

## **KERALA POWER SYSTEM AT A GLANCE (as on 31-3-2007)**

No. of Consumers	: 87,13,870
Maximum Demand	: 2742 MW
Per Capita Consumption	: 430 KWH
Installed (Generating) Capacity	: 2085.73 MW (Hydel + Thermal + Wind)
Power available	: 15844.95 MU
Generation of power	: 7745.78 MU
System loss	: 23.43%

## POWER PURCHASE 2006-07

Sl. No.	Source	Purchase (Mkwh)
1.	NTPC-RSTPS	2710.54
2.	NTPC-Kayamkulam	-74.66
3.	Talcher-II	3556.46
4.	NLC-Stage-I	327.46
5.	NLC-Stage-II	596.17
6.	NLC Expansion	509.83
7.	Maps	138.25
8.	Kaiga	279.10
9.	UI	-170.02
10.	Bses	183.01
11.	Kpcl	23.70
	<b>Total</b>	<b>8149.84</b>

## INSTALLED (GENERATING) CAPACITY AS ON 31-03-2006

Sl.	Name of Station	MW
1.	Pallivasal	37.50
2.	Poringalkuthu + PLB Extension	48.00
3.	Sengulam	48.00
4.	Neriamangalam	50.00
5.	Panniar	30.00
6.	Sholayar	54.00
7.	Sabarigiri	310.00
8.	Kuttiadi + Kuttiadi Extn	125.00
9.	Idukki (1 & 2)	780.00
10.	Idamalayar	75.00
11.	Kallada	15.00
12.	Lower Periar	180.00
13.	Kakkad	50.00
14.	Malampuzha 2.5 MW	2.50
15.	Peppara	3.00
16.	Maduppetty	2.00
17.	Chembukkadavu 1 & 11	6.45
18.	Urumi 1 & 11	6.15
19.	MSHEP Malankara	10.50
20.	Lower Meenumutty	1.50
21.	Wind-Kanjikode	2.03
22.	Brahmapuram DPP	106.60
23.	Kozhikode (Diesel)	128.00
24.	Lower Meenumutty	2.00
25.	Sabrigiri HEP (Capacity increase)	10.00
26.	R & M of Neriamangalam (Capacity increase)	2.50
	<b>Total</b>	<b>2085.73</b>

## Classification of Voltage [ IER 2(1) (a) ]

Low Voltage	(L V)	Upto 250 V
Medium Voltage	( M V)	Up to 650 V
High Voltage	(H V)	650 V & Upto 33KV
Extra high voltage	(EHV)	Above 33 KV
Ultra high voltage	(UHV)	Above 735 KV

### TARIFF REVISION ORDER - NOVEMBER 2007 Tariff Wef. 1 - 12 - 2007

ABSTRACT				
Category				Rate
LT- I(a)	0-40		Ps/Unit	115
	41-80		Ps/Unit	190
	81-120		Ps/Unit	240
	121-150		Ps/Unit	300
	151-200		Ps/Unit	365
	201-300		Ps/Unit	430
	301-500		Ps/Unit	530
	Above 500		Ps/Unit	545
	Tariff minimum payable other than during the period of disconnection	SinglePhase	Rs/month	30+2.50 Duty
	Tariff minimum payable during the period of disconnection	ThreePhase	Rs/month	170+12.30 Duty
Lt-I(b)	0-40		Ps/Unit	155
	41-80		Ps/Unit	240
	81-120		Ps/Unit	280
	121-150		Ps/Unit	345
	151-200		Ps/Unit	405
	201-300		Ps/Unit	505
	Above 300		Ps/Unit	630
	Tariff minimum payable other than during the period of disconnection	SinglePhase	Rs/month	40+3.00 Duty
	ThreePhase	Rs/month	205+17.00 Duty	

