1.

3. 7 11 kV SWITCHGEAR BOX

3. 7. 1 General

The switchgear shall be indoor metal clad totally enclosed type and so designed that it can be extended at either end with panels of the same dimension and with arrestor box. It shall be rated a minimum 150 MVA with 100 amp, 3 phase, bus bars.
The panel shall be complete with all necessary interconnection, cable sockets, small wiring, and all instruments and devices shall be labeled.

Test terminal blocks for current and voltage measuring, metering, relaying, and regulating circuits.

All necessary potential and current transformer.

Alarm bell or horn.

3. 7. 2 Circuit Breaker

The circuit breaker shall be of the horizontal or vertical isolation, horizontal draw-out type, with a test position. It may be either bulk oil, or small oil content type. In all cases it shall have a minimum continuous rating of 100 amp and a minimum interrupting rating of 150 MVA.

It shall be of the stored energy type with springs automatically motor loaded or, in case of emergency manually by crank. The operating mechanism should be capable of carrying out the following operative cycles, without springs being reloaded:

- With breaker "open" and "springs" loaded: closing - opening.
- With breaker "closed" and "springs" loaded: opening - closing - opening.

1) Indicating lamps (red, green and white) on front of panel board to show "closed" "open" and "test" position of breaker.

2) Circuit breaker control switches or push buttons on front of panel.

3) Automatic safety shutters in breaker cells.

Circuit breaker shall be designed, tested and operated in accordance with the recommendation of I. E. C. below the latest revision thereof.

I. E. C. Publ. 56 - 1～6

3. 7. 3 Current Transformer and Potential Transformer for Box

Current transformers and potential transformer shall be mounted inside of the switchgear box. More detailes see III-3. 12 and III-3. 13.

3. 7. 4 Panel

All items III-3. 7. 1, III-3. 7. 2 and III-3. 7. 3 apply plus:

1) A. C. ampermeter with selector switch for reading all phase currents.

2) Voltmeter

3) Watthourmeter - demand meter

4) Three (3) very inverse phase overcurrent relays and one over voltage grounding relay. Two relay test plugs with necessary accessories shall be furnished.

The detailed specifications of panel and wiring shall conform to the corresponding specifications given in III-3. 2. 4 "Control Panel".

3. 8 ARRESTER BOX

An arrester shall be provided at the sending point of 11kV distribution system. The arrester box shall be connected to 11 kV switchgear box either by the bus bar or by the power cable and arranged to have the same layout as 11kV switchgear box.

For any further details of the arresters, refer to III-5. 2.

3. 9 D. C. - SUPPLY

D. C. - supply system shall consist of battery, battery charger, D. C. distribution panel and emergency D. C. generator. D. C. - supply system shall be made in accordance with Fig. 6.

3. 9. 1 Battery

Batteries shall be high performance vented type nickel cadmium alkaline. The system shall be complete with all necessary battery racks, metering and instrument control

boards. The capacity of the battery should be sufficient to supply the maximum power requirements of the installation for:

1) Indication.

2) Control.

3) Alarm circuits.

4) Emergency lighting.

5) Circuit breaker tripping and closing if necessary.

D. C. battery shall be manufactured and tested in accordance with IEC Publ. 285, 285-1, 285-1A.

3. 9. 2 Battery Charger

The automatic completely self contained battery charger with adequate capacity shall be supplied. The float charge rate shall be adjustable and the equalizing charger shall be automatically in certain intervals. The charger shall be capable of charging a completely discharged battery to full charge in about ten hours while simultaneously supplying the station demand.

The charger shall be of the self regulating type which will automatically adjust the charging rate to maintain desired battery cell voltage. The nominal input voltage is 240 V, A. C. 50 Hz.

At any tapsetting the voltage regulator shall regulate the voltage within plus and minus one percent of regulator setting with an A. C. supply voltage variation of plus or minus ten percent. An externally operated device shall be furnished for adjusting the charging voltage. The rectifiers of the charger shall be the full wave silicon type. Adequate automatic protection for over loads shall be provided. An alarm shall be provided, to operate upon failure of charging current whether it is due to A. C. line failure, internal charger failure or any other circumstance which causes the output voltage of the charger to fall below the battery voltage. The charger shall be enclosed in an adequately ventilated, free standing, metal cabinet arranged for easy access to internal equipment. A voltmeter and an ammeter shall be provided on the load side and a voltmeter and 3 way switch on the line side.

3. 9. 3 D. C. Distribution Panel

The D. C. distribution panel board shall consist of a two pole main fuse free breaker with ample interrupting capacity and with instantaneous trip capacity for heavy short circuit current, and a two pole fuse free breaker for each feeder circuit, all enclosed in a suitable metal cabinet. An ammeter for measuring discharge current of the battery and voltmeter to indicate voltage shall be provided on this panelboard.

The detailed specifications of panel and wiring shall conform to the corresponding specifications given in III-3. 2. 4 "Control Panel".

3. 10 SUPERVISORY PANEL

The supervisory panel shall be installed in the control room for continuous and permanent supervision of the whole equipment and apparatus in operation.

The panel shall be metal clad, free standing and totally enclosed. The panel shall consist of, but not limited to, the following equipment.

- Ampermeter for each diesel electric generator.
- Ampermeter for each 11 kV feeder
- Frequency meter for L. V. bus.
- Voltmeter for L. V. bus.
- Annunciation lights
- Alarm

The detailed specifications of panel and wiring shall conform to the corresponding specifications given in III-3. 2. 4 "Control Panel".

3. 11 FUSE FREE BREAKER (AIR CIRCUIT BREAKER)

The fuse free breaker shall be able to break the short circuit current automatically at rapid speed. It shall consist of switching mechanism, arc extinguishing device and tripping unit.

3. 11. 1 Switching Mechanism

The switching mechanism is a quick-make/quick break type utilizing a trip-free toggle mechanism.

3. 11. 2 Arc Extinguishing Device

When the moving contacts are opened, the arc moves from the moving contacts into the divided chamber, and then the arc is confined and extinguished.

3. 11. 3 Tripping Unit

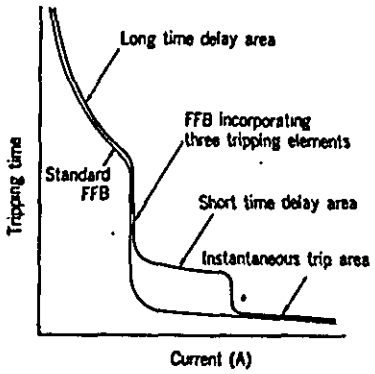
The tripping unit is produced in two types; a thermal-magnetic type and a full-magnetic type.

3. 11. 4 Switching

The breaker can be opened by D. C. 110 V signal as well as manual.

3. 11. 5 Characteristics of Tripping

When Contractor is required in this specification, Contractor shall supply the fuse free breaker with THREE TRIPPING ELEMENTS. This breaker is provided with a short time-delay element in addition to the long time-delay and instantaneous tripping. (see figure)
This breaker prevents the series tripping of breakers.



Overcurrent Tripping Characteristic of FFB Incorporating Three Tripping Elements

3. 12 CURRENT TRANSFORMER

The current transformers shall comply with the latest revision of the "IEC-Recommendation", Publication 185

The secondary winding of each current transformer shall be earthed at one point only. The current transformer shall be capable of carrying the rated primary current for a period of one minute with the secondary windings open circuited. Where the open circuit secondary voltage under such conditions would exceed 3. 5 kV, suitable protection is to be provided at the secondary terminals to limit the voltage.

Current transformers provided for protective relaying purposes shall have overcurrent and saturation factors not less than those corresponding to the design short circuit level of the system.

The primary and secondary terminals of the current transformer shall be marked clearly and indelibly either on the surface or in the immediate vicinity.

3. 13 POTENTIAL TRANSFORMER

The voltage transformers shall be manufactured and tested in accordance with IEC Publication 186 or the latest revision thereof.

The voltage transformers shall be suitable for measuring and protection purposes.

The voltage transformer's secondary and tertiary circuits shall be complete in themselves and shall be earthed at one point only.

3. 14 OVERHEAD TRAVELLING CRANE See, item III-7 "CIVIL WORKS"

3. 15 STATION LIGHTING See, item III-7 "CIVIL WORKS"

3. 16 EARTHING See, item III-7 "CIVIL WORKS"

3. 17 LIGHTNING See, item "CIVIL WORKS"

3. 18 WATER SOFTENING

For supplementary feed of water to the radiators, a complete set of water softening equipment or water stills having such a capacity and a softening possibility as may be required shall be provided after a field water survey.

4. DISTRIBUTION SYSTEM

4. 1 BASIC INFORMATION

4. 1. 1 General

1) Technical specification for high-voltage (H. V.) and low-voltage (L. V.) town system is given here to cover the equipment and materials required for power supply by distribution line to the towns, the Government is planning to electrify and such public facilities as secondary schools and hospitals lying scattered on their out-skirts, and the installation works thereof.

2) For specification purposes, the town distribution system is classified into:

Overhead line supported on poles.
Substation.
Underground line with cables laid.
Street lighting system.
Service connection.

3) This specification is worked out as a standard one on the basis of the I. E. C. standards, the Laws of the Federation of Nigeria and Lagos Chapter 57, NEPA's standard drawings and British Standards. Anything not specified herein but required for a complete distribution system shall be deemed implicitly to form an integral part of this specification.

4) For earlier electrification of the towns and easier maintenance, utmost efforts shall be made to use as far as possible such equipment and materials, to say nothing of system design, as actually adopted by NEPA.

4. 1. 2 Outline of System

The distribution system hereinafter specified in details shall meet the requirements outlined below:

Type of supports	Concrete pole or wooden pole 10 m (33 or 34 ft.) 8. 5 m (28 ft.)
Note: The type of supports shall be subject to the instructions given by the Government.	
Type of conductors	H. V. A. A. C. 50 mm^2 bare L. V. A. A. C. 50, 100 mm^2 bare Covered conductors for line and jumper
Length of span in town area	40 m
outside town area	80 m
Type of insulators	H. V. Pin and disc L. V. shackle
Number of conductors	H. V. 3 L. V. 4 Street lighting 1
Capacity of transformers	Outdoor type 100 kVA 200 kVA.

Type of cables	H. V.	paper insulated cable or CV cable	70 mm^2
	L. V.	PVC	70 mm^2, 150 mm^2

4. 1. 3 Mechanical and Electrical Design

a) Mechanical Design

1) General

Below described are the essential requirements for mechanical design.

2) Strength of Poles

i) Concrete poles shall normally be capable of withstanding without deformation and transverse loads are as follows at 60 cm (2 feet) from the top.

8. 5 m (28 feet)	150 kg design load
10 m (33 or 34 feet)	300 kg design load

ii) Wooden poles shall meet the requirements specified in Table III-3 given in 4. 2. 4.

3) Length of Span

Average length of span shall be as follows:

40 m in town area.
80 m outside town area.

In this connection, design shall be made to allow for the conditions given below under (i) temperature of conductors and (ii) wind pressure.

Note:

i) Temperature of conductors

Average temperature	25° C (77° F)
Minimum temperature	5° C (40° F)
Maximum temperature	65° C (150° F)

ii) Wind pressure

on conductors
inside town 58. 6 kg/m^2 (12 lb per sq. foot)
outside town 87. 9 kg/m^2 (18 lb per sq. foot)

on poles
146. 5 kg/m^2 (30 lb per sq. foog) – plane surface.
87. 9 kg/m^2 (18 lb per sq. foot) – diametrical plane of a cylindrical surface.

on H poles
1. 5 times as high as those on poles.

4) Saggings

Stringing shall be so made that the maximum stress on conductors may be kept at 8 kg/mm^2 or less.

The minimum saggings (maximum stresses) are given at minimum temperature with wind load and the maximum saggings at maximum temperature without wind load.

5) Strength Requirements for Joints

The tension clamps and tension joints shall not permit slipping-off, or cause damage to, or failure of the conductors at a load less than 95 per cent of the ultimate strength of the corresponding conductor.

Non tension joints shall not permit any slip or damage of the jumper connections at a load of less than 30 per cent of the ultimate strength of the conductors, and of other connections at a load of less than 5 per cent of the conductors.

6) Safety Factor

This specification requires design to be so made as to maintain the safety factor at the following values.

concrete pole	2.5
wooden pole	4.0
steel crossarm	3.5
stay wire	2.5
steel parts	3.0
conductor	2.0
foundation	2.5

b) Electrical Design

The whole equipments installed in accordance with this specification shall meet the requirements specified in III-1 "GENERAL CHARACTERISTICS", while it is in connected conditions. On the other hand, for any portion where current is to be applied, selection shall be made of such materials and construction as may correspond in current rating and temperature rise to the specified conductors, cables and transformers.

Especially at joints, no equipments shall be allowed to present a temperature rise higher than that of the corresponding conductor when any current passes through this parts.

4.1.4 Clearances

Clearance requirements are given in Table III-1.

Table III-1 CLEARANCES (AT MAXIMUM DESIGN CONDITION)

	CONDITION	11 kV	L. V.
(a)	Bare conductor to ground level across streets and roads	5. 80 m (19')	5. 80 m (19')
(b)	Bare conductor to ground level along streets and roads	5. 49 m (18')	5. 19 m (17')
(c)	Bare conductor to ground level in places inaccessible to vehicular traffic	4. 88 m (16')	4. 58 m (15')
(d)	Bare conductor to any part of a fence, wall, building or other structure upon which a man may stand or against which a ladder may be placed.	3. 05 m (10')	3. 05 m (10')
(e)	Over-head line phase centres	76. 25 cm (2' 6")	20. 32 cm (8")
(f)	Vertical clearance between different voltage on the same support. 11 kV and L. V.	122 cm (4')	-
(g)	11 kV conductors and insulated P & T wires	122 cm (4')	-
(h)	Neutral conductor of L. V. system to P & T wires.	-	61 cm (2')
(i)	Minimum clearance for rigid jumper connections.		
	Phase to phase	25. 4 cm (10")	15. 24 cm (6")
	Phase to earth	20. 32 cm (8")	5. 08 cm (2")
(j)	Maximum unsupported jumper length on structures carrying conductors at different voltages	152. 50 cm (5')	-
(k)	Minimum clearance from conductor to buildings		
	horizontal	3. 05 m (10')	2. 44 m (8')
	vertical	3. 05 m (10')	0. 61 m (2')
(l)	Minimum clearance between conductors of different voltages on substation structures.	61 cm (2 ')	-
(m)	Crossing of P & T line vertical	2. 44 m (8')	1. 04 m (3. 5')
(n)	Minimum clearance from transformer to fence	1 m (3. 5')	-

Note: The vertical clearance shall be measured at a temperature of 65° C, and the horizontal clearance shall be measured when the line is at a maximum deflection from the vertical, due to wind pressure.

4. 2 OVERHEAD LINE

4. 2. 1 Type of Poles

Those poles which are to constitute a main element of the overhead distribution line are classified into the following types:

Classification I
- High voltage only
- High and low voltage common use
- Low voltage only

Classification II
- Intermediate poles
- Angle poles 5° - 20°, 20° - 45°, 45° - 90°
- Section poles
- Tee-off poles
- Terminal poles

Classification III
- Single poles
- Double (H) poles

The type of poles classified above are shown in Fig. 7 to Fig. 9. For any further details, refer to Fig. 10 to 38.

4. 2. 2 Assembly and Parts

Assembly and parts for overhead lines are given in Table III-2.

Table III-2 LIST OF ASSEMBLIES AND PARTS

Assemblies	Parts
Concrete Pole (Wooden Pole)	10 m (33 or 34 feet) 8 m (28 feet)
Cross-arm Assembly	cross-arm 2. 24 m 1. 63 m 2. 5 m or more strap cross-arm and strap bolts with nut and washer
H. V. Pin Insulator Assembly	Pin insulator with pin binding wire armour tape hard aluminum strap
H. V. Disc Insulator Assembly	disc insulator strain clamp (4 bolt) socket crevis insulator hook cross-arm strap

Assemblies	Parts
L. V. Shacke Insulator Assembly	L. V. shackle insulator D iron with shackle bolt and pin shackle strap
Stay Assembly	stay wire stay insulator stay rod stay wire balk bands
Earth Assembly	earthing lead earthing rod earthing wire capping staple earthing clamp
Foundation	concrete base balk stone concrete with aggregate
Accessories	danger plate number plate barbed wire bind wire
Conductors with parts	A. A. C. 50 mm^2 bare 100 mm^2 bare covered conductors for line covered conductors for jumper strain clamp, tension joint non tension joint

4. 2. 3 Construction of Lines

a) Distribution Line

1) Every overhead line shall take it route along the road or by the roadside.

2) Every pole for overhead lines shall be so located as to avoid any undue obstruction of pedestrian or vehicular traffic.

3) Where any overhead line is erected parallel to a wire fence the supports, where practicable, shall be at such a distance from the fence that a vertical line taken from the end of the cross-arm nearest the fence will touch the ground at a distance of not less than 1.53 (5') from the fence.

4) Where poles are erected on both sides of a street, they shall, where practicable, be placed opposite each other.

5) Where an overhead line crosses any street within which it is erected, any angle formed by the street and the line crossing the street shall not be less than 45°. This specification shall not apply to street intersection where the line does not change its direction.

b) Post Office or Telegraph Line Protection

Where an HV line is erected and crosses a post office or telegraph line (P & T line), the latter must be protected against contact with the former. The following alternatives may be used:-

i) Use covered conductor.
ii) Use underground cable.
iii) A cradle guard under the H. V. lines in accordance with B. S. 1320.

Where an overhead line crosses or is in close proximity to a P & T line of the Posts and Telegraphs, Ministry of Communications, it must comply with the special requirements of the Ministry of Communications.

c) Railways, or River and Other Overhead Line Crossings

1) Where an overhead line to this specification is erected along or across a railway or river it shall comply with Nigerian Statutory Regulations for such crossing. Away leave must be obtained from the Railways Authority.

2) The span where the line crosses the railway shall be kept as short as possible, and shall not exceed 30 m (100 feet) in length where practicable. No pole shall be placed at a less distance from the nearest rail than 4 m (12 feet) without the consent of the Railway Authority.

The minimum clearance above rail-level shall be 8 m (27 feet) for all H. V. lines and 7 m (24 feet) for L. V. lines.

3) At all navigable rivers the distance between maximum conductor sagging and high water level shall not be less than 9 m (30 feet).

4. 2. 4 Poles

a) Description of Poles

1) The poles for overhead line conductors shall be one of following:

Prestressed reinforced concrete poles
Fully creosoted wooden poles.

Though light in weight, manually transportable and easy to handle, wooden poles are rather short in service life because of decay, unapplicable in particular at such places as may be rather high in humidity or liable to be affected by animals and insects, and require much labor in drilling bolt and nut holes. From the standpoint of construction and maintenance, it can therefore be concluded that concrete poles have advantages over wooden poles. The Contractor shall, however, follow the instructions given by the Government on final selection between concrete and wooden poles. Description given below applies mainly to concrete poles.

2) In case use is made of imported poles, the Contractor shall give proof of their superiority in mechanical and chemical properties to the corresponding poles domestically produced in Nigeria and, at the same time, shall apply for approval by the Government of possible modifications of assembly required by difference in construction.

b) Pole Lengthes and Their Respective Application

1) For simplification, poles shall be available in two different lengthes, 10 m (33 ft or 34 ft) and 8 m (28 ft).

2) As specified below, application of poles shall vary according to their length.

10 m (33 ft or 34 ft) Nominal

1. 11 kV lines (B. S. 1320 construction)
2. Combined 11 kV and L. V. lines
3. H-poles for 11 kV and L. V. lines
4. H-poles for substation

8 m (28 ft) Nominal

1. L. V. lines
2. Flying stays poles
3. Service poles (general use)

c) Concrete Poles

1) Use shall be made of prestressed concrete poles. For this purpose, selection shall be made between poles domestically produced in Nigeria and circular poles. The former have a constructional fault that their top and edges are liable to chip, while the latter are so strong in construction that they are hardly broken off. But the former are locally manufactured in Nigeria and readily made available for local procurement. With this taken into consideration, the Contractor is requested to use prestressed concrete poles domestically produced in Nigeria and try its utmost in design to cover up their fault.

2) Concrete poles shall have a length of either 8 m or 10 m and a shape as shown in Fig. 10. 8 m poles shall be 10.7 cm x 8.3 cm in top size and 31.8 cm x 22.2 cm in butt size, while 10 m poles shall be 10.2 cm x 8.9 cm and 38.1 cm x 26.5 cm respectively.

3) Each pole has holes. The centre line of the highest-hole shall be 15 cm (6", 10 m pole) and 10 cm (4", 8m pole) from the top of the poles.

4) Concrete poles shall be manufactured on the basis of B. S. 607 with special attention paid to the following requirements.

i) Cement in use shall be portland cement specified in B. S. 4027 or more than equivalent. After molding, cement shall be sufficiently tamped and cured.

ii) Water in use shall not contain harmful quantities of oil, acid, alkali, salt, organic matters and such other matters as may badly affect the quality of concrete and reinforcing steel.

iii) Aggregate in use shall be clean, strong and high in durability and shall not contain harmful quantities of dust, dirt, organic matters, etc.

iv) Reinforcing steel shall be free from any such rust and oil as may reduce adhesion of concrete and assembled in such a manner as shall allow it to be fixed in correct position. Reinforcing steel shall never be provided with any joint.

v) For the purpose of earthing pole-mounted steel fittings, each and every pole shall be provided inside with a copper earth wire to connect the upper part (below the cross-arms) and the lower. (underground part)

d) Wooden Pole

1) The basis for the preparation of wooden poles is the specification for wood poles. (Nigerian Standards Organization).

Table III-3 POLE DIMENSIONS FOR CLASSES AND SPECIES

Pole Class			EX:H.	V. H.	H	M	L	V. L.	EX:L.
			Extra Heavy	Very Heavy	Heavy	Medium	Light	Very Light	Extra Light
Load Applied 61 cm from Top (KN)			24.5	20.0	15.6	11.1	8.9	6.7	5.3
Minimum Top Diameter (cm)			22.9	20.3	17.8	15.2	14.0	12.7	10.2
Pole Length (m)	Butt to Ground Line (m)	Species	Minimum Pole Diameter 1.52 m from Butt (cm)						
8.54	1.52	ID	34.9	32.4	29.8	26.7	24.8	22.9	20.9
		OP	28.6	26.7	24.8	22.2	20.3	18.4	17.1
		TE	26.7	24.8	22.9	20.3	19.1	17.1	15.9
10.06	1.84	ID	36.8	34.3	31.8	28.6	26.0	24.1	22.2
		OP	29.8	27.9	27.3	23.5	21.6	19.7	18.4
		TE	28.6	26.7	24.1	21.6	20.3	19.7	17.1

Abbreviation: D - Idigbo; OP - Opepe; TE - Teak.

2) The poles shall be pressured impregnated with creosote.

3) They shall be Nigerian Opepé or other suitable wood pole. If imported wood poles are being used, there shall be red firm or european larch and this fact must be stated.

4) A template shall be used for marking off the poles required for securing the cross-arm and its tie straps or struts in order that the pole shall be level when the pole is erected, the centre line of the template shall be placed parallel to the effective centre line of the pole. Each pole shall be drilled, scarfed and marked as shown on the drawings. This marking shall indicate the overall length, diam, species of wood, year of creosoting etc.

e) Installation of Poles

1) Pole Selection

i) Wooden poles even of the same length usually have difference in top diameter and annual ring density. For such important poles as tee off poles, selection shall therefore be made of poles large in thickness and high in annual ring density.

ii) Concrete poles shall be subjected to an appearance check to see whether or not they are provided with holes in correct position and shape or they have any portion broken off or chipped. For such important poles as tee off poles, selection shall be made of the best possible poles, just as in the case of wooden poles.

2) Description and Application of Drilling Mehtods

i) Circular drilling shall be adopted, in principle, for drilling pole erecting holes.

ii) In hard soil with little subsoil water, pole erecting holes shall be drilled, in principle, by the circular drilling method. In places where there is much subsoil water, soil is rather soft or there are a number of buried structures, however, step drilling shall be adopted instead for drilling pole erecting holes.

Note: In sandy soil or in places where mud and sand may prevent smooth drilling, the drum can process will provide an effective means of drilling pole erecting holes (the drum can process is a method of drilling a pole hole and erecting a pole by inserting a drum can split in halves with the upper and lower covers removed into the pole erecting hole to prevent the surrounding earth and sand from falling down).

iii) Pole erecting holes shall be as narrow and small as possible with thickness of pole butt, depth of embedment and attitude after erection taken into consideration.

iv) Drilling shall be conducted with special care in such places as may have some structures buried in the ground and, if any, care should be taken not to cause any external damage to them.

v) In case soil is so soft as may slide or fall down, preventive sheathing shall be provided.

vi) In case of subsoil water in drilled holes, appropriate drainage shall be provided.

3) Standard depth of embedment of the poles shall be as specified below:

Pole length	8 m (28 ft)	1.5 m
	10 m (33 or 34 ft)	1.8 m

For standard compensating depth of embedment in places with inclined shoulders, however, compensation shall be made as shown in Fig. 32, 33.

In swampy areas, standard compensating depth of embedment shall be: standard depth of embedment + 0.3 m.

4) For back-filling purposes, soil shall be sufficiently tamped and, if necessary, compacted by sprinkling. In addition, after a fixed period of time, an investigation shall be conducted to check for depressions and, if necessary, banking shall be provided.

4.2.5 Cross-arm Complete

1) For high-voltage lines, use shall be made of hot dip galvanized steel cross-arms of long service life.

2) Standard cross-arms shall have a size of either 1.63 m or 2.24 m. For use is such places as may require a span length of far more than 80 m or be in special conditions, however, cross-arm size shall individually be studied and decided.

3) Application of cross-arms shall vary with the type and size as listed below in the tabulation.

Table III-4 APPLICATION OF CROSS-ARMS

Type and Size	Conductor Spacing	Condition of Use
"L" or "Γ" 1.63 m (5'-4")	76.25 cm (2'-6")	For pole types other than those listed below.
"L" 2.24 m (7'-4")	106.6 cm (3'-6")	For poles installed at a span of 80 m. For poles with an angle of 20° or more H poles Railway or river crossings Where it is necessary to provide wider conductor spacing than the normal 76.25 cm (2'-6").
"L" 2.5m or more	more	H poles Special poles for spans larger than 80 m.

4) Bolts and nuts shall be used for securing the cross-arms, straps. Washers shall be fitted between the head of the bolt and the pole.

4.2.6 Insulators

a) General

For insulation of the distribution lines, use shall be made of porcelain insulators as specified in B.S. 137 or by I.E.C.

b) H.V. Insulators

1) Insulators shall be available in pin type and disc type with standard size as shown in Fig. 27 and composition characteristics as given in Table III-5.

2) Disc type insulators shall be slightly higher in insulation level than pin type insulators.

3) The insulators are produced from high grade wet process porcelain and are usually glazed brown or insulators with blue-gray glass shall be used.

4) Each and every insulator shall be marked on the surface with the manufacturing date and manufacturer's name.

5) Pin Insulators

i) Pin insulators shall be used as standard with metal thimble cemented in and threaded to receive pin having steel head to B. S. 3288.

ii) Pin insulators with special head grooves to accommodate proprietary conductor fastenings shall be available.

iii) Pin shall be 114mm (4 1/2") or more in length measured from the pin collar.

6) Disc Insulators

Disc insulators shall be standard ball and socket coupling in accordance with B. S. 137 and B. S. 3288, and supplied complete with phosphor bronze security crip.

c) L. V. Insulators

i) L. V. insulators shall be the single groove type shackle insulator.

ii) L. V. insulators are manufactured in wet process porcelain and comply with B. S. 137 where applicable.

iii) Their standard size shall be as shown in Fig. 28 and their composition characteristics as given in Table III-5.

iv) The groove shall be suited to conductor diameter.

Table III-5 INSULATORS

Item \ Type	H. V. Pin Type	H. V. Disc Type	L. V. Shockle Type
Diameter	approx. 267 mm	approx. 254 mm	approx. 76 mm
Leakage distance	241 mm	292 mm	-
Dry arcing distance	152 mm	197 mm	-
Power frequency withstand (one-minute) Dry	75 kV	78 kV	23 kV (flashover)
Wet	50 kV	45 kV	11 kV (flashover)
Impulse withstand	95 kV	105 kV	-
Mechanical failing load	1,080 kgf 10.6 kN	1,120 kgf 10.6 kN	1,900 kgf 19 kN
Weight	2.2 kg	6.3 kg	0.4 kg

d) Installation of Insulators

Insulators shall be supported by type of poles on cross-arms, D-iron or some other assembly.

1) Pin insulators shall be vertically mounted.

2) In order to reduce to a minimum the necessity for replacement because of damages caused to pin insulators or repair by reason of ruptured conductors, two pin insulators shall be used as shown in Fig. 13 for any complicate type of poles and on any pole installed at a road crossing, so that stress can be reduced.

3) Before binding the conductors on the insulators, the Conductor shall be prestressed to 5% over tension for two hours.

4.2.7 Conductors

a) General

1) Use shall exclusively be made of aluminum conductors.

2) Bare conductors shall be used in normal conditions, but covered conductors shall be applied to meet such requirements as mentioned later.

b) Bare Conductors

1) Conductors shall be 50 mm^2 and 100 mm^2 in size with marketability taken into accou and conform to the specification given in Table III-6.

2) Conductors shall be hard-drawn aluminum twisted wires made of aluminum metal for electric purposes. Finished conductors shall be free from any such flaw as may be visible to the naked eye and smooth on the surface to the touch.

3) Twisting shall be as dense as possible.

4) Twisting shall be right-handed.

Table III-6 CONDUCTORS

Item \ Size (mm^2)	50	100
Application	H.V. & L.V.	L.V.
Code Name	Ant	Wasp
equivalent copper area	32.3 mm^2	64.5 mm^2
stranding and wire diameter	7/3.10 mm	7/4.39 mm
approximate overall diameter	9.3 mm	13.2 mm
total area	52.8 mm^2	106.0 mm^2
weight	145 kg/km	290 kg/km
nominal breaking load	846 kgf	1632 kgf
maximum DC resistance at 20° C	0.5419Ω/km	0.2702Ω/km
tropical amp	112 Amp	158 Amp

c) Covered Conductors

1) In the following cases, covered conductors shall be used to meet the requirements of personal and installation safety.

i) For jumpers
Jumper conductors for tee off poles

Connection between underground line and overhead line for substation poles and others

ii) For lines
Crossing with P & T lines and main roads.
In case of less clearance than specified.

2) Covered conductors shall have such a size as may allow them to have the same current rating as the bare conductors. They shall be available in two sizes, one for the distribution lines and the other for jumper conductors.

3) Conductors shall be coated uniformly with crosslinked polyethylene or some other insulating material of equivalent or better quality without involving any such flaw or bubble as may be detrimental to actual service.

Conductors will also be coated, if necessary, with an appropriate black separator layer or a semiconductive layer, thickness of which shall constitute a part of the thickness of insulating material.

d) Length and Packing

Conductors shall be wound around a drum in such length as shall be decided after consulation with the Government. A drum of conductor shall be limited to 400 kg in weight for easier transportation and installation. Drums shall be provided with battens for protection of conductors. They shall be marked on the surface with the shape, size, length and winding direction of conductors.

e) Installation of Conductors

Conductors shall be installed with attention paid to the following instructions.

1) With 4. 1. 3 taken into account, average span length for poles shall be as follows:

i) Town area:

H. V.	:	Average 40 m, Max. 50 m
H. V. & L. V.	:	Average 40 m, Max. 50 m
L. V.	:	Average 40 m, Max. 50 m

ii) Outside town area:

H. V.	:	Average 80 m Max. 90 m

An additional pole shall be installed wherever the above-mentioned span length requirements are not met. In case of any larger span length required, for example, at a river crossing, H poles shall be used instead

2) Stringing work shall be carried out in the following procedure.

i) Assembling of stays and others shall in principle be made before proceeding to stringing.

ii) A plan shall be mapped out in advance for preparation of necessary tools and distribution of field workers, with type of poles, traffic situation and thickness, length and

weight of the conductors to be installed taken into consideration, and consideration shall be given to whether or not temporary stays shall be installed on such tee off poles and terminal poles as may get dislocated due to tension.

iii) In case any overhead line is required to be installed across or close to an electric railway contact line or a telegraph or telephone line, notice shall be given of the time and place, if necessary, to the authorities concerned on before the work is started, so that their persons in charge can be present.

iv) For stringing operation a wire drawing-out device shall be installed by the pole at a spot where conductors are to be pulled out. Conductors shall then be drawn out with communication kept with workers in charge of pulling conductors. In this connection, care shall be taken not to cause anything abnormal to the conductors.

v) Each anchor section shall generally constitute a stringing division, so that stringing can be carried out division by division.

vi) Conductors shall be strung one by one and any temporary dip of one conductor shall be taken up before proceeding to stringing the next one.

vii) For stringing over such obstacles as other lines, service conductors and structures, a hemp wire shall be stretched across them in advance from one pole to the other. A conductor shall then be tied up with the hemp wire at one end and the hemp wire shall be pulled in hand over hand by the other end, so that stringing can be carried out without causing any damages to any such obstacle.

viii) After stringing, conductors shall be supported temporarily at the ends for dip adjustment.

ix) Dip shall be taken up first manually or in a similar way, and finally by means of a draw device.

x) Gripping shall generally be made first of both outer conductors simultaneously and then of the center conductor.

xi) Before binding or clamping, overhead line conductors shall be prestressed to 5% over tension for a period of 2 hours.

xii) With regard to the distribution line, stringing shall be such that sagging of conductors strung at 5°C shall range from 0.8 to 1 %. Special consideration shall be given to the sagging, in particular in case of stringing:

over a long span.

across a railway track.

For proper sagging adjustment in general stringing, care shall be taken:

to avoid any excessive conductor gripping, if stringing is carried out in hot season.

to take up the sagging as far as possible, if stringing is carried out in cool season. In this case, however, any excessive conductor gripping shall be avoided.

All conductors thus strung shall be bound after adjustment to a prescribed sagging by means of strain clamps.

Sagging measurement shall in principle be made by the method shown in Fig. 35.

4.2.8 Lightning Arresters

1) Lightning arresters shall be installed:

on H. V. line at intervals of 500 m;

on substation poles;

at connections between underground cable and overhead conductor (including risers from diesel power station).

In areas with frequent thunder, however, lightning arresters shall be installed at much shorter intervals.

2) Lightning arresters shall be of the cross-arm mounted type and their construction shall be as specified in 5. 2.

4.2.9 Pole and Conductor Parts

a) General

Parts used for conductors and poles shall conform to the corresponding B.S. or I. E. C. standards.

After final decision of the poles and conductors to be used, the contractor shall make a selection of all the parts to be applied and apply for approval by the Government of their respective construction and performance.

b) Materials of Insulators and Conductor Parts

1) For insulator parts and conductor parts, use shall be made of such materials as shall be the best in quality, mechanically as well as electrically.

2) The aluminum parts of the clamps and joints shall be of at least 99. 5 per cent purity or of equivalent alloy with regard to corrosion.

3) The split pins for other fittings shall be of tinned copper.

c) Insulator Binding

Armor tapes, binding wires and hard aluminum straps shall be used to bind conductors, as shown in Fig. 27 for H. V. pin insulator and in Fig. 28 for L. V. shacke insulator.

d) Joints and Clamps

1) Types of joints and clamps and their materials shall be as follows:

i) Strain clamp

Strain clamps shall be used to support conductors at H. V. disc insulators and for supporting 50 mm^2 AAC or covered conductors, use shall be made of 4-bolt strain clamps. Though they are available in two types as shown in Fig. 29, adoption shall be made of the type which has brought about satisfactory results in actual service. Arrangements shall be made with the Government before final decision of the materials to be used.

ii) Tension joint:

In principle, no tension joint shall be allowed. In this connection, however, if requested by the Government, the Contractor shall apply for approval by the Government of the construction and performance of any tension joint whatsoever as well as any die and tool required.

iii) Non-tension joint:

Non-tension joints shall be used for jumper connection of H. V. and L. V. lines. Line connectors or line taps shall be used for H. V. lines, while parallel connectors shall be used for L. V. lines, so that they can be used for copper service conductors, too. For easier line disconnection, the bolt connecting type shall be sufficient in spring force effectively to grip the connected conductors and have such construction as may not allow any looseness in principle.

2) Conductor joints and clamps shall have same electrical conductivity and current carrying capacity or more than the equivalent length of the conductors.

3) All joints shall be effectively covered with weather proof tape.

4) Application of tension joints, if any, shall meet the following requirements;

Minimum number of mid-span joints shall be fitted within 15 m (50 feet) from the pole support. No more than one joint per span will be allowed. No joints are allowed over crossings of railways, P & T lines, roads for two spans either side of the crossing. For connecting different metals, bimetal connectors to prevent electrolytic action shall be used.

5) Below given are the directions on conductors to be spliced.

i) Burrs shall be completely removed from each cut end.

ii) Any twisted conductor end, if found loosened, shall be cut off.

iii) A metal saw or a cutter shall be used for cutting conductors. In cutting a twisted conductor, a tape or a binding wire shall be wound around the conductor on both sides of the portion to be cut, in order to prevent it from coming loose.

iv) Conductors shall be polished on the surface with a brush or by some other means, until they get lustrous.

6) Below given are the directions for use of connector clamps.

i) Any joint shall not allow the conductor to protrude by more than 20 mm.

ii) For conductor splicing, care should be taken to fit conductors properly into the connector guide grooves and tighten them sufficiently. Unproperly inserted conductors may possibly get loosened due to vibration, deviation, etc.

iii) Nuts shall be so tightened as to allow screw threads to fit properly into slots. Care should be taken not to tighten them with screw threads left out of place.

e) Steel Parts

1) All the following parts composing a supporting structure shall be made of steel with strength of not less than 41 kg/mm^2 :

Cross-arm, strap, insulator pin, bolt, nut, washer, D-iron, socket crevis, insulator hook, shackle strap, stay rod, etc.

2) Steel plates used for manufacturing those parts shall be 2.3 mm or more in thickness in order to secure safety even when they get corroded.

3) They shall not present on the surface any flaw, rust or other defects detrimental to actual service.

4) No crack and flaw shall be caused on the outside of any test piece sampled from those steel plates, even when it is bent through 180° to have an inner radius of not more than 1.5 times its thickness by applying pressure or hammering on it.

5) All the above-mentioned steel parts shall be galvanized by hot dipping as specified in B.S. 137. The number of one-minute dips for the "Preece Test" shall not be less than 6.

f) Bolts, Nuts and Washers

For tightening purposes, use shall be made of bolts, nuts and such washers as required to keep tightening secured for a long period of time. All of them shall be made of steel.

1.9 cm (3/4") dia. bolts shall be for 2.4 cm (15/16") dia. holes, while 1.6 cm (5/8") dia. bolts shall be for 2.1 cm (13/16") dia. holes.

Bolts shall extrude on the nut side by 5 to 30 mm. Bolts intended for use at portions where an earthing lead is to be fitted shall be provided with double nut and double washer.

g) Markings

Each and every material shall be marked on the surface with application (description and length of conductors) and manufacturer's name or mark.

4.2.10 Foundations

a) General

In the northern part of Nigeria, the soil is mainly sandy. This means that soil can provide an extremely strong foundation for supporting structures.

b) Types of Foundation

Foundation normally adopted is classified into the following 3 types:

Concrete base
Kicking block
Concrete foundation.

c) Classification by Application

Selection shall be made of one of those three types of foundation, with consideration paid to the foundation soil and wind pressure on the supported conductors and supporting surface. Below given are the directions for their respective use. In this connection, however, for foundation design, refer to Fig. 34.

1) Concrete Base

Generally all poles will stand on a reinforced concrete base, 60 cm (2 ft) x 60 cm (2 ft) and 5 cm (2 inch) thick. In this case, pole erecting holes shall in principle be drilled by the circular drilling method (see Fig. 32).

With sandy soil taken into consideration, the foundation soil shall be tamped sufficiently and, if necessary, compacted by water sprinkling at the time of back-filling.

2) Kicking Block

This type of foundation shall usually be adopted in places where pole erecting holes are drilled by the step drilling method or the soil is found rather soft. No kicking block will be required, if the foundation soil is sufficiently compacted by water sprinkling, even in places where the step drilling is adopted with sandy soil taken into consideration. Adoption shall compulsorily be made of a kicking block for any stay pole without stay. In this connection, the pole shall be erected on a concrete base.

Size of block	concrete	120 cm x 24 cm x 12 cm
	wooden	200 cm x 24 cm x 12 cm

3) Concrete Foundation

Concrete foundation shall be adopted in places where sandy or muddy soil is so soft as to cause earth to fall down during or after excavation. If wooden poles are used in places where there is much subsoil water, concrete foundation shall be adopted for corrosion prevention.

4.2.11 Stay Complete

a) General

Stay complete shall be installed on any pole for H. V. line and pole in joint use for H. V. and L. V. lines with design load of more than 300 kg and on any pole for L. V. line with design load of more than 150 kg. For its arrangement, refer to Fig. 36.

b) Stay

1) Number of Stays

Intermediate and Angle	up to 5°	H. V. 0	L. V. 0
Angle	5° - 20°	H. V. 1	L. V. 1
Angle	20° - 45°	H. V. 1	L. V. 1
Angle	45° - 90°	H. V. 2	L.V. 1 - 2

2) The upper part of a stay shall be fitted close to the point of composition of horizontal tensions applied by the conductors but 2.5m (9 ft.) or more above ground, with care taken that the stay thus fitted shall not impede possible mounting or replacement of crossarms, crossarm braces and others.

Any stay shall be installed, in principle, with a clearance of 30 cm with respect to a H. V. line and 10 cm with respect to a L. V. line. It shall be installed below any H. V. line, unless otherwise required due to circumstances beyond control.

