CMR INSTITUTE OF TECHNOLOGY

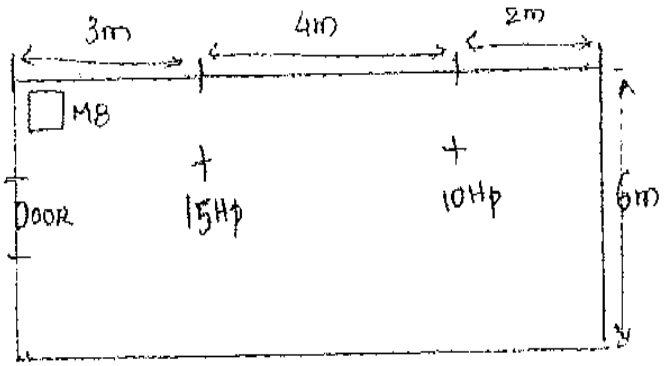
USN | | | | | | | | | | |

Internal Test –April 2018

Sub:	Electrical Design Estimation and Costing							Code:	10EE81
Date:	17/04 /2018	Duration:	90 mins	Max Marks:	50	Sem:	VIII	Branch:	EEE

Note: Answer any **FIVE** full questions. Assume data wherever necessary.

		Marks	OBE CO	OBE RBT
1.	What are the main requirements of the line supports? Describe the factors governing height of pole.	[10]	CO6	L1
2.	List the points to be considered at the time of erection of overhead lines.	[10]	CO6	L1
3.	Explain with a block diagram how electrical energy is conveyed in a typical AC electrical power supply system.	[5+5]	CO6	L1
4.	Mention any ten considerations regarding motor installation wiring. Also explain how rating of fuses is determined.	[8+2]	CO5	L2
5.	A pole for an overhead 11kV, 3-phase, 50 Hz line is required to be earthed and a stay is to be provided. Make a neat sketch showing how it should be done. Prepare a list of materials required.	[5+5]	CO6	L3
6.	Two ac 3ϕ, 415V,50 Hz squirrel cage motors are to be installed in a workshop. The rated outputs of the motors and their locations are as shown in figure. Y-Δ starters supplied with each motor are to be installed on the wall. The supply company's meter will be located at the position marked. The wiring of the machine to be carried out according to IE rules. Make a neat sketch of the wiring diagram the number and size of cables used. Prepare a list of material required for the wiring including necessary earthings. Efficiency 85% and pf=0.8	[10]	CO5	L3



1. Main Requirements of Line Supports

must have the characteristics-high mechanical strength,
light in weight, without loss of mechanical strength
low initial as well as maintenance cost,