	Tariff minimum payable during the period of disconnection	SinglePhase ThreePhase	Rs/month Rs/month	40 80
LT-II	Fixed Charge Energy Charge		Rs/month Ps/Unit	1990 565
LT-III	Energy Charge or Daily Minimum		Ps/Unit Rs/KW	1200 120
LT-IV	Fixed Charge Energy Charge		R/KW Ps/Unit	45 325
LT-V	Fixed Charge Energy Charge		Rs/KW/month Ps/Unit	6 65
LT-VI(A)	Fixed Charge Energy Charge	Up to 500 Units Above 500 Units	Rs/KW/month Ps/Unit Ps/Unit	40 385 520
LT-VI(B)	Fixed Charge Energy Charge	Up to 500 Units Above 500 Units	Rs/KW/month Ps/Unit Ps/Unit	55 450 590
LT-VI (C)	Fixed Charge Energy Charge	Up to 500 Units Above 500 Units	Rs/KW/month Ps/Unit Ps/Unit	170 675 840
LT-VI (D)	Fixed Charge Energy Charge  Tariff Minimum Payable During the period of disconnection and non- disconnection.	SinglePhase Three phase	Ps/Unit  Rs/month Rs/month	NIL 85  15+1.00 Duty 25+2.00 Duty

LT-VII (A)	Fixed Charge	SinglePhase	Rs/KW/month	50
	Energy Charge	Three Phase	Rs/KW/month	100
		Up to 100 Units	Ps/Units	543
		Up to 200 Units	Ps/Units	605
		Up to 300 Units	Ps/Units	675
		Up to 500 Units	Ps/Units	730
	Above 500 Units	Ps/Units	805	
LT-VII (B)	Fixed Charge		Rs/month	30
	Energy Charge	Upto 100 Units	Ps/Units	330
		Above 100 Units	Ps/Units	520
LT-VII (C)	Fixed Charge		Rs/KW/month	80
	Energy Charge	Upto 1000 Units	Ps/Units	440
		Above 1000 Units	Ps/Units	590
LT-VIII	Fixed Charge		Rs/KW	50
HT-I	Demand Charge		Rs/KVA	270
	Energy Charge		Ps/Units	300
HT-II	Demand Charge		RS/KVA	300
	Energy Charge		Ps/Units	300
HT-III	Demand Charge		Rs/KVA	165
	Energy Charge		Ps/Units	130
HT-IV	Demand Charge		Rs/KVA	350
	Energy Charge		Ps/Units	370
EHT 66KV	Demand Charge		Rs/KVA	260
	Energy Charge		Ps/Units	290
EHT 110KV	Demand Charge		Rs/KVA	245
	Energy Charge		Ps/Units	290
Railway Traction	Demand Charge (KVA less than 0.5 shall be ignored and KVA equal to greater than 0.5 shall be rounded to the next higher value).		Rs/KVA	230
	Energy Charge		Ps/Units	225

## COMPOSITE TARIFF

Monthly Street Light Charge payable per Lamp if Lamp/Bulb, Holder, Condenser and Choke are supplied by the local Bodies free of cost for initial installation and periodical replacement

Types of lamp	Watts	Rs. Lamp / month Burning Hours per day		
		4 hours	6 hours	12 hours
Ordinary	25/40	22	23	27
Ordinary	60	28	29	34
Ordinary	100	30	33	41
Fluorescent Tube	40	32	33	38
Fluorescent Tube	2 x 40	36	40	48
Flood light	1000	94	123	213
Mercury Vapour Lamp	80	44	46	56
Mercury Vapour Lamp	125	47	56	71
Mercury Vapour Lamp	160	53	62	72
Mercury Vapour Lamp	250	64	75	102
Mercury Vapour Lamp	400	82	96	140
Sodium Vapour Lamp	70	42	45	53
Sodium Vapour Lamp	80	44	46	56
Sodium Vapour Lamp	100	45	48	59
Sodium Vapour Lamp	125	47	51	65
Sodium Vapour Lamp	150	52	58	74
Sodium Vapour Lamp	250	64	72	100
Mercury Vapour Lamp on semi-high mast only for 12 hours burning / day	3 x 400			755

Sodium Vapour Lamp on semi-high mast 12 hrs. burning/day	250			375
CFL/	1X11	17	18	20
	2X11	18	20	21
	4X11	21	22	27
Automatic ON/OFF CFL	1X18	18	18	20

## DIFFERENTIAL PRICING METHOD

Billing demand will be the highest of the following

Recorded maximum demand between

Normal Time (0600 hrs - 1800 hrs)