3) Stay wire shall be of galvanized steel 45 ton.
All staying shall be carried out with 95 mm^2 (7/8, 7 wires each 8 gauge) stranded wire in conjuction with approximate 19 mm (3/4") diameter stay rods.

4) The minimum angle between the stay and the pole shall be 30°.

5) Size of baulks shall not be less than 70 cm x 23 cm x 13 cm (2'3" x 9" x 5") and they shall be planted at a minimum depth of 1.6m (5 feet).

6) When excavating for stay baulks, the ground at the bottom of the hole shall be undercut so that the baulk pulls against virgin ground.

7) Stays shall be made by the splicing method with the use of bands and others.

8) Stay rods shall be fitted with adjusting devices.

9) Stay wires shall have strain insulators.

i) At any point where a stay is likely to get in contact with a L. V. line due to circumstances beyond control, a L. V. shackle insulator shall be mounted to provide a clearance between the stay and the conductors.

ii) Each of the stay insulators used shall have a mechanical strength at least equal to that of the stay in which it is installed, and shall also have a minimum flashover voltage for H. V. line.

Flashover voltage :	dry	20 kV
	wet	11 kV

iii) Stay insulators shall be monnted between 2.5 m and 4 m from the supporting point on 10 m poles and between 2 m and 4 m on 8 m poles.

c) Flying Stays

1) In situations where it is not possible to install a stay, a "flying-stay" shall be installed, which will consist of 8 m fly stay pole erected on the opposite side of the road (or path etc.) or other poles for the main line, which will have a stay provided.

2) 8 m concrete poles or wooden poles shall be used to serve as stay poles.

3) Stay poles shall be installed in the same way as the poles, except that they shall be slightly inclined in the direction opposite to that of tension applied and make practically a right angle with fly stays, unless otherwise required due to circumstances beyond control.

4) Stay poles shall usually be provided with stays above the fly stays.

5) In case they are not provided with any stay, they shall be provided with kicking block.

6) Any such fly stay as will cross the road on its way to be stay pole shall be at least 5. 5 m (18 ft.) above the road level as shown in Fig. 36.
The end of any such fly stay as will run parallel with the road shall be as low as possible but at least 3 m above the road level, unless otherwise required due to circumstances beyond control.

7) A ball insulator shall be provided, so that any fly stay shall be maintained about 2. 5 m above the ground level, in case it should be broken near the stay pole.

d) Struts

In situation where stays cannot be used, struts shall be installed, which shall be of the same materials as the poles and shall be provided with kicking blocks.

4. 2. 12 Earthing

1) Earthing shall conform to the Low of Nigeria and the provisions specified below.

2) Provisions shall be made to earth:

i) Neutral of L. V. system

Neutral conductors of L. V. system shall be earthed at the supply point (transformer) and each and every terminal as well as at intervals of 200 m along the distribution line route.

ii) Lightning arrester

The arrester shall be earthed by means of an independent earthing lead and earthing rod. The rod of arrester shall be placed not less than 2 m from any other earthing rod.

iii) Steel parts

All steel parts shall be required to be earthed.

iv) Cable guards

Cable guards shall be earthed independently of the above-mentioned steel parts.

3) For earthing purposes, the following parts shall be used:

i) Earthing leads

Earthing leads shall be covered copper conductor and cross section shall be not less than 25 mm^2.

ii) Earthing rods

Earthing rods shall usually be used to serve as earthing electrodes and, if necessary, some other means shall be made available for joint use. Each earthing rod shall be a copper weld rod about 2. 5 cm (1") in diameter and 1. 8 m or more in length.

iii) Earthing clamps

Earthing leads shall be connected to each other by means of an earthing clamp.

iv) Earthing lead capping staple. (See Fig. 37)

4) Installation of Earth

i) If several earthing rods are used, the distance between two neighbouring rods shall be not less than their rod length. They shall be connected together by means of earthing leads.

ii) Earthing-leads which are led down the outside of poles shall be protected by a wooden earth lead capping for a distance of 3 m from the ground and 15 cm (6 inch) below ground level.

iii) Earthing-leads for lightning-arresters shall not pass through iron or steel pipes, and shall be taken as direct as possible between the lightning-arrester and the earth-connexion. Bends shall be avoided where possible, but where bends are unavoidable they shall have as large a radius as possible.

iv) In sandy soil, an earthing rod shall be driven in, after earth is dug down to the clay stratum. In case it shall be impossible to reach the clay stratum, earthing shall be made by some other suitable means.

v) A joint shall be provided 3 m above the ground level for measurement of the earthing resistance.

5) Earth Test

All earthings shall, before the electrical lines are livened up, be tested for electrical resistance, and if such resistance exceeds ten ohms at dry seasons the Government shall not, use the electric line, electrical apparatus or other device so earthed until the resistance has been reduced to ten ohms or less. In this connection, the Contractor shall take charge of making available all necessary measuring apparatus.

4.2.13 Accessories of Pole

a) Anti Climbing Device

A barbed wire shall be mounted at 2.1 m (7' 0") above ground level in the manner shown on Fig. 38. The anti climbing device shall be installed at each 11 kV pole. All the fences installed around the substation shall also be provided on the top with barbed wires to serve as anti-climbing device.

b) Danger Plates and Number Plates

1) Danger plates and number plates shall be mounted at each 11 kV distribution pole.

2) Danger plates and number plates in use shall be as shown in Fig. 38.

3) They shall be made of such steel plates, zinc plates or plastic boards as will be capable of withstanding a long period of service. Indications given on their surface

shall be in letters well-fitted to their material and shall not disappear easily, even if they are exposed to ultraviolet rays or clouds of dust raised by the wind.

4) Written in red letters on white background are to be provided and fitted so that it faces the direction from which it is most likely to be seen.

c) Pole Guard Paintings

For protection of poles against traffic, H. V. lines shall be provided with pole guard painting in black and white, as shown in Fig. 38, on the following poles:

Poles at crossroads.
Poles erected within 3 m from the pavement on main roads and in town areas.

4. 3 SUBSTATION

4. 3. 1 General Arrangement

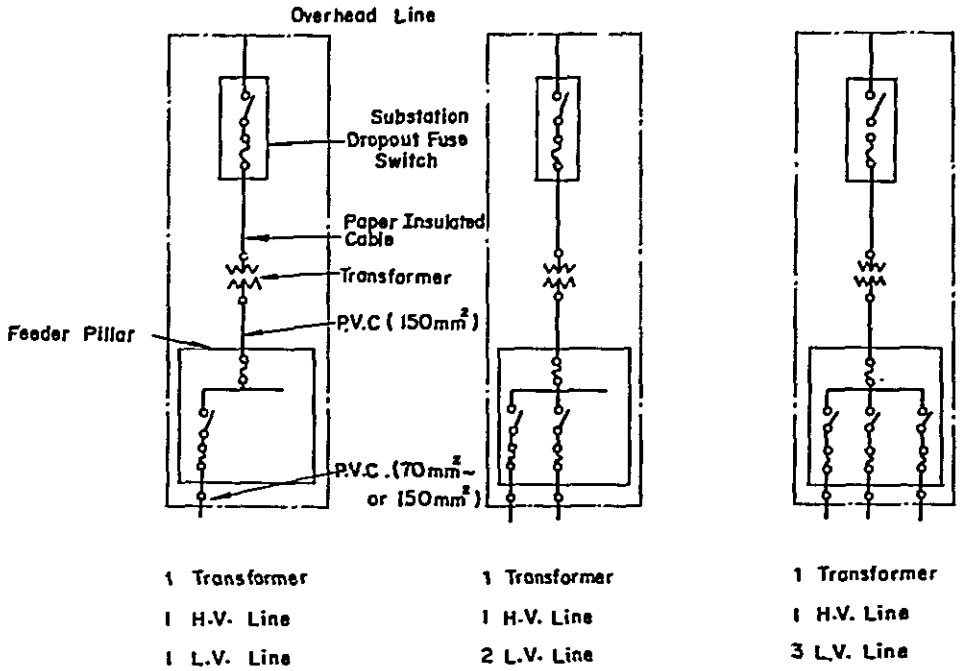
1) Substation shall be of the ground mounted type.

2) Substation capacity shall be 100 kVA and 200 kVA.

3) All installations shall be of the outdoor type.

4) Substation shall be equipped as shown in Fig. 30.

5) Substation connections shall be as shown below.



6) Ground installations shall be so composed as to prevent their live parts from being exposed and so arranged as to have enough space on their side to allow operators to carry out adjustment and operation.

7) For composition of poles, refer to Fig. 17~19.

8) Connections between underground cables and overhead lines shall be made through tier type outdoor cable boxes.

9) Substations shall be surrounded by a fence 2 m high having a lockable door.

10) The transformers are protected against surge voltages by lightining arresters and against over-current by dropout fuses. Arresters and fuses shall be mounted on crossarm. The L. V. feeders are protected by fuses.

4.3.2 Composition

Substation shall be composed of:

- 1 transformer with fixing parts and service platform.
- 1 L. V. distribution feeder pillar with fixing parts.
- 1 H pole with necessary crossarms, stay wires H. V. disc insulators and pin insulators, L. V. insulators, danger plates and number plates, anti-climbing device.
- 3 dropout fuse switches with fixing parts.
- 3 lightning arresters with fixing parts.
- H. V. cable with available cable box, cable guard and fixing parts.
- L. V. cables with available cable boxes, cable guards and fixing parts.
- Earthing equipments.
- Fence with door.

4.3.3 Transformers

1) Step-down transformers shall be of the ground mounted outdoor type. For its construction and performance, refer to 5-1.

2) Transformers are to be installed in the position shown on Fig. 30 and on rollers installed on concrete base.

3) The H. V. and L. V. sides of transformers shall be fitted with cable boxes in accordance to B.S. 2562 part equipment. They shall be mounted on opposite side of walls of the transformer tank with cable entry from below, suitable for compound filling and shall be supplied with undrilled cable sockets. They shall allow connection of 50 mm^2 paper insulated copper cables or CV cable on H. V. side and 150 mm^2 PVC insulated copper cables on L. V. side.

4) After installation of the transformer, the following checks and adjustments shall be carried out.

Check transformer oil to see it is filled up to the oil level indicating line.

Adjust the tap voltage as specified in the design papers.

Check the bushings and lead wires for any damage and rupture.

Conduct an insulation resistance test.

4.3.4 L.V. Feeder Pillar

1) Four feeders shall be provided for four L.V. line. The L.V. feeder pillar shall be waterproofed and mounted at operation hight on bases. Each pillar shall contain;

3 fuse sets 3 phases and a neutral for overhead line feeders.
1 fuse set 3 phases and a neutral for input cable from transformer.

For easier control of the transformer load, ammeters, voltmeters and power meters, all provided with a maximum indicator, shall be provided. Street lighting switches, if necessary, shall be provided.

2) Current Readings and Fuse Handle Short-Circuiting Arrangement

Current transformers can be fitted to the unit, with connections to secondary instruments and ammeter switch, or with portable instruments connected by plug and socket.

Ammeter readings can be taken around the fuse handle.

Ammeter plug sockets can be fitted to the unit, enabling the fuse handle to be short-circuited. With this arrangement the handle can be withdrawn for maintenance purposes. Alternatively, a direct reading ammeter can be connected in the wander leads for taking current readings.

3) Fuse Carriers

The porcelain fuse handles are designed on robust lines and afford ample shrouding of the fuse contact and fuses. All fuse handles can be fitted with an insulated thumb-screw contact tightening device, which arrangement ensures that very heavy currents can be carried continuously without deterioration of the contact clips. All handles, can be of the through-grip type, ensuring that the operator has full control of the handle during operation.

4) Phase Identification

All busbars, barriers, fuse handles and secondary potential fuses are fitted with phase identification discs to indicate the circuit to which they are connected.

5) Secondary Wiring

Secondary wiring is run in the appropriate phase colour and bears terminal identification sleeves. The potential fuses are mounted as near as possible to the busbar to include as much secondary equipment as possible in the protected zone.

6) Busbar and Busbar Fittings

The busbar fittings are made in one piece and give a generous contact area with the busbar. The faces are machined to close tolerances to ensure electrical contact. The busbar faces are specially planed to remove all imperfections and are supplied in continuous lengths.

7) Cable Connections

Incoming and outgoing cable terminations shall allow connection to 150 mm copper cables on the transformer side and 70 mm copper cables on feeder side
These include sockets for sweating cable clamps and earthing braids where an irradiated shrink-on glove is to be fitted over the crutch of the cable.

8) Metering

A full range of current transformers is available for use with the units, enabling indicating or integrating instruments to be operated.

4. 3. 5 Dropout Fuse Switches

1) On the H pole, dropout fuse swithces with high voltage fuses shall be mounted. Switches shall be completed with replaceable fuse elements of correct rating and connection. This dropout fuse switches shall be connected to the cable box and H. V. distribution line by means of covered conductors.

2) The dropout fuse switches shall be of the single phase type 11 kV class.

3) Current rating shall be 100 A.

4) The dropout fuse switches shall be of the crossarm mounted type with such construction as shall allow opening and closing operation of the contact safely by an operating rod. Its construction shall be such that after operation of the fuses, the primary and secondary sides will be disconnected from each other and complete insulation will be maintained.

5) Porcelain insulators shall be used for insulating purposes.

6) Fuses intended for the dropout fuse switch shall be mounted on the dropout fuse switches and shall meet the rating capacity of 100 MVA in case of short-circuit failure on the transformer side. The Contractor shall make a selection of the types of fuse, but before final decision, it shall have a consultation with the Government about its selection.

4. 3. 6 Lightning Arresters

Lightning arresters shall be of the crossarm mounted outdoor type. For their construction, refer to 5-2.

4. 3. 7 Pole and Assemblies

The pole shall be of H type and 10 m (34 ft.) in length, the H. V. line is anchored by insulators on a steel crossarm. For the type of H pole, foundation and stays, refer to the corresponding provisions hereof.

4. 3. 8 H. V. and L. V. Cable

See 4. 4 and 5. 3.

4. 3. 9 Fence and Door

The fence and door of the substation shall be constructed to prevent access by climbing and not to enter.

The entrance doors of substations shall, where practicable, be provided with a spring or other approved device, which shall ensure that the door remains wide open when not properly shut and locked.

4. 3. 10 Street Lighting

One street light shall be provided on the H pole of the substation

4. 3. 11 Earthing

Provisions shall be made in the substation to earth:

lightning arresters.

L. V. neutral

Tank of transformer and box of feeder pillar.

fence.

In this connection, it is to be pointed out that the fence shall be earthed at each and every corner.

4. 3. 12 Accessories

Danger plates and an owner plate shall be installed at readily noticeable spots, while an attention plate shall be provided on the feeder pillar.

4. 3. 13 Installation of Substation

1) Substation shall be installed away from any such place:

i) as lies along a heavy traffic road where motor cars are likely to collide.

ii) where the soil is soft.

iii) where people are frequent, such as centre of public meeting plazas.

iv) as is likely to be flooded.

2) The foundation on which the transformer is to be installed shall be composed of:

i) an upper concrete base 20 to 25 cm in thickness and wider than the transformer bottom by 10 cm, reinforced by steel wires 10 mm or more in diameter placed crosswise at a depth of 5 mm or more below the surface.

ii) a lower concrete base wider than the upper one by 10 cm.

iii) and thereunder, a layer of stones 150 to 200 mm in diameter shall be 30 cm in thickness.

4.4 UNDERGROUND LINE

4.4.1 Installation of Underground Line

With priority given to the security of human life, underground cables shall be applied to:

i) outgoing line from the diesel power station.

ii) H. V. incoming line and L. V. outgoing line of the substation.

iii) H. V. consumer service line.

4.4.2 Type of Cables

H. V. cables shall be screen type paper insulated cables or cables equivalent or superior in construction and performance. (See 5-3)

L. V. cables shall be P. V. C. insulated cables or cables equivalent or superior in construction and performance. (See 5-3).

4.4.3 Cable Size and Application

The cables shall be of following sizes

a) For H. V. Lines

for transformer connections to overhead line.	70 mm^2
for diesel power station connections to overhead line.	70 mm^2
other use for high voltage	70 mm^2

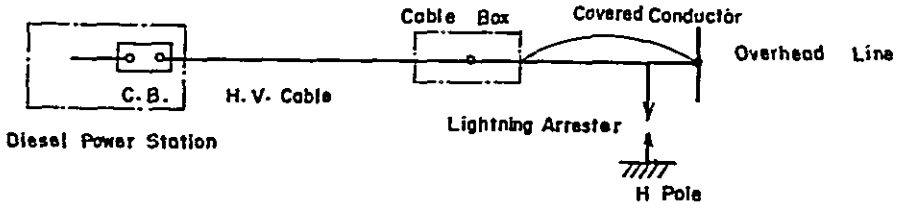
b) For L. V. Lines

for feeder pillar connections to overhead line (100)	150 mm^2
(50)	70 mm^2
for transformer connections to feeder pillar	150 mm^2

4.4.4 Diesel Power Station Connections to Overhead Line

a) General Arrangement

1) Connections shall be as shown below:



2) No isolating switch will be required, while there is only one cable leading out from the diesel power station. With maintenance taken into consideration, however, isolating switches shall be provided at feeding points, when the diesel power station requires two or more cables as a result of installation of another step-up transformer.

b) Composition

Diesel power station shall be composed of:

1) H pole with necessary cross-arms, stay wires, H. V. and L. V. insulators, danger and number plates, anti-climbing device.

2) 3 lightning arresters with fixing iron.
H. V. cables with available box, cable guard and fixing device.

For individual composition, refer to the corresponding provisions specified for the substation.

4.4.5 Cable Splicing

1) For connection between a cable and the distribution line, use shall be made of an outdoor type cable box as specified below.

In this connection, the contractor shall supply an instruction manual specifying the cable splicing procedure in addition to a detail drawing.

The cable box shall contain all the parts required for cable connection. Cable splicing shall be avoided as far as possible midway on a line.

2) H. V. Cable Box

Suitable for 70 mm^2 3 core H. V. cable

Compound filling type

Cast-iron and cross-arm mounted type

Porcelain insulators shall be used for insulating purposes.

3) L. V. Cable Box

Suitable for 70 or 150 mm^2 4 core L. V. cable.

Compound filling type

Cast-iron and cross-arm mounted type.

Porcelain insulators shall be used for insulating purposes.

4.4.6 Installation

a) Installation of Cables

1) The work must be carried out in orderly manner to avoid unnecessary inconvenience or obstruction to traffic and pedestrian.

2) Except by permission of the Director of Posts and Telegraphs, all underground lines shall be placed on the same side of the street as overhead electric lines.

3) Traffic regulations and local laws must be observed and where it is necessary to close either partially or wholly any traffic road the Police shall be informed well beforehand.

4) It is preferable that the excavation, filling in and reinstatement shall be carried out in sections which can be completed in one day. Where this is impracticable, open trenches shall be protected by barriers and, in carriageways accessible to traffic, strong cover boards or steel plates shall be placed over the trenches. Red danger lamps shall be required during the night and nitht watchmen put in charge of the work.

5) Trenches shall be pegged out, and where obstructions are suspected along the route, small trial holes shall be excavated.

6) Excavations shall be kept to the minimum dimensions necessary to give the specified cover, any paving slabs being carefully handles to avoid damage and ensure correct replacement.

7) Concrete drives and carriageways shall not be broken up more than is necessary and 'driving' shall be resorted to whereever practicable. Care shall be taken to back fill and consolidate these excavations after the cable is pulled in the prevent subsidence.

8) Before the cable is pulled in, all large stones shall be removed from the trench and in the case of unarmoured cables the bottom of the trench shall be filled with three inches of sifted sand or topsoil.

9) Cable drums shall be mounted firmly on jacks in such a manner that the cable shall run out as straight as possible and shall fall from the drum without 'snatch'

10) Where the cable is being pulled through ducts, a stocking shall be used to distribute the pull and avoid damage. In the case of long duct lines a suitable lubricant, such as commercial petroleum jelly, shall be necessary.

11) In handling the cable, if a sufficient number of men is available, they shall be posted not more than 1.8 m (6') apart; alternatively, cable rollers shall be used and placed at the same intervals.

12) To avoid risk of damage during handling, it is desirable that the cables described shall be installed only when both the cable and the ambient temperatures are above 0°C.

13) Cables shall be cut to the correct length for jointing purposes. Not more than 76 cm (2' 6") overlap shall be allowed for straight joints and not more than 30 cm (1' 0") extra at temperating joints. Scrap cable shall not be left coiled or buried in the ground.

14) The greatest care shall be taken to avoid bending the cable unnecessarily and under no circumstances shall the radius of bending be less than twelve times the overall diameter of the cable included in B.S. 6480, Part 1.

15) Cables shall be laid on top of the sand and covered with a further 8 cm (3") of fine sand measured from the top of the cable. The cables shall then be covered from end to end by reinforced concrete slabs, not less than 5 cm (2") thick, or purpose made cable tiles as approved by the Government. The trench shall be backfilled and the earth thoroughly rammed. All surplus soil shall be removed from the site.

b) Standard Depth

1) The standard depth of laying shall be as follows:

H. V. cables laid in the pavement, road verge or centre island.	76 cm (2' 6") below finished surface to bottom of trench.
L. V. cables laid in the pavement, road verge or centre island.	46 cm (1' 6") below finished surface to bottom of trench.

2) If more than one cable is laid in the same trench the width shall be increased by minimum of 5 cm (2") or 2 times the diameter for each extra cable, whichever is the greater.

c) Protection under Road Ways

Where cables pass under roadways, passages, etc. they shall be protected for the width of the roadway or passage plus 60 cm (2') at each end by fibre or concrete pipes with allowance of 60 cm (2') diameter cable loop at one end of the road. The pipe shall be laid at 110 cm (3' 6") below the finished road level.

d) Jointing

1) Jointing and the cutting of cables shall be carried out under clean and dry conditions. Cables which have been cut for any purpose shall be capped or sealed by an approved method immediately after cutting to prevent abscription of moisture.

2) Cables shall not be bent or worked unnecessarily since this shall cause the lead sheath to stretch and wriggle, thereby leading to the formation of voids and possible damage to the paper insulation.

3) Before the cores are set for jointing, a tight, impregnated tape binder shall be applied to the crutch. A temporary lapping of tape shall be applied to the cores before they are handled and the greatest care shall be taken to set the gradually to avoid damage to the paper insulation.

4) After the cores have been sweated all surplus solder shall be removed by wiping whilst hot, after which any protrustions or sharp edges shall be carefully removed with a file.

5) Insulating tape shall be applied to the joint carefully and with even tension to eliminate voids and wriggles.

6) Multi-core cables shall have the cores individually numbered for identification purposes. In H. V. straight joints the cores need not be connected number to number if this shall cause difficulties in jointing. Cross-joints are therefore permissible and phasing out shall be arranged in the terminal boxes at each end of the cables. L. V. cable must always be connected in accordance with the following code.

Core No.	Connection
0	Neutral
1	Red Phase
2	Yellow Phase
3	Blue Phase
4	Special Purpose Conductor

7) Where due to obstruction these depths cannot be obtained, additional protection, such as reinforced concrete slabs, shall be placed over the cable.

8) H. V. pole mounting cable boxes of the inverted type with porcelain insulators, copper stem connections, brass plumbing glands and armour clamps.

9) H. V. dividing boxes for transformers and other plant shall be supplied by the manufacturers.

10) H. V. joints shall be supplied complete with jointing tapes and all necessary installating materials except compound.

11) The manufacturer's instructions include cable gland, boxes and parts detailed drawings for the above joints shall be issued to the Contractor in charge of the work and also to the cable jointer. These instructions shall be carefully observed.

12) Jointing compounds are used of the British type.

e) Earthing

The armor or shield of power cables shall be earthed by connecting a flexible cables. Power cables shall be earthed at both ends cable and boxes shall be earthed with copper cable connection on one of the mounting bolts.

f) Cable Markings

All cable routes shall be marked every 23 m (75 feet) and at joint boxes or point of directional change.

g) Testing

1) After laying, all cables shall be tested for insulation and continuity before and after back filling. All tests shall be carried out in the presence of the Government.

2) Insulation between cores or between cores and earth when measured with a 1,000 V Megger shall not be less than 23 megohms

3) Continuity of earthing shall not have a resistance of more than 0.05 ohms between any point on the installation and the main earth.

4) Conductor resistance shall be as specified for the particular cable used subject to B. S. tolerances.

l. 5 STREET LIGHTING

l. 5. 1 Street Lighting System

1) The street lightings are switched on and off by

i) photoelectric switching cells individually provided for the street lighting switches.

ii) Street lighting switch wire.

2) Street lights shall be switched on and off at the power station, substation or on the poles.

3) The Contractor shall have a consultation with the Government for final selection between the two switching methods mentioned above in 1)-i) and -ii). For reference purposes, description is given below of the switching method mentioned above in 1)-ii) which has so far been widely adopted.

4. 5. 2 Composition

1) For lighting purposes, use shall be made of fluorescent lamps. Fluorescent fittings each 20 W x 2or40 W x 2 are to be provided mounted generally on mainly combined H. V. and L. V. poles. An equivalent lighting of another make may be acceptable and shall be stated at the time of tendering.

Fluorescent lamps shall conform in construction to the following requirements:

Lamp body shall be of the closed type with rain proof construction capable of withstanding a long period of service.

The window fitted into the lamp body, through which light is to pass, shall be made of such material as shall be strong and capable of withstanding a long period of service without being easily deteriorated or broken.

2) Illumination shall be at least one (1) lux on the ground surface beside the pole.

3) A suitable fitting holder shall be provided for each street lamp.

4) Each group of street lights is to be controlled from street lighting panel through suitably rated contacts. Street lighting panel includes fuses, switching (time switch etc.) facilities and control lights.

5) The switch line conductors shall be 50 mm stranded aluminium conductors.

6) Covered cables shall be used for connection between street lights and street wires.

7) The Contractor shall have a consultation with the Government for installing methods to be selected separately on wooden poles and concrete poles, since installing methods usually vary with the types of supporting structure.

8) Fluorescent fittings shall be installed below the L. V. line 4 m or more above the ground level.

9) Street lighting panel shall be rigidly mounted as close as possible to the corresponding street lights and its reliable operation shall be secured.

10) No connection other than those between connecting cables and switch wires, between street lights and lead wires and between panels and conductors shall be allowed. In this connection, use shall be made of tapes for insulating treatment of all connected portions.

4.6 SERVICE CONNECTION

1) All service connections from an overhead line to a building shall be of covered wire taken direct from L. V. shackle insulators, and shall not be tapped off the aerial lines between supports, and of size to be approved by the Government depending upon the load.

2) Covered wires shall be P.V.C./P.V.C. cables with 2 or 3 conductors of a cross section of 6 mm^2, 10 mm^2 and 16 mm^2.

3) Service connections shall be terminated at the building by shackle insulators. Line connectors shall be shrouded and if jointing aluminium and copper, shall be bi-metal clamps.

4) No service span shall exceed 7.5 m (25 feet) in length. In any span exceeding this limit due to circumstances beyond control, a pole of 8.4 m (28') or less length shall be provided midway for supporting the service wire.

5) The tension of any service wire shall not exceed 9 kg (20 lbs).

6) Service line shall not be brought out through the roof or attached to insulators fixed on the roof of a building. In case any service line shall be brought out in this way for unavoidable reason, it shall be protected by some insulating material.

7) Service line shall enter the building as near as practicable to the point at which the service connexion is first attached to the building, and the lead wire shall be further protected by some insulating material.

   The distance between the last point of attachment of the service lines and the point of entry shall not exceed 75 cm (30").

8) The Contractor shall supply all service connections cutouts and single-phase kilowatts hour meter or three-phase combined maximum demand and kilowatt hour meters wherever applicable.

9) Such specific consumers as are to be connected to the distribution line shall be definitively selected in consultation with the Government.

10) Clearance of Service Lines

   Provided that in the case of service lines, the height above ground level in the span between the building and the nearest pole thereto may be not less than

   4.3 m (14') where the line crosses any way open to the public.

   3.6 m (12') where the line crosses any way used exclusively by vehicles.

   2.7 m (9') in any other part of the span.

11) Crossing of P & T Lines

   Service lines shall pass over telegraph lines and telegraph service lines shall pass under electric lines.

5. SPECIFICATIONS OF OTHER ELECTRICAL EQUIPMENT

5.1 POWER TRANSFORMER

a) General

The transformer shall be supplied, erected and tested in accordance with the following IEC-Recommendations:

IEC 76	Power Transformers
IEC 137	Bushings for alternating voltages above 1000 V
IEC 296	Specification for new insulating oils for transformers and switchgear
IEC 296A	First supplement to Publication 296

b) Power Transformers

All transformers shall be of the self-cooled, oil immersed, outdoor, and must comply with the relevant standard specifications. The first filling of oil shall be supplied. Each transformer shall comply with the following requirements.

1) Rating Continuous

Rating as specified in the attached Schedule I of materials, single line drawings, and other data. These ratings should be obtainable at the maximum ambient conditions specified in this specification.

Where no rating is specified the Contractor is expected to size the transformers to suit the step up and distribution use.

2) Impedance

Impedance shall be in the range of approximately 4%.

3) Tappings

Manually operated, off load switch with ± 2 1/2% and ± 5% tap positions, position indicator and provision for padlocking.

4) Tanks

The transformer shall be provided with a steel tank of suitable construction which shall be oil tight and provided with and oil cover. Transformer tanks shall be designed so as to allow the complete transformer in the tank, with oil, to be lifted by crane or jacks and to be transported without overstraining any joint and without causing subsequent leakage of oil.

The joint between the case and cover shall be provided with a suitable flange and a sufficient number of properly spaced bolts and gaskets so that the assembly will be oil tight.

The outside of the transformer shall be painted with one rust proof coat, and finishing coat. The inside of the tank shall be finished with one coat of oil resistant paint or enamel.

5) Fittings

The transformer shall be provided with a conservator tank with a filling cap, sump and drain valves. The conservator shall be so designed that it can be completely drained by means of the drain valve. All oil valves shall hold hot oil without leakage. The transformers shall have a rating plate, a diagram plate and a name plate.

Silica gel dehydrating breather.

Skid under base.

Explosion vent.

Earthing terminal.

Double float buchholz relay on step up transformer with contacts for alarm and tripping. These contacts shall be connected to the 11 kV switchgear for annunciation and circuit breaker tripping.

c) Terminating Facilities

The cable entrance box which shall be affixed to the transformer for terminating cables per phase with all required terminators and cable supports shall be provided.

5.2 LIGHTNING ARRESTER

The lightning arresters shall be manufactured and tested in accordance with IEC Publication 99 or the latest revision thereof.

The 11 kV lightning arresters shall be of the pole mounted type for distribution system and of indoor type in the arrester box for power station and suitable for operation on system without earthed neutral and under the condition given in other parts of this specification. The lightning arresters shall be of the valve type.

5.3 POWER CABLE

5.3.1 H.V. Cable

a) General

H.V. cables shall be 11,000 V grade paper insulated cables, CV cables or other cables equivalent or superior in heat resisting construction and performance and shall conform to B.S 6480 and other relevant standards.

Below given is a description of the paper insulated cable.

b) Types and Composition

Three core screened type cable, lead sheathed, single wire armoured and served.

$70\ mm^2$

Each core shall be surrounded by a screen of metal tape, in electrical contact with the earthed metallic sheath, the effect being to eliminate undesirable tangential stresses in the insulation. Core screening also shall minimized the possibility of

core-to-core faults and the construction, in general, permits some increase in current rating as compared with the belted form.

Minimum thickness of insulation	2.8 mm
Thickness of sheath	1.7 mm
Approximate cable diameter	48.8 mm
Approximate cable weight	622 kg/km
Drum length	as required from the Government

c). Construction

Constructors shall consist, unless otherwise approved, of an annealed copper having a conductivity not less than 100 per cent. (B.S. 6360)

Core insulation shall consists of layers of paper tapes applied helically, with accurately controlled gap, lay and tension.

Each core shall have an outer layer of metallized paper or metal tape, the laid-up cross and included fillers being bound together with a copper-woven fabric tape. The copper strands in this binder shall ensure electrical contact between the core screens and the sheath of the finished cable.

Insulating papers shall be carefully selected to ensure a combination of physical and electrical characteristics, each defined by strict specification and testing. Tensile and tearing tests shall ensure the high mechanical strength necessary to withstand bending of the finished cable; tests for thickness, density, mineral matter, alkalinity water extract and moisture content control the physical and chemical qualities. Strict standards of porosity and density shall be necessary to provide, in conjunction with the selected impregnating compound, the required electrical performance and reliability.

The impregnating compound used shall be non drain type.

A closely fitting seamless sheath shall be extruded directly over the paper insulated cores, and physical characteristics can be obtained suitable for most conditions of installation.

Bedding and serving shall provide protection against corrosion and shall be applied over the sheath or the amour. Combinations of paper, cotton and hessian tapes shall be used, treated with bituminous compound before and during application.

5.3.2 L.V. Cable

a) General

L.V. cables shall be 1,100 V grade P.V.C. cables or other cables equivalent or superior in construction and performance and shall conform to B.S. 6346 and other relevant standards.

Below given is a description of the P.V.C. cable.

b) Types and Composition

Four core cable, single wire armoured and P. V. C. oversheathed.

70 mm^2	For O. H. Line A. A. C.	50 mm^2
150 mm^2	For O. H. Line A. A. C.	100 mm^2 and feeder pillar connections to transformer

For installation of street lighting switches on the feeder pillar, use shall be made of 5-core cable.

Cores	Stranded Copper (B. S. 6360)	70 mm^2	150 mm^2
Minimum thickness of insulation		1.4 mm	1.8 mm
Approximate cable diameter		32.0 mm	44.7 mm
Approximate cable weight		422 kg/100 m	818 kg/100 m
Drum length	as required from the Government		

c) P. V. C. and Colour

The P. V. C. shall be compounded under strict control and complies with B. S. 6746: 1969 "P. V. C. Insulation and Sheath of Electric Cables". Thickness shall comply with same standard.

Core identification shall be by the following colours:

Red, yellow, blue, black.

Note: The colours red, yellow and blue are intended to indicate phase conductors and black the neutral.

P. V. C. fillers shall be included, where necessary, between laid-up cores.

The armour shall consist of a single layer of galvanized steel wire. The direction of lay of the armour shall be left hand and the size of the armour wire or strip is as specified in B. S. 6346. Where necessary, tinned copper wires can be provided in the armour of wire armoured cables to raise its conductance.

The standard finish of all cables shall consist of an extruded black P. V. C. oversheath, the thickness of which conforms to B. S. 6346. The external surface of this oversheath shall be embossed with the voltage designation.

5.4 ACCESSORIES

Required accessories which are necessary for security of staff for installation maintenance, operation, repair works and emergency situations are following. These accessories shall be provided by the Contractor.

1) Five Extinguisher

Details see item III-7 "CIVIL WORKS FOR POWER STATION".

2) Grounding Equipments

The flexible P.V.C. -insulated conductors shall be of flexible braid copper wires of minimum 50 mm^2, or equivalent with universal earthing clamps for all equipment conductors, busbars and fixed points of the earthing system. For operation adequate insulated operating rods shall be supplied.

Each station shall be equipped with 2 sets for each voltage rating. Each set shall be provided with the necessary wall brackets and fitting for conductors and operation rods.

3) Testers

4) Warning Signs

See item 4.2.13 and Fig. 38 for Poles and Substations.
And see item III-7 "CIVIL WORKS"

5) Emergency Portable Lamps

Emergency portable lamps shall be provided under this Specification for all substations newly erected. The lamps shall be of the rechargeable type with nickel-cadmium-battery with charger (240 V). The lamps shall be constructed of two parts: spotlight and handle, and the battery. Both parts shall be easily disconnectable.

6) Keys

Keys shall be provided in three kinds for regular use for offices, storerooms and general purposes.

7) Tools

Below enumerated are the tools recommended for permanent stock.

Tools required for installation of poles and conductors.
General purpose tools, such as cutting pliers and knives.
Voltage detectors, phase detectors, voltmeters and ammeters.
Operating rods for dropout fuse switch.

5.5 SPARE PARTS

a) General

Requirements of spare parts are for distribution system and power station except diesel electric generator. The spare parts required are intended to be ordered together with the supply of equipment.

All spares supplied shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements.

b) Requirements

For the normal replacement spare parts the Contractor shall prepare his own proposals. In making these proposals, he shall keep in mind that the climatic conditions shall be very severe which may cause more rapid deterioration of some parts of the equipment.

The proposal shall be made on the basis of 3 years' requirements of spare parts.

c) Spare Parts

Below enumerated are the spare parts recommended for stock during construction of the distribution lines covered by this electrification project and for a period of three (3) years thereafter.

1)	Concrete poles	8 m	: 7% of No. of new consumers
		10 m	: 3 % in quantity of poles required for actual use
2)	Conductors and their parts		: 3% of quantity required for actual use
3)	Cables and their parts		: Corresponding in quantity to the requirement at one place
4)	Insulators and their parts		: 3% of quantity required for actual use
5)	Crossarms complete		: 3% of quantity required for actual use
6)	Lightning arresters		: 15
7)	Stay complete		: 3% of quantity required for actual use
8)	Earth complete		: 3% of quantity required for actual use
9)	Foundation		
	Concrete base		: 5% of quantity required for actual use
	Kicking block		: 5% of quantity required for actual use
10)	Transformers and feeder pillars		: 2
11)	Dropout fuse switches		: 6
12)	Fuses	H. V.	: 10
		L. V.	: 20
13)	kWH meters		: 5
14)	Street lighting fittings		: 3% of quantity required for actual use

6. TEST

6. 1 GENERAL

All materials are to be tested according to ICE Recommendation or better modern approved method in the presence of an authorized representative during manufacturing erection and completion to determine whether the materials and apparatus comply with the Specification.

The Contractor shall satisfy the Government regarding the accuracy of all instruments used for the tests.

All such expenses as may be incurred in connection with the tests conducted on specimens shall be deemed to be included in the contract price.

6. 2 APPLICATION FOR APPROVAL OF CONTRACTOR'S SPECIFICATIONS FOR MATERIALS

The Contractor shall submit such specifications as it shall work out item by item on the basis of this specification, as well as the type test results, for approval thereof by the Government in relation to the construction and performance of each and every item.

6. 3 TESTS DURING MANUFACTURING

1) Test during manifacturing works shall include type tests, sample tests, routine tests of each materials and synthesized test with accessaries.

2) The Contractor shall carry out during manufacturing all tests specified in the relevant standards. The tests results shall be forwarded to the Government together with certificate stating that the equipment and materials comply with the relevant standards.

3) The Contractor shall be responsible for the delivery to site of all equipment and materials necessary for the completion and satisfactory working of the project.

4) From the commencement of delivery to commissioning the Contractor shall check and supervise transit of all materials for this project.

5) Deliveries shall be kept to the minimum number possible and any items which are required to be built shall be delivered to site in ample time to avoid delays.

6) Manufacture tests shall be conducted on the supplies before delivery to see that they meet the minimum requirements imposed by mutual agreement between the Contractor and the Government, and the test results shall be submitted to the Government

6.4 DERIVERY TEST

1) The Contractor shall take charge of conducting the following checks as acceptance test and inspection.

   Appearance check for abnormality.
   Quantity checks.
   Checking of dimensions.
   Assembling test

2) Such tests as shall correspond to the type test and manufacturing process checks may be carried out, if deemed necessary, on any number of articles sampled from the supplies delivered.

3) In case any defect is found in one or more items or articles during the acceptance test or inspection, an investigation shall be made to see if it should be attributable to defects in design and manufacture or errors in operation, and appropriate measures shall correspondingly be taken.

6.5 OPERATING TEST

1) Copies of certified tests of a prototype unit shall be furnished for all major equipment.

2) Performance tests of one complete unit, shall be made and a full and comprehensive certificate of these tests.

3) When the particulars and performance entered in the Tender shall be considered as binding on the Contractor in the event of tests showing any of the performance to be in any way inferior to those stated in the Tender, the Contractor shall modify or replace at his own expense such items as are necessary until the performance comply with those stated in the Tender.

6.6 COMMISSIONING AND SITE ACCEPTANCE TRIALS

After complete erection of all diesel power station, overhead lines, and substations, the Contractor shall commission and conduct Site Acceptance Trials. Each item of equipment shall be subjected to a continuous TWENTY FOUR HOURS trials under normal working conditions. For this purpose it shall be necessary that the completion period for one part of the project shall coincide with another part of the project to ensure that the entire scheme is commissioned satisfactorily.

Should any item of equipment fail to comply with the Performance Guarantee of fail to function correctly the Contractor shall modify or replace at his own expenses such items as are necessary until the equipment does meet the Performance Guarantee to the satisfaction of the Government. The Contractor shall test the new installation throughout in the presence of the Government in accordance with the relevant standard, for continuity, polarity, insulation resistance, etc.

6.7 CLEARING UP ON COMPLETION

The Contractor shall clear up the Site of the Contract work to the satisfaction of the Government and shall remove all his equipment and temporary works of any whatsoever on the Site.

6.8 OPERATION ON COMPLETION

After completion of the Site acceptance trials the scheme shall be operated under the supervision of the Contractor for a period of SIX MONTHS during this time the Contractor shall train the employer's operatives in order that they may take over and be responsible for operation of the scheme.

6.9 RESPONSIBILITY FOR CORRECT OPERATION

The Contractor shall be responsible for ensuring that all items of equipment which he has connected up function correctly, whether or not they were supplied by him. If however any item of equipment fails to function correctly the Contractor shall demonstrate to the satisfaction of the Government that there is no fault in the work which he has carried out, then the Contractor who had supplied that item of plant or equipment shall be responsible for finding the cause of the failure to function correctly.

7. CIVIL WORKS FOR POWER STATIONS

7.1 SPECIAL CONDITIONS

7.1.1 Tropical Serviceability

All materials and equipment supplied under the Contract shall be suitable for being delivered, stored installed, constructed, operated and maintained under tropical conditions of the plant sites. Where necessary, materials and equipment shall be adequately treated and processed.