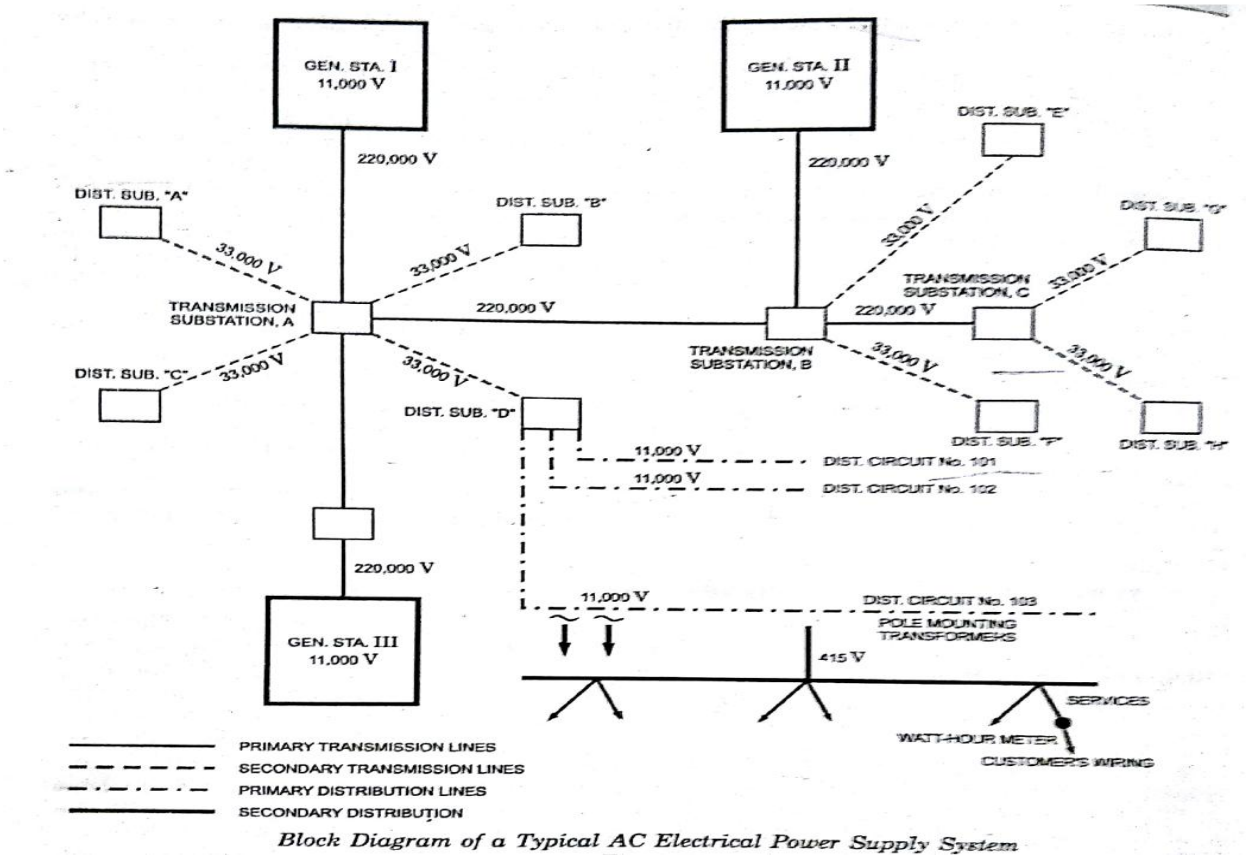
longer life,
good looking
easily accessible for painting and erection of line conductors.

Factors Governing Height of Pole

- Minimum height of pole depends upon:
  - Minimum clearance of lowest conductor from ground
  - Numbers of conductors to be carried and minimum vertical clearance between conductors
  - Length of the pole to be buried in the ground(about one-sixth of total length to be buried if soil is normal)

2. **Points to be considered at the time of erection of overhead line**
   a) Continuous ground wire earthed at the substation should be provided. Every 4th span of the pole and first and last pole should be properly earthed and wire should be joined properly to the continuous earth wire.
   b) The clearance of conductor from the ground and adjoining should be according to IE
   c) All metallic parts, line components(except the main line conductor) should be earthed properly
   d) Permissible spacing should be maintained between the conductors throughout the line
   e) anti-climbing device and danger plate should be fixed on each pole
   f) One-sixth of the pole should be properly buried and rammed in the soil
   g) The joints of the conductor should be mechanically strong and in proper sleeves
   h) Conductors should be tightened on the insulators with binding wires
   i) Guard wire should be provided where essential
   j) Pole steps should be given in the towers to line man to climb the pole
   k) Proper jumper should be used where required

3.