OR

Peak Time (1800 hrs - 2200 hrs)

OR

75% of the Contract Demand

OR

50 KVA

1. Demand Charge
  - (a) Normal Demand Charge      Normal Demand Charge + Time of use Charge-Incentive
  - (b) Time of use Charge      Billing Demand X Ruling Demand Charge/KVA
  - (c) Incentive      Demand during peak time in excess of 60% of the demand during normal time X Ruling Demand Charge KVA X 0.8 X 4/24.
  - (c) Incentive      Demand during off peak time in excess of 60% of the Demand during normal time (Upto 105% of the contract demand) X Ruling demand charge/KVA x 0.25 X 8/24.
2. Excess Demand Charge      Excess Billing demand X Demand charge/KVA X 0.5 (Only if the maximum recorded Demand during normal peak time exceeds the Contract Demand).
3. The recorded maximum demand during off peak hours in excess of 120% of the Contract Demand (as against Contract demand), shall be charged at the normal rates we are giving incentive upto 120% of the Contract demand during such period. This will be applicable only when the recorded maximum demand during off peak hours exceeds billing demand.



4	Abstract estimate for LT three phase weather proof service connection above 25kW & below 50kVA	21000	<p>If Energy meter is provided by Board meter rent of Rs. 75/- per month to be collected extra.</p> <p>Cost of providing weatherproof Service connection to be collected as per Serial No: 1 to 4</p>
5	Abstract estimate for LT single phase over head service connection 1 Post	6200	
6	Abstract estimate for LT single phase over head service connection 2post	9900	
7	Abstract estimate for LT single phase over head service connection 3 Posts	14000	
8	Abstract estimate for LT single phase over head service connection 4 Posts	22100	
9	Abstract estimate for LT single phase over head service connection 5 Posts	27000	
10	Abstract estimate for LT three phase over head service connection 1 Post	14000	
11	Abstract estimate for LT three phase over head service connection 2 Post	25100	
12	Abstract estimate for overhead portion of LT three phase over head service connection 3 Posts	33300	
13	Abstract estimate for overhead portion of LT three phase over head service connection 4 Posts	47600	
14	Abstract estimate for overhead portion of LT three phase over head service connection 5 Posts	58600	
15	Abstract estimate for conversion of LT single phase weatherproof service connection with load upto 5kW to three phase weather proof service connection with load upto 10kW	1700	
16	Abstract estimate for conversion of LT single phase weatherproof service connection with load upto 5kW to three phase weather proof service connection with load 10 to 15kW	6300	
17	Abstract estimate for conversion of LT single phase weatherproof service connection with load upto 5kW to three phase weather proof service connection with load 15 to 25kW	13400	

18	Abstract estimate for conversion of LT single phase weatherproof service connection with load upto 5kW to three phase weather proof service connection with load 25kW to 50kVA	19500	
19	Estimate for LT UG cable service excluding cost of energy meter weatherproof wire & GI wire		Plus Supervision charges for cable laying @ Rs. 18/- meter or part of subject to a minimum of Rs. 300 per service
	(i) Single Phase	1200	
	(ii) Three Phase (up to 10 KW)	1700	
	(iii) Three Phase (between 10 KW and 25 KW)	3900	
	(iv) Three Phase (between 25 KW and 50 KVA)	7100	

## II. DISTRIBUTION LINES

1	Dismantling, shifting and re-erecting one LT pole with or without stays, Single Phase Overhead lines, of ACSR Weasel all accessories and fittings	932
2	Dismantling, shifting and re-erecting one LT pole with or without stays, Single Phase Overhead lines, of ACSR Rabbit all accessories and fittings	979
3	Dismantling, shifting and re-erecting one LT pole with or without stays, Three Phase Overhead lines, of ACSR Weasel all accessories and fittings	1149
4	Dismantling, shifting and re-erecting one LT pole with or without stays, Three Phase Overhead lines, of ACSR Rabbit all accessories and fittings	1291
5	Dismantling, shifting and re-erecting one 11KV pole with or without stays, 11KV Overhead lines, all accessories and fittings	2026
6	Dismantling, shifting and re-erecting one 11KV double pole with or without stays, 11KV Overhead lines, all accessories and fittings	4627
7	Adding one conductor ACSR Weasel on the existing poles (where cross arm is available) inclusive of cost of insulator, pin etc. and labour	38 per metre
8	Adding one conductor ACSR Rabbit on the existing poles (where cross arm is available) inclusive of cost of insulator, pin etc. and labour	66 per metre