7.1.2 Standards

Unless specified otherwise, the civil works shall be deisgned, manufactured, tested and constructed in accordance with the following applicable standards and codes:

General Specification of Materials and Workmanship for Building Works tor the Government of Northern Nigeria.

British Standards Institution.

British Standards and Codes of Practice mentioned in the Building Regulations 1972.

Equivalent Standards

Equivalent standards and codes to the above-mentioned standards and codes are acceptable provided the Contractor provides the standards and proves them equivalent in the proposal.

7. 1. 3 Specification and Drawings

1) Construction Drawings and Technical Specifications.

All civil works covered by this specification shall be constructed in accordance with construction drawings and technical specifications which shall be prepared by the Contractor and submitted to the Government for approval.

2) Shop Drawings

The Contractor shall provide all necessary shops drawings required for proper execution of the works and shall submit them to the Government for approval.

3) Design Analysis

All necessary design analysis shall be prepared by the Contractor and submitted to the Government for approval.

7. 1. 4 Inspections and Tests

1) Materials Tests

Unless otherwise specified material tests shall be required in accordance with requirements of the applicable standards and codes.

2) Field Tests

Field tests shall be made in accordance with requirements of the Government. Unless otherwise specified, such tests shall be made in accordance with the applicable standards and codes.

3) Certified Tests Reports

The Contractor shall furnish to Government certified copies of required test reports. These test reports, in addition to being certified, shall be approved by the Government.

4) Inspection

Works covered by this specification will come under the inspection and supervision of the Government. Inspection will include work performed at field tests, preparation of the sites, preparation preliminary to the pouring of concrete, steel reinforcing placement, form work and concreting as required by the applicable standards and codes.

7. 2 TECHNICAL SPECIFICATION

7. 2. 1 General

All description stated in this technical specification are minimum requirement for the civil works. The following specifications required, or upon request of Contractor pending prior consultation with the Government.

Proposal shall be made taking into account the specifications and attached standard type design of diesel power station as a basis.

Estimations shall be undertaken as follows:

1) Lighting system shall be estimated in accordance with attached estimation from Schedule No. II-20.

2) Earthing and lighting system shall be estimated in accordance with attached estimation from Schedule No. II-21.

3) Travelling crane shall be estimated in accordance with attached estimation from Schedule No. II-17, 18, 19.

4) Civil works except above items shall be estimated in accordance with attached estimation from Schedule No. II-22, 23, 24.

7. 2. 2 Scope of Civil Works

The scope of civil work is the designing and performance of all civil works and the supply of all materials, equipment labour and services necessary for all diesel power plants.

The diesel power plants to be supplied shall be the following three (3) types:

Type	Output Capacity per/ Diesel Power Generator
Type I	229 kW
II	115 kW
III	75 kW

The civil works shall include but shall not be limited to the following item:

1) Site investigation and preparation.

2) Diesel power house consisting of diesel generator and switchboard room, battery room, storeroom, control room and service room.

   i) Substructure and superstructure

   ii) Indoor equipment foundations, pits and trenches.

   iii) Achitectural work

   iv) Building services

   - Airconditioning and ventilation.

- Water supply, sanitary system and service system.
- Lighting system.
- Building lighting.

v) Overhead travelling crane

vi) Furniture

3) Outdoor equipment foundations, pits and trenches.

i) Outdoor electrical and mechanical equipment foundations.

ii) Oil tank foundations and oil fence.

iii) Pipe supporting foundations and trenches.

iv) Fire lighting system.

4) Site landscaping

i) Access roads and pavement.

ii) Fence and gates.

iii) Drainage system.

iv) Pavement.

7.2.3 Structural Material for Civil Works

The following material shall be used for construction work:

1) Concrete

fc = 150 kg/cm^2	For layer concrete.
fc = 180 kg/cm^2	For diesel power house and foundations and all structural members except as stated otherwise.
fc = 240 kg/cm^2	For placing concrete under water if any.

fc: Compressive strength of concrete.

2) Reinforcing Steel Bars

mini fy = 2,400 kg/cm^2	For all reinforcing steel bars.

fy: Yield strength of reinforcing steel bars

3) Structural Steel

mini fy = 2,400 kg/cm^2	For structural steel of diesel power house.

7.2.4 Design Load

1) Wind velocity and shape factor designed wind velocity for structure or building shall be 40 meters per second.

The following shape factors shall be applied:

For exterior walls	Co = 1.2
For diesel generator house exterior structure	Co = 1.2

2) Seismic Load

National and local codes shall be applied.

3) Live Load

Roof	60 kg/m2
Basement floor	500 kg/m2

Note: The above loads do not include any equipment or impact loads.

7. 2. 5 Site Investigation and Preparation

1) Site Investigation

All necessary topographic surveys of the site shall be carried out and survey drawings shall be submitted to the Government before commencement of the construction works.

Adequate soil investigation and tests of approved methods shall be carried at the exact site locations to obtain the subsoil conditions and allowable bearing capacity. Before starting work, the Contractor shall obtain full information from the Government on the exact location of all existing embediments (i.g. cable, water pipes, etc.).

2) Site Preparation

The site shall be cleared of fences, trees, logs, stumps, brush, vegetation, rubbish and any/or interfering matter.

The site shall be ready-for-construction and installation by preparation.

The entire site area shall be sloped for drainage. Drainage shall be computed on an estimated downpour of 50 mm per hour up to 4 hours.

7. 2. 6 Diesel Power House

The diesel power house shall consist of diesel generator and switchboard room, battery room, storeroom and service rooms.

Required room area

Type	Appr. Required room area (m^2)		
Room name	Type I	Type II	Type III
D/G room	250	230	210
Control room	26	26	26
Office	9	9	9
Washroom	6	6	6
Storeroom	22	22	22
Battery room	6	6	6

a) Substructure and Equipment Foundations

Substructure and equipment foundations shall be of reinforced concrete and may be directly supported on the subsoil when its bearing capacity is capable of support.

In case the bearing capacity is of insufficient grade, piling or other proper supporting methods shall be provided at the Contractor's expense.

The diesel generator foundation shall be designed without any construction joint so as to avoid any harm or damage by machine vibration.

b) Superstructure

The superstructure of the diesel generator room shall be of prefabricated structural steel and having a practical and appealing style for meeting the working condition. Structural steel surface shall be given two (2) shop coats of synthetic polymeric resin blend type of protective coating and two (2) finishings of oil paint.

The service area, where office, control room and other service rooms are located, shall be provided with reinforced concrete ceiling and masonry block walls.

c) Roof and Siding

The roof of the diesel generator room shall be of 1.0 mm thick corrugated colored protected metal or 4.5 mm thick corrugated asbestos sheets of good grade and of applicable standard.

All bolts, brackets and clips used to fasten the corrugated sheets to the building frame shall be galvanized.

d) Interior Finish

Floors shall be of reinforced concrete slab type. Unless otherwise specified, all reinforced concrete floors shall be applied with 30 mm thick, hard dust-proof mortar finish.

Masonry blocks and reinforcing concrete walls shall be applied with vinyl painting of two (2) coats.

All rooms except diesel generator room and storeroom shall be provided with suspended ceilings 2.7 m in height. Material for ceiling shall be of 6 mm thick asbestos cement board.

e) Doors, Windows and Louvers

Unless otherwise specified, doors, windows and louvers shall be of metal and shall be of fabricated galvanized steel sheet covered with sufficient coats of baked-on rust inhibiting primer.

Finish for metal shall be one coat of rust preventive paint and two coats of oil paint.

All exterior doors, windows and louvers shall withstand wind pressure of 140 kg per square meter.

f) Air Conditioning and Ventilating System

An air conditioning system shall be provided in the control room and the office to protect control equipment from exposure to excessively warm ambient air and to keep the rooms in good working condition.

The work shall include the supply and installation of equipments, ducts, pipes, fittings and other necessary furnishings to complete all parts of the system.

A package type air conditioner with sufficient cooling capacity will be furnished and installed in the control room. Conditioned air shall be delivered to such room through air ducts.

The temperature of the design room shall be 28° C with relative humidity not over 50 per cent (50%). An applicable standard type and low speed acid resisting ventilating fan shall be installed for the battery room. The temperature of battery room shall not exceed 40°C.

g) Water Supply

The water supply systems shall consist of a potable water main distribution conduit to bring the water to the points of use from the water source.

The work shall include thesupply and installation of all equipment, pipes, accessories, valves and fittings to complete all parts of the system. All cold water pipes, drainage pipes and others shall be insulated or painted in a proper and operative manner.

In case no adequate water sourse is found around the site, the Contractor shall provide the source by means of a water well or other proper method at the Contractor's expense.

h) Sanitary and Sewage System

The work includes furnishing and installing of all sanitary fixtures, sewage equipments and other necessary materials to provide satisfactory sanitary and sewage facilities.

The sanitary fixtures shall be of good grade and of applicable standard type. Dirty waste water shall be disposed of by means of a septic tank or by other accepted methods as practiced in Nigeria. Required lavatory and toilet facilities are as follows:

Type of Plant	Type I	Type II	Type III
wash basin (no)	1	1	1
water closet (no)	1	1	1

i) Lighting System and AC Power Source

A 240 V AC indoor lighting system shall be provided for the D/G power house with such illumination levels as specified below:

	AC illumination level
· Control room	300 lux
· D/G room	100
· Battery room and others	100

Minimum of 4 mercury vapor fload lights shall be used for outdoor partial lighting and shall be mounted on the building walls or supporting posts.

All rooms, except washrooms, shall be provided with a low tension A. C. electrical outlets spaced approx. 45 m from outlet to outlet for plant operation and maintenance.

Electrical panel boards shall contain feeders to supply power for air conditioning equipments, ventilating fans, travelling crane, power receptacles and lighting system.

j) Travelling Crane

The following electrically-operated overhead crane shall be provided complete with push botton remote control for operation and maintenance in the diesel generator house.

Type of Plant	Type I	Type II	Type III
No. of crane (set)	1	1	1
Lifting capacity (ton)	6	5	4
Approx. lifting speed (m/min)	4	4	4
Approx. trolling speed (m/min)	12	12	12
Approx. travelling speed (m/min)	30	30	30
Power source (V)	415	415	415
Approx. lifting (m)	4	4	4
Approx. crane span (m)	14	14	14

The crane shall be capable of raising, lowering and holding in position and transporting an occasional hook overload of 125 per cent of the rated load without damage or excessive deflection to any crane part.

All crane equipment, apparatus and accessories shall be of applicable standard type.

k) Furniture

The following furniture shall be supplied.

Type of Plant	Type I	Type II	Type III
Desk and chair (no)	3 sets	3 sets	3 sets
Shelves (no)	2	2	2
Cabinet (no)	2	2	2

All furniture shall be made of steel or uncombustible material.

7.2.7 Outdoor Equipment Foundations

Unless otherwise specified, all foundations shall be of reinforced concrete. Exposed surfaces of concrete foundations shall be finished with 25 mm thick cement mortar finish.

All tank foundations containing combustible or dangerous liquid shall in all instances be surrounded by appropriate concrete or earth dikes. Enclosed volume with dikes shall equal tank contents. An access stairway shall be provided for each dikes.

The Contractor shall provide adequate facilities, i. e. oil separator pits, deposit pond, and any/all other necessary fixtures for industrial waste water to be chemically treated before being discharged to a proper disposal area.

7. 2. 8 Access Roads

Access roads leading from the main road to the site as well as those on/at the site shall be built by the Contractor.

Unless otherwise specified, the access roads shall be constructed as follows:

Thickness of Sub-base	:	1-layer of 60 mm thick after compaction
Thickness of Base-course	:	1-layer of 60 mm thick after compaction
Thickness of AC finish surface	:	75 mm thick

Adequate compaction of sub-base and base-course shall be obtained by pneumatic tired rollers of double wheel load or other suitable machines. Compactions of sub-base and base-course shall be carried to 95% of their relative density. The cross gradient shall be 3 per cent to prevent rain water from impounding.

7. 2. 9 Fence and Gates

Fences and gates shall be provided for the site boundary. The following steel fence or equivalent shall be used.

Wire mesh	:	2. 6 mm dia x 56 mm mesh hot galvanized wire.
Barbed wire	:	2. 0 mm dia. hot galvanized wire.
Height	:	2. 1 meter above ground level.

Fences and gates shall withstand a wind pressure of 140 kg per square meter.

All steel, except rails to be used for gates, shall be hot dipped galvanized in shop after fabrication.

The main gate shall be the same width as the road, doubleswing, wire-mesh, and topped with barbed wire to prevent over-climbing.

7. 2. 10 Earthing and Lightning

1) Earthing

The earthing system shall be made safe for operating personnal by providing connections to ground of generators, transformers, motors and other power-equipments.

Cables comprising the grounding mat shall be of stranded copper wire not less than 50 mm^2 in size. Ground resistance throughout the system shall not exceed 10 ohms. All fencing of site boundaries and isolated structures shall also be grounded. Cable installation and resistance tests shall be performed in accordance with applicable standards and/or codes.

2) Building Lightning

Sufficient numbers of air terminals under applicable standards and/or codes shall be supplied and mounted on the D/G power house roof for building protection.

The system shall be grounded and isolated from the station earthing system. Ground resistance for the system shall not exceed 10 ohms.

IV SCHEDULE OF CHARACTERISTICS

Contractor shall deliver such equipment and device as shall conform to this Schedule I in type, rating and other requirements specified herein. Furthermore, Contractor shall fill in all the blanks on his own responsibility and deliver such equipment and device as shall conform to all the entries therein as well as the provisions set forth in Chapter III "TECHNICAL SPECIFICATIONS". In case of delivery of any such equipment and device as may be equivalent or superior in performance, Contractor shall be allowed to make modifications of the entries with the Government's approval, provided however that such equipment and device shall conform to this schedule in type, rating and other requirements specified herein.

V SCHEDULE OF COMPONENTS AND UNIT PRICE

a) This schedule is to specify the composition of the unit on the basis of Chapter IV "SCHEDULE OF CHARACTERISTICS". Contractor shall therefore quote his price in Naira item by item in accordance with this schedule.

In this connection, Contractor shall submit a separate sheet indicating:

i) rate of exchange, date

ii) rate of insurance

iii) rate of railage, dock dues, transport

b) Any such equipment and device as Contractor may deem particularly necessary in addition to those specified herein may be specially entered in blank space hereof.

c) Composition of the distribution system is specified in details in SCHEDUEL II-27-1, II-28-1, II-29-1 and II-32-3. Contractor shall therefore quote their price in accordance with those SCHEDULES.

SCHEDULE No. I

Item No. I-1

CHARACTERISTICS OF
DIESEL ENGINE

Particulars	Unit	75kW	115kW	229kW
Manufacturer				
Type				
Application		indoor	indoor	indoor
Speed	r.p.m			
Continuous site rating	kW			
Cycles		4	4	4
Number of cylinders				
Bore and stroke	mmxmm			
Piston speed	m/sec			
Total displacement at cylind.				
Naturally aspirated or super-charged				
Make and type of trubo charg				
Cyclic irregularity				
Make and type of governor				
Make and type of fuel system				
Make and type of fuel filters				
Number of fuel filters	No.			
Recommended fuel oil				
Fuel consumption				
- at 25 % load	g/kWh			
- at 50 % load	g/kWh			
- at 75 % load	g/kWh			
- at 100 % load	g/kWh			
- at 110 % load	g/kWh			
Indoor tank for daily con-sumption	ℓ			
Cooling system		Radiator	Radiator	Radiator
Total capacity of lubricating oil system	ℓ			
Fuel transfer pump	kW			
Lubricating oil consumption at rated output	g/kWh			

SCHEDULE No. I

Item No. I-1

CHARACTERISTICS OF
DIESEL ENGINE

(Cont'd)

Particulars	Unit	75kW	115kW	229kW
Make and type of air cleaner				
Air required for combustion				
Air starting motor or starting device				
- Make and type				
- Pressure of compressed air for starting	kg/cm^2			
- Value of air for starting under atmospheric pressure	ℓ			
- Unit air tank	ℓ			
Total weight of engine	kg			

SCHEDULE No. I

Item No. I-2

CHARACTERISTICS OF GENERATOR

Particulars	Unit	75kW	115kW	229kW
Manufacturer				
Type				
Form of protection				
Phase				
Connection		Star	Star	Stor
Power factor		0.85	0.85	0.85
Rated voltage	V	415	415	415
Rated current	A			
Rated capacity for continuous 24-hours duty, 10 % overload for one hour after 24-hours at rated load	kW			
Rated frequency	Hz	50	50	50
Basic insolation level				
Speed	l/min.			
Guaranteed efficiencies at rated P.F. for				
110 % load	%			
100 % load	%			
75 % load	%			
50 % load	%			
25 % load	%			
Wave form deviation				
Exciter				
- Manufacturer				
- Type				
- Rated voltage	V			
- Rated capacity	W			
Voltage regulator				
- Manufacturer				
- Type				
- Regulation accuracy	%			

SCHEDULE No. I

Item No. I-2

CHARACTERISTICS OF GENERATOR

(Cont'd)

Particulars	Unit	75kW	115kW	229kW
- from no load cold field to full load hot field with 5 % speed variation - Regulator drift for 40° C ambient change - Adjustment range of rated voltage	%	±10	±10	±10
Total weight of generator	kg			

SCHEDULE No. I

Item No. I-3

CHARACTERISTICS OF
COMPLETE DIESEL GENERATING UNIT

Particulars	Unit	75kW	115kW	229kW
Diesel electric generating unit deliver continuously (24 hours duty) at a power factor of 0.85 and an ambient room temperature of 40°C	kW			
Voltage regulation from no load to 110 % load	%			
Frequency regulation from no load to 110 % load	%			
Dimensions and weights:				
- Overall unit length	m			
- " " width	m			
- " " height	m			
- Total weight of unit	kg			

SCHEDULE No. I

Item No. I-4

CHARACTERISTICS OF
FUEL STRAGE TANK

Particulars	Unit	50001	100001	150001
Manufacturer				
Type				
Application		Outdoor open air	Outdoor open air	Outdoor open air
Contents	ℓ	5000	10000	15000
Material				
Protection against corrosion				
Dimension				
Overall height	m			
Overall width	m			
Overall length	m			
Total weight (without fuel)	kg			

SCHEDULE No. I

Item No. I-5

CHARACTERISTICS OF
AIR COMPRESSOR

Particulars	Unit	Motor Driven	Engine Driven
Manufacturer			
Type			
Application		Indoor	Indoor
Pressure of compressed air	kg/cm^2		
Rated Capacity	kW	≧ 1	≧ 1
Input Voltage (A. C.)	V		—
Recommended fuel oil		—	
Dimension of Compressor			
- Height	mm		
- Width	mm		
- Length	mm		
Weight of compressor	kg		

SCHEDULE No. I

Item No. I-6

CHARACTERISTICS OF
STRAGE AIR TANK

Particulars	Unit	Characteristics
Manufacturer		
Type		
Application		
Contents of air tank	ℓ	
Pressure of compressed air	kg/cm^2	
Material of air tank		
Dimension of air tank		
- Height	mm	
- Width	mm	
- Length	mm	
Weight of air tank	kg	

SCHEDULE No. I

Item No. I-7

CHARACTERISTICS OF
WATER SOFTENING EQUIPMENT
(or Water Still)

Particulars	Unit	Characteristics
Manufacturer		
Type		
Capacity	ℓ/H	
Input Power (Electricity)	kW	
or (Fuel)	ℓ/H	
Dimension of Set-Height	mm	
-Width	mm	
-Length	mm	
Weight of set	kg	

SCHEDULE No. I

Item No. I-8

CHARACTERISTICS OF
STEP UP TRANSFORMERS

Particulars	Unit	200kVA	300kVA	500kVA	700kVA
Manufacturer					
Type					
Application		Outdoor	Outdoor	Outdoor	Outdoor
Design		ONAN	ONAN	ONAN	ONAN
Rated frequency	Hz	50	50	50	50
Nominal system voltage	kV	11	11	11	11
Phase		3	3	3	3
Rated primary voltage	kV	11	11	11	11
Primary taps above rated voltage (off-load taps)	%	2x2.5	2x2.5	2x2.5	2x2.5
Primary taps below rated voltage (off-load taps)	%	2x2.5	2x2.5	2x2.5	2x2.5
Rated secondary voltage	V	415/240	415/240	415/240	415/240
Rated capacity (natural cooling)	kVA	200	300	500	700
Primary connection		Delta	Delta	Delta	Delta
Secondary connection		Star	Star	Star	Star
Connection group		Dyll	Dyll	Dyll	Dyll
Rated primary current	A				
Rated secondary current	A				
Iron losses at rated voltage	kW				
Cupper losses at rated current	kW				
Efficiency at unity power					
- full load (natural cooling)	%				
- 75 % load (natural cooling)	%				
- 50 % load (natural cooling)	%				
Efficiency at 0.8 power					
- full load (natural cooling)	%				

SCHEDULE No. I

Item No. I-8

CHARACTERISTICS OF
STEP UP TRANSFORMERS

(Cont'd)

Particulars	Unit	200kVA	300kVA	500kVA	700kVA
- 75 % load (natural cooling)	%				
- 50 % load (natural cooling)	%				
Impedance voltage between primary and secondary winding at rated capacity	%	4	4	4	4
Temperature rise of windings at 40° C ambient	°C	55	55	55	55
Permissible continuous overload at 40° C max. ambient temperature	°C				
Max. current density high voltage	A/mm^2				
Max. current density low voltage	A/mm^2				
Max. flux density	Lines/cm^2				
Impulse withstand voltage (B.I.L.) high voltage winding	kV-peak	75	75	75	75
Impulse withstand voltage (B.I.L.) low voltage winding	kV-peak				
Power frequency withstand voltage high voltage winding	kV-rms	35	35	35	35
Power frequency withstand voltage low voltage winding	kV-rms	3	3	3	3
Total weight	kg				
Weight of oil	kg				

SCHEDULE No. I

Item No. I-8

CHARACTERISTICS OF
STEP UP TRANSFORMERS

(Cont'd)

Particulars	Unit	200kVA	300kVA	500kVA	700kVA
Overall dimensions					
Height	m				
Width	m				
Length	m				
Max. noise level at a distance of 1 m	dB				
Reference literature	No.				

SCHEDULE No. I

Item No. I-9

CHARACTERISTICS OF
CIRCUIT BREAKER & FUSE FREE BREAKER

Particulars	Unit	11kV (Circuit Breaker)	415V (Fuse Free Breaker)
Manufacturer			
Type			
Application		Indoor	Indoor
Rated frequency	Hz	50	50
Nominal system voltage	kV	11	0.415
Phase		3	3
Rated current	A	≥ 100	See Attached Sheet
Rated short time current 2 sec	kA	20	See Attached Sheet
Rated peak current	kA	36	See Attached Sheet
Rated breaking capacity (symmetrical)	MVA	≥ 150	See Attached Sheet
Rated total breaking time	sec		
Making time	sec		
Impulse withstand voltage (B.I.L.)	kV-peak	75	
One-minute power frequency withstand voltage	kV-rms	35	3
Method of closing			
Method of tripping			
Aux. voltage for tripping	V	110DC	110DC
Aux. voltage for closing	V	110DC	
Number of Aux. contacts NC and NO			
Net weight complete	kg		See Attached Sheet
Reference literature	No.		See Attached Sheet

* Attached Sheet No. — Item No. I-9. 10 - (i)

SCHEDULE No. I

Item No. I-10

CHARACTERISTICS OF
DISCONNECTING SWITCH & KNIFE SWITCH

Particulars	Unit	Disconnecting Switch	Knife Switch
Manufacturer			
Type			
Application		Outdoor	Indoor
Rated frequency	Hz	50	50
Nominal system voltage	kV	11	0.415
Phase		3	3
Rated current	A	100	See Attached Sheet
Rated short time current 2 sec	A		
Impulse withstand voltage (B.T.L.)	kV-Peak	75	
Power frequency withstand voltage	kV-rms	35	3
Type of operating mechanis mechanism			
Number of aux. contacts NC and NO			
Net weight complete	kg		
Reference Literature	No.		

* Attached Sheet No. – Item No. I-9. 10-(i)

SCHEDULE No. I

Item No. I-9, 10-(i)

CHARACTERISTICS OF
FUSE FREE BREAKERS & KNIFE SWITCHES

(Cont'd)

Particulars	Unit	Fuse Free Breakers 1000A	700A	400A	300A	200A	150A	125A	30A
Rated current	A	1000	700	400	300	200	150	125	30
Rated short time current 2 sec.	kA								
Rated peak current	kA								
Min. rated breaking capacity (systemetrical)	kA	10	10	10	10	10	10	10	10
Weight	kg								
Reference literature									
Characteristics				*		*	*		
		*Fuse Free Breakers for D.G. has the characteristics of "Short Time Delay".							

		Knife Switches 1000A	700A	400A	300A	200A	150A	125A	30A
Rated current	A	1000	700	400	300	200	150	125	30
Rated short time current 2 sec.	A								

SCHEDULE No. I

Item No. I-11

CHARACTERISTICS OF
CURRENT TRANSFORMER H.V.

Particulars	Unit	40/5A	30/5A	20/5A
Manufacturer				
Type				
Application		Indoor	Indoor	Indoor
Rated frequency	Hz	50	50	50
Nominal System voltage	kV	11	11	11
Rated primary current	A	40	30	20
Rated secondary current	A	5	5	5
Rated burden	VA	≧ 30	≧30	≧30
Accuracy class	Class	1	1	1
Saturation factor		n>5	n>5	n>5
Impulse withstand voltage (B.I.L.)	kV-peak	75	75	75
Power frequency withstant voltage	kV-rms	35	35	35
Max. continuous current	A			
Rated short time current 2 sec.	A	≧100xIn	≧100xIn	≧100xIn
Rated peak short time current	A	≧250xIn	≧250xIn	≧250xIn
Net weight complete	kg			
Reference Literature	No			

SCHEDULE No. I

Item No. I-12

CHARACTERISTICS OF
CURRENT TRANSFORMER L.V.

(Cont'd)

Particulars	Unit	400/5A	200/5A	150/5A
Manufacturer				
Type				
Application		Indoor	Indoor	Indoor
Rated frequency	Hz	50	50	50
Nominal system voltage	V	415	415	415
Rated primary current	A	400	200	150
Rated secondary current	A	5	5	5
Rated burden	VA	≧30	≧30	≧30
Accuracy class	Class	1	1	1
Saturation factor		n>5	n>5	n>5
Impulse withstand voltage (B.I.L.)	kV-peak			
Power frequency withstand voltage	kV-rms	3	3	3
Max. continuous current	A			
Rated short time current 2 sec.	A	≧ 60xIn	≧ 60xIn	≧ 60xIn
Rated peak short time current	A	≧ 150xIn	≧ 150xIn	≧ 150xIn
New weight complete	kg			
Reference Literature	No.			

SCHEDULE No. I

Item No. I-13

CHARACTERISTICS OF
POTENTIAL TRANSFORMERS & AUX. POTENTIAL TRANSFORMERS

Particulars	Unit	Transformer	Aux. Potential Transformers
Manufacturer			
Type			
Application		Indoor	Indoor
Rated frequency	Hz	50	50
Nominal system voltage	kV	11	0.415
Phase		3	3
Rated primary voltage	kV	$11/\sqrt{3}$	0.415
Rated secondary voltage	V	$110/\sqrt{3}$	110
Rated tertiary voltage	V	$110/\sqrt{3}$	
Rated burden	VA	$\geqq 40$	$\geqq 40$
Accuracy class	Class	1	1
Impulse withstand voltage (B.I.L.)	kV-peak	75	-
Power frequency withstand voltage	kV-rms	35	3
Net weight complete	kg		
Reference Literature	No.		

SCHEDULE No. I

Item No. I-14

CHARACTERISTICS OF
LIGHTING ARRESTORS & SURGE ABSORBORS

Particulars	Unit	Lighting Arresters	Lighting Arresters	Surge Absorbors
Manufacturer				
Type				
Application		Indoor	outdoor	Indoord
Rated frequency	Hz	50	50	50
Nominal system voltage	kV	11	11	0.415
Rated arrester voltage	kV	12	12	
Power frequency sparkover voltage	kV			
Max. value of 100 % impulse sparkover voltage (1.2/50 wave)	kV			
Peak sparkover voltage on switching overvoltages (200/2000 wave)	kV			
0-5 sec. wave front impulse sparkover	kV			
Max. value of residual vo voltage				
- at 5 kA discharge current	kV			—
- at 10 kA discharge current	kV			—
Short circuit strength 0.4 sec.	kA			
Rated discharge current	kA			
High impulse current	kA			
Net operating weight	kg			
Reference Literature	No.			

SCHEDULE No. I

Item No. I-15

CHARACTERISTICS OF
11kV SWITCHGEAR BOX & 11kV ARRESTER BOX

Particulars	Unit	11kV Switch-gear Box	11kV Arrester Box
Manufacture			
Type			
Apprication		Indoor	Indoor
Rated frequency	Hz	50	50
Rated voltage	kV	11	11
Material of busbar		Cupper	Cupper
Rated current	A	≧ 100	—
Rated short circuit capacity	MVA	≧ 100	≧ 150
Type of mounting			
Type of sheet metal			
Panel dimention - Height	mm		
Width	mm		
Length	mm		
Type of metal primer			
Type of finishing paint			
Colour of finishing paint (to be specified at a later data)			
Net operating weight	kg		

SCHEDULE No. I

Item No. I-16

CHARACTERISTICS OF
LOW VOLTAGE DISTRIBUTION BOARD & D.C. DISTIBUTION PANEL

Particulars	Unit	L.V.D.B. 1200A	L.V.D.B. 600A	L.V.D.B. 400A	D.C. Distribution Panel
Manufacturer					
Type					
Application		Indoor	Indoor	Indoor	Indoor
Rated voltage	V	415 A.C.	415 A.C.	415 A.C.	110 D.C.
Material of busbar		Cupper	Cupper	Cupper	Cupper
Rated current (Bus)	A	1200	600	400	
Short circuit current	kA	≥10	≥10	≥10	—
Type of mounting					
Type of sheet metal					
Panel dimention - Height	mm				
Width	mm				
Length	mm				
Type of metal primer					
Type of finishing paint					
Colour of finishing paint (to be specified at a later date)					
Net operating weight	kg				

SCHEDULE No. I

Item No. I-17

CHARACTERISTICS OF
CONTROL PANEL FOR D.G., SUPERVISONARY PANEL
& COMPRESSED AIR SYSTEM PANEL

Particulars	Unit	Control Panel	Supervison-ary Panel	Compressed Air System Panel
Manufacturer				
Type				
Application				
Type of sheet metal				
Thickness of sheet metal				
Panel dimention - Heigth	mm			
- Width	mm			
- Length	mm			
Type of metal primer				
Type of finishing paint				
Colour of finishing paint (to be specified at a later date)				
Form of protection				
Net operating weight	kg			

SCHEDULE No. I

Item No. I-18

CHARACTERISTICS OF
BATTERY

Particulars	Unit	Battery
Manufacturer		
Type		Vented alkaline (Ni-Cd) Type
Application		Indoor
Nominal voltage	V	110 D.C.
Rated capacity at 10 hours discharge rate	Ah	≥ 45
Voltage of one-cell	V	
Type of negative plates		
Type of positive plates		
Type of separators		
Type of electrolyte		
Specific density of electrolyte		
- fully charged	g/cm^3	
- discharged	g/cm^3	
Overall dimension - Height	mm	
- Width	mm	
- Length	mm	

SCHEDULE No. I

Item No. I-19

CHARACTERISTICS OF
BATTERY CHARGER

Particulars	Unit	Charger
Manufacturer		
Type		
Application		Indoor
Nominal voltage	V	110 D.C.
Input voltage (A.C.)	V	
Rated current	A	≥ 10
Charging characteristic		
Float charge voltage adjustable between ...	V	
Equalize voltage adjustable between ...	V	
Temperature rise	°C	
Type of mounting		
Dimensions of the charger		
- Height	mm	
- Width	mm	
- Length	mm	
Weight of the charger	kg	

SCHEDULE No. I

Item No. I-20

CHARACTERISTICS OF
EMERGENCY D.C. ENGINE GENERATOR

Particulars	Unit	D.C. Engine Generator
Manufacturer		
Type		
Application		Indoor
Normal Generating Voltage	V	110 D.C.
Rated capacity	kW	≥ 2
Recommended fuel oil		
Dimention of Generator		
- Height	mm	
- Width	mm	
- Length	mm	
Weight of generator	kg	

SCHEDULE No. I

Item No. I-21

CHARACTERISTICS OF
OVERHEAD TRAVELLING CRANE

Particulars	Unit	4 ton	5 ton	6 ton
Manufacturer				
Type				
Application		Indoor	Indoor	Indoor
Load capacity	ton	4	5	6
Span	m	14	14	14
Length of the rails	m			
Trolley Motor				
- Input voltage	V			
- Required capacities	kW			
Crane bridge				
- Input voltage	V			
- Required capacities	kW			
Hoist Motor				
- Input voltage	V			
- Required capacity	kW			
Operating Method				
Weight of Crane				
Reference literature	No.			

SCHEDULE No. I

Item No. I-22

CHARACTERISTICS OF
OVERHEAD DISTRIBUTION LINES
GENERAL CHARACTERISTICS

Particulars	Unit	Characteristics
Low		
Standards applied		IEC N.E.P.A. B.S.
Frequency	Hz	50
Nominal system voltage	kV	11
	kV	0.415 - 0.240
Number of conductors		
H.V.		3
L.V.		4
Street Lightings		1
Ruling Span Town Area	m	45
Outside Town	m	90
Type of Poles		Concrete or Wood
Type of Conductor		A.A.C.
Type of Insulator H.V.		Pin and Disc
L.V.		Shackle
Phase spacing	m	
Minimum Factor of Safety		As specified

SCHEDULE No. I

Item No. I-23

CHARACTERISTICS OF
CONCRETE POLES

Particulars	Unit	10m 33 or 34 Feet	8m 28 Feet
Manufacturer			
Type			
Standards applied			
Material		Concrete and Steel Wire	Concrete and Steel Wire
Profile			
Total length	m		
Depth of foundation	m	1.8	1.5
Maximum top pull without stay	kg	300	150
Hole diameters	cm		
Diameter of pole			
- at ground line	m		
- at top	m		
- at butt	m		
Weight	kg		

SCHEDULE No. I

Item No. I-24

CHARACTERISTICS OF
WOODEN POLES

Particulars	Unit	10m 34 Feet	8m 28 Feet	Remarks
Manufacturer				
Type				
Standard		Nigerian Standard	Nigerian Standard	
Class of pole				(according to Nigerian Standard)
Profile				
Total length	m			
Depth of foundation	m	1.8	1.5	
Maximum top pull without stay	kg			
Diameter of pole				
- at ground line	m			
- at top				
- at butt				
Weight	kg			
Preservation material				
Impregnation method				

SCHEDULE No. I

Item No. I-25

CHARACTERISTICS OF CONDUCTORS

Particulars	Unit	AAC 50 mm^2	AAC 100 mm^2	Covered conductor for pole	Covered conductor for line
Manufacturer					
Catalogue No.					
Standards applied					
Type		AAC	AAC		AAC
Material		Alumi-nium	Alumi-nium		Alumi-nium
Material of Insulator					
Nominal area	mm^2				
Number of conductor wires	No.				
Diameter of conductor wire	mm				
Weight of conductor	kg/m				
Nominal breaking load	kg	800	1600		
Maximum Modulus of elasticity	kg/mm^2				
Co-efficient of thermal expansion	$10^{-6}/°C$				
Max. D.C. resistance at 20°C	/km				
Co-efficient of resistivity	$10^{-3}/°C$				
Length per drum	m				
Gross weight per drum	kg				
Conductor weight per drum	kg				
Dry one-minute power frequency with stand voltage	kV				
Insulation resistance	MΩ-km				
Maximum modules of elastivity	kg/mm^2				

SCHEDULE No. I

Item No. I-26

CHARACTERISTICS OF INSULATORS (1)

Particulars	Unit	H. V. Pin	H. V. Disc	L. V. Shackle	Stay Insulator
Manufacturer					
System voltage					
Catalogue No.					
Standards applied					
Type					
Insulating material					
Diameter	mm				
Spacing	mm				
Pin diameter	mm				
Number of sheds					
Leakage distance	mm				
Weight	kg				
Maximum working load	kg				
Minimum electro-mechanical strength	kg				
Dry impulse withstand voltage	kV	95	105	–	–
Dry one-minute power frequency withstand voltage	kV	75	75	20	20
Wet one-minute power frequency withstand voltage					
Minimum puncture voltage	kV	50	45	11	11

SCHEDULE No. I

Item No. I-27

CHARACTERISTICS OF
STEEL PARTS

Particulars	Unit	Characteristics
Cross arm		
Manufacturer		
Length		1.63m, 2.24m, Over 2.5 m
Maximum modulus of elasticity	kg/mm^2	
Preece test		6
Bolts, Nuts, Washers		
Manufacturer		
Maximum modulus of elasticity	kg/mm^2	
Ultimate tensile strength	kg	
Preece test		6
Other steel part (Strup, Diron, Insulator hook, Shackle strop, etc.)		
Manufacturer		
Maximum modulus of elasticity	kg/mm^2	
Preece test		6

SCHEDULE No. I

Item No. I-28

CHARACTERISTICS OF
CONDUCTOR AND INSULATOR PARTS

Particulars	Unit	Characteristics
Line connector		
Manufacturer		
Type		
Material		
Length		
Minimum slip strength	kg	
Rated current		
Conductivity		
Clamps		
Manufacturer		
Type		
Material		
Minimum slip strength	kg	
Rated current		
Conductivity		
Parallel clamp		
Manufacturer		
Type		
Material		
Minimum slip strength		
Rated current		
Conductivity		
Binding wire		
Manufacturer		
Material		
Armour tape		
Manufacturer		
Material		

SCHEDULE No. I

Item No. I - 28

CHARACTERISTICS OF
CONDUCTOR AND INSULATOR PARTS

(Cont'd)

Particulars	Unit	Characteristics
Hard aluminum strup		
Manufacturer		
Material		

SCHEDULE No. I

Item No. I-29

CHARACTERISTICS OF
STAYS AND FOUNDAYTION ASSEMBLY

Particulars	Unit	Characteristics
Stay wire		
Manufacturer		
Standards applied		
Type		
Material		
Nominal area	mm^2	
Diameter of stay wire	mm	
Number of wires		
Maximum working load	kg	
Breaking load	kg	
Stay rod		
Manufacturer		
Type		
Material		
Diameter of rod	mm	
Length	cm	
Stay balk		
Manufacturer		
Catalogue No.		
Type		
Material		
Length	cm	
Concrete Base		
Manufacturer		
Material		

SCHEDULE No. I

Item No. I-30

CHARACTERISTICS OF
EARTH ASSEMBLY

Particulars	Unit	Characteristics
Earthing load		
Manufacturer		
Material Conductor		
Covering		
Conductivity percentage	%	
Cross-section	mm^2	
Weight	kg/m	
Minimum Length per drum	m	
Earthing rods		
Manufacturer		
Material		
Diameter	mm^2	
Length	m	
Weight	kg	
Earthing clamp		
Manufacturer		
Material		

SCHEDULE No. I

Item No. I-31

CHARACTERISTICS OF
DISTRIBUTION TRANSFORMERS

Particulars	Unit	100 kVA	200 kVA
Manufacturer			
Type			
Application		Outdoor	Outdoor
Design		ONAN	ONAN
Rated frequency	Hz	50	50
Nominal system voltage	kV	11	11
Phase		3	3
Rated primary voltage	kV	11	11
Primary taps above rated voltage (off-load taps)	%	2x2.5	2x2.5
Primary taps below rated voltage (off-load taps)	%	2x2.5	2x2.5
Rated secondary voltage	V	415/240	415/240
Rated capacity (natural cooling)	kVA	100	200
Primary connection		Delta	Delta
Secondary connection (neutral full insulated)		Star	Star
Vector group		Dyll	Dyll
Rated primary current	A		
Rated secondary current	A		
Iron losses at rated voltage	kW		
Cupper losses at rated power	kW		
Efficiency at unity power			
- factor full load (natural cooling)	%		
- 75 % load (natural cooling)	%		
- 50 % load (natural cooling)	%		
Efficiency at 0.8 power			
- factor full load (natural cooling)	%		

SCHEDULE No. I

Item No. I-31

CHARACTERISTICS OF
DISTRIBUTION TRANSFORMERS

(Cont'd)

Particulars	Unit	100 kVA	200 kVA
- 75 % load (natural cooling)	%		
- 50 % load (natural cooling)	%		
Impedance voltage between primary and secondary winding at rated capacities	%	4	4
Temperature rise of windings above 40° C max. ambient temp	°C	55	55
Permissible continuous overload at 40° C max. ambient temperature	%		
Max. current density high voltage	A/mm^2		
Max. current density low voltage	A/mm^2		
Max. flux density	Lines/cm^2		
Impulse withstand voltage (B.I.L.) high voltage winding	kV-peak	75	75
Impulse withstand voltage (B.I.L.) low voltage winding	kV-peak		
Power frequency withstand voltage high voltage winding	kV-rms	35	35
Power frequency withstand voltage low voltage winding	kV-rms	3	3
Total operating weight	kg		
Weight of oil	kg		

SCHEDULE No. I

Item No. I-31

CHARACTERISTICS OF
DISTRIBUTION TRANSFORMERS

(Cont'd)

Particulars	Unit	100 kVA	200 kVA
Overall dimensions Height	m		
Width	m		
Length	m		
Max. noise level at a distance of 1 m	dB	54	54
Reference Literature	No.		