Block Diagram of a Typical AC Electrical Power Supply System

Electrical Power supply system

i. Generating stations
ii. Step-up transformer substations
iii. Primary transmission lines
iv. Primary transmission substations
v. Secondary transmission lines
vi. Secondary transmission substations
vii. Primary distribution lines
viii. Service transformer banks
ix. Secondary distribution lines
x. Secondary distribution lines

Electrical power is generated by 3 phase alternators operating in parallel at generating stations
Generation voltage in India 11kV
For economy reasons voltage is stepped up from 11kV to 220/400/765 kV at generating stations by means of 3-phase transformers
Primary(HV) tr. Lines transmit electrical power from generating stations to primary transmission substations
At primary transmission substations voltage is stepped down to 33-132kV level by step-down transformers.
From primary substations electrical power is transmitted through secondary transmission lines at33/66/132kV to various secondary transmission substations

At secondary substations voltage is further stepped down to 11kV by means of 3-phase transformer
Power is supplied to distribution substations through primary distribution lines at 11kV.
Distribution substations are located at suitable places in the area in which power is to be supplied
At Distribution substations voltage is stepped down to 415 V
Secondary distribution lines ,called distributors are laid along the road and service connections to the consumers are tapped off from the distributors .

Domestic/commercial/small scale industrial consumer s are supplied power at 415-3-phase or 240V-1-phase

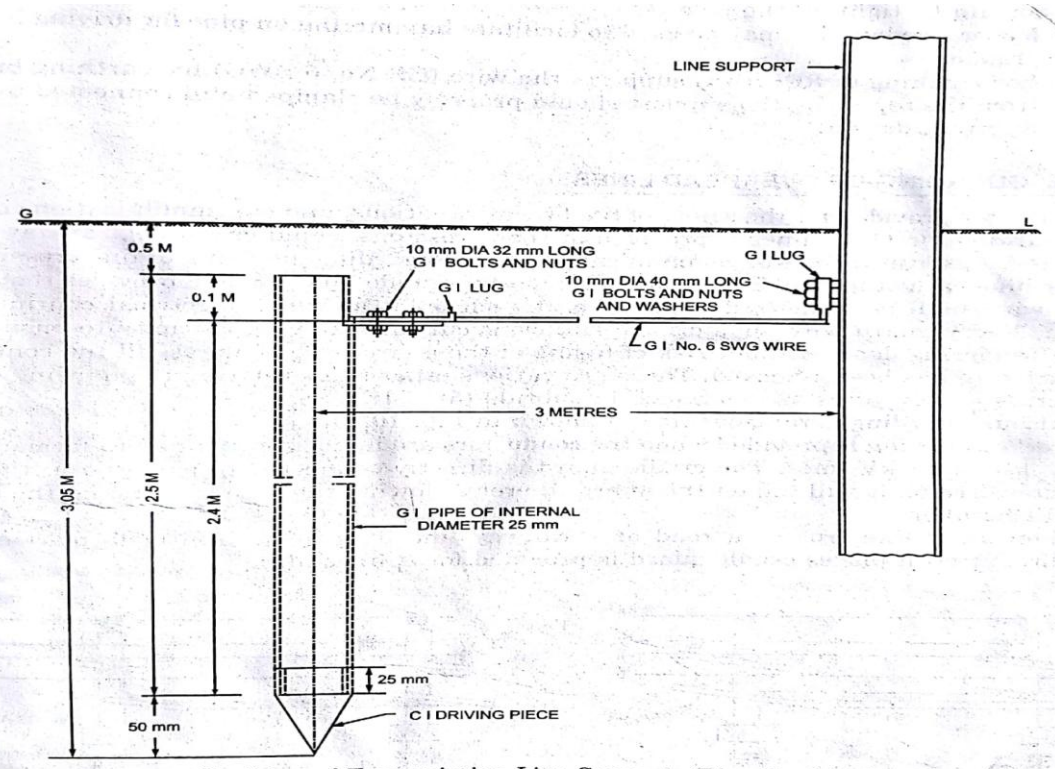
Large commercial organizations, public buildings and industries having load>100kW collect power at11kV/33kV