SCHEDULE No. I

Item No. I-32

CHARACTERISTICS OF
LV FEEDER PILLAR

Particulars	Unit	Characteristics
Manufacturer		
Type		
Number of Circuits		4
Application		Outdoor
Rated voltage	kV	0.415
Material of box		
Material of busbar		
Rated current		
Short circuit current	kA	25
Type of mounting		Concrete foundation

SCHEDULE No. I

Item No. I-33

CHARACTERISTICS OF
DROP OUT FUSE SWITCH WITH FUSE

Particulars	Unit	Characteristics
Manufacturer		
Catalogue No.		
Standards applied		
Type		
Mounting		Vertical
Voltage		11 kV
Rupturing capacity	MVA	
Phase		Single
Rating	Amps	100 A
Material		
- Insulator		
- Contact		
One-minute power frequency withstand voltage of supports		
- to earth	kV	
- across the isolating distance of insulators		
Impulse withstand voltage of support		
- to earth	kV	
- across the isolating distance of insulator	kV	
Insulation class of operating rod	kV	
Temperature rise	°C	
Length of fuse	mm	
Rating of fuse	A	
Dimensions of support without fuse		
- length	mm	
- height	mm	
Weight	kg	

SCHEDULE No. I

Item No. I-34

CHARACTERISTICS OF
UNDERGROUND CABLES (1)

Particulars	Unit	H.T.	L.V.	Remarks
Manufacturer				
Catalogue No.				
Standards applied				
Standards tested				
Type				
Material of conductor		Copper	Copper	
Number of conductor		3	4	
Installation				Outdoor
Nominal area	mm^2			
Diameter of conductor wires	mm			With error scope
Material				
- Insulator (thickness)	mm			
- Armour (thickness)	mm			
- Sheath (thickness)	mm			
Conductor, e.g. plain, tinned, compacted, etc.				
Number of strand				
Diameter of phase conductor including screen	mm			
Outer diameter of cable	mm			
Weight	kg/m			
Length per drum	m			
Gross weight perdrum	kg			

SCHEDULE No. I

Item No. I-34

CHARACTERISTICS OF
POWER CABLE (2)

(Cont'd)

Particulars	Unit	H.T.	L.T.	Remarks
Minimum bending radius		12 D	12 D	D: dia
Continuous current carrying capacity at 20°C	Amp			
Short time current carrying capacity at: 0.2 seconds	kA			
0.5 seconds	kA			
1.0 seconds	kA			
2.0 seconds	kA			
Resistance of isolation	Ω/km			
Capacity	MF/km			
Inductance	mH/km			
Maximum D.C. resistance of each phase conductor at 20°C	Ω/km			

SCHEDULE No. I

Item No. I-35

CHARACTERISTICS OF
CABLE PARTS

Particulars	Unit	H.T.	L.T.
HV Cable Box			
Manufacturer			
Type			
Material			
Type of support structure			
Accessories			
Instruction buletin			
LV Cable Box			
Manufacturer			
Type			
Material			
Type of support structure			
Accessories			
Instruction buletin			
Cable Guards			
Manufacturer			
Dia			
Length			
Preece test			

SCHEDULE No. I

Item No. I-36

CHARACTERISTICS OF
STREET LIGHTING FITTINGS

Particulars	Unit	Characteristics
Flourescent		
Manufacturer		
Voltage	kV	0.240
Type		Outdoor
Life	Hour	
Street Lighting Panel (include fuse switching facilities and control light.)		Pole mounted type
Life of phote electric cell	Number of times	
Material of schell		

SCHEDULE No. II

ITEM No. II-1

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 75 kW

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Diesel engine Alternator Radiator Baseplate complete with vibration isolators Control panel complete with instruments controls, relays, voltage regulator, aux. potential transformer and surge absorbor current transformers metering control cable etc. Excitor Batteries Air starting motor or starting device						

SCHEDULE No. II

ITEM No. II-1

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 75 kW

(Cont'd)

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Unit air tank Speed Governor Tank for daily consumption with fuel transfer pump Recommended tools Silencer Recommended spare parts for 1 year (6000 h) Accessories as necessary to make the unit self-contained and complete						

SCHEDULE No. II

ITEM No. II.2

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 115 kW

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Rallage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Diesel engine Alternator Radiator Baseplate complete with vibration isolators Control panel complete with instruments controls, relays, voltage regulator, aux. potential transformer and surge absorbor current transformers metering control cable etc. Excitor Batteries Air starting motor or starting device						

SCHEDULE No. II

ITEM No. II-2

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 115 kW

(Cont'd)

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Unit air tank Speed Governor Tank for daily consumption with fuel transfer pump Recommended tools Silencer Recommended spare parts for 1 year (6000 h) Accessories as necessary to make the unit self-contained and complete						

SCHEDULE No. II

ITEM No. II-3

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 229 kW

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Diesel engine Alternator Radiator Baseplate complete with vibration isolators Control panel complete with instruments controls, relays, voltage regulator, aux. potential transformer and surge absorbor current transformers metering control cable etc. Excitor Batteries Air starting motor or starting device						

SCHEDULE No. II

ITEM No. II-3

COMPONENTS AND UNIT PRICES OF
DIESEL ELECTRIC GENERATOR 229 kW

(Cont'd)

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Unit air tank Speed Governor Tank for daily consumption with fuel transfer pump Recommended tools Silencer Recommended spare parts for 1 year (6000 h) Accessories as necessary to make the unit self-contained and complete						

SCHEDULE No. II

ITEM No. II-4

COMPONENTS AND UNIT PRICES OF
FUEL STRAGE TANK 5000 ℓ

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Strage tank Pipes and other accessories to connect the strage tank with fuel transfer pump and return pump of the tank for daily consumption Measuring instruments Accessories to make the fuel supply system complete						

SCHEDULE No. II

ITEM No. II-5

COMPONENTS AND UNIT PRICES OF
FUEL STRAGE TANK 10000 ℓ

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Rallage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Strage tank Pipes and other accessories to connect the strage tank with fuel transfer pump and return pump of the tank for daily consumption Measuring instruments Accessories to make the fuel supply system complete						

SCHEDULE No. II

ITEM No. II-6

COMPONENTS AND UNIT PRICES OF
FUEL STRAGE TANK 15000 ℓ

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Strage tank Pipes and other accessories to connect the strage tank with fuel transfer pump and return pump of the tank for daily consumption Measuring instruments Accessories to make the fuel supply system complete						

SCHEDULE No. II

ITEM No. II-7

COMPONENTS AND UNIT PRICES OF
COMPRESSED AIR SUPPLY

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Compressor motor driven (2 sets) Compressor engine driven Compressed air system panel Strage air tank Pipes and other accessories to connect the compressors and strage air tank with the unit air tank Accessories to make the compressed air system complete						

SCHEDULE No. II

ITEM No. II-8

COMPONENTS AND UNIT PRICES OF
WATER SOFTENING EQUIPMENT

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Water softening equipment (or water still) All other accessories and small materials complete for operation						

SCHEDULE No. II

ITEM No. II-9

COMPONENTS AND UNIT PRICES OF
STEP UP TRANSFORMER 200 kVA

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Transformer complete L. V. connecting cables and boxes to the low voltage distribution board H. V. connecting cables and boxes to 11 kV switch-board All other accessories to make the system complete for operating						

SCHEDULE No. II

ITEM No. II-10

COMPONENTS AND UNIT PRICES OF
STEP UP TRANSFORMER 300 kVA

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Transformer complete L. V. connecting cables and boxes to the low voltage distribution board H. V. connecting cables and boxes to 11 kV switch-board All other accessories to make the system complete for operating						

SCHEDULE No. II

ITEM No. II-11

COMPONENTS AND UNIT PRICES OF
STEP UP TRANSFORMER 500 kVA

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Transformer complete L.V. connecting cables and boxes to the low voltage distribution board H.V. connecting cables and boxes to 11 kV switch-board All other accessories to make the system complete for operating						

SCHEDULE No. II

ITEM No. II-12

COMPONENTS AND UNIT PRICES OF
STEP UP TRANSFORMER 700 kVA

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Transformer complete L.V. connecting cables and boxes to the low voltage distribution board H.V. connecting cables and boxes to 11 kV switch-board All other accessories to make the system complete for operating						

SCHEDULE No. II

ITEM No. II-13

COMPONENTS AND UNIT PRICES OF
11 kV SWITCHGEAR BOX 11 kV ARRESTOR BOX

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Circuit breaker Current transformer Potential transformer Share off bus bar Panel Relay board with instruments 11 kV power cable box with terminals to distribution system 11 kV arrestor 11 kV power cable or bus bar connecting 11 kV switchgear box with 11 kV arrester box All other accessories to make the panel complete for operation						

SCHEDULE No. II

ITEM No. II-14

COMPONENTS AND UNIT PRICES OF
POWER STATION L.V. DISTRIBUTION BOARD

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
L.V. distribution board L.V. fuse free breakers Knife switches Aux. potential transformers Metering control cables L.V. power cable connecting L.V. distribution board with control panel of disel generator All other accessories to make the panel complete for operation						

SCHEDULE No. II

ITEM No. II-15

COMPONENTS AND UNIT PRICES OF
SUPERVISONARY PANEL

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Supervisonary panel complete with metering, lighting indicator etc. Cabling to control panel of disel generators, L.V. distribution board, 11 kV switchgear box, etc. All other accessories and small materials complete for operation						

SCHEDULE No. II

ITEM No. II-16

COMPONENTS AND UNIT PRICES OF
D. C. -SUPPLY

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
110 V battery Charger D. C. Distribution panel Emergency D. C. Engine Generator Cables and other specified accessories (between L. V. distribution board and D. C. distribution panel, and between D. C. distribution panel and battery and others) Other accessories if any to make the D. C. supply complete						

SCHEDULE No. II

ITEM No. II-17

COMPONENTS AND UNIT PRICES OF
OVERHEAD TRAVELLING CRANE 4 ton

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Overhead travelling crane Iron rail L. V. power cable connecting the crane with L. V. distribution board All other accessories and small materials complete for operation						

SCHEDULE No. II

ITEM No. II-18

COMPONENTS AND UNIT PRICES OF
OVERHEAD TRAVELLING CRANE 5 ton

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Overhead travelling crane Iron rail L. V. power cable connecting the crane with L. V. distribution board All other accessories and small materials complete for operation						

SCHEDULE No. II

ITEM No. II-19

COMPONENTS AND UNIT PRICES OF
OVERHEAD TRAVELLING CRANE 6 ton

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Overhead travelling crane Iron rail L.V. power cable connecting the crane with L.V. distribution board All other accessories and small materials complete for operation						

SCHEDULE No. II

ITEM No. II-20

COMPONENTS AND UNIT PRICES OF
POWER STATION: LIGHTING

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Lamps to reach the specified lux densities (including emergency D.C. lamps) Complete L.V. and D.C. cabling and connecting including switches lockets, plugs, etc. Air conditioner for control room Switch box for power stations use All other accessories and small materials to complete the installation						

SCHEDULE No. II

ITEM No. II-21

COMPONENTS AND UNIT PRICES OF
POWER STATION: EARTHING AND LIGHTNING PROTECTION

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Earthing grid Earthing connection as specified Lightening protections All accessories to complete a effective protection						

SCHEDULE No. II

ITEM No. II-22

COMPONENTS AND UNIT PRICES OF
POWER STATION: CIVIL WORKS (For 229 kW DG)
Type I

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Total price of all materials and civil works to complete power station in accordance with the attached drawings and statement in III-7 "CIVIL SPECIFICATIONS"						

SCHEDULE No. II

ITEM No. II-23

COMPONENTS AND UNIT PRICES OF
POWER STATION: CIVIL WORKS (For 115 kW DG)
Type II

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Total price of all materials and civil works to complete power station in accordance with the attached drawings and statement in III-7 "CIVIL SPECIFICATIONS"						

SCHEDULE No. II

ITEM No. II-24

COMPONENTS AND UNIT PRICES OF
POWER STATION: CIVIL WORKS (For 75 kW DG)
Type III

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Total price of all materials and civil works to complete power station in accordance with the attached drawings and statement in III-7 "CIVIL SPECIFICATIONS"						

SCHEDULE No. II

ITEM No. II-25

COMPONENTS AND UNIT PRICES OF
SURVEY FOR DIESEL POWER STATION SITE

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Survey for diesel power station site for one town						

SCHEDULE No. II

ITEM No. II-26

COMPONENTS AND UNIT PRICES OF
SURVEY FOR DISTRIBUTION LINES ROUTE

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Survey for distribution lines route per km						

SCHEDULE No. II

ITEM No. II-27

COMPONENTS AND UNIT PRICES OF
POLE TYPE (1) H.V. ONLY

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Intermediate Angle (1) (5° - 20°) Angle (2) (20° - 45°) Section (1) - Intermediate Section (2) - Angle (45°-90°) Section (3) - H pole special Tee off						

SCHEDULE NO. II

ITEM NO. II-27-1

DETAILED COMPONENTS OF
POLE TYPE (H.V. ONLY)

Unit	Description	1-1	1-2	1-3	1-4	1-5	1-6	1-7
		Intermediate	Angle (1) (5° - 20°)	Angle (2) (20° - 45°)	Section (1) (Intermediate)	Section (2) (Angle 45°-90°)	Section (3) H pole Special	Tee Off
Each	Concrete (or Wooden) Pole 10 m (33 or 34 Feet)	1	1	1	1	1	2	1
Each	Concrete (or Wooden) Pole 8 m (28 Feet)							
Each	Crossarm Assembly with Strup and Bolt, Nut (2.24 m)			2		2	4	
Each	Crossarm Assembly with Strup and Bolt, Nut (1.63 m)	1	1		2			2
Each	Pin Insulator Assembly with Line Pin and Nut	3	3	6	3	3	3	3
Each	Disc Insulator Assembly with Strain Clamp and Fittings				6	6	6	6
Each	4 L.V. Shackle Insulators with Diron and Fittings							
Each	Stay Assembly with Wire, Insulator, Stay Rod and Balk		1	1		2		2
Each	Earth Assembly	1	1	1	1	1	1	1
Each	Foundation	1	1	1	1	1	2	1
Each	Danger and Number Plate	1	1	1	1	1	1	1
Each	Anti Climbing Device	1	1	1	1	1	1	1

SCHEDULE No. II

ITEM No. II-28

COMPONENTS AND UNIT PRICES OF
POLE TYPE (2) H.V. L.V. COMMON USE

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Intermediate						
Angle (1) (5° - 20°)						
Angle (2) (20° - 45°)						
Section (1) - Intermediate						
Section (2) - Angle (45°-90°)						
Intermediate with L.V. tee off (3 ways)						
Intermediate with L.V. tee off (4 ways)						
Intermediate - H pole H.V. section						
Tee off (1) - H.V. L.V. tee off						
Tee off (2) - L.V. three or four ways						
Tee off (3) - L.V. three or four ways						

SCHEDULE NO. II

ITEM NO. II-28-1

DETAILED COMPONENTS OF
POLE TYPE (H.V. ONLY)

Unit	Description	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9	2-10
		Intermediate	Angle (1) (5° - 20°)	Angle (2) (20° - 45°)	Section (1) (Intermediate)	Intermediate with L.V. Tee Off (Three Ways)	Intermediate with L.V. Tee Off (Four Ways)	Intermediate, H pole-H.V. Section	Tee Off (1) H.V. L.V. Tee Off	Tee Off (2) H pole L.V. three or four Ways	Tee Off (3) H pole L.V. three or four Ways
Each	Concrete (or Wooden) Pole 10m (33 or 34 Feet)	1	1	1	1	1	1	2	1	2	2
Each	Concrete (or Wooden) Pole 8m (28 Feet)										
Each	Crossarm Assembly with Strup and Bolt, Nut (2.24 m)							4		4	4
Each	Crossarm Assembly with Strup and Bolt, Nut (1.63 m)	1	1	2	2	1	1		3		1
Each	Pin Insulator Assembly with Line Pin and Nut	3	3	6	3	3	3	3	3		3
Each	Disc Insulator Assembly with Strain Clamp and Fittings				6			6	6	3	6
Each	4 L.V. Shackle Insulators with Diron and Fittings	1	1	1	2	2	3	3	2	3	3
Each	Stay Assembly with Wire, Insulator, Stay Rod and Balk		1	1		1			1	2	2
Each	Earth Assembly	1	1	1	1	1	1	1	1	1	1
Each	Foundation	1	1	1	1	1	1	2	1	2	2
Each	Danger and Number Plate	1	1	1	1	1	1	1	1	1	1
Each	Anti Climbing Device	1	1	1	1	1	1	1	1	1	1

SCHEDULE No. II

ITEM No. II-29

COMPONENTS AND UNIT PRICES OF
POLE TYPE (3) L.V. ONLY

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Intermediate						
Intermediate (special)						
Angle (5° - 90°)						
Angle (5° - 90°)(special)						
Section Intermediate						
Section Intermediate (special)						
Intermediate with tee off (three ways)						
Intermediate with tee off (four ways)						
Terminal (four ways)						

SCHEDULE NO. II

ITEM NO. II-29-1

DETAILED COMPONENTS OF
POLE TYPE (L.V. ONLY)

Unit	Description	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8	3-9
		Intermediate	Intermediate (Special)	Angle (1) (Up to 90°)	Angle (2) (Up to 90° - Special)	Section (1) (Intermediate)	Section (2) (Intermediate - Speciel)	Intermediate with Tee Off (Three Ways)	Intermediate with Tee Off (Four Ways)	Terminal
Each	Concrete (or Wooden) Pole 10 m (33 or 34 Feet)		1		1		1	1		
Each	Concrete (or Wooden) Pole 8 m (28 Feet)	1		1		1			1	1
Each	Crossarm Assembly with Strup and Bolt, Nut (2.24 m)									
Each	Crossarm Assembly with Strup and Bolt, Nut (1.63 m)									
Each	Pin Insulator Assembly with Line Pin and Nut									
Each	Disc Insulator Assembly with Strain Clamp and Fittings									
Each	4 L.V. Shackle Insulators with Diron and Fittings	1	1	1	1	2	2	2	3	1
Each	Stay Assembly with Wire, Insulator, Stay Rod and Bank			1	1			1		1
Each	Earth Assembly	1	1	1	1	1	1	1	1	1
Each	Foundation	1	1	1	1	1	1	1	1	1
Each	Danger and Number Plate	1	1	1	1	1	1	1	1	1
Each	Anti Climbing Device									

SCHEDULE No. II

ITEM No. II-30

COMPONENTS AND UNIT PRICES OF CONDUCTORS

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
A.A.C. H.V. 50 mm^2 per m 100 mm^2 per m Covered conductors for line per m Insulated conductors for pole per m						

SCHEDULE No. II

ITEM No. II-31

COMPONENTS AND UNIT PRICES OF CABLE

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Paper insulated cable H.V. 70 mm^2 per m P.V.C. L.V. 150 mm^2 per m P.V.C. L.V. 70 mm^2 per m						

SCHEDULE No. II

ITEM No. II-32

COMPONENTS AND UNIT PRICES OF
SUBSTATION WITH POLE PARTS

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
100 kVA L.V. 2 ways 100 kVA L.V. 3 ways 200 kVA L.V. 2 ways 200 kVA L.V. 3 ways						

SCHEDULE No. II

ITEM No. II-33

COMPONENTS AND UNIT PRICES OF
CABLE HEAD WITH POLE PARTS

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
H.V. Cable head L.V. Cable head						

SCHEDULE NO. II

ITEM NO. II-32, 33-1

DETAILED COMPONENTS OF SUBSTATION AND CABLE

Unit	Description		4 - 1	4 - 2	4 - 3	4 - 4	4 - 5
			100 kVA S.S. 2 L.V. Line	100 kVA S.S. 3 L.V. Line	200 kVA S.S. 2 L.V. Line	200 kVA S.S. 3 L.V. Line	H.V. Connection (Pole - D.P.S.)
Each	Transformer	200 kVA	(1)	(1)	(1)	(1)	
Each	Transformer	100 kVA	1	1	1	1	
Each	Foundation of Transformer		1	1	1	1	
Each	L.V. Feeder Piller with Bus etc.	4 Feeder	1	1	1	1	
Each	Foundation of L.V. Feeder Piller		1	1	1	1	
Each	Dropout Fuse and Holder		3	3	3	3	
Each	Lightning Arrester		3	3	3	3	3
Each	Cable Box (Paper Cable Available)	H.V.	1	1	1	1	1
Each	" (P.V.C Available)	L.V.	2	3	2	3	
Each	Cross Arm		1	1	1	1	1
Each	Cable Guard		3	4	3	4	1
Each	Earth Assembly with Lead and Rod		8	8	8	8	3
Each	Fence with Concrete Brock		1	1	1	1	
Each	Danger Plate for Sub Station		1	1	1	1	
Each	Concrete, Slab etc.		1	1	1	1	1

SCHEDULE No. II

ITEM No. II-34

COMPONENTS AND UNIT PRICES OF
LIGHTNING ARRESTER WITH PARTS

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Lightning arrester Fitting parts						

SCHEDULE No. II

ITEM No. II-35

COMPONENTS AND UNIT PRICES OF STREET LIGHTING

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Street lighting with parts Street lightings with fittings Shackle insulator Diron with bolt and nut Street lighting panel Insulated cable per m						

SCHEDULE No. II

ITEM No. II-36

COMPONENTS AND UNIT PRICES OF
SERVICE CONNECTION (SMALL CONSUMERS)

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Conductor (7 m) Insulated cable (3 m) Parts Diron with bolt and nut Arm Meter with parts Single-phase kilomatts hour meter Meter base or box Service breaker Other parts						

SCHEDULE No. II

ITEM No. II-36

COMPONENTS AND UNIT PRICES OF
SERVICE CONNECTION (BIG CONSUMERS)

(cont'd)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
P.V.C. 100 m Mid cable joint with parts Meter with parts Three phase maximum demand and kilomatts hour meter Meter box Other parts						

SCHEDULE No. II

ITEM No. II-37

COMPONENTS AND UNIT PRICES OF ACCESSORIES

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Units prices of the proposed accessories for one town exept distribution line						

SCHEDULE No. II

ITEM No. II-38

COMPONENTS AND UNIT PRICES OF SPARE PARTS

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Units prices of the proposed spare parts for one town (except Diesel Generator)						

SCHEDULE No. II

ITEM No. II-39

COMPONENTS AND UNIT PRICES OF
PERSONNEL TRAINING

(Unit ₦)

Description	F.O.B. Country of Origine or F.O.R. Works in Nigeria	Freight and Insurance to Nigerian Port	Railage Dock Dues Transport and Insurance	Erection and Insurance (Local)	Erection and Insurance (Foreign)	Unit Total Price
Personnel training for one town						

DRAWINGS

Content

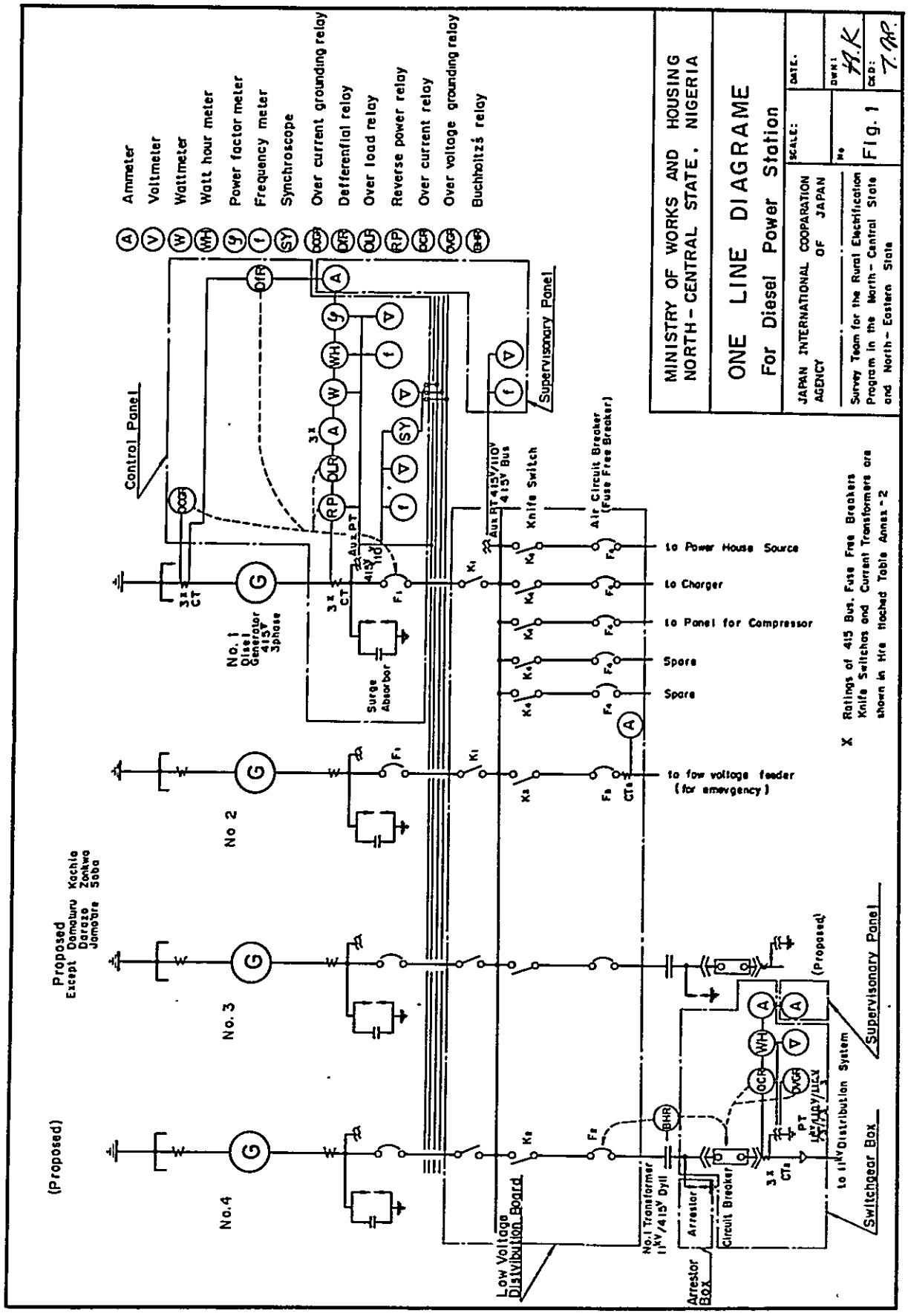

MINISTRY OF WORKS AND HOUSING
NORTH-CENTRAL STATE, NIGERIA
ONE LINE DIAGRAME
For Diesel Power Station
JAPAN INTERNATIONAL COOPARATION AGENCY
OF JAPAN
Survey Team for the Rural Electrification Program in the North-Central State and North-Eastern State
Fig. 1
Ammeter
Voltmeter
Wattmeter
Watt hour meter
Power factor meter
Frequency meter
Synchroscope
Over current grounding relay
Defferenfial relay
Over load relay
Reverse power relay
Over current relay
Over voltage grounding relay
Buchholtz's relay
Control Panel
Supervisonary Panel
No. 1 Diesel Generator 415V 3phase
No 2
No.3
No.4
Proposed
Except Damaturu Kachia
Darazo Zonkwa
Jamaare Soba
(Proposed)
Surge Absorber
Aux PT 415V/110V
Aux BT 415V/110V 415V Bus
Knife Switch
Air Circuit Breaker (Fuse Free Breaker)
to Power House Source
to Charger
to Panel for Compressor
Spare
Spare
to low voltage feeder (for emergency)
X Ratings of 415 Bus, Fuse Free Breakers Knife Switches and Current Transformers are shown in the Hached Table Annex-2
Low Voltage Distribution Board
No.1 Transformer 11KV/415V Dyll
Arrestor
Circuit Breaker
Arrestor Box
Switchgear Box
Supervisonary Panel
to 11KV Distribution System

Table Annex 1

Ratings of 415 V Bus, Fuse Free Breakers, Knife Switches & Current Transformers

415 V Bus		Amp	when D.G. 75 kW	when D.G. 115 kW	when D.G. 229 kW	
			400	600	1200	
Fuse Free Breakers & Knife Switches			when D.G. 75 kW	when D.G. 115 kW	when D.G. 229 kW	
F_1	K_1	Amp	150	200	400	
			when Tr. 200 kVA	when Tr. 300 kVA	when Tr. 500 kVA	when Tr. 700 kVA
F_2	K_2	Amp	300	400	700	1000
F_3	K_3	Amp	125			
F_4	K_4	Amp	30			
Current Transformers			when D.G. 75 kW	when D.G. 115 kW	when D.G. 229 kW	
CT_1		ratio	150/5	200/5	400/5	
			when Tr. 200 kVA	when Tr. 300 kVA	when Tr. 500 kVA	when Tr. 700 kVA
CT_2		ratio	20/5	20/5	30/5	40/5
CT_3		ratio	150/5			

* Symbol marks (F_1, K_1, CT_1 . . . . .) are shown in One Line Diagram.

Fig.2 SYSTEM OF FUEL

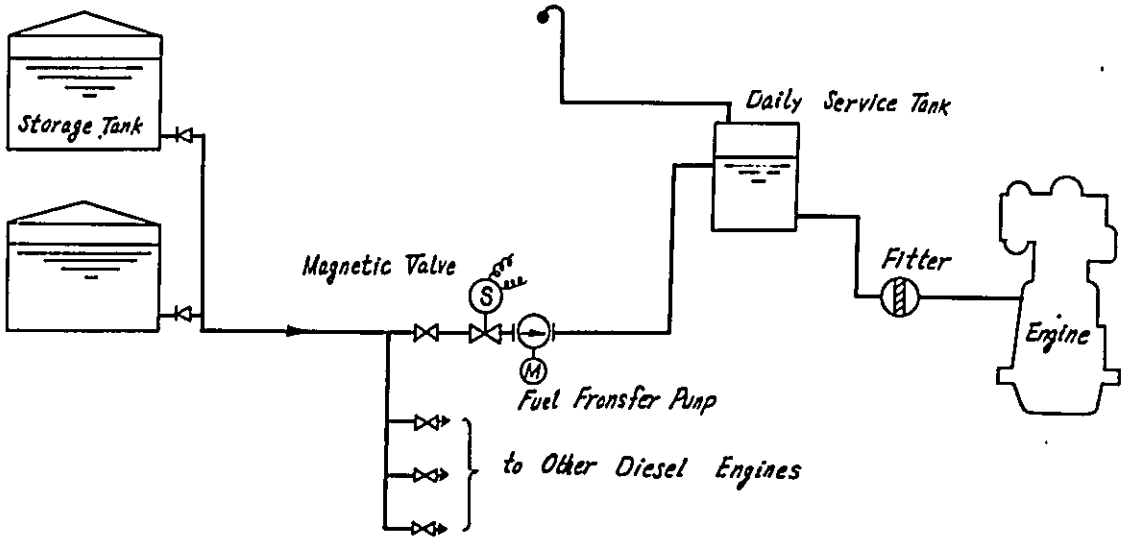


Fig. 3 SYSTEM OF COMPRESSED AIR

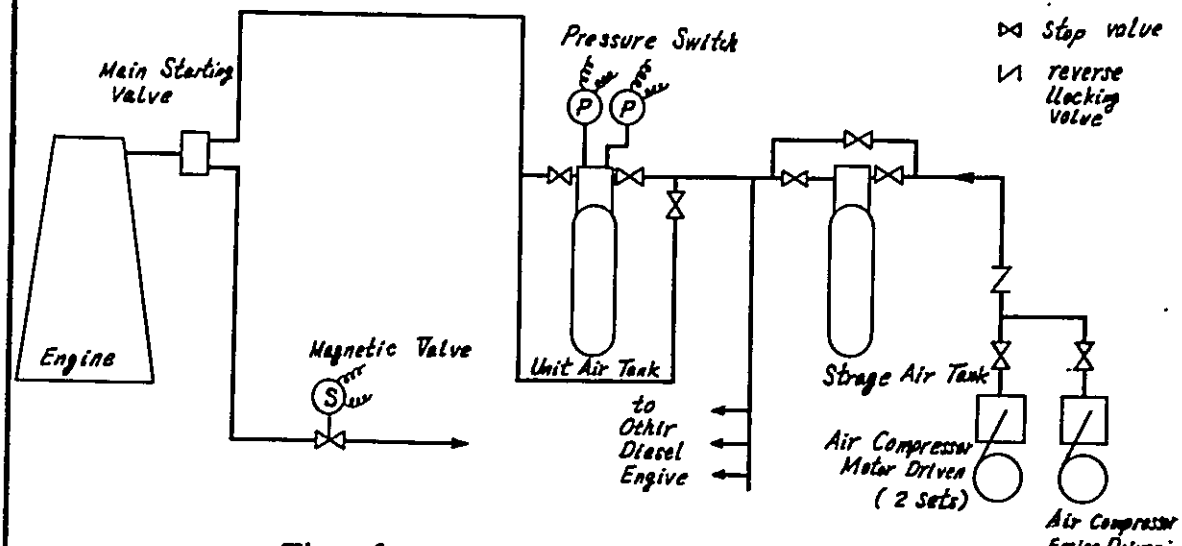


Fig.4 SYSTEM OF COOLING WATER

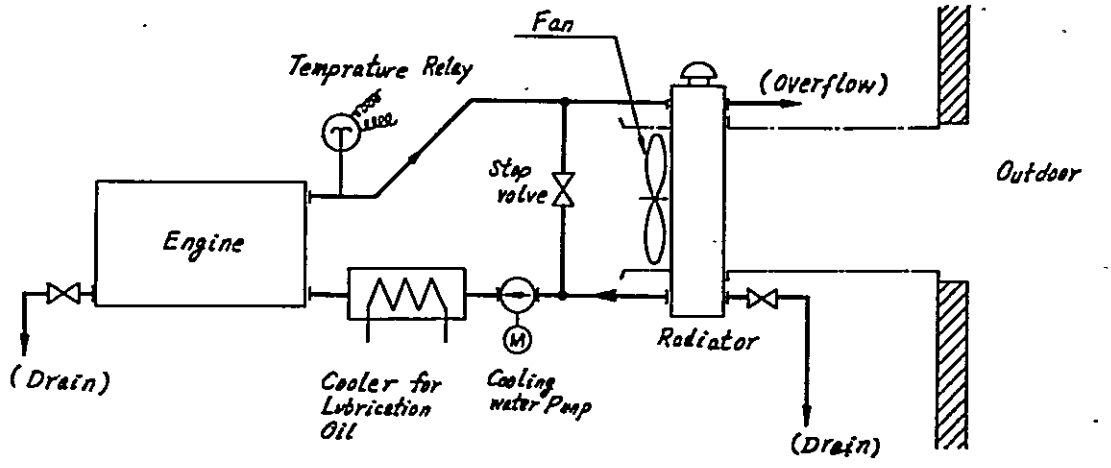


Fig. 5 SYSTEM OF LUBRICATION OIL

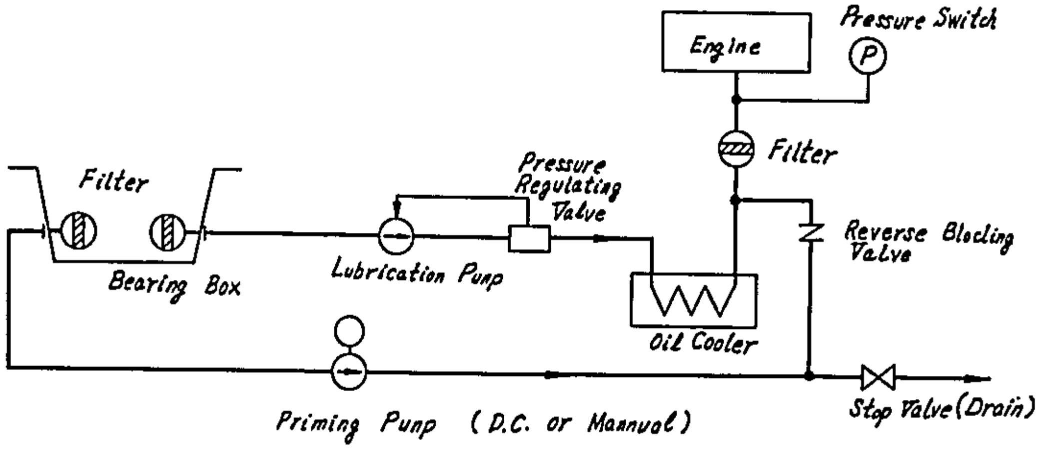


Fig. 6 SYSTEM OF D.C. SUPPLY

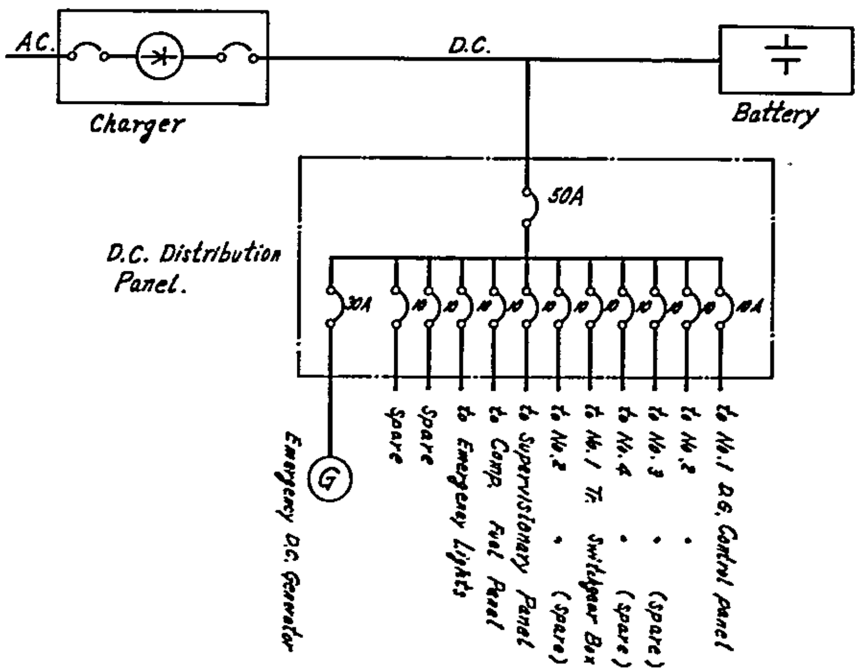


Fig. 7 TYPE OF POLES – H.V. ONLY

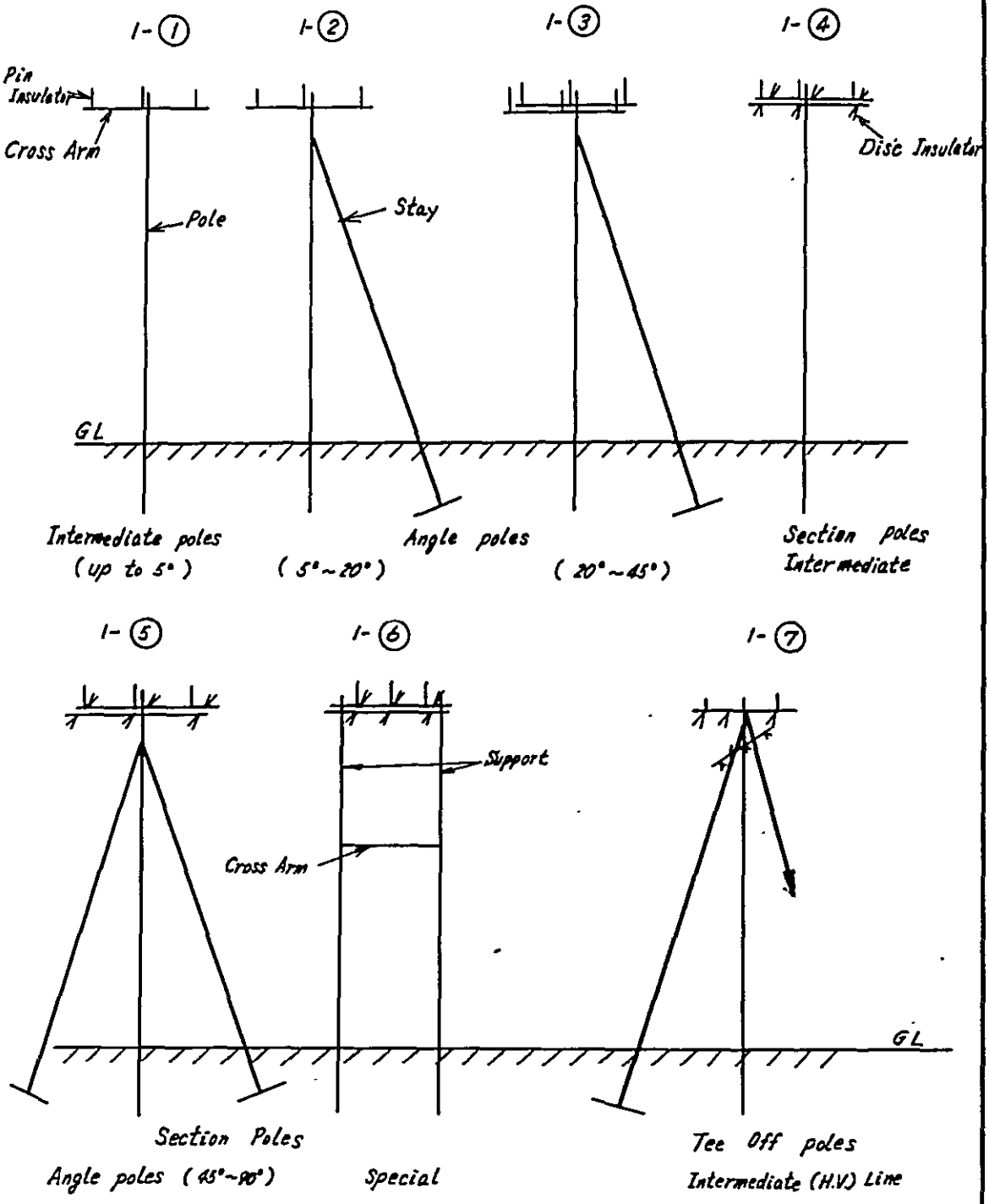


Fig. 8 TYPE OF POLES-H.V. AND L.V. COMMON USED

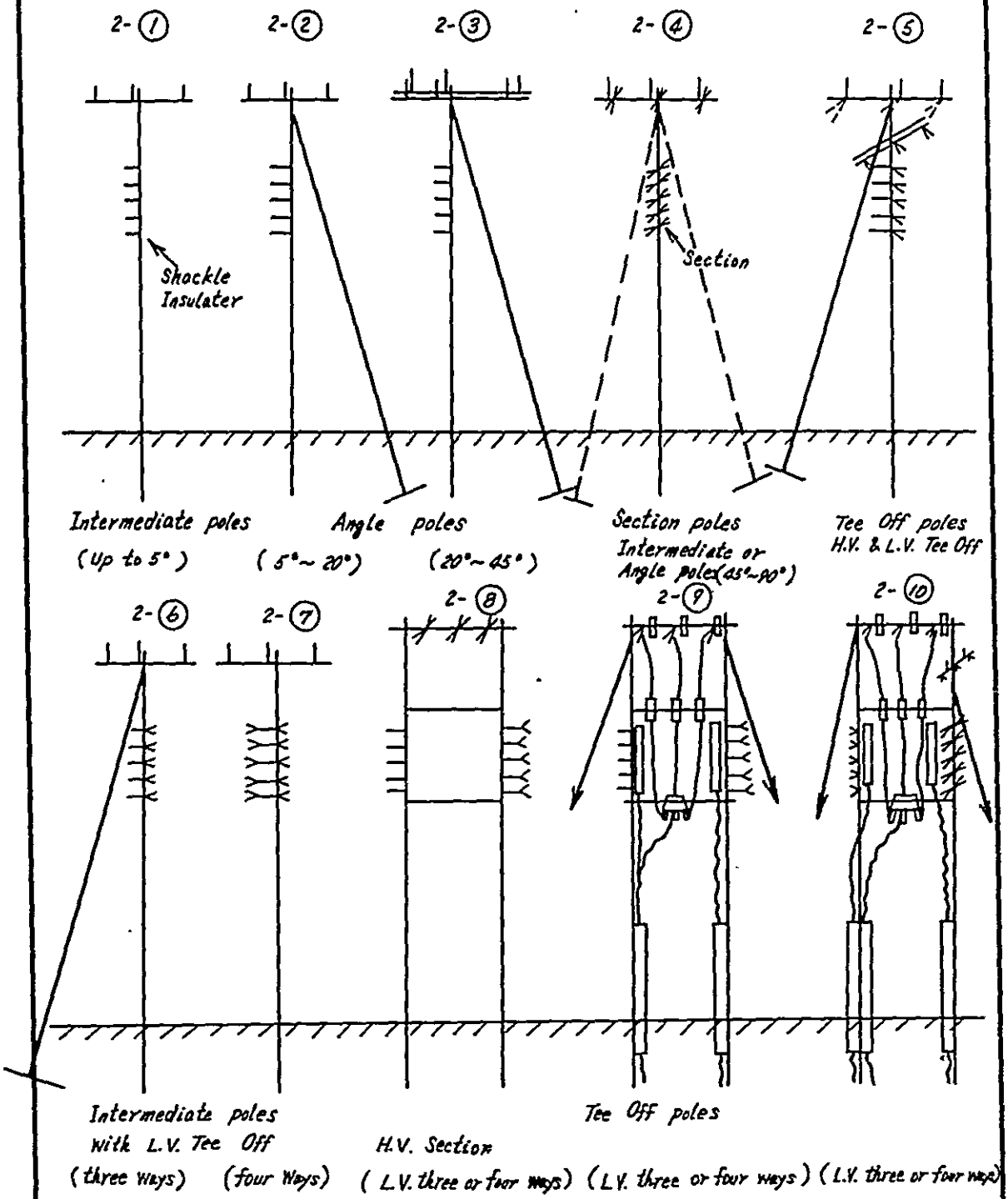
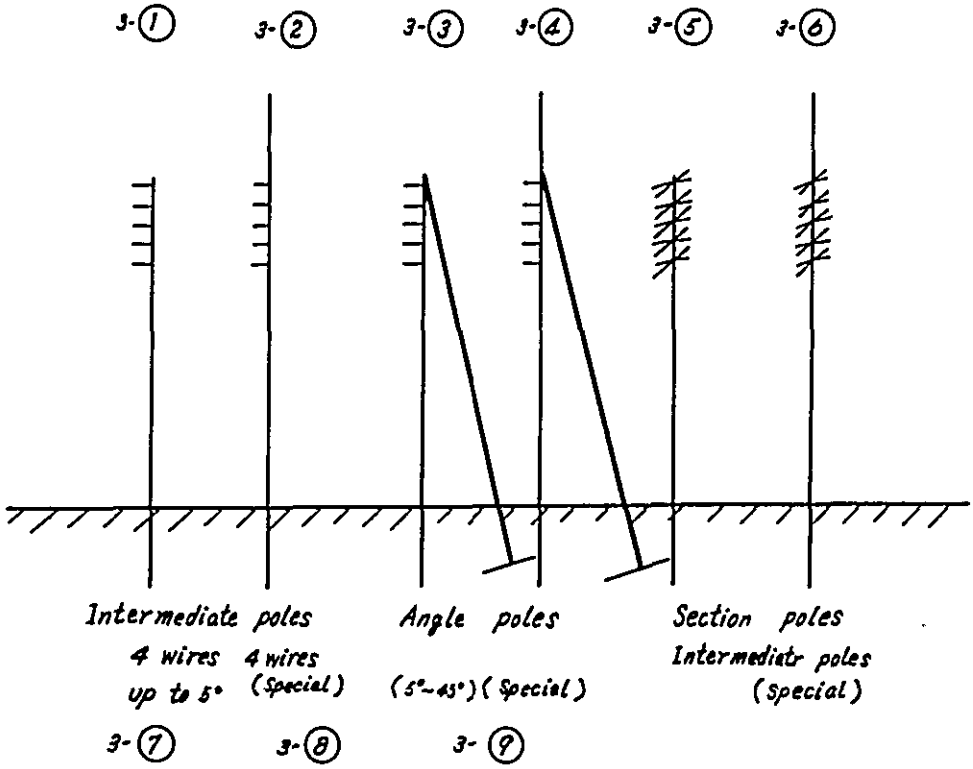


Fig. 9 TYPE OF POLES – L.V. ONLY



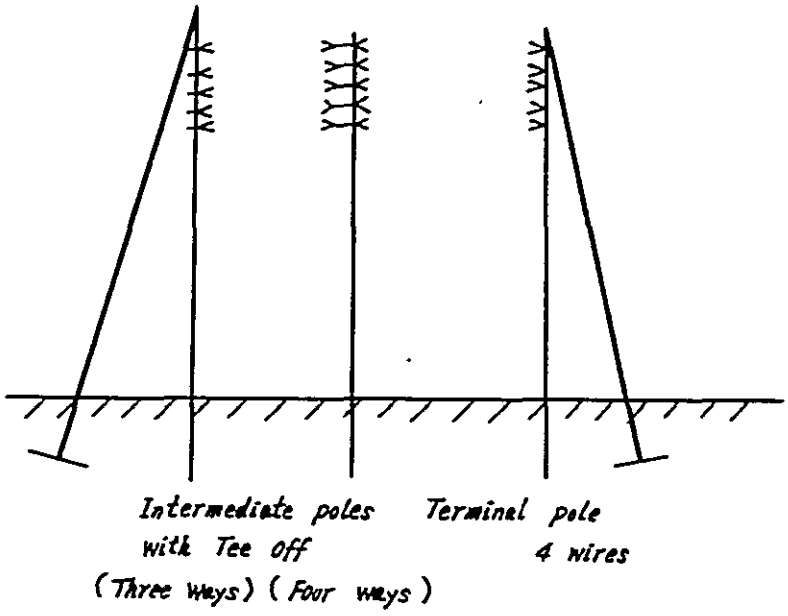
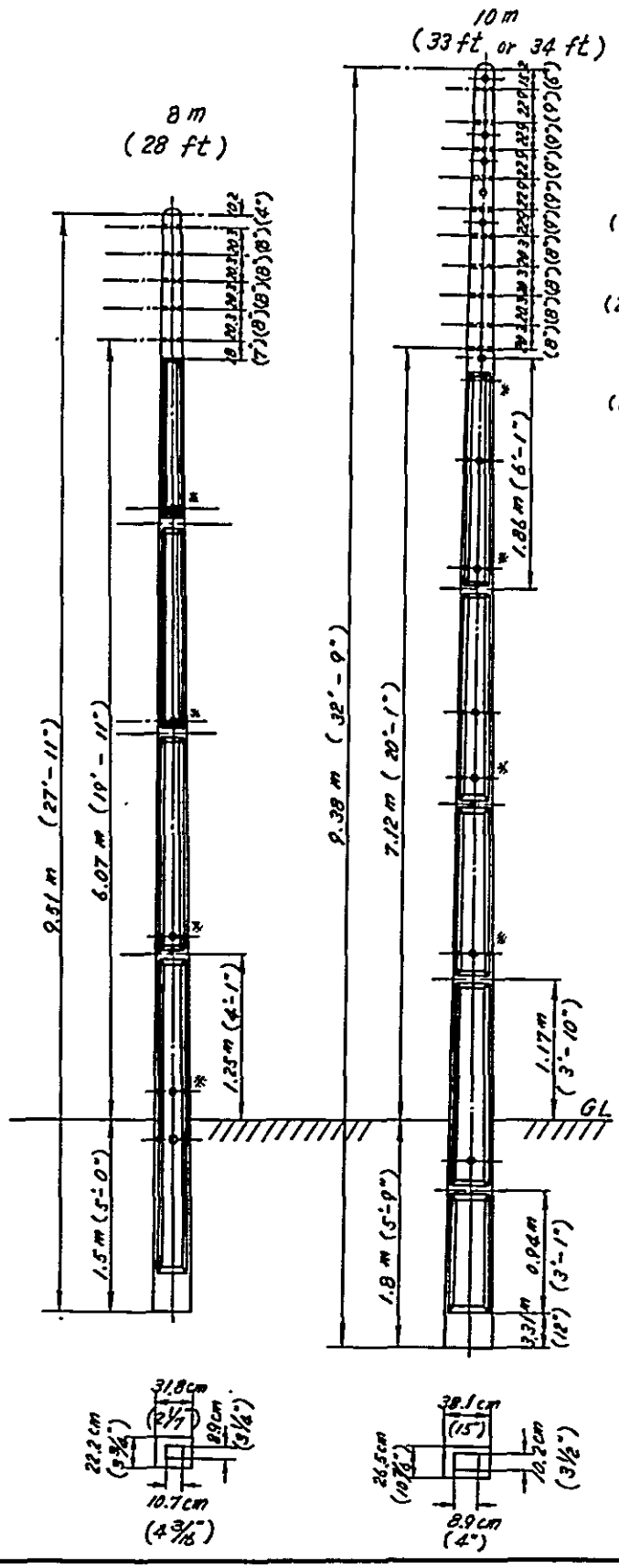


Fig. 10 PRESTRESSED CONCRETE POLES



Hole Diameters

(1) 8 m (28') POLE - ALL HOLES
19 mm (¾") DIA

(2) 10 m (33') POLE { TOP HOLE 25 mm (1") DIA
ALL OTHER HOLES 22 mm (⅞") DIA

(3) ※ 25 mm (10") DIA

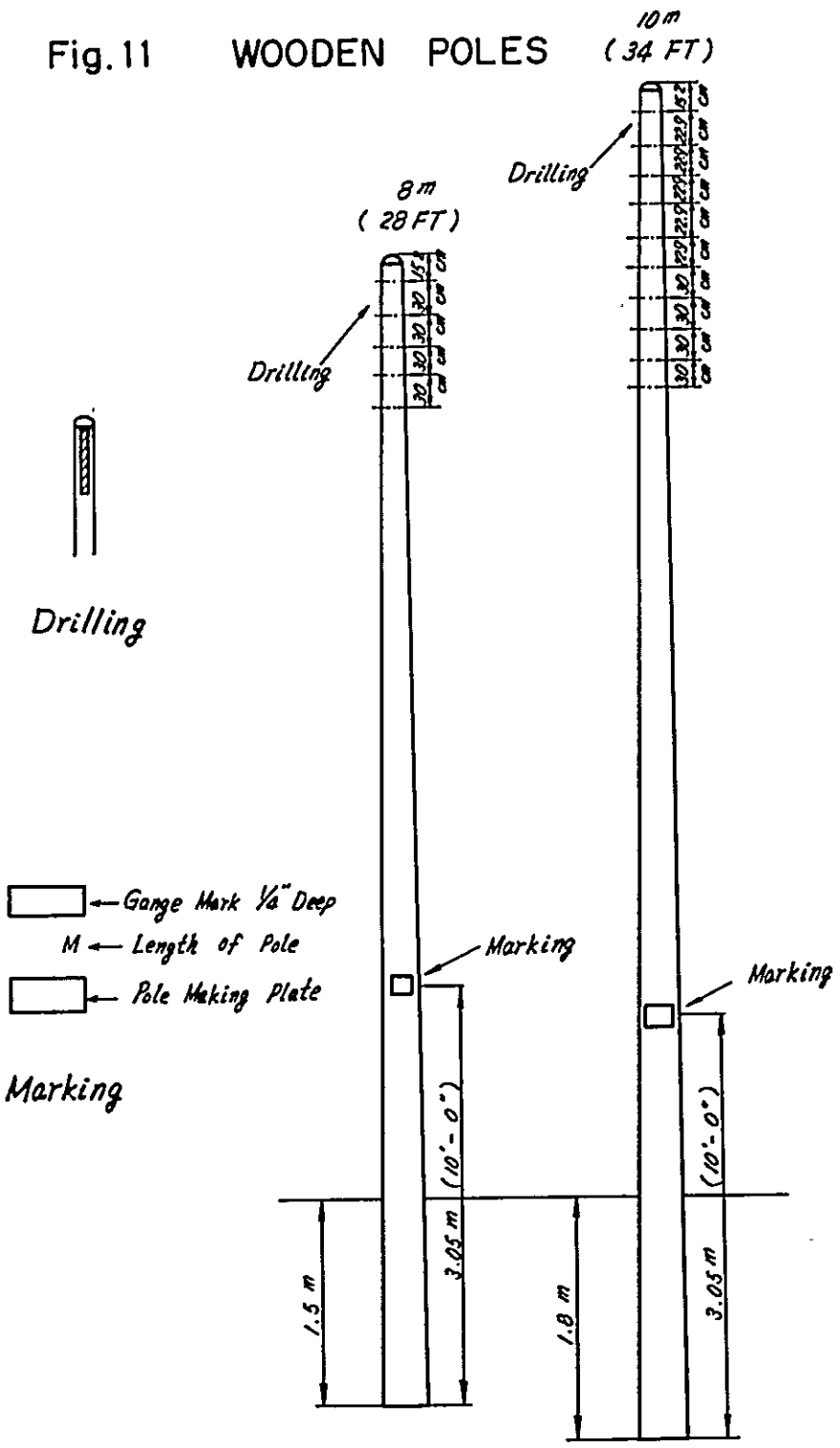
Marking

(1) Gange Mark

(2) Length of pole

(3) Pole making plate

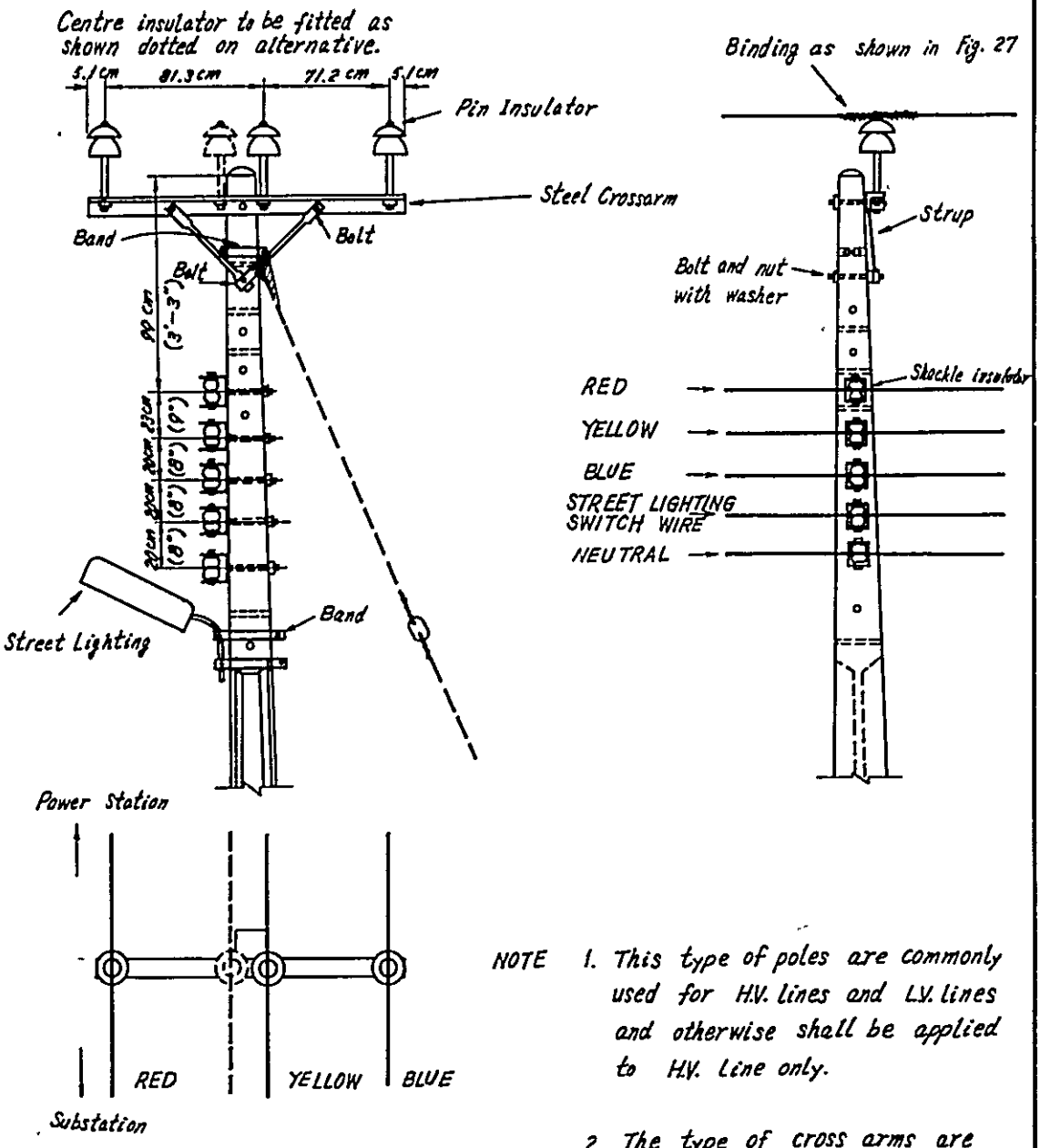
Fig. 11 WOODEN POLES



NOTE Hole of diameters is same as the hole of prestressed concrete poles and each poles shall be drilled.

Fig. 12 INTERMEDIATE AND ANGLE POLE

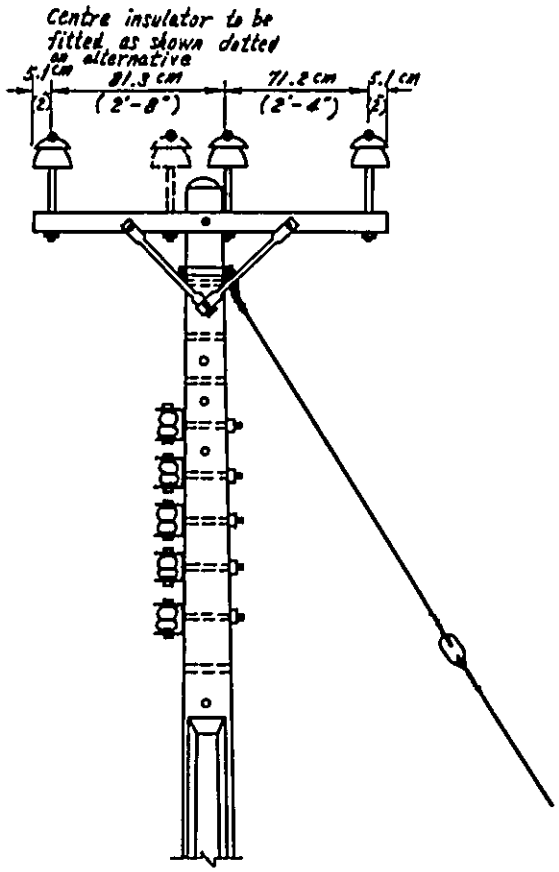
(Up to 20° line deviation)

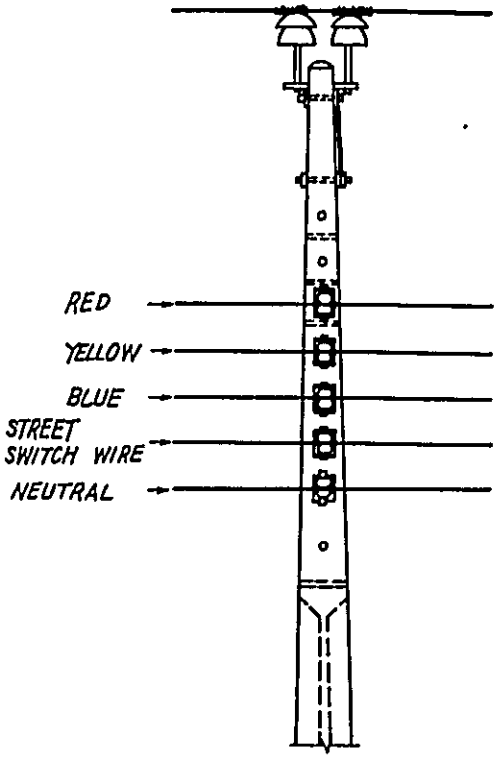


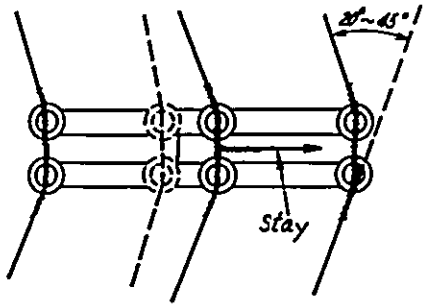
NOTE 1. This type of poles are commonly used for H.V. lines and L.V. lines and otherwise shall be applied to H.V. line only.

2. The type of cross arms are either of "L" or "C" type (refer to Table No. II-4)

Fig. 13 ANGLE POLE

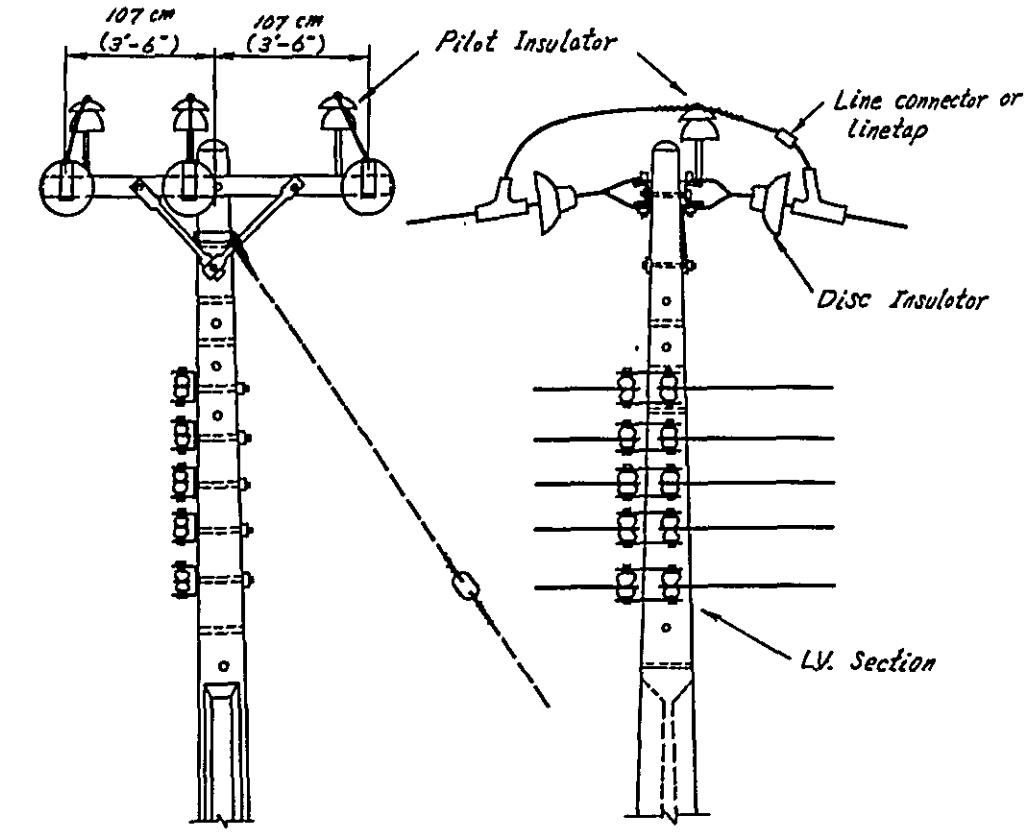


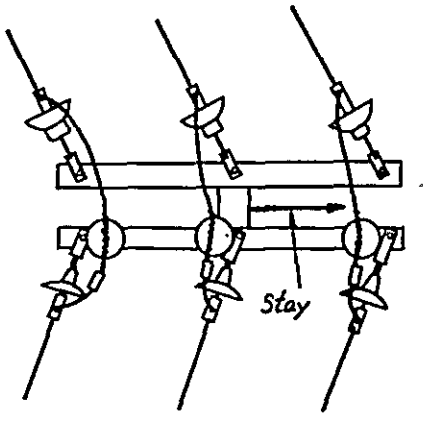




NOTE
1. This type of poles are commonly used for H.V. lines and L.V. lines and otherwise shall be applied to H.V. line only.
2. The type of crossarms are either of "L" or "I" type. (refer to Table No. II-4)

Fig.14 SECTION POLE

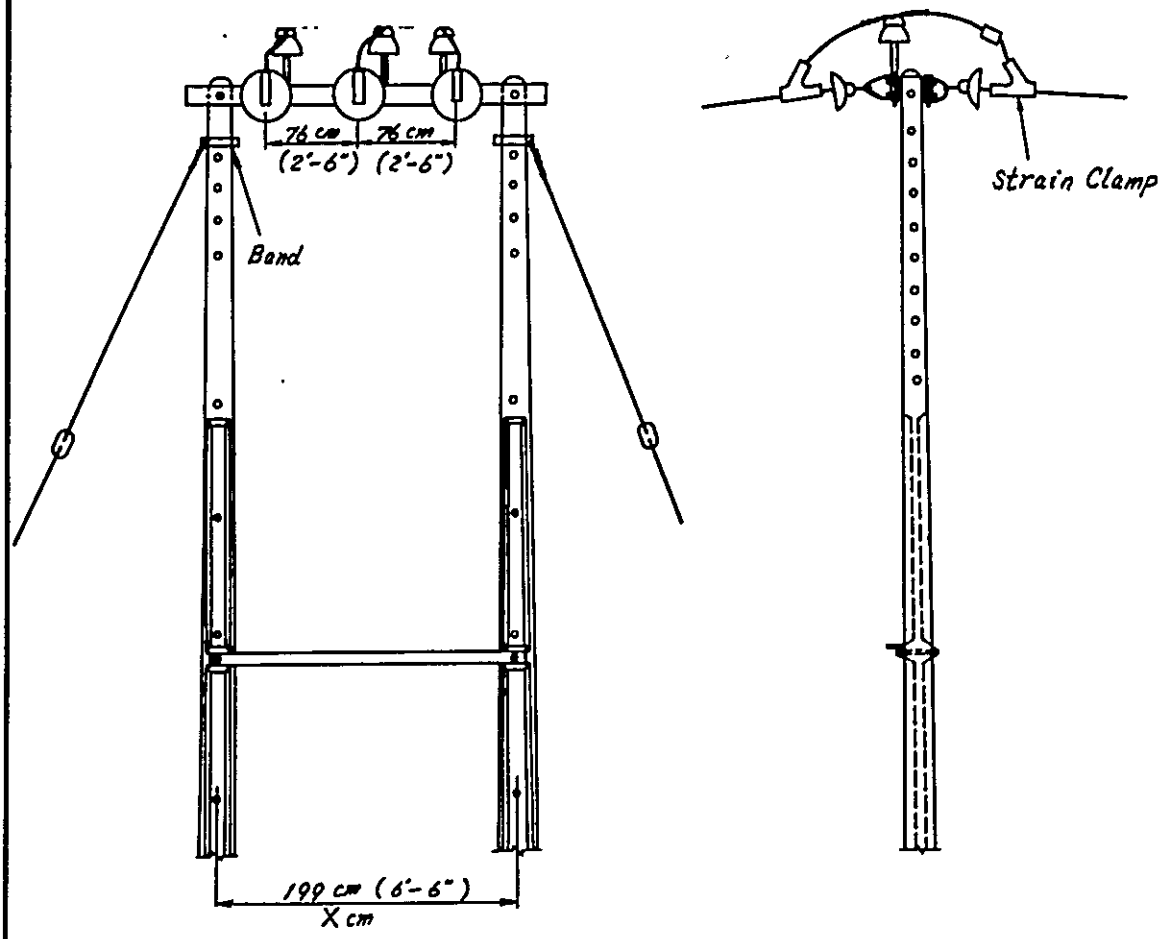




NOTE

1. The average distance between section poles shall be about 1.5 km.
2. This type of poles shall be applied to angle pole (45°~90°)
3. This type of poles shall be applied to H.V. line only.
4. The type of crossarms are "⊏" Type (refer to Table No.Ⅲ-4)

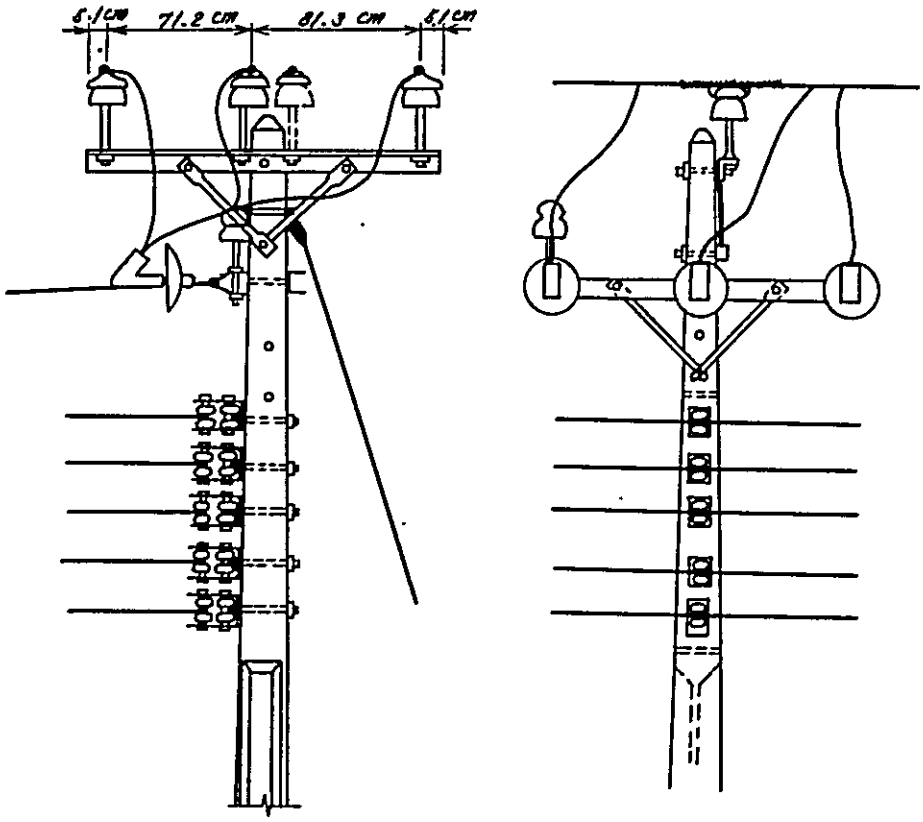
Fig. 15 SECTION POLE (H. Type)



NOTE

1. This type of poles are applied to those of long span in the cases of river crossings or spans over 120 m. Determination of X followed to the decision of conductor.
2. This type of poles shall be also applied to the connection between cable lines and overhead lines.

Fig. 16 TEE OFF POLE



NOTE Tee Off poles shall be single pole or H pole (See Fig 19)

Fig. 17 SUBSTATION POLE
(Terminal Pole)

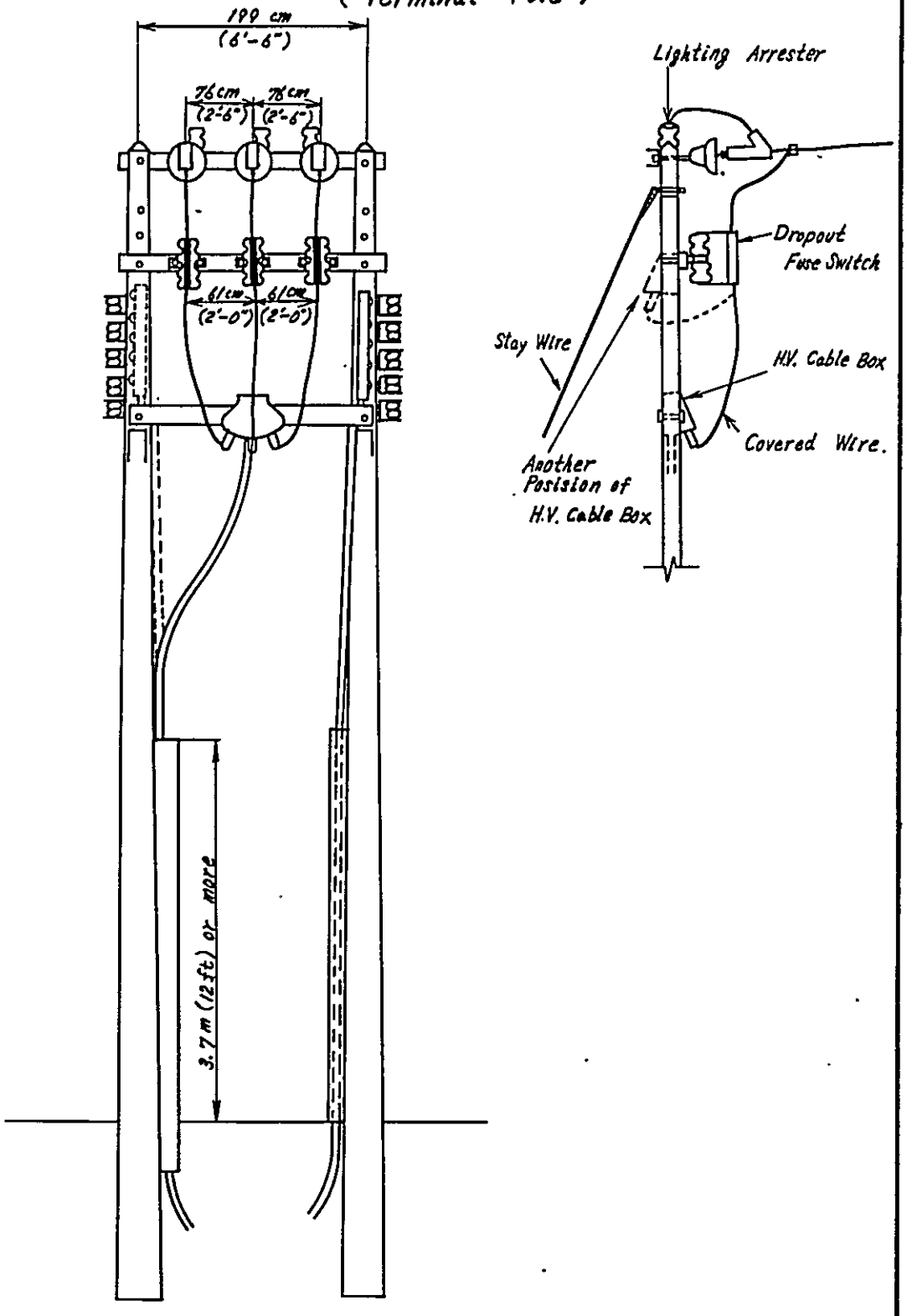
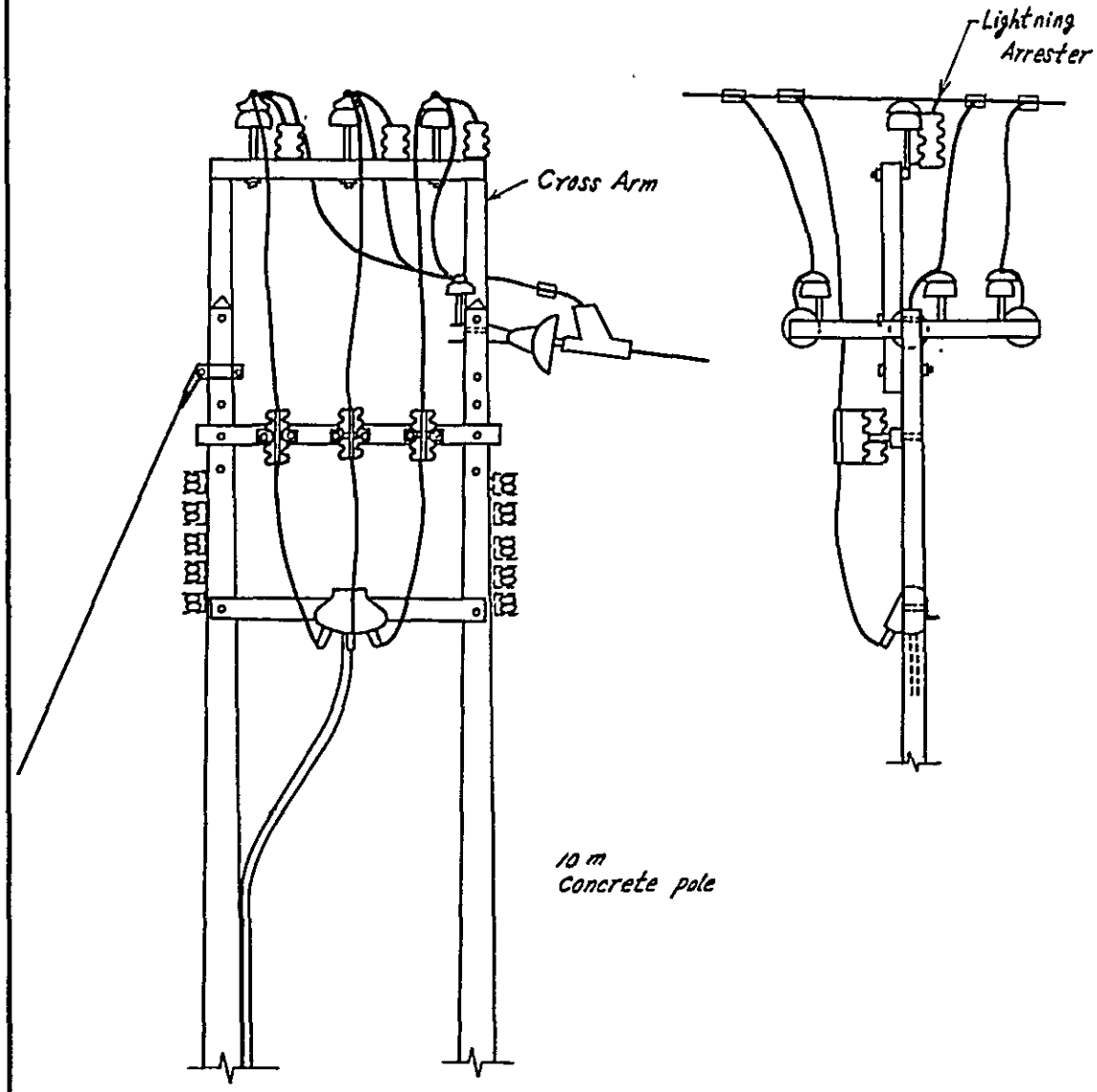


Fig. 18 SUBSTATION POLE

(Tee Off Pole (1))

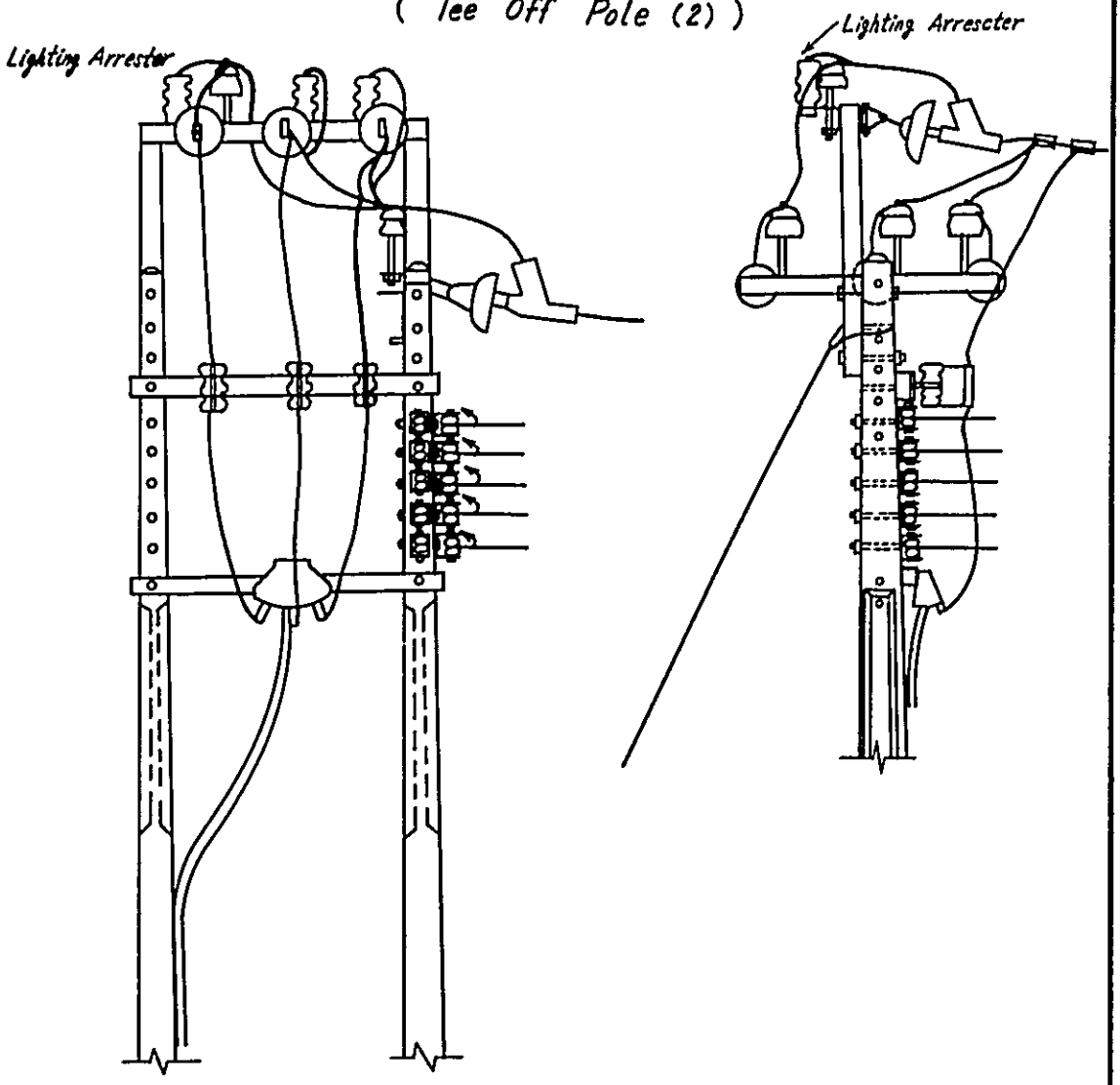


NOTE

In the case of wooden poles this type of poles Shall be applied the long poles covering from 12~13 m long.