4. **Important considerations regarding motor installation wiring**
   a. All equipment used shall be of iron clad construction and wiring shell be of armoured cable or conduit type.
   b. Looping of conductors and use of joints shall not be done
   c. Length of flexible conduit shall not exceed 1.25metre.
   d. Every motor, regardless of its size shall be provided with a switch fuse placed near it.
   e. All motors shell be provided with suitable means for starting and stopping placed at convenient places.
   f. Conduit should be preferably laid in covered trenches to facilitate safe operator movement.
   g. While deciding the current rating of a main switch controlling a group of motors, starting current of one motor (highest rating)+ full load current of remaining motors shall be considered.
   h. Laying of cables must be in separate conduit for separate motors.
   i. Minimum cross section of conductor that can be used for power wiring is 2.5mm^2 (Cu) and 1.25mm^2 (Al) cables.
   j. Current rating of the cable may be based on normal full-load current but fuse rating should be based on starting current
   k. In no case rating of fuse be greater than twice the rating of cable
   l. Conduit used shall be electrically continuous throughout and connected to the frame of the motor.
   m. Frame of the motor shall be earthed by the owner by two separate and distinct connections of earth .
   n. Earthing conductor shall be of Cu or GI.

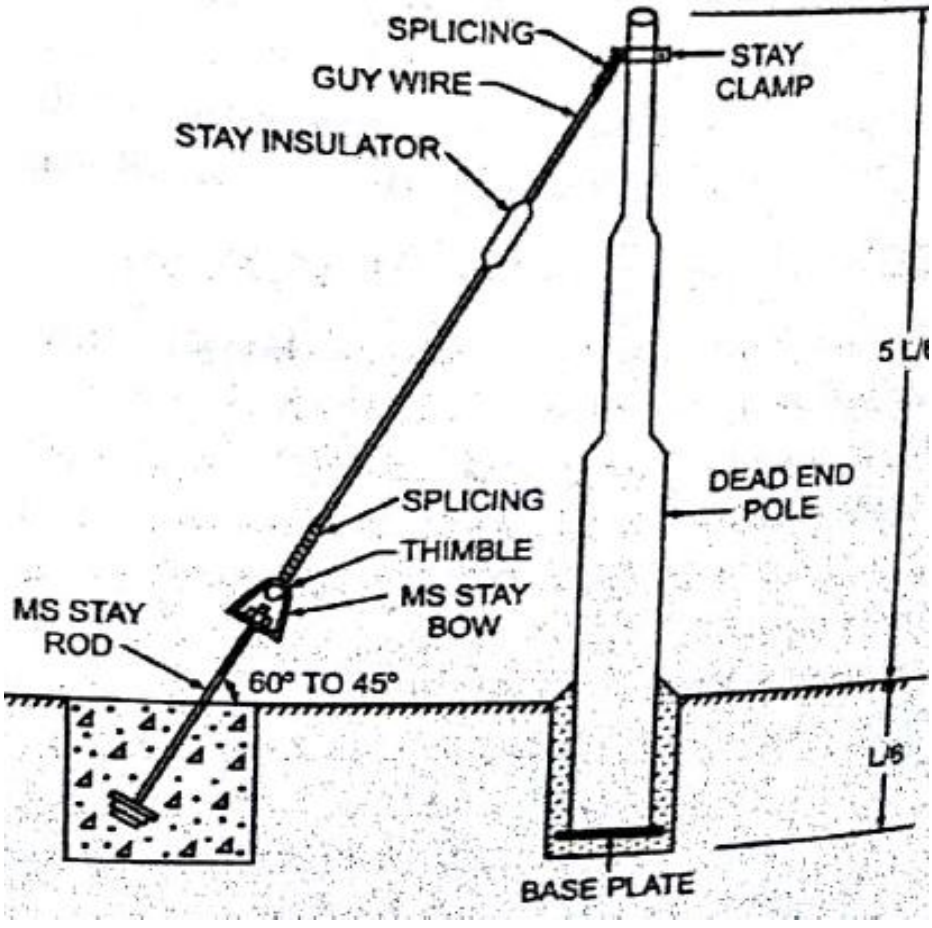
Determination of rating of fuse

- Size that may carry the starting current safely.
- In no case rating of fuse should be greater than twice the rating of cables.
- If starting current > 2x full load current, choose rating of fuse according to starting current, cable should be of current rating not lower than half of the current rating of fuse.