Fig.19 SUBSTATION POLE

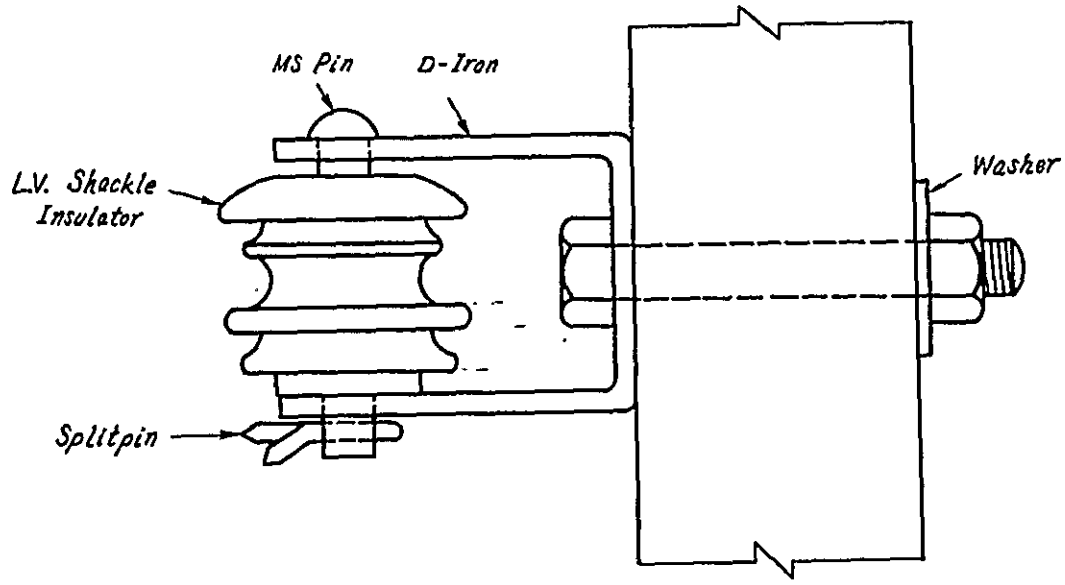
(Tee Off Pole (2))

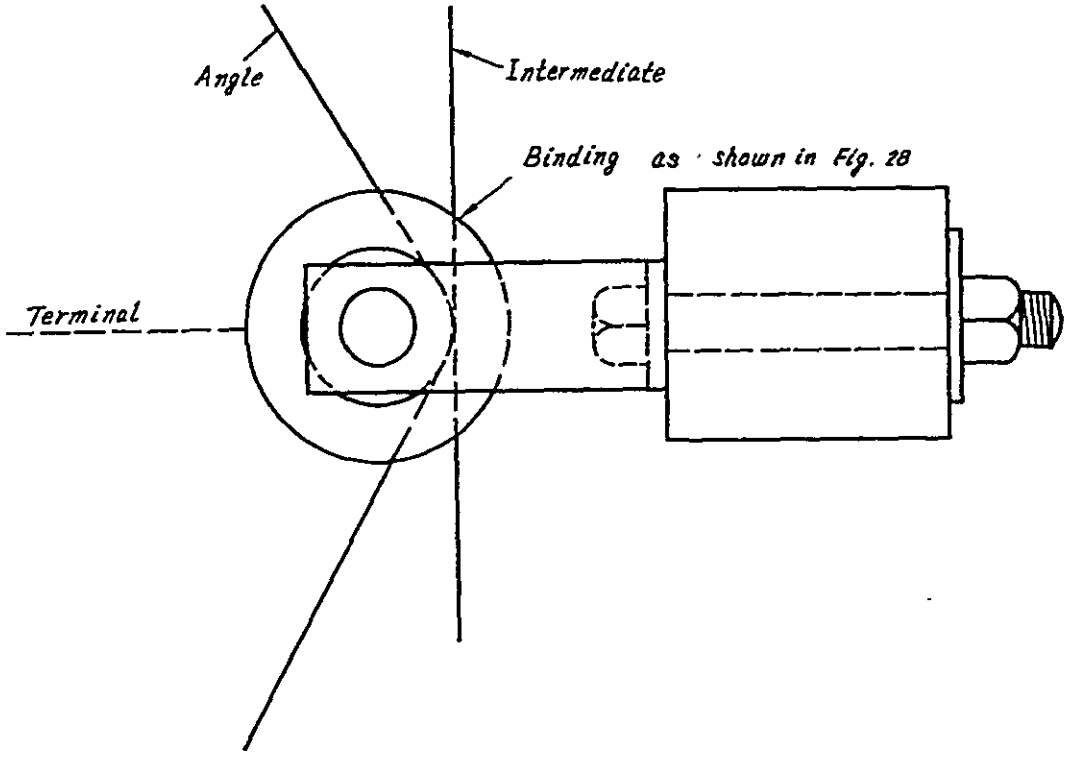


NOTE

In the case of wooden poles, this type of poles shall be applied the long poles covering from 12~13 m long.

Fig. 20 L.V. INSULATOR ASSEMBLY





NOTE

1. All the L.V. lines shall be applied to shackle insulators
2. Insulators figured on the following are applied to on intermediate insulator assembly, but shall not be applied hereafter.

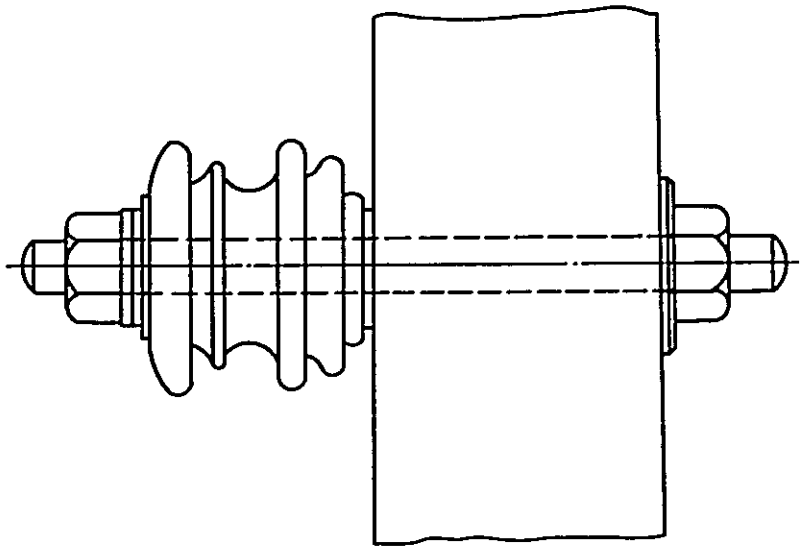
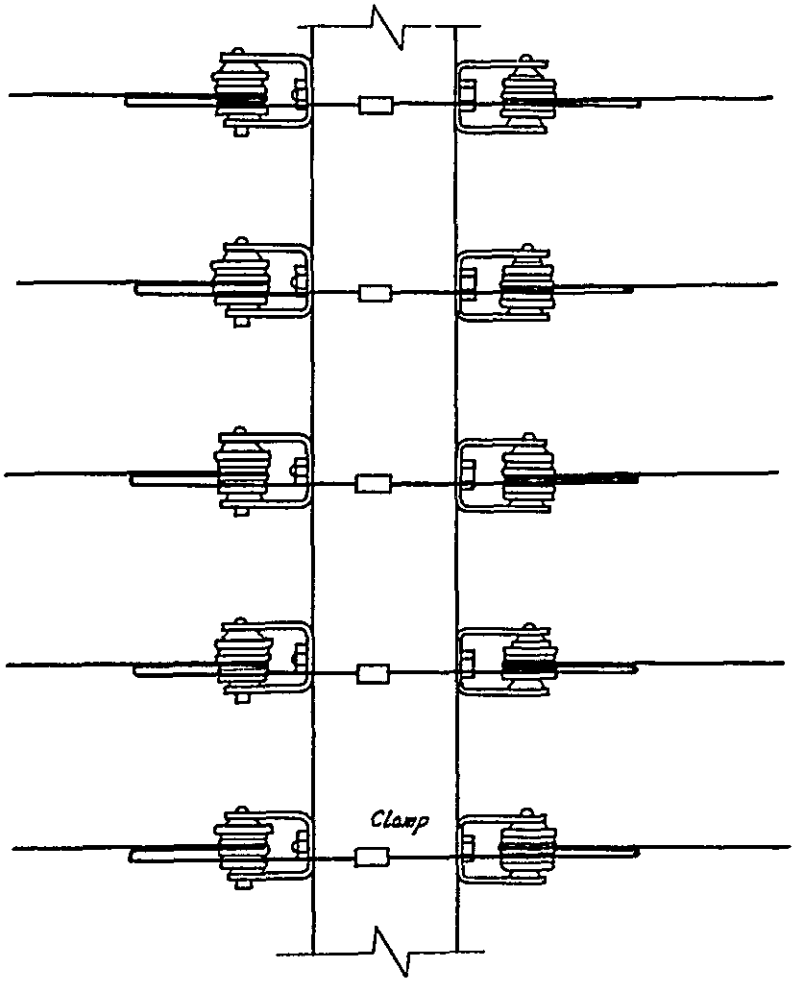


Fig. 21 L.V. SECTION ASSEMBLY



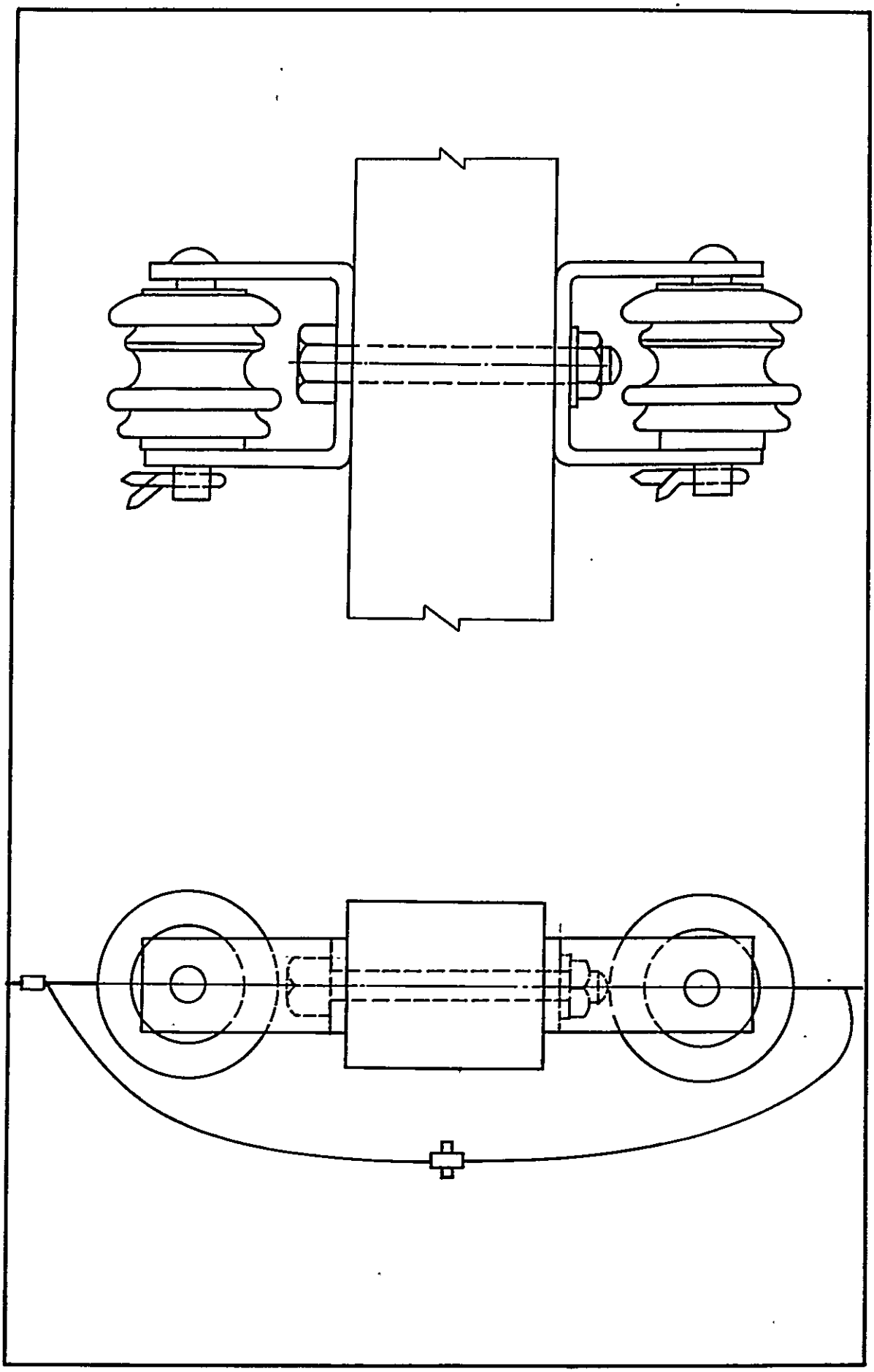
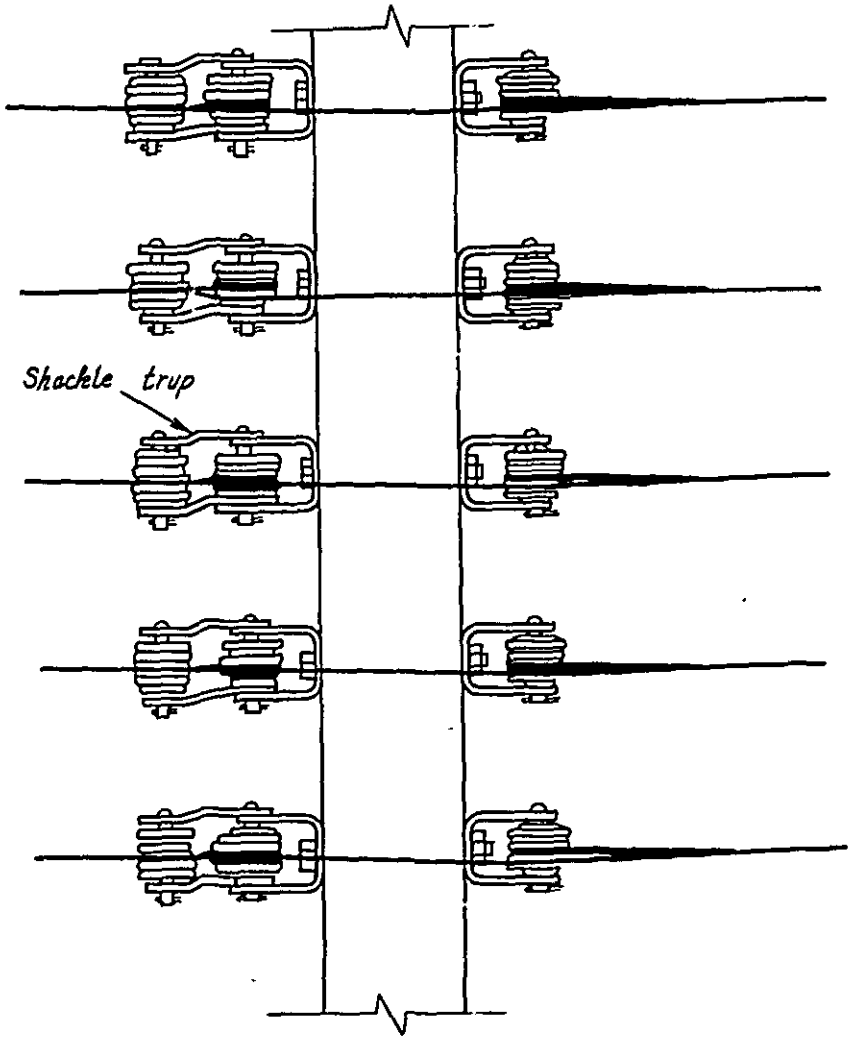
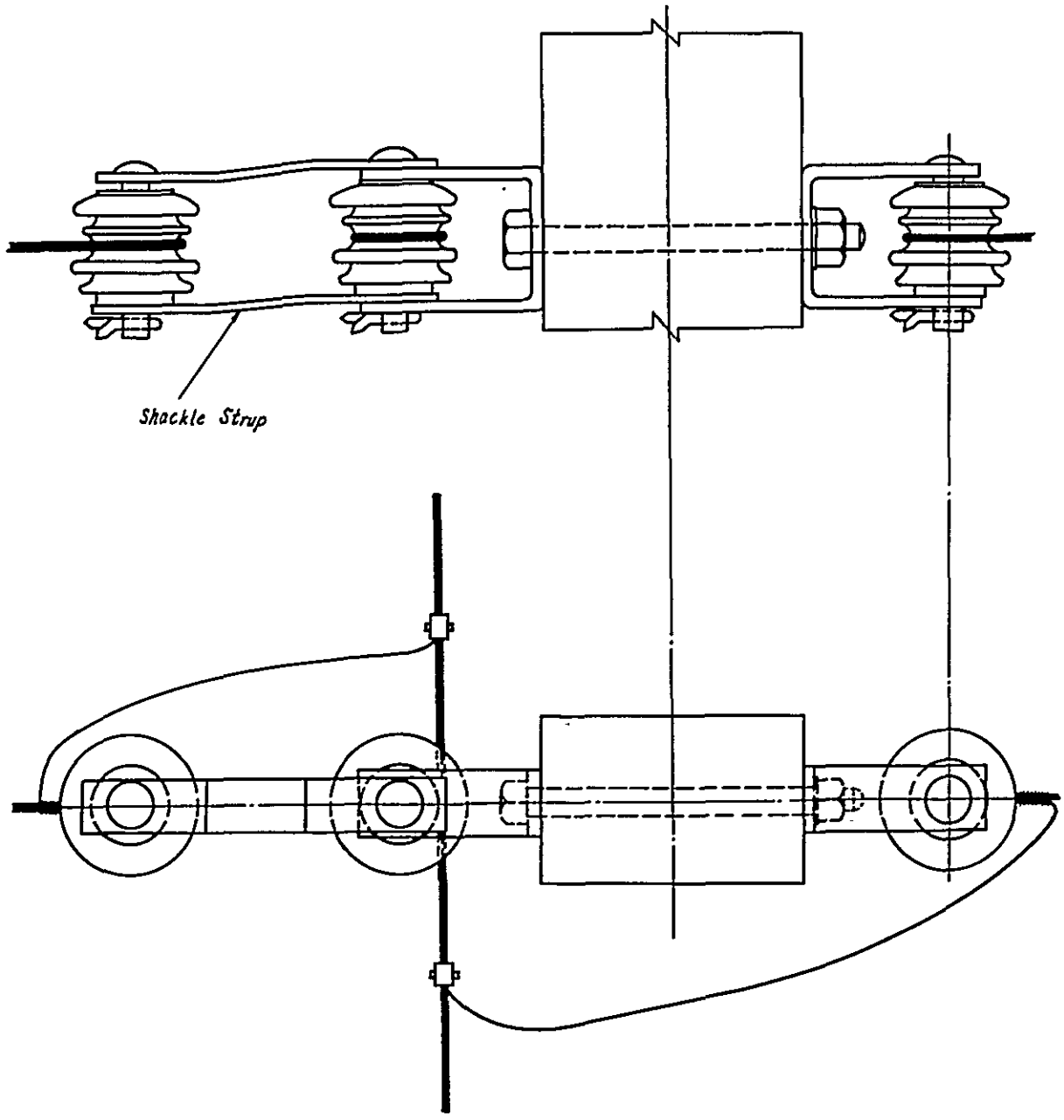


Fig.22 L.V. INTERMEDIATE ASSEMBLY WITH TEE OFF

(Three or Four Ways)





NOTE Tee Off insulator shall be applied to service line insulator.

Fig. 23 L.V. TERMINAL POLE

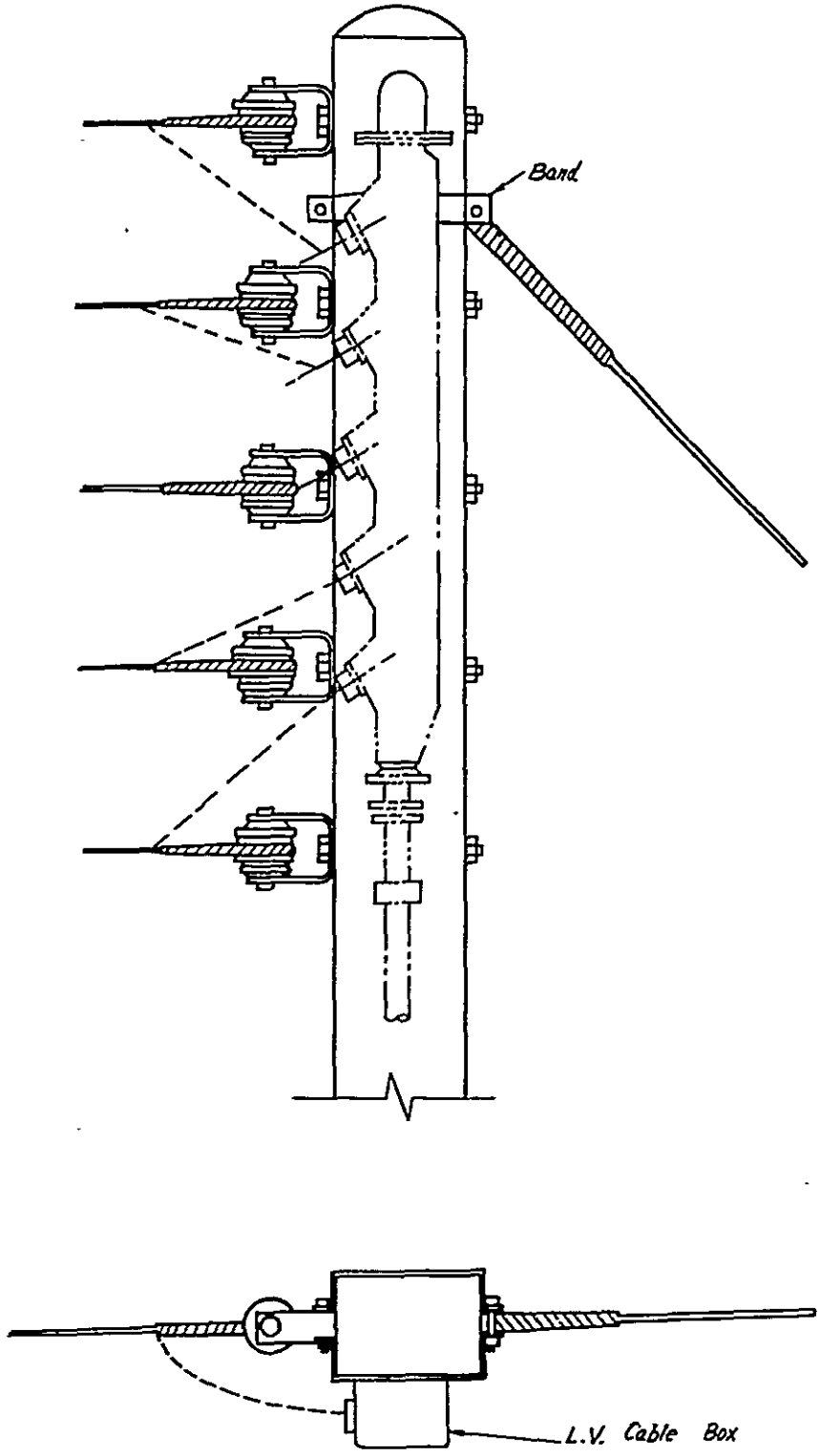
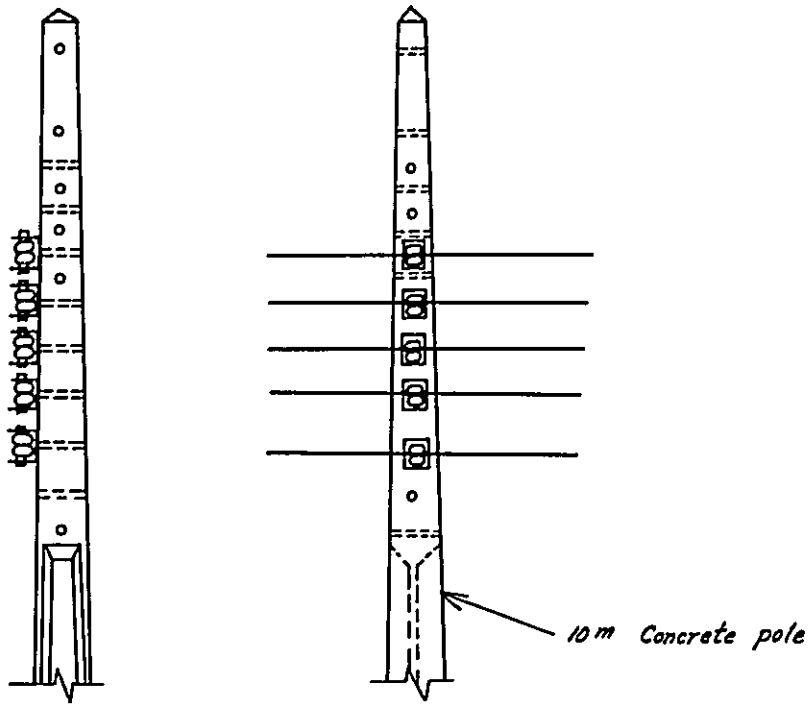


Fig. 24 L.V. SPECIAL POLE

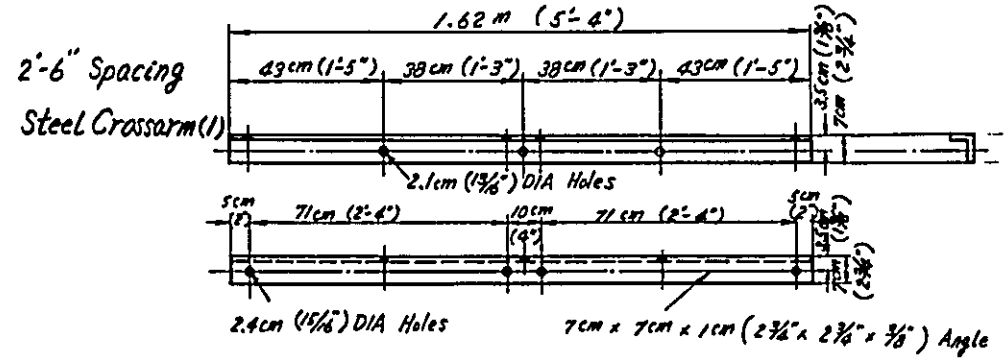
(*Intermediate*)

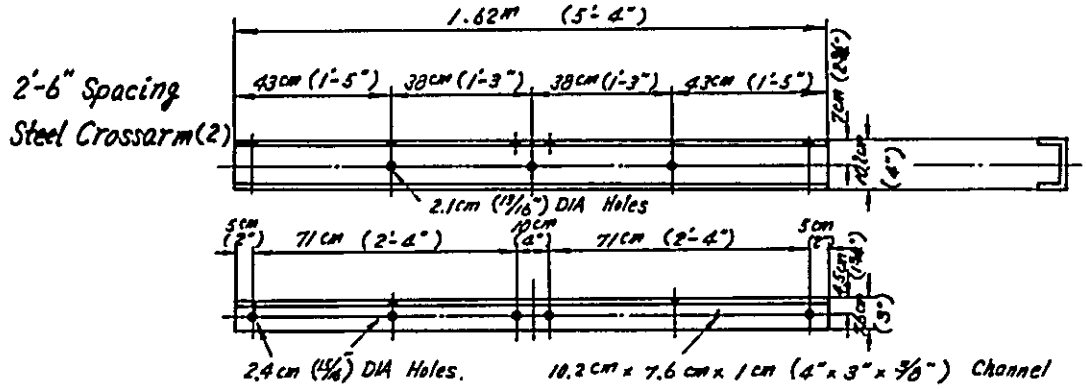


NOTE

The L.V. special poles shall be applied at which H.V. overhead lines will be foreseeable to be installed.

Fig. 25 CROSS ARM





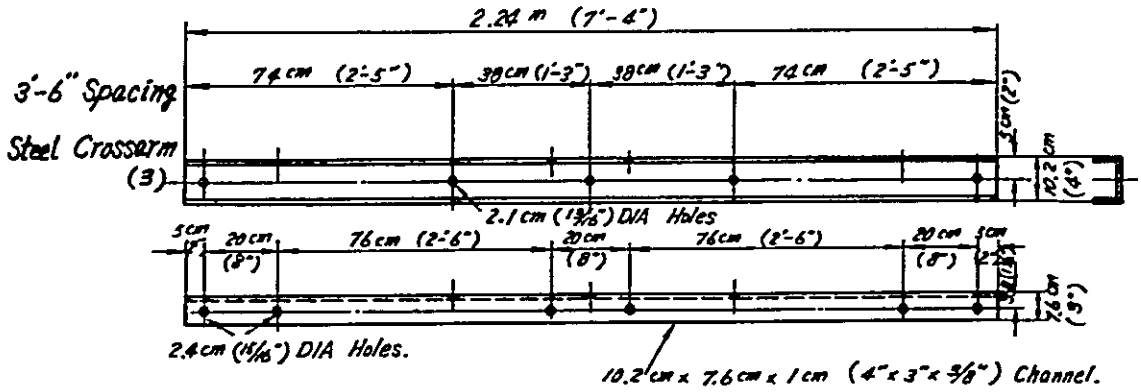
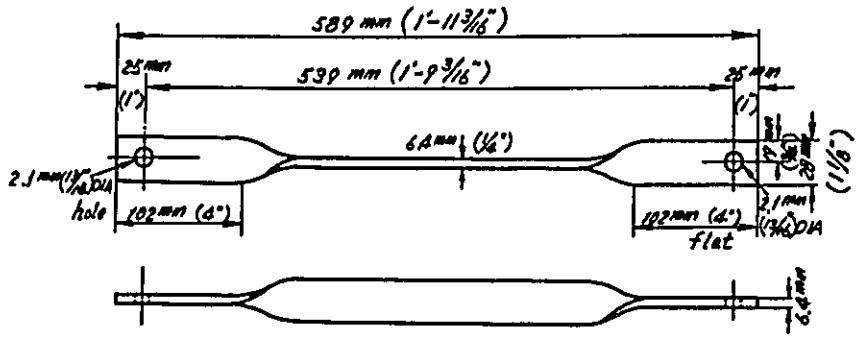
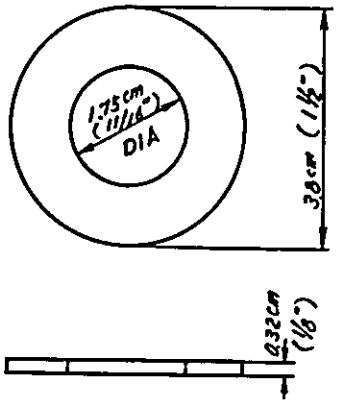


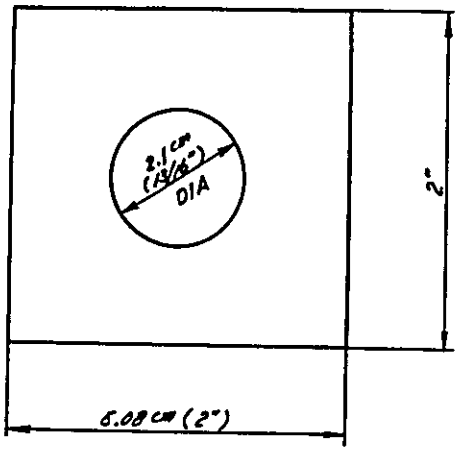
Fig. 26 PARTS OF POLE



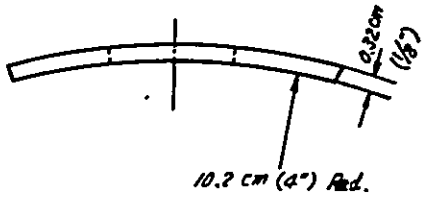
Strup



Flat Washer

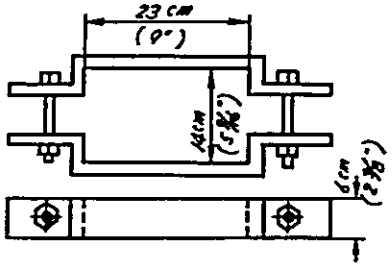


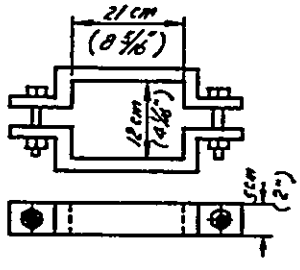
Curved Washer



10.2 cm (4") Rad.

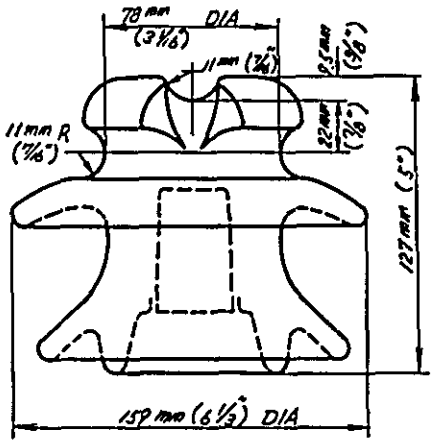
NOTE These washers is suitable for 1.6 cm DIA bolts (flat washer) and 1.9 cm DIA bolt (Curved washer)



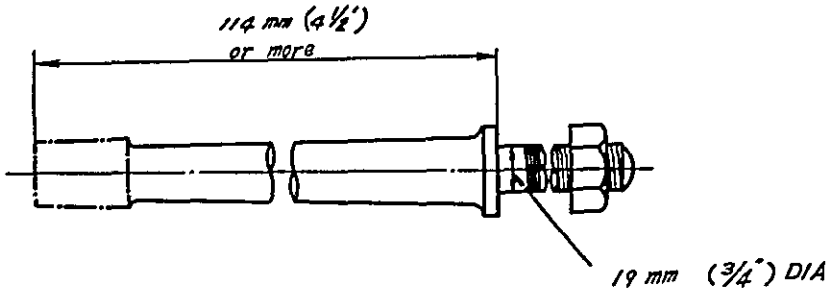


NOTE These bands shall be applied for supporting stays and street lightings which are supported on poles.