5.



Earthing of Transmission Line Supports (Pipe Earthing)
Fig. 10.63



S. No.	Description of Material With Complete Specifications	Quantity Required		Rate		Amount			Remarks
		Quantity	Unit	₹	P	Per	₹	P	
A	**EARTHING (Pipe Earthing)**								
1.	25 mm diameter GI pipe	2.5	m	120	00	m	300	00	
2.	19 mm diameter GI pipe	1.5	do	90	00	do	135	00	
3.	12 mm diameter GI pipe	4.0	do	75	00	do	300	00	
4.	GI wire 6 SWG	12 (1.2)	do kg	27	00	kg	32	40	
5.	GI lugs	2	nos	15	00	each	30	00	
6.	10 mm diameter, 32 mm long GI bolts and nuts	2	nos	15	00	do	30	00	
7.	16 mm diameter, 40 mm long GI bolts, nuts and washers	2	do	18	00	do	36	00	
8.	12 mm diameter GI bends	1	do	15	00	do	15	00	
9.	30 cm square cast iron frame	1	no	150	00	each	150	00	
10.	30 cm square cast iron cover	1	do	75	00	do	75	00	
11.	Funnel with wire mesh	1	do	75	00	do	75	00	
12.	Charcoal	10	kg	15	00	kg	150	00	
13.	Common salt	10	do	5	00	do	50	00	
14.	Cement concrete 1 : 4 : 8	0.15	m^3	1,500	00	m^3	225	00	
B.	**STAYING**								
1.	MS anchor plate 45 cm × 45 cm × 6.0 cm (not galvanised)	1	no	675	00	each	675	00	
2.	MS stay rod 16 mm diameter and 2.42 m long	1	do	675	00	do	675	00	
3.	Stay bow made of MS rod 12 mm diameter	1	do	450	00	do	450	00	
4.	Stay insulator	1	do	150	00	do	150	00	
5.	Stay wire (7/8 SWG GI wire)	7.5 (4.5)	m kg	270	00	kg	1,215	00	
6.	Stay clamp	1	no	80	00	each	80	00	
7.	16 mm diameter, 76 mm long bolts and nuts for fixing	2	do	50	00	do	100	00	
8.	MS thimbles	2	do	15	00	do	30	00	
9.	Cement concrete 1 : 4 : 8	0.2	m^3	1,500	00	m^3	300	00	
						Total	5,278	40	

6.

Solution : Assuming efficiency of motor 85% and power factor 0.8, we have full load currents of motors

$$I_1 = \frac{15 \times 735.5}{\sqrt{3} \times 415 \times 0.85 \times 0.8} = 22.5 \text{ A for 15 hp motor}$$

$$I_2 = \frac{10 \times 735.5}{\sqrt{3} \times 415 \times 0.85 \times 0.8} = 15.0 \text{ A for 10 hp motor}$$

Full-load current of two motors = 22.5 + 15 = 37.5 A

Hence 3-core, PVC, 1100 V grade, 25 mm^{2*} aluminium conductor cable having current carrying capacity of 54 A will be used from meter board to main board.

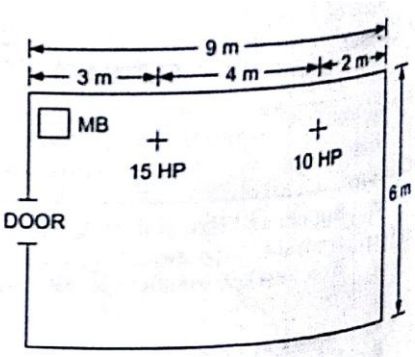


Fig. 9.5

The main switch and main distribution board will be mounted on main board of size 45 cm × 60 cm at a height of 1.3 metres form the floor level and 0.25 m from the supply main board.

The main switch used should be capable of handling starting current of one motor (of highest rating, plus full-load current of the other motor i.e. 22.5 × 2 + 15.0 = 60 A

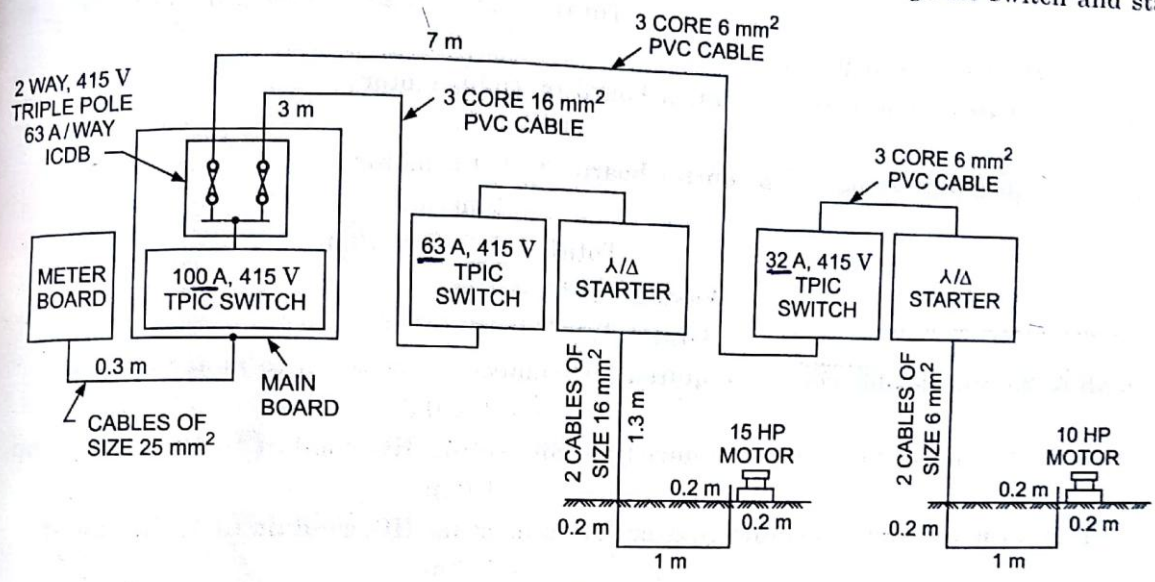
Hence 100 A, 415 V grade TPIC switch shall be used as main switch.

As there are two circuits and starting current of one circuit (of highest rating) is 45 A, therefore, 2-way, 415 V, 63 A/way ICDB shall be used.

*** Note :** Cables of higher ratings are taken from safety point of view.

63 A, 415 V, TPIC switch shall be installed for control of 15 hp (metric) motor and 32 A, 415 V, TPIC switch shall be installed for control of 10 hp (metric) motor.

3 core, 1,100 V grade, PVC, 16 mm^{2*} aluminium conductor cable having current carrying capacity of 38 A shall be used from main distribution board to 15 hp motor through its switch and starter.