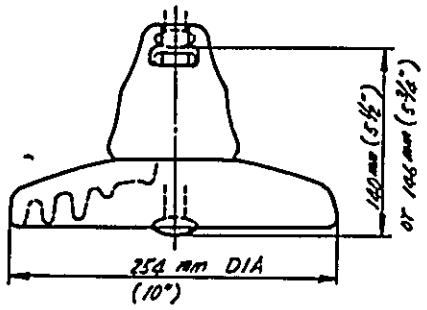
Fig. 27 H.V. INSULATORS



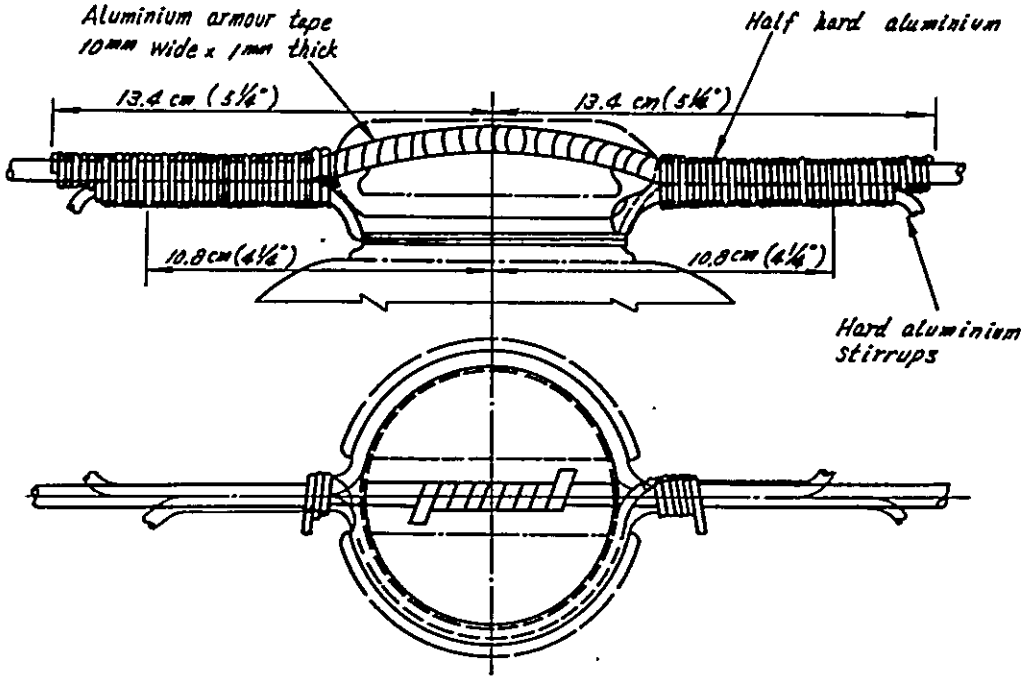
Pin Insulator



Line Pin

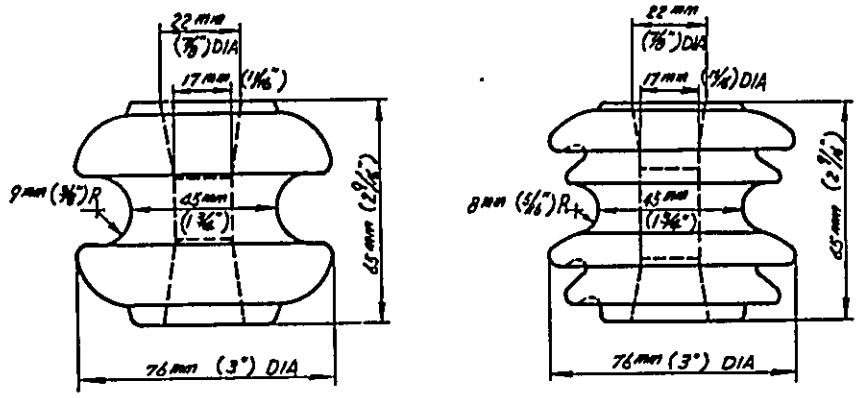


Disc Insulator

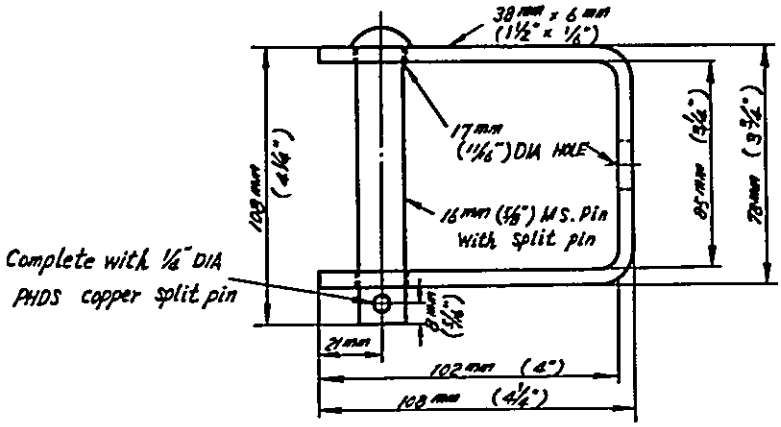


Binding at Insulator

Fig. 28 L.V. INSULATORS

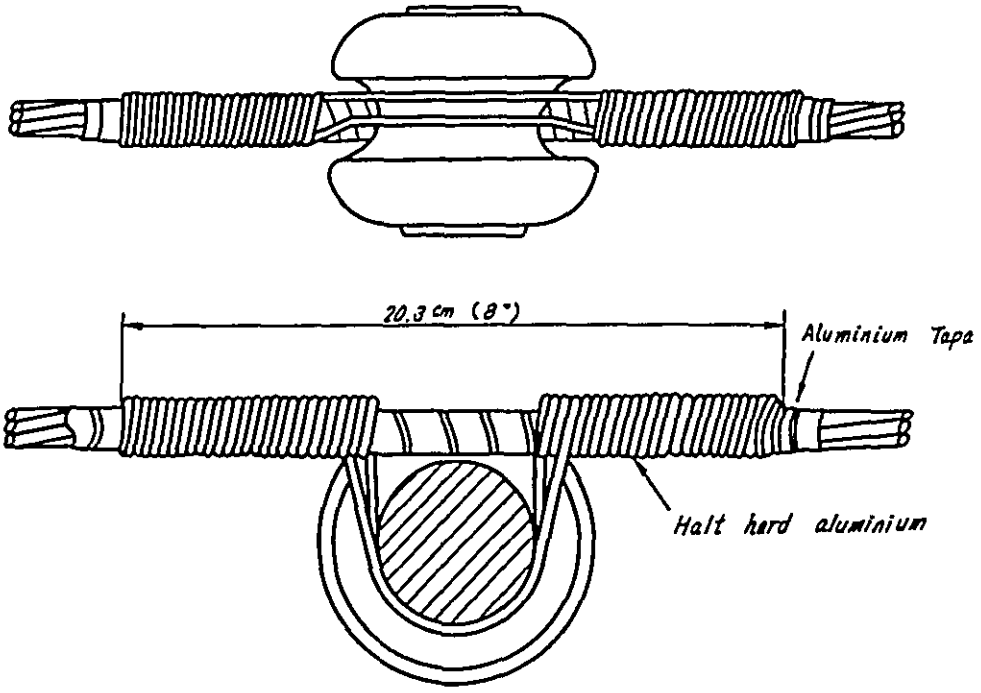


Shackle Insulators

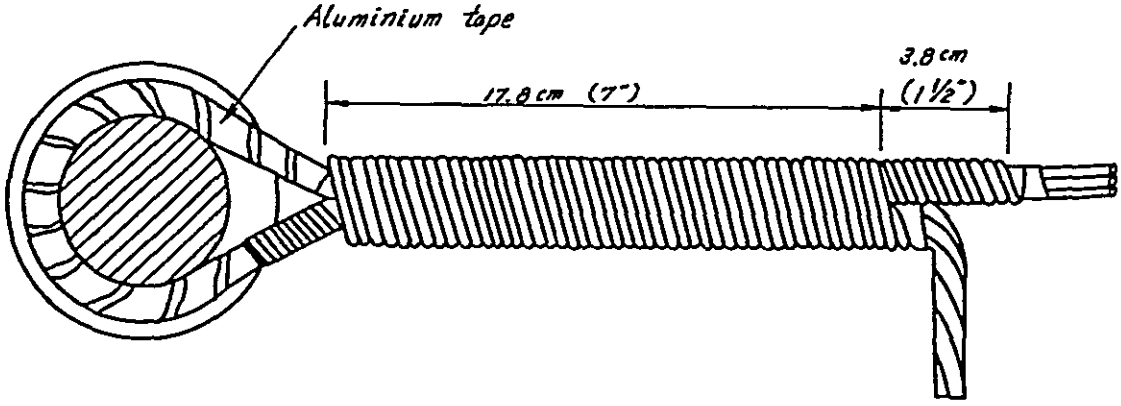


Copper split pin
Material galvanized mild steel 28. 33 ton quality

D - Iron (with Shackle Bolt)

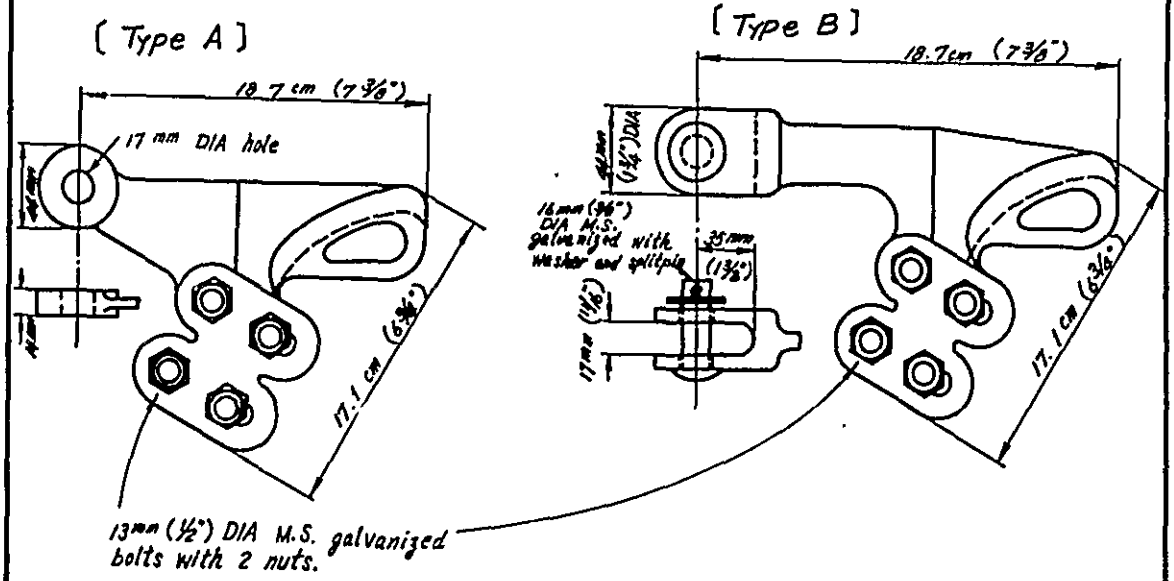


Binding at Intermediate Insulators



Binding at Terminals

Fig. 29 H.V. INSULATOR PARTS

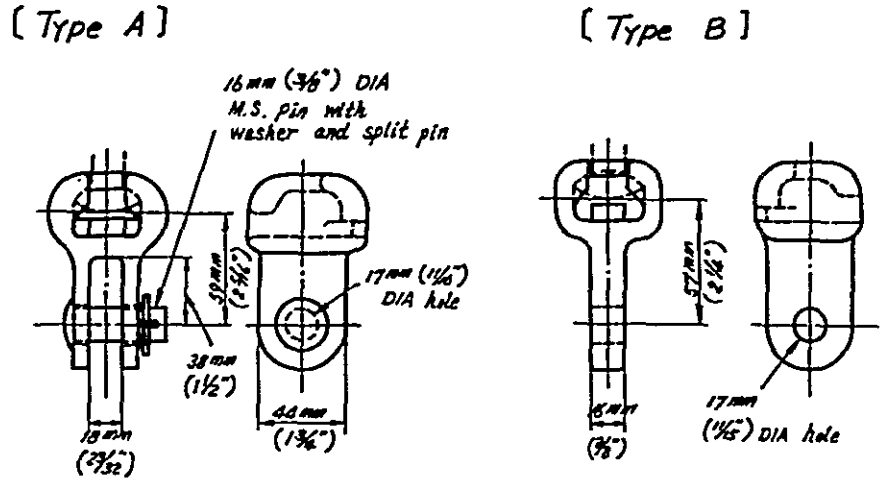


NOTE

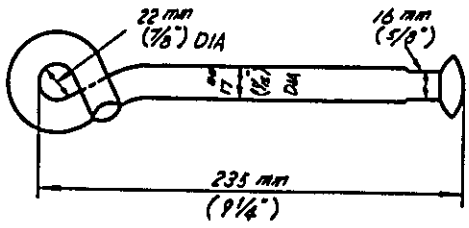
Conductor diameter

7~13 mm (for AAC 50 mm²)

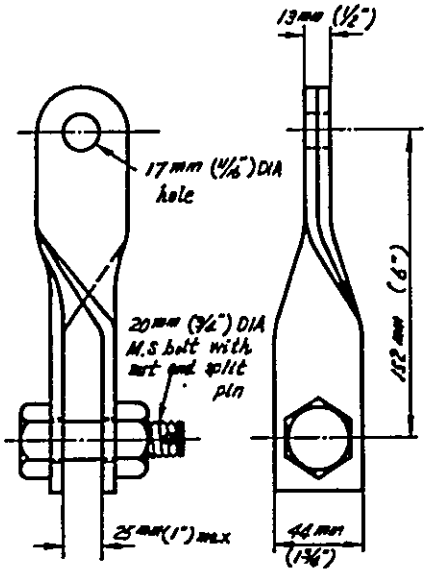
Strain Clamp



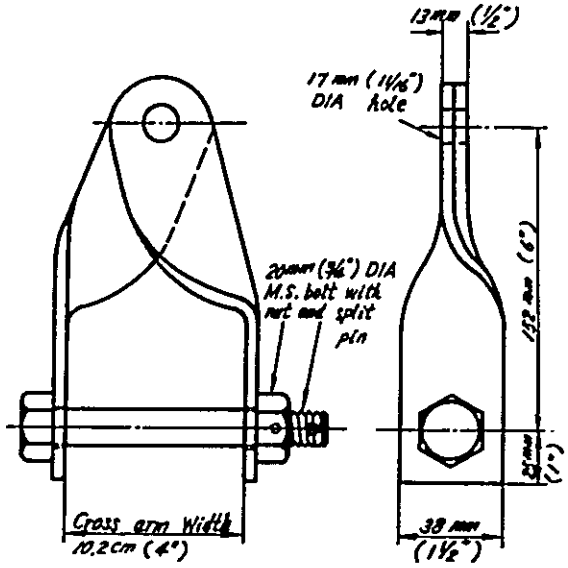
Socket Crevis



Insulator Hook



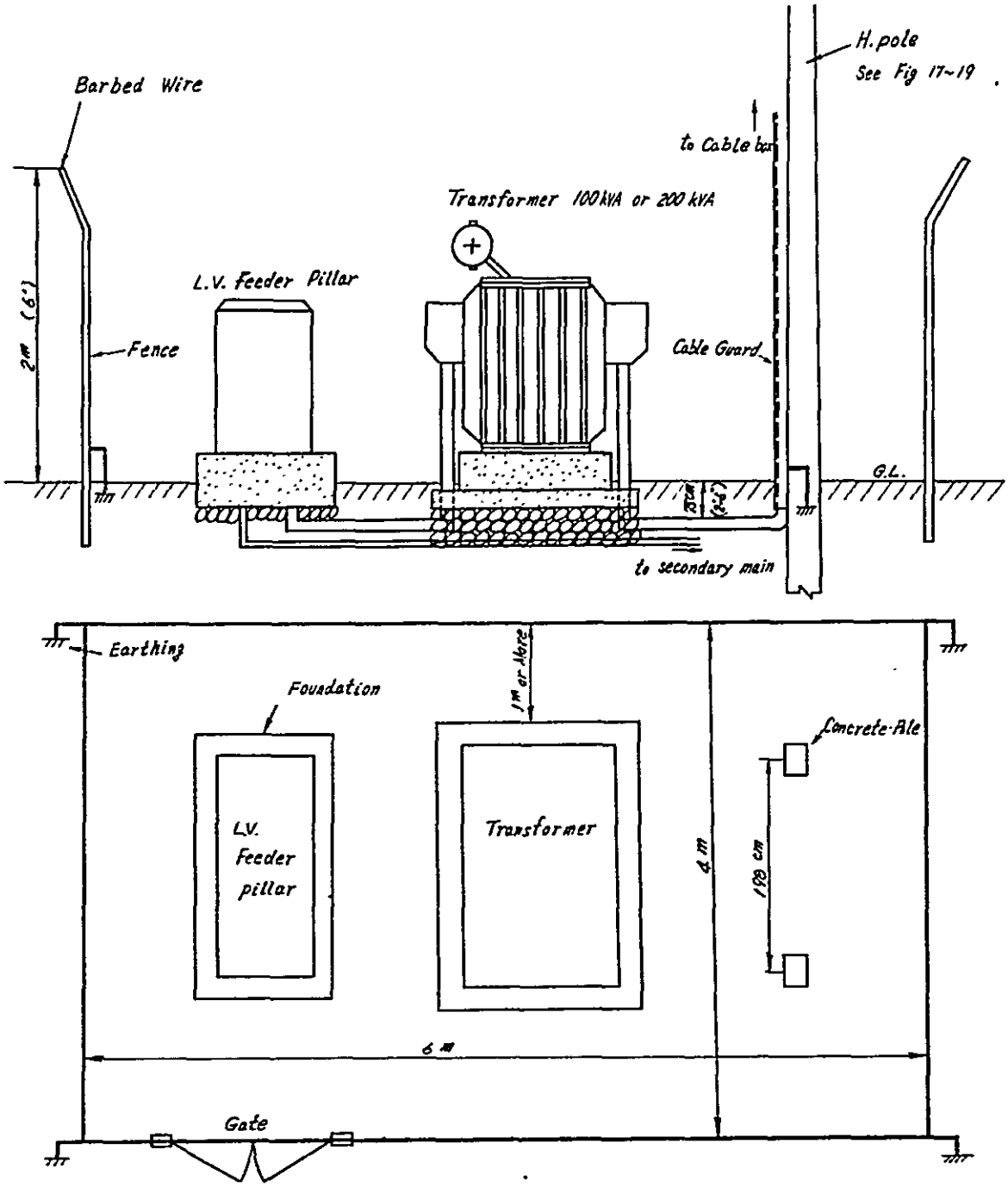
Angle Type

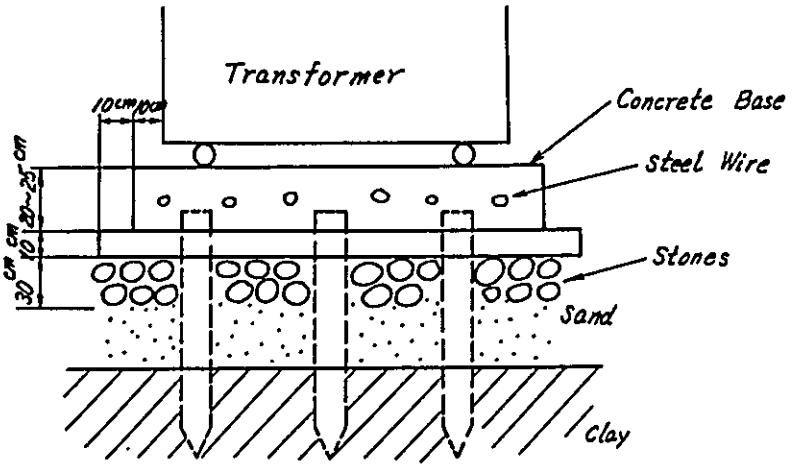


Channel Type

Crossarm Strap

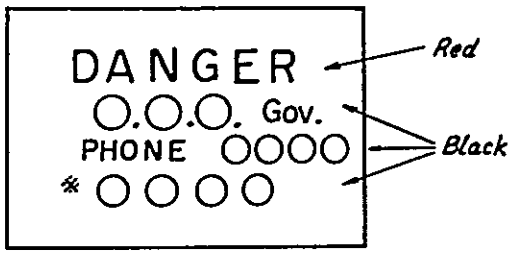
Fig. 30 SUBSTATION





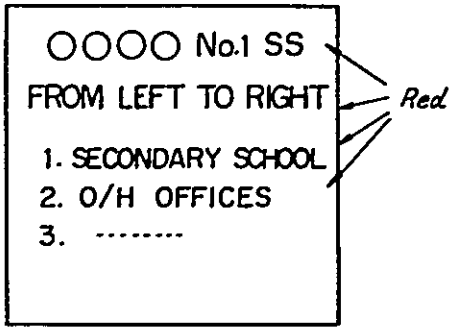
Foundation of Transformer

NOTE The piles shall be used if required



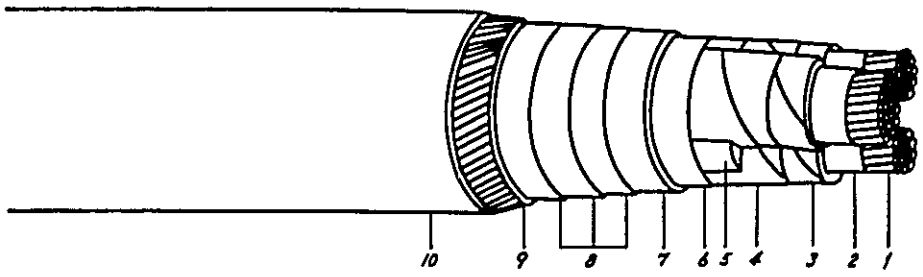
Danger Plate in Substation

※ Number of substation



Attention Plate on Feeder Pillar

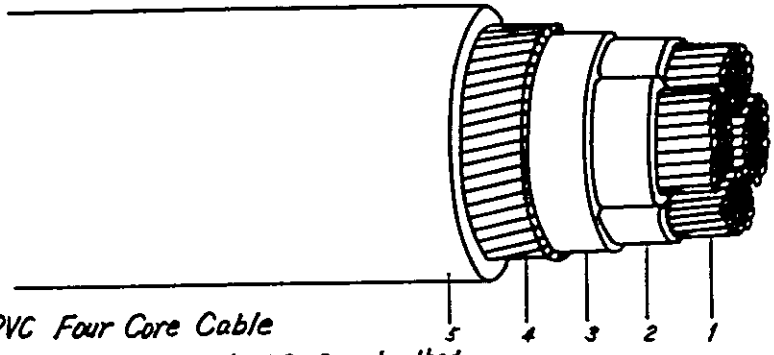
Fig. 31 UNDERGROUND CABLE AND PARTS



H.V. Paper Insulated Cable

Screened type. lead sheathed, single wire armoured and served

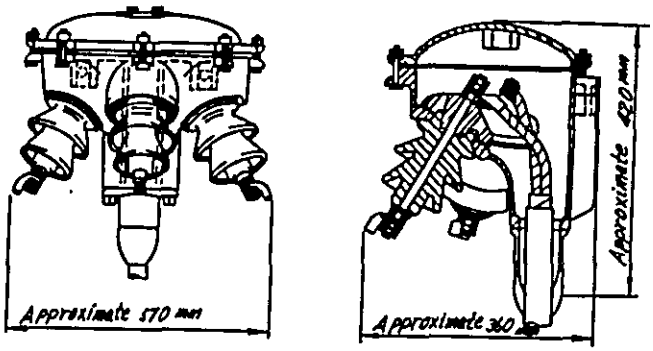
1. *Shaped stranded conductor*
2. *Carbon paper screen*
3. *Impregnated paper insulation*
4. *Screen of metal tape intercalated with paper tape*
5. *Filler*
6. *Copper woven fabric tape*
7. *Sheath lead or lead alloy*
8. *Bedding*
9. *Galvanized steel wire armour*
10. *Serving*



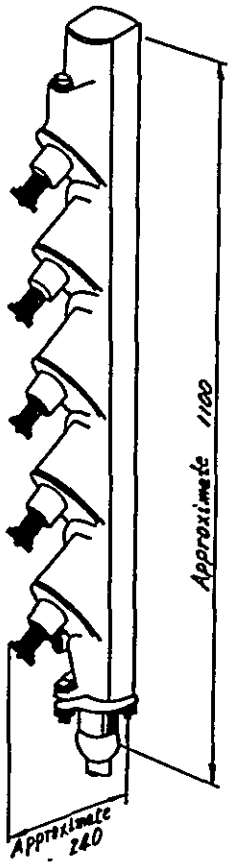
L.V.- PVC Four Core Cable

Single wire armoured and PVC Oversheathed

1. *Shaped stranded copper conductor*
2. *PVC insulation*
3. *Extruded bedding*
4. *Galvanized steel wire armour*
5. *PVC oversheath*



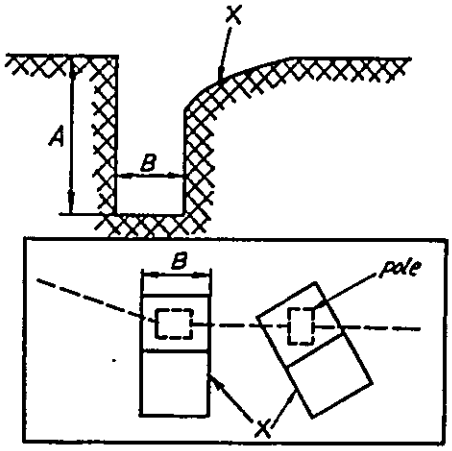
H.V. Cable Box



L.V. Cable Box (5 Conductors)

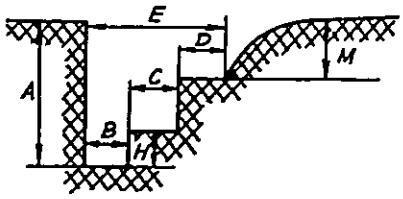
Fig. 32 EXCAVATING OF HOLES FOR POLE ERECTION

Excavating of Round Holes

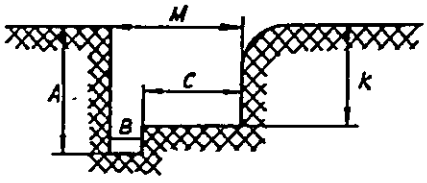


Excavating of Step Dounholes

a. 10m pole



b. 8m pole



NOTE

1. The depth of a hole "A" shall be defined with the buried part of poles and the thickness of concrete bases.
2. The shape of holes shall be unifoum to the bottom.
3. B shall be about two times as much as the butt is in diameter
4. X shall be scraped as much as possible.

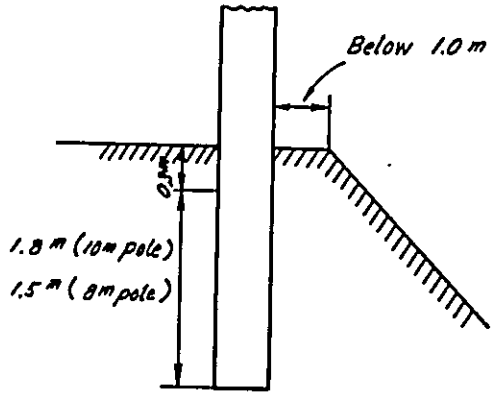
A	Buried part of poles + thickness of concrete base
B	Butt diameter × 1.5
H	Buried part of poles × 0.2
M	" × 0.4
C	" × 0.35
D	" × 0.35
E	" × 1.0

A	Buried part of poles + thickness of concrete base
B	Butt diameter × 1.5
C	Buried part of poles × 0.7
k	" × 0.8
M	" × 1.0

NOTE

In determining the width of excavation, it shall be better as narrow as possible.

Fig. 33 THE DEPTH OF HOLES ON DEEPLY INCLINED GROUND SURFACE.



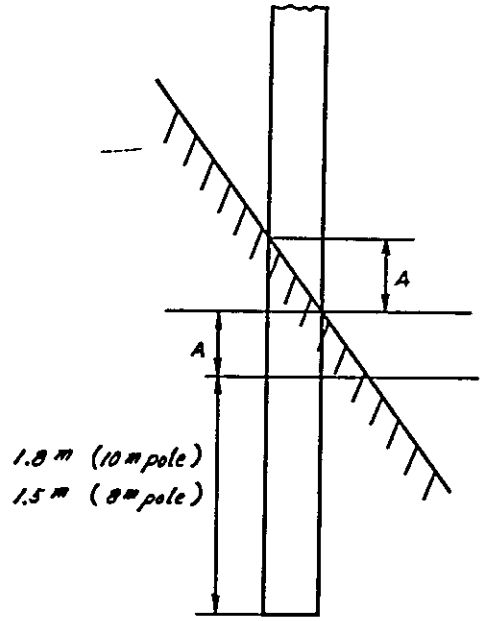
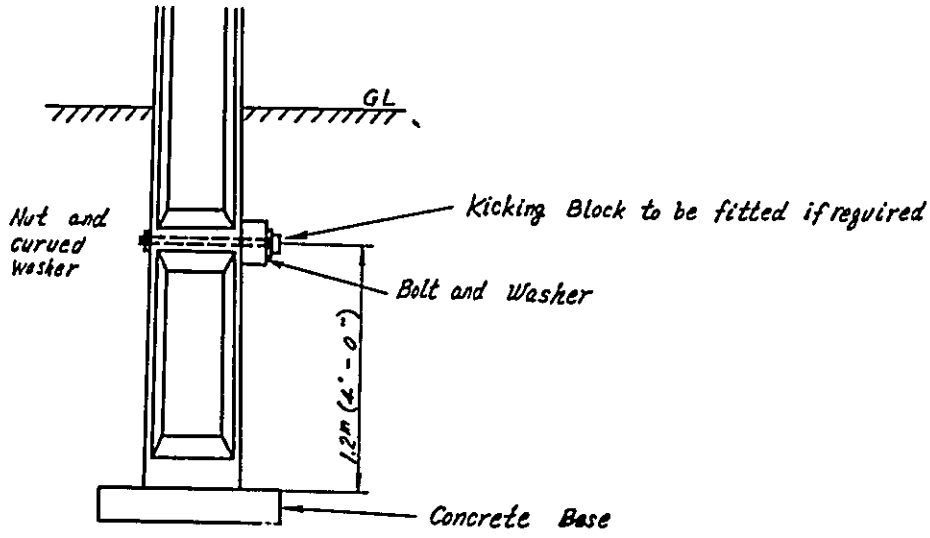
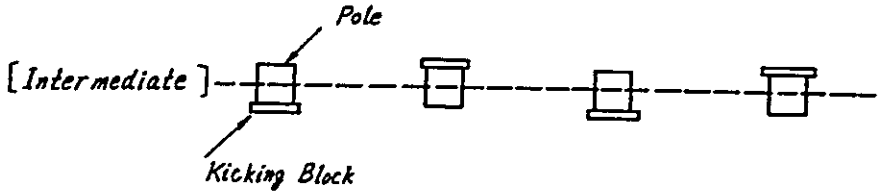
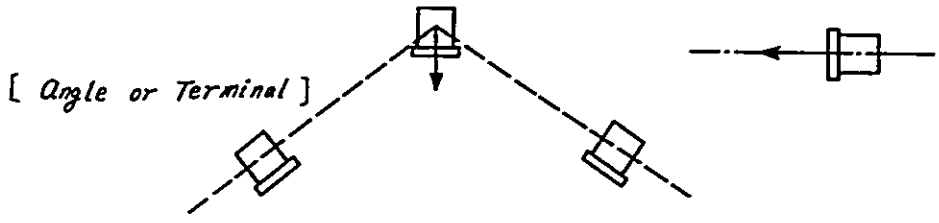


Fig. 34 FOUNDATION

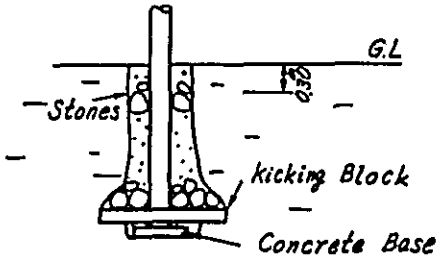


Concrete Base and Kicking Block

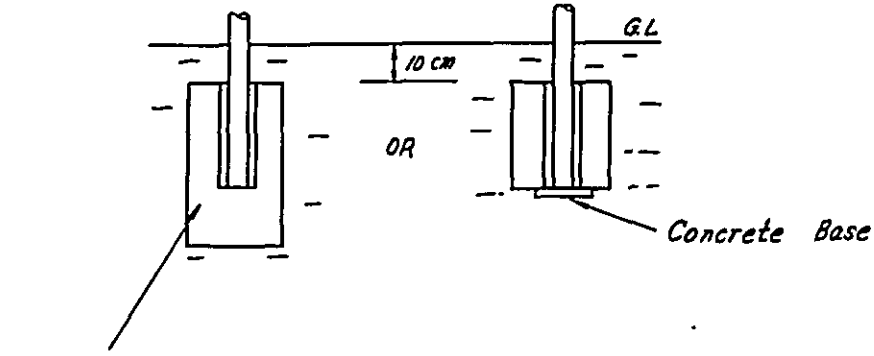




Arrangement of Kicking Block

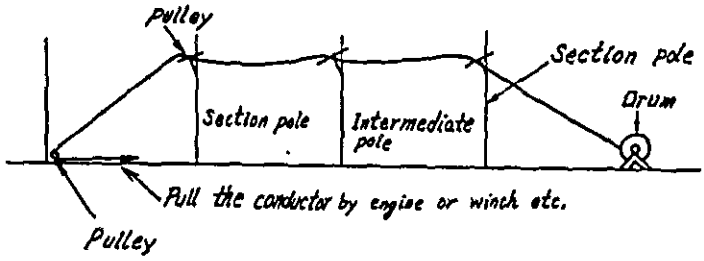


kicking Block (for Wooden poles)



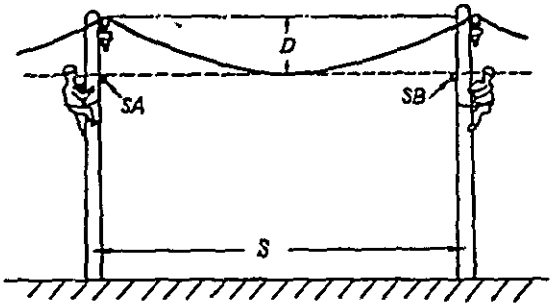
Concrete Foundation

Fig. 35 INSTALLATION OF CONDACTOR



Stringing of Conductor

Bad Stringing



Measurement of Sagging

NOTE

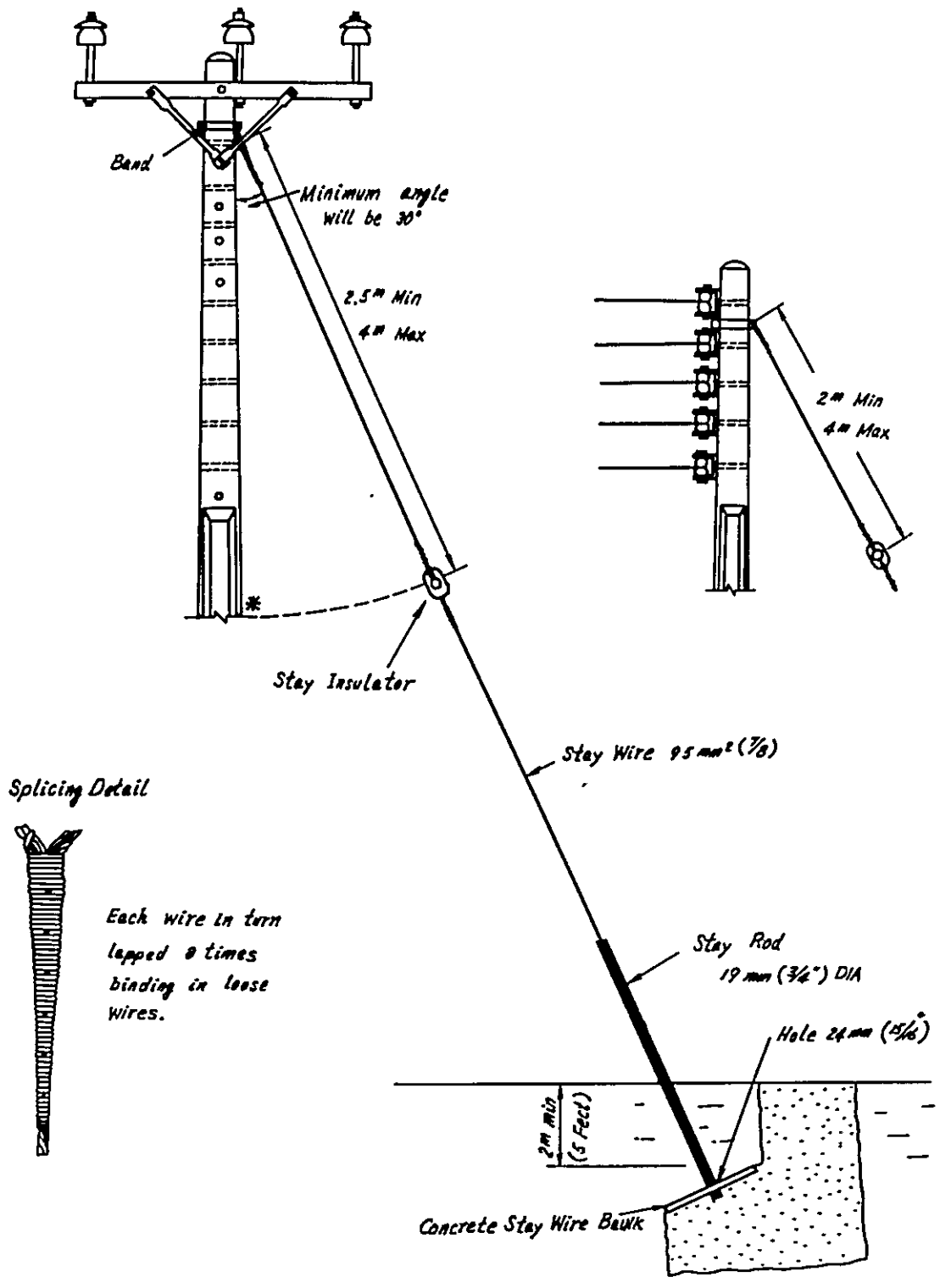
$$K = \frac{D}{S} \times 100\ (\%)$$

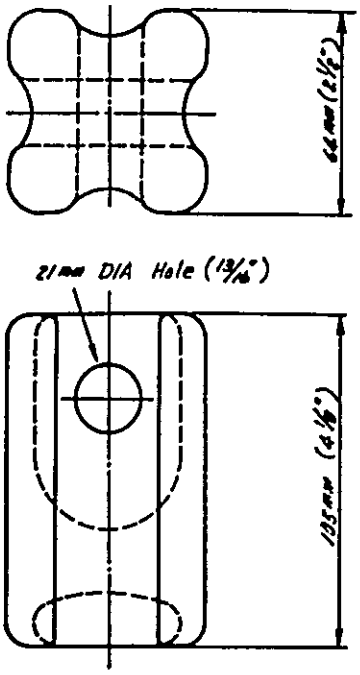
K = Sagging percentage (%)

D = Sagging (m)

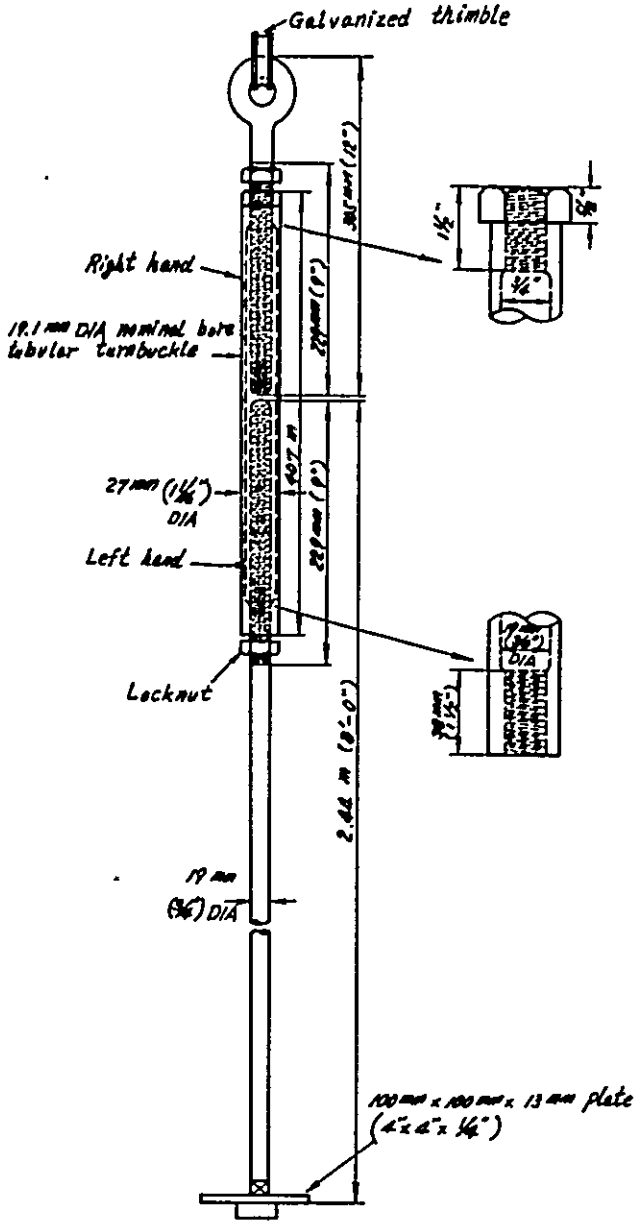
S = length of span (m)

Fig. 36 STAY ASSEMBLY





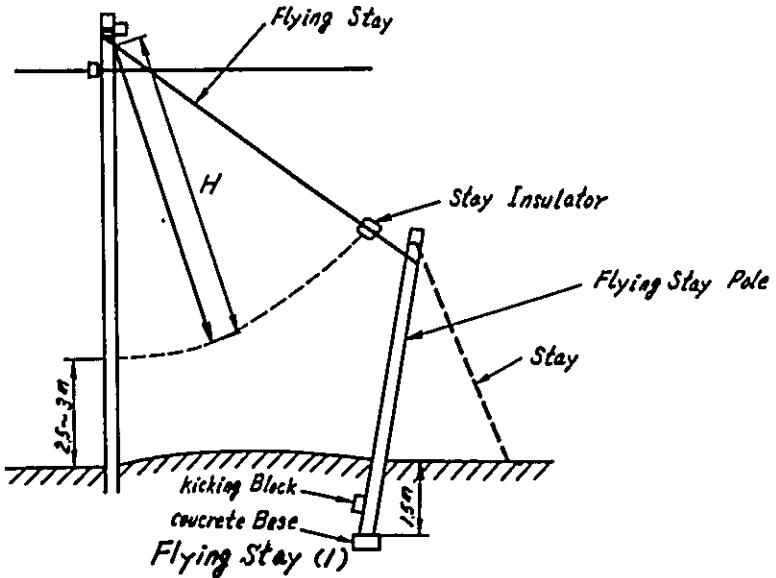
Stay Insulator



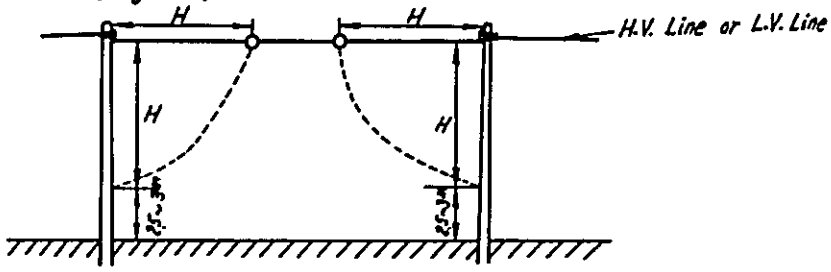
Stay Rod.

NOTE The number of stays to be used shall be

Intermediate and Angle	up to 5°	HV	0	LV	0
Angle	5° ~ 20°	HV	1	LV	1
Angle	20° ~ 45°	HV	1	LV	1
Angle	45° ~ 90°	HV	2	LV	1 ~ 2



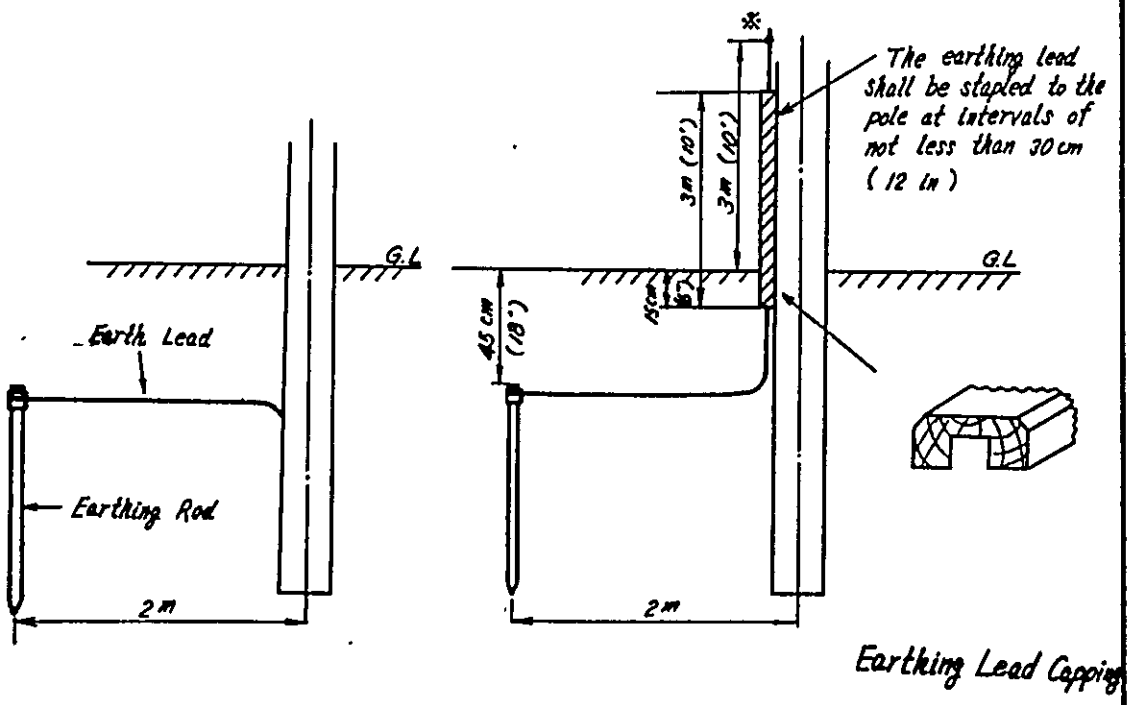
Flying Stay (1)



Flying Stay (2)

NOTE There is no need to install kicking blocks when flying stay poles are equipped with stay.

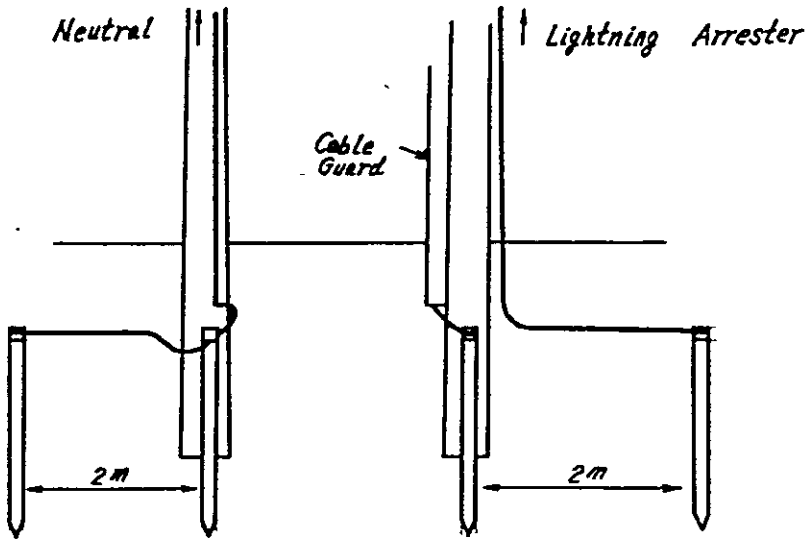
Fig. 37 EARTHING



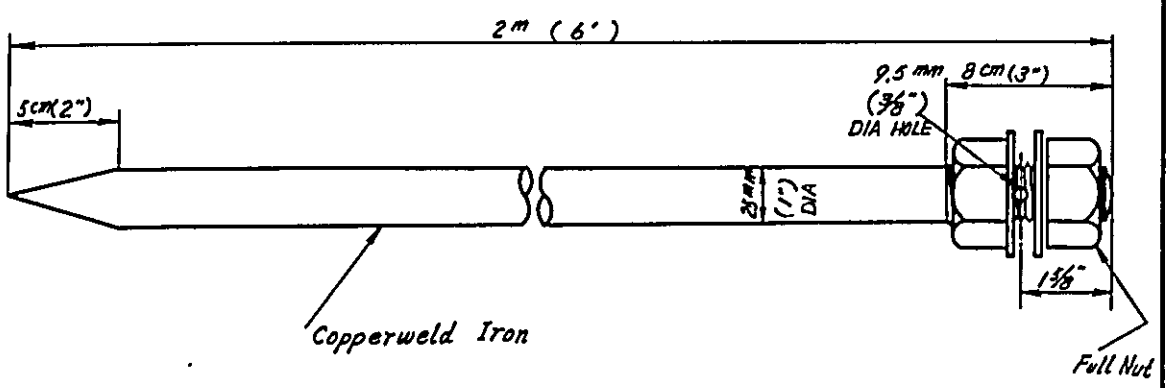
※ Bolted link to measure the earthing resistance

Concrete Pole

Wooden Pole



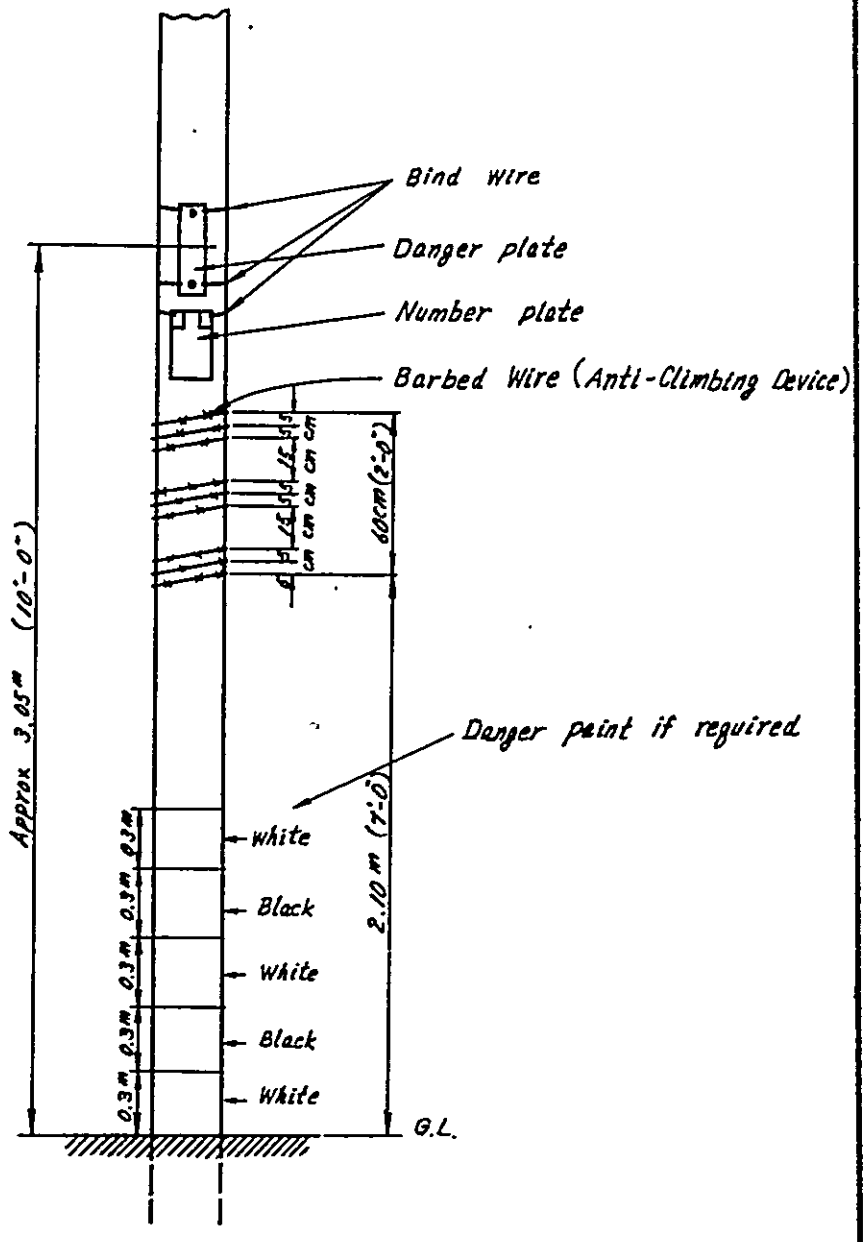
Terminal Pole



Earthing Rod

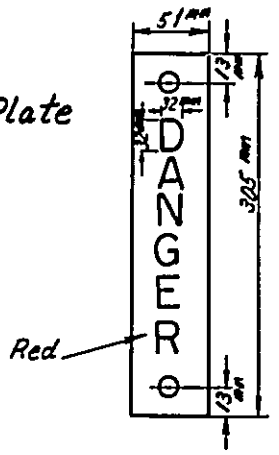
NOTE. The connection between earth wires and steel parts shall be with double nuts and washers

Fig. 38 ACCESSARIES OF POLE

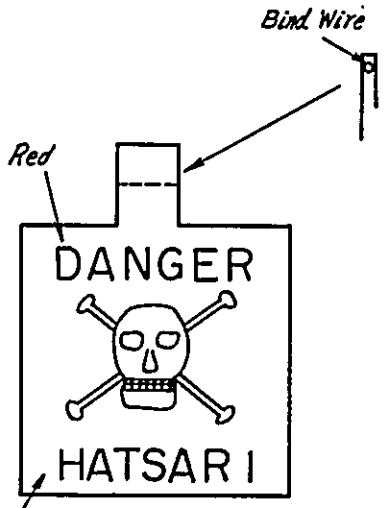


NOTE. Anti-climbing device shall be installed at each 11 kV pole.

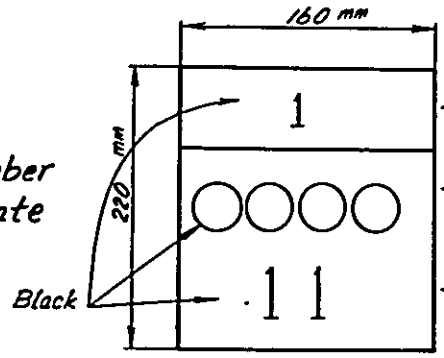
Danger Plate



OR



Number Plate



Explanations

Voltage — 1. for 11kV and lower voltage; 2. for 33kV

Letter code like town name (This shall be provided by the Goverment)

Number of the pole

44.000

OIL TANK

SUMP PIT
600X600 H=800

SECTION A

SECTION B

SECTION C

23.000

4.500

2.250

4.500

5.000

2.250

2.000

3.000

BATTERY ROOM

OFFICE

CONTROL ROOM

AIR CONDITIONER

LUBRICATION OIL STORE ROOM

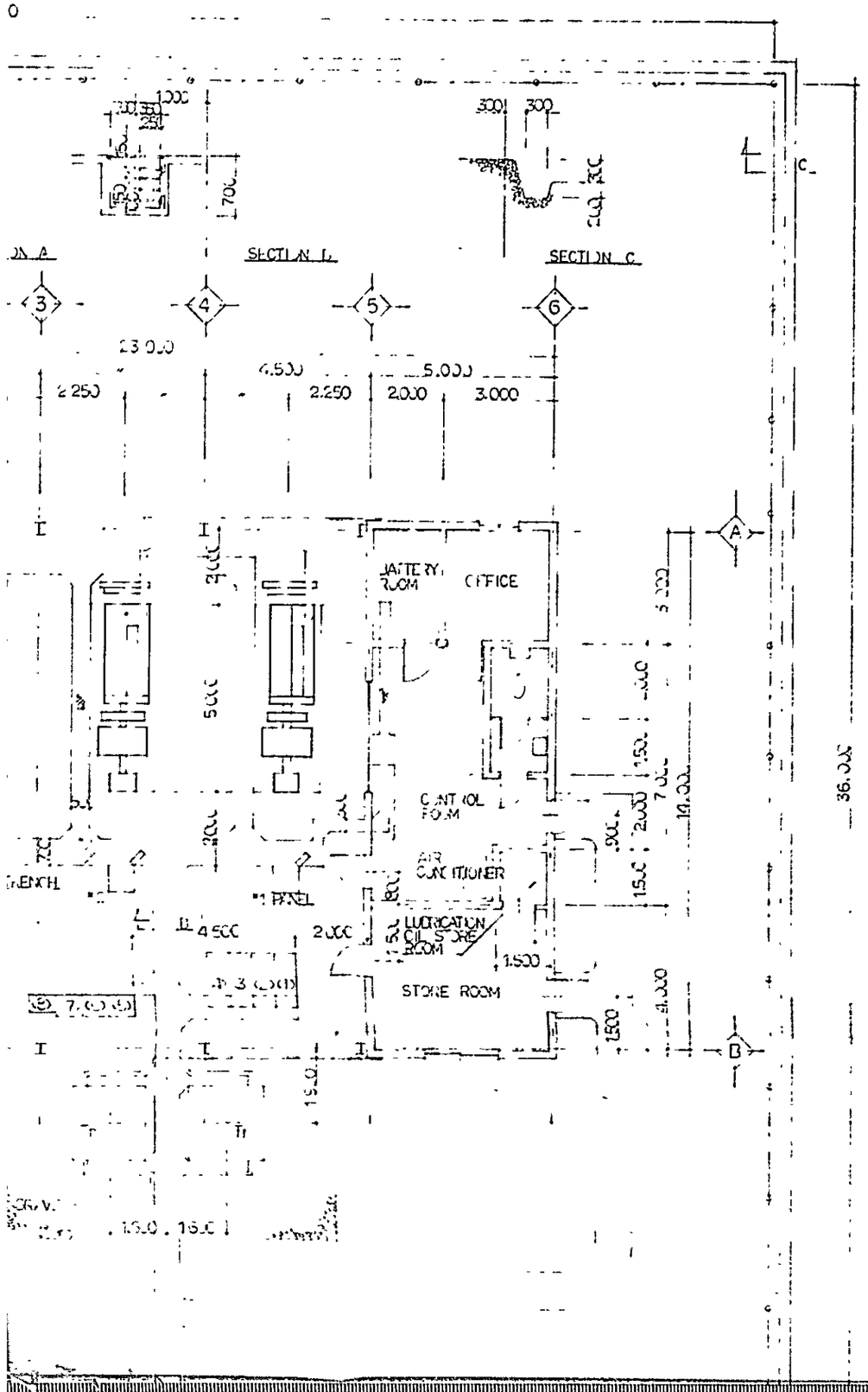
STORE ROOM

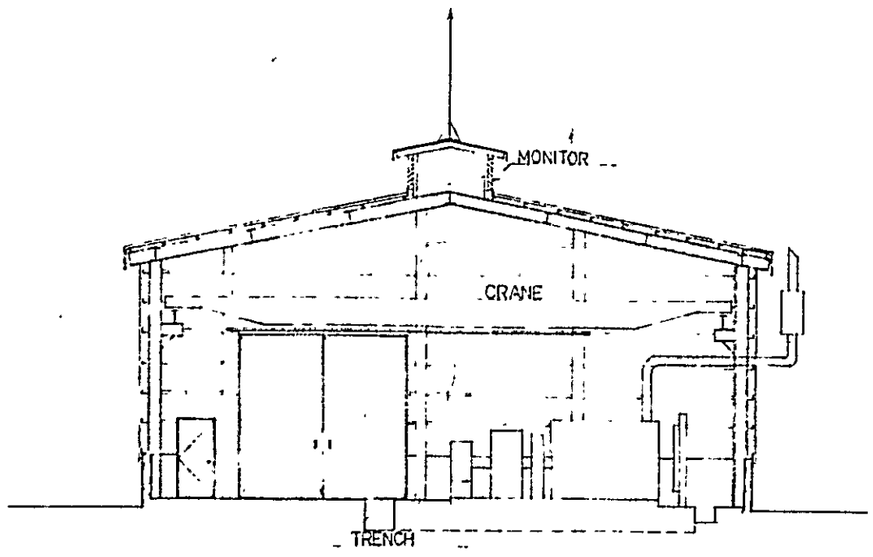
TRENCH

"1 PANEL

GRAVEL

36.000

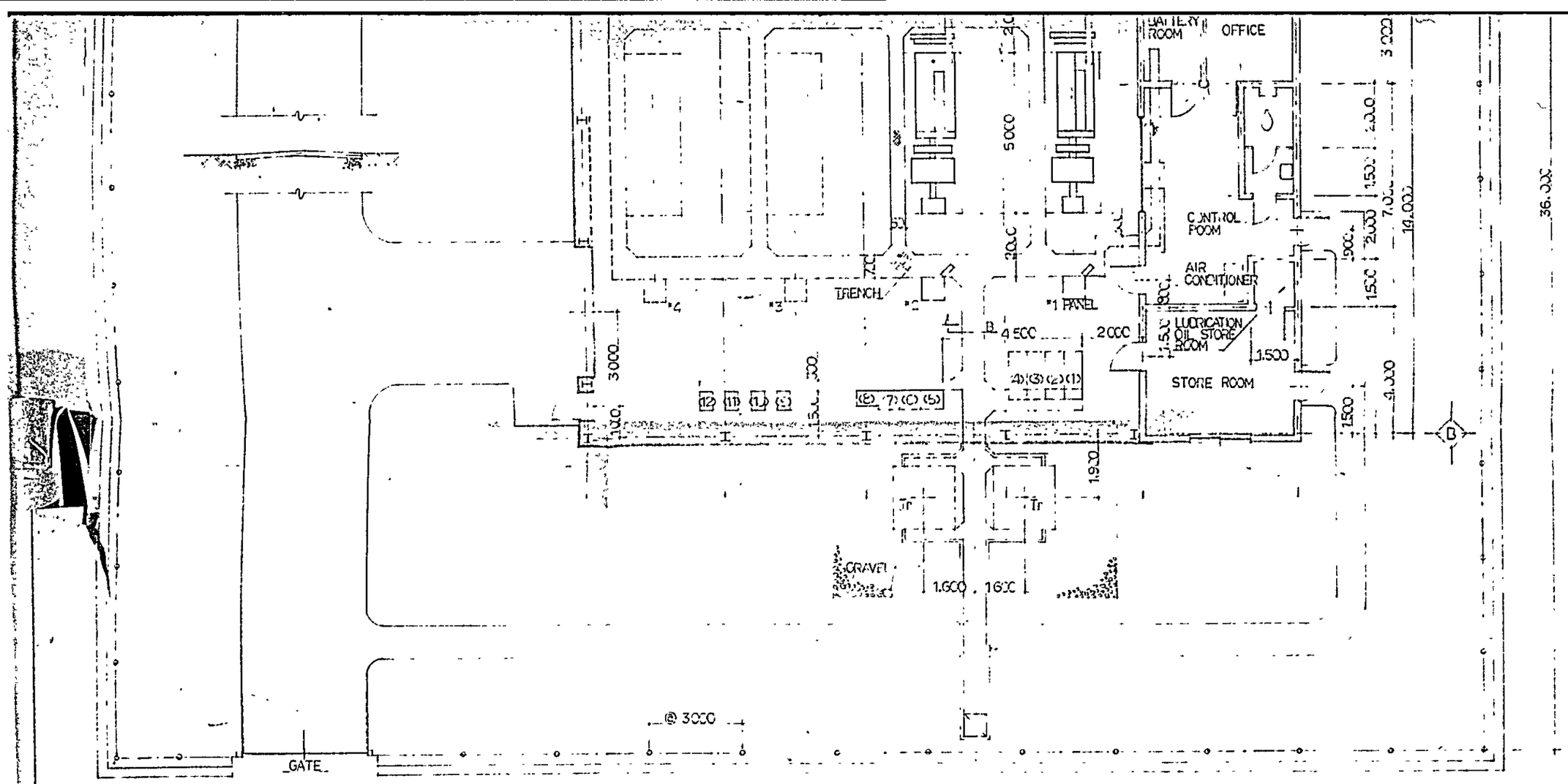




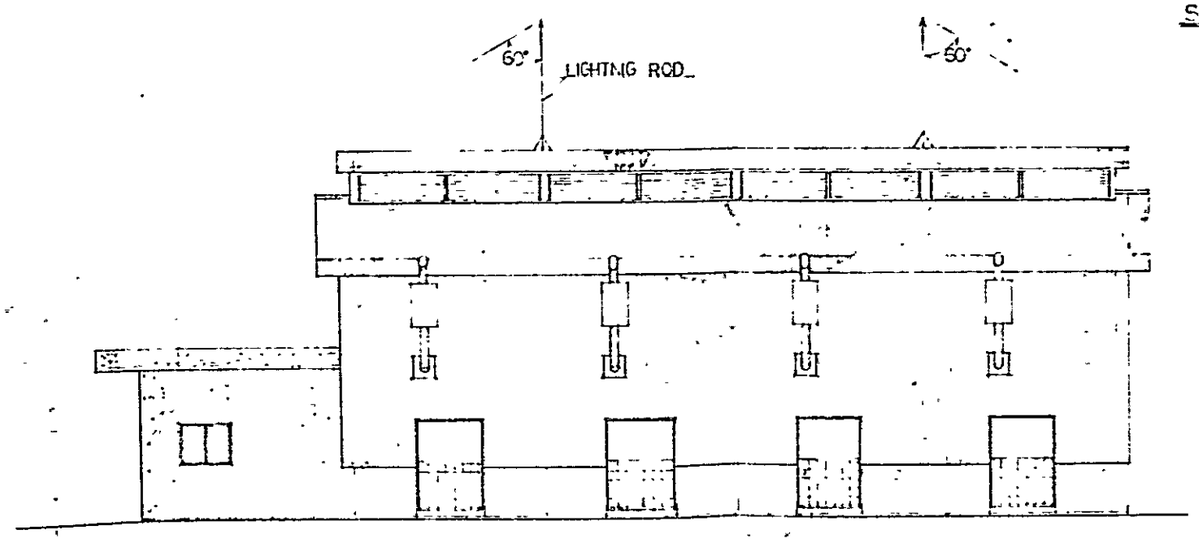
SECTION

NOTES

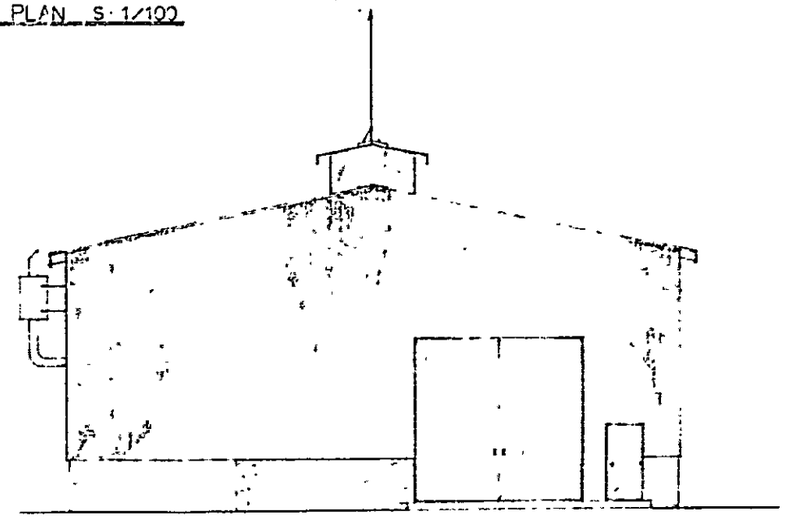
1. PANEL AND SWITCHING BOARD
(1) 11Kv FEEDERSWITCHING BOARD
(2) 11Kv P.T. LA BOARD
(3) SPARE
(4) SPARE
(5) LT. SWITCHING BOARD
(6) D.C. CHARGER
(7) D.C DISTRIBUTION BOARD
(8) D.G STARTING BOARD
(9) SURPER UISION PANEL
(10) AIR COMPRESSOR A.C. MCTOR DRIVEN



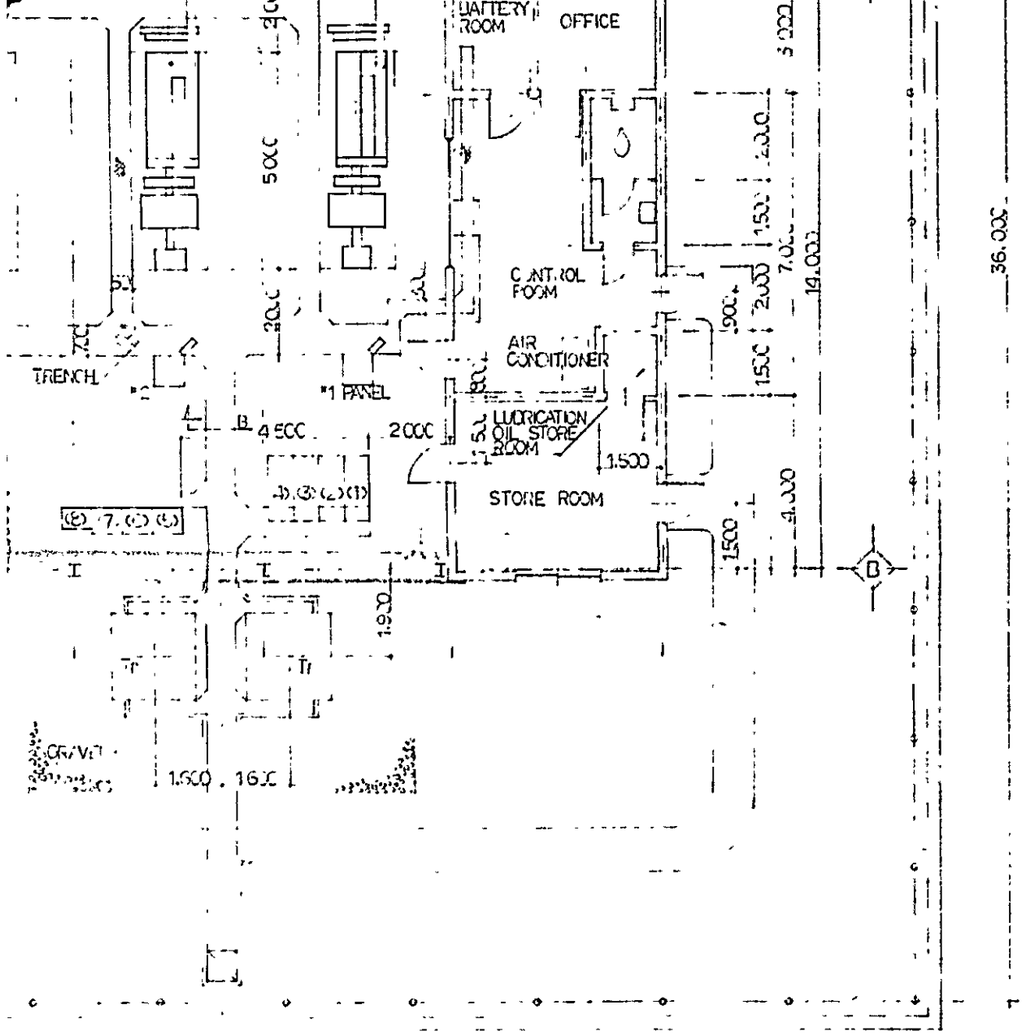
SITE PLAN S: 1/100



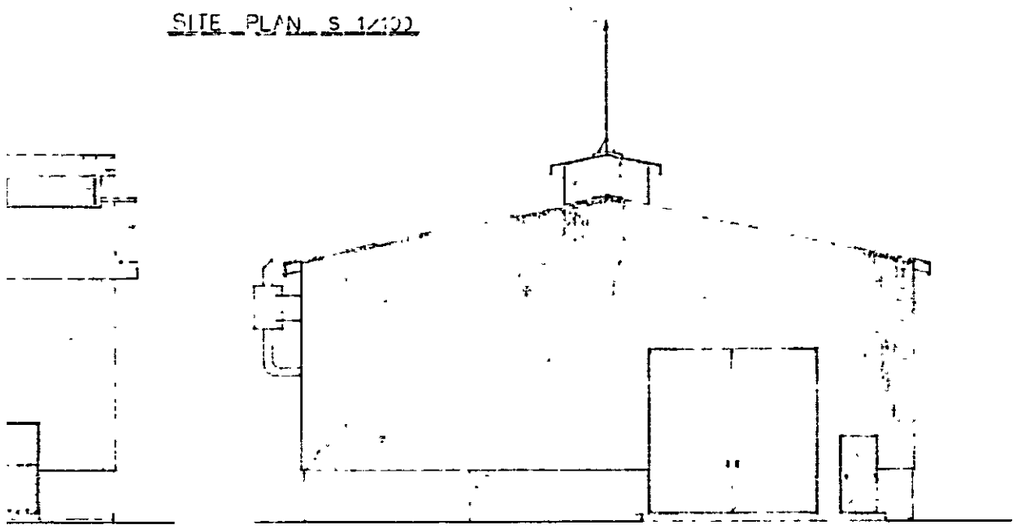
ELEVATION 1



ELEVATION 2



SITE PLAN S 1/100



ELEVATION 2

SECTION

NOTES

1. PANEL AND SWITCHING BOARD
(1) 11Kv FEEDER SWITCHING BOARD
(2) 11Kv PT. LA BOARD
(3) SPARE
(4) SPARE
(5) LT SWITCHING BOARD
(6) D.C. CHARGER
(7) D.C DISTRIBUTION BOARD
(8) D.G STARTING BOARD
(9) SURPER UISION PANEL
(10) AIR COMPRESSOR A.C. MOTOR DRIVEN
(11) AIR COMPRESSOR ENGINE DRIVEN
(12) D.C EMERGENCY GENERATOR

MINISTRY OF WORKS AND HOUSING
NORTH - CENTRAL STATE, NIGERIA

SITE LAYOUT PLAN FOR P.S ...

JAPAN INTERNATIONAL COOPARATION AGENCY
GOVERNMENT OF JAPAN
Survey Team for the Rural Electrification Program In the North-Central State and North-Eastern State

SCALE: 1/100
NO. Fig.39
DATE: ---
DWN: M. K.
CKD: T. M

44.000

OIL TANK

SUMP PIT 500x600 H=800

2.500 5.000 2.500

800 10.000

2500 3500 10.000 500

120 GL 500 300 500

SECTION A

1000 250 350 60° 700

SECTION B

300 300 200 PCC

SECTION C

1 2 3 4 5 6

23.000

4.500 4.500 5.000

2.250 2.250 2.000 3.000

A

BATTERY ROOM

OFFICE

3.000

2.000

CONTROL ROOM

AIR CONDITIONER

LUBRICATION OIL STORE ROOM

STORE ROOM

1.500 2.000 4.000 7.000 14.000

36.000

B

5.000

2.000

500

TRENCH

#4 #3 #2 #1

B 4.500 2.000

1.500

3.000

1.000 1.500 300

(12) (11) (10) (9) (8) (7) (6) (5)

(4) (3) (2) (1)

1.500

1.900

Ir Ir

GRAVEL

1.600 1.600

N u v w

NFB 3P 440

NFB 440V 3φ 30AT/50AF

NFB 440V 15AT/

AIR.CON. 11KVA 1

NFB 250V 1φ 15AT/50AF

NFB 250V 15AT/5

LIG. 1040VA 1

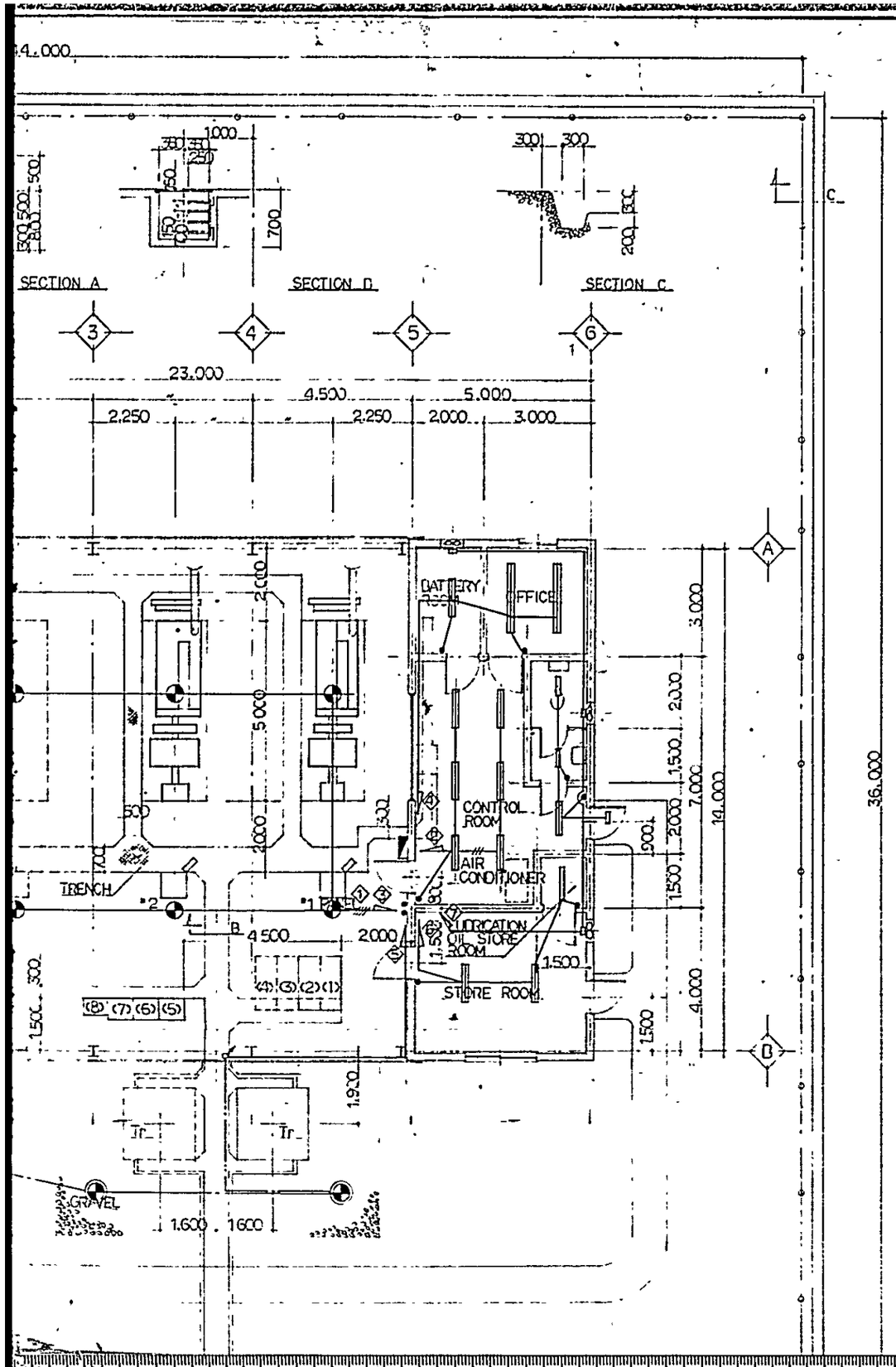
LIG. 1040VA 3

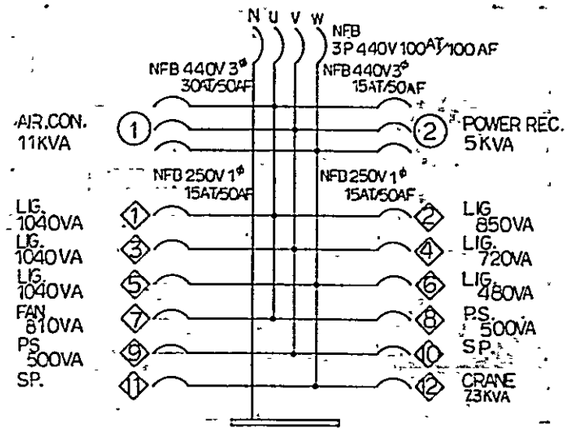
LIG. 1040VA 5

FAN 210VA 7

PS 500VA 9

SO 11





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(3) SPARE
(4) SPARE
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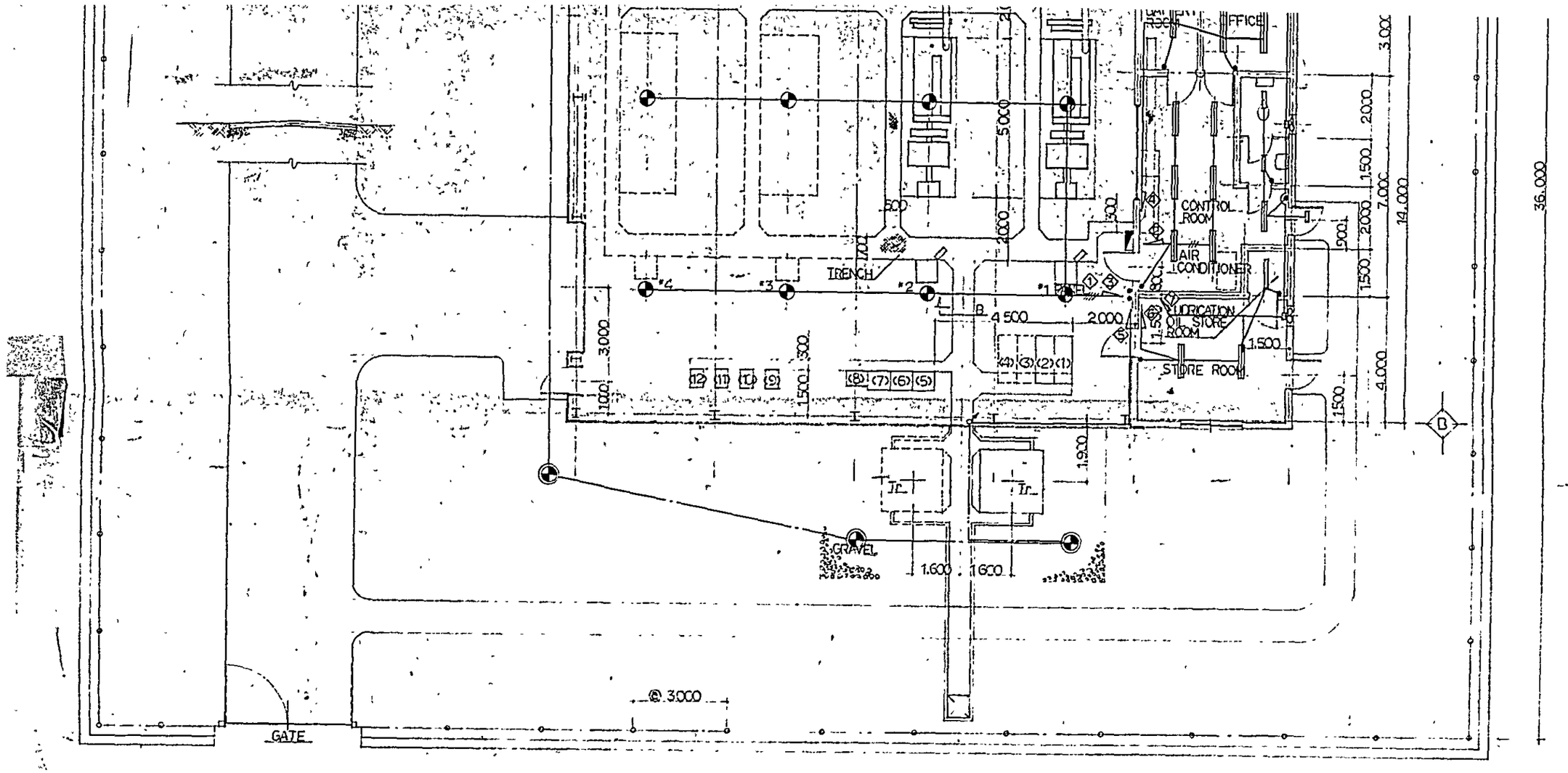
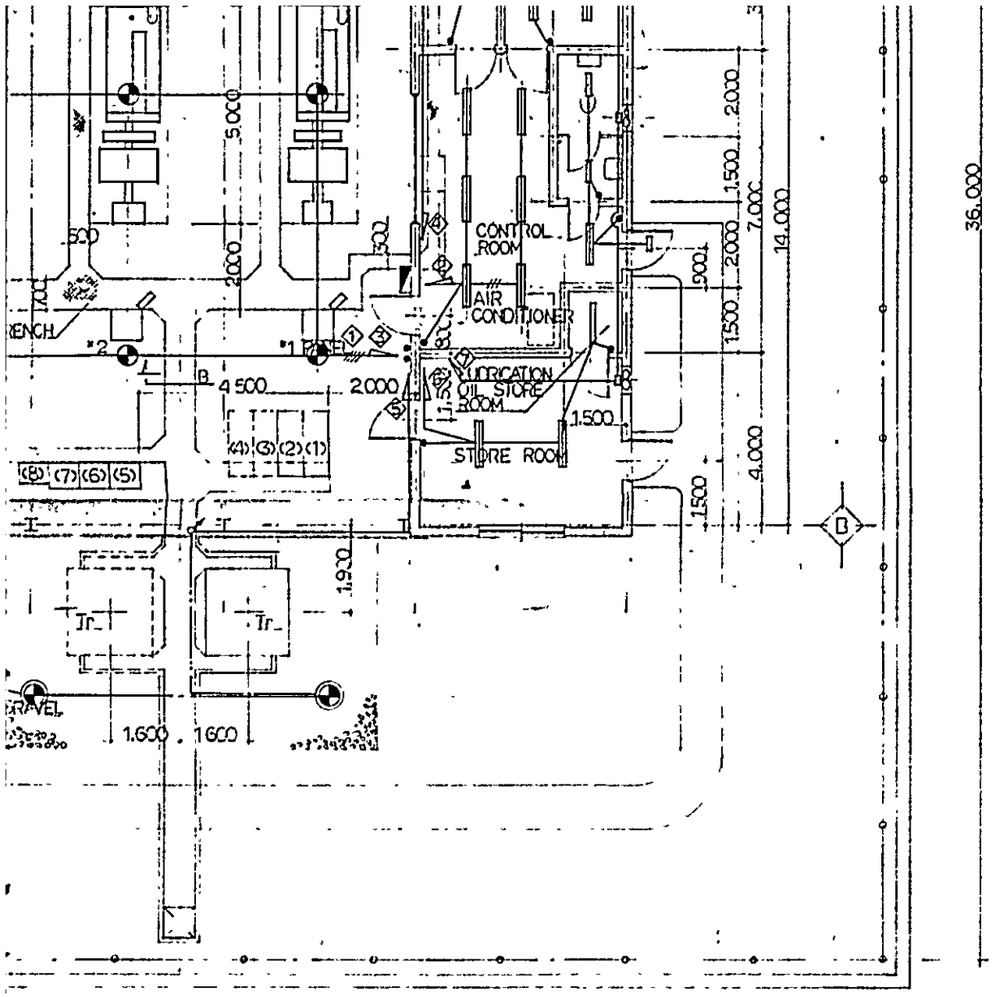
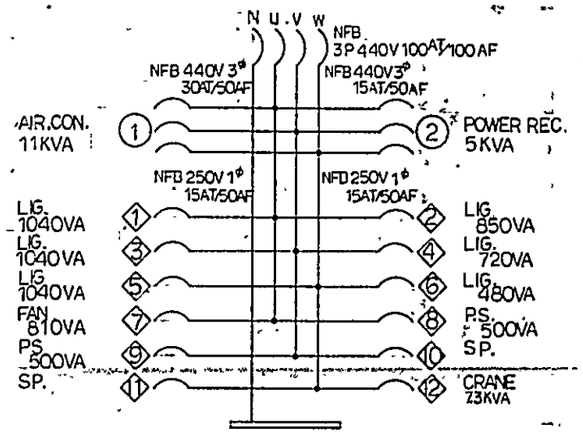
(8) D.G. STARTING BOARD
(9) SURPER VISION PANEL
(10) AIR COMPRESSOR A.C. MOTOR DRIVEN



SITE PLAN S: 1/100



SITE PLAN S: 1/100



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(2) 11Kv P.T. LA. BOARD
(3) SPARE
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(11) AIR COMPRESSOR ENGINE DRIVEN
(12) D.C. EMERGENCY GENERATOR

MINISTRY OF WORKS AND HOUSING
NORTH - CENTRAL STATE, NIGERIA

LIGHTING SYSTEM AND STATION POWER

JAPAN INTERNATIONAL COOPARATION AGENCY GOVERNMENT OF JAPAN Survey Team for the Rural Electrification Program In the North-Central State and North-Eastern State	SCALE:	DATE:
	NO. Fig. 40	DWN: M. K.
		CKD: T. M.