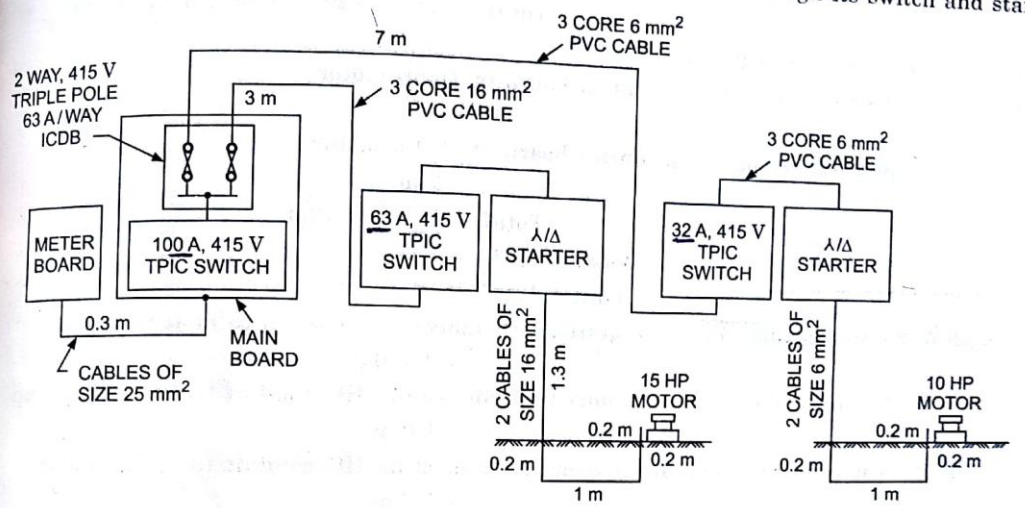


Single Line Wiring Diagram

Fig. 9.6

63 A, 415 V, TPIC switch shall be installed for control of 15 hp (metric) motor and 32 A, 415 V, TPIC switch shall be installed for control of 10 hp (metric) motor.

3 core, 1,100 V grade, PVC, 16 mm^{2*} aluminium conductor cable having current carrying capacity of 38 A shall be used from main distribution board to 15 hp motor through its switch and starter.



Single Line Wiring Diagram

Fig. 9.6

3 core, 1100 V grade, PVC, 6 mm^2 aluminium conductor cable having current carrying capacity of 24 A shall be used from main distribution board to 10 hp motor through its switch and starter.

Size of HG conduit, used from meter board to main board, required to accommodate 3-core cable of size 25 mm^2 aluminium conductor, 1100 V grade will be of size 50 mm.

Size of HG conduit used from main distribution board to control board for 15 hp motor, required to accommodate 3 core cable of size 16 mm^2 aluminium conductor, 1100 V grade will be of size 25 mm.

Size of HG conduit, used from control board to motor of 15 hp, required to accommodate 2 cables of 16 mm^2 aluminium conductor, 1100 V grade will be of size 50 mm.

Size of HG conduit, used from main distribution board to control board for 10 hp motor, required to accommodate 3 core cable of 6 mm^2, aluminium conductor, 1100 V grade will be of size 25 mm.

Size of HG conduit, used from control board to motor of 10 hp, required to accommodate 2 cables of 6 mm^2, aluminium conductor, 1100 V grade will be of size 31 mm.

Flexible conduits of size 50 mm and 31 mm shall be used for connecting H G conduits to 15 hp and 10 hp motors respectively.

Length of HG Rigid Conduit of 50 mm size

From meter board to main board = 0.3 m

From control board to 15 hp motor to ground, 0.2 m below it and then to motor foundation

$= 1.3 + 0.2 + 1 + 0.4 + = 2.9$ m

Total $= 0.3 + 2.9$ m $= 3.2$ m

Wastage 10% $= 0.32$ m

Grand Total $= 3.2 + 0.32 = 3.52$ m $= 3.6$ m (say)

Length of HG Rigid Conduit of 31 mm size

From control board of 10 hp motor to ground, 0.2 below it, 1 m along the ground and then to foundation = 1.3 + 0.2 + 1 + 0.4 + = 2.9 m

Wastage 10% = 0.29 m

Total = 2.9 + 0.29 = 3.19 ≅ 3.2 m (say)

Length of HG Conduit of 25 mm size

From main distribution board to control board of 15 hp motor = 3 m

From main distribution board to control board of 10 hp motor = 7 m

Total = 3 + 7 = 10 m

Wastage 10% = 1 m

Grand Total = 10 + 1 = 11 m

Length of 25 mm flexible conduit required for connecting switches to motor starters = 2 × 0.25 = 0.5 m

Length of 31 mm flexible conduit required for connecting HG conduit to motor of 10 hp = 1.0 m

Length of 50 mm flexible conduit required for connecting HG conduit to 15 hp motor = 1.0 m

Length of 25 mm^2, aluminium conductor, 3 core, 1100 V grade PVC cable = 0.35 m

Length of 16 mm^2, aluminium conductor, 3 core, 1100 V grade PVC cable

= 3 + 0.25 + 2 (1.3 + 0.2 + 1 + 0.4 + 1)

= 11.05 m

Wastage 10% = 1.105 m

Total = 11.05 + 1.105 = 12.155 m ≅ 12.5 m (say)

Length of 6 mm^2, aluminium conductor, 3 core, 1100 V grade PVC cable

= 7 + 0.25 + 2(1.3 + 0.2 + 1 + 0.4 + 1) = 15.05 m

Wastage 10% = 1.505 m

Total = 15.05 + 1.505 = 16.555 m = 17 (m) say

Length of earth wire (6 SWG GI wire) = 2 × length of conduit including length of flexible conduit

= 2 × (3.6 + 3.2 + 11.0 + 1 + 1)

= 40. 6 m ≅ 40 metres (say) 5 kg

ESTIMATE 9.2 ON THE BASIS OF ITEM WISE RATES

S. No.	Description of Material With Full Specifications	Quantity Required		Rate			Amount		Remarks
		Quantity	Unit	₹	P	Per	₹	P	
1.	IC boards complete with locking arrangement etc. (*i*) 45 cm × 60 cm (*ii*) 30 cm × 45 cm	1 1	no do	900 400	00 00	each do	900 400	00 00	

Contd...

S. No.	Description of Material With Full Specifications	Quantity Required		
		Quantity	Unit	
2.	TPIC switches with fuses			
	(*i*) 100 A, 415 V	1	do	5,
	(*ii*) 63 A, 415 V	1	do	3,
	(*iii*) 32 A, 415 V	1	do	1,
3.	2-Way, 63 A/Way, 415 V, IC Distribution board complete with fuses	1	do	6,
4.	3-core, 1100 V, aluminium conductor PVC cable of sizes			
	(*i*) 25 mm^2	0.35	m	
	(*ii*) 16 mm^2	12.5	do	
	(*iii*) 6 mm^2	17	do	
5.	Heavy gauge conduit 16 SWG			
	(*i*) 50 mm diameter	3.6	do	
	(*ii*) 31 mm diameter	3.2	do	
	(*iii*) 25 mm diameter	11	do	
6.	Flexible conduit			
	(*i*) 50 mm diameter	1	do	
	(*ii*) 31 mm diameter	1	do	
	(*iii*) 25 mm diameter	0.5	do	
7.	Conduit bends			
	(*i*) 50 mm diameter	4	nos	
	(*ii*) 31 mm diameter	2	do	
	(*iii*) 25 mm diameter	8	do	
8.	Conduit saddles			
	(*i*) 50 mm diameter	6	do	
	(*ii*) 31 mm diameter	3	do	
	(*iii*) 25 mm diameter	12	do	
9.	Wooden bushings			
	(*i*) 50 mm diameter	5	do	
	(*ii*) 31 mm diameter	3	do	
	(*iii*) 25 mm diameter	8	do	
10.	Conduit locknuts			
	(*i*) 50 mm diameter	5	nos	
	(*ii*) 31 mm diameter	3	do	
	(*iii*) 25 mm diameter	8	do	
11.	Box connector coupling			
	(*i*) 50 mm diameter	1	do	
	(*ii*) 31 mm diameter	1	do	
	(*iii*) 25 mm diameter	4	do	
12.	Coupling between flexible and rigid conduit			
	(*i*) 50 mm diameter	1	do	
	(*ii*) 31 mm diameter	1	do	
13.	Teak wood gutties	150	do	
14.	6 SWG GI bare wire	40	m (5 kg)	
15.	Iron screws 31 mm	100	nos	
16.	Earth wire clips	60	do	

S. No.	*Description of Material With Full Specifications*	*Quantity Required*	
		Quantity	*Unit*
17.	G I thimbles with bolts and nuts	27	do
18.	Caution plates	3	do
19.	Shock treatment chart	1	no
20.	Earthing sets	2	sets
21.	Civil Engineering works (lump-sum provision)		