9	Adding one conductor ACSR Weasel on the existing poles (where cross arm is not available) inclusive of cost of insulator, pin etc. and labour	48 per metre
10	Adding one conductor ACSR Rabbit on the existing poles (where cross arm is not available) inclusive of cost of insulator pin etc. and labour	77 per metre
11	Conversion of LT single phase 2 wire line to LT Three phase 4 wire line	112 per metre
12	Conversion of LT single phase 2 wire line to LT Three phase 5 wire line	147 per metre
13	Conversion of LT single phase 3 wire line to LT Three phase 5 wire line	111 per metre
14	Drawing Single Phase 2 wire line under existing HT line	91 per metre
15	Drawing Single Phase 3 wire line under existing HT line	121 per metre
16	Drawing Three Phase 4 wire line under existing HT line	239 per metre
17	Drawing Three Phase 5 wire line under existing HT line	269 per metre
18	Construction of LT, single phase ,2 wire line using PSC Poles	153 per metre
19	Construction of LT, single phase ,3 wire line using PSC Poles	191 per metre
20	Construction of LT, 3 phase ,4 wire line using PSC Poles	310 per metre
21	Construction of LT, 3 phase ,5 wire line using PSC Poles	335 per metre
22	Construction of 11KV ACSR RACOON using PSC Poles	409 per metre
<b>III</b>	<b>TRANSFORMERS</b>	
1	Erection of 11KV/433V, 25 KVA transformer pole mounted including 2 Nos PSC Poles	84410
2	Erection of 11KV/433V, 100 KVA transformer pole mounted including 2 Nos PSC Poles	146000
3	Installation of 11KV/433V, 160 KVA transformer	200000
4	Installation of 11KV/433V, 250 KVA transformer	248000
5	Installation of 11KV/433V, 500 KVA transformer	322000
<b>IV</b>	<b>STREET LIGHTS</b>	
1	Installation of double tube fittings	1600
2	Installation of street light complete with fitting, clamp, weather proof wire, fuse, DC reflector, bracket, nipple and holder but without lamp	924

Note: Estimated rates are calculated for 3 phase, with ACSR Rabbit for phase conductor and ACSR Weasel for neutral and street main; for single phase, ACSR Weasel for phase, neutral and street main.

For Overhead service line connection provision for strut is to be included wherever necessary

## SERVICE CONNECTION CHARGES FROM 09-09-1997

Category	Group	Amount Rs
Low Tension		
a. Single phase Domestic, Libraries & Reading rooms recognized by K.G.S., Sports / Arts Club with C/L below 2000W	upto 30 units 31 to 65 units 66 to 100 units above 100 units	Exempted 300.00 525.00 750.00
b. 3Phase	upto 10 KW above 10 KW	1500.00 200/KW in excess of 10KW
c. Temporary connection, Festivals & Fairs		Exempted
d. Agricultural	both HT & LT	Exempted
e. LT VIIB		Exempted
f. *Orphanages recognised by Govt.		Exempted
g. New domestic connection/ conversion of SP to 3 phase of serving/retired employees of KSE Board		Exempted
h. * Telephone booths run by physically handicapped persons		Exempted
i. Industrial	LT having SSI regn., C/L below 50 KVA & OH Length does not exceed 500m C/L upto 5KW C/L above 5 KW	Exempted  115/KW or part 225/KW or part
j. Non Domestic	VIA, VIB, VIC Single or 3 phase	200/KW or part
k. Commercial	VII (A,C) Single LT VII C includes Sports & Arts Club above 2000W) upto 10 KW above 10 KW	750.00  2250.00 4500.00

I. Commercial small shops & bunks below 1000W above 1000W charge applicable to VII A	VII B	Exempted
i. HT other than agriculture (Subjected to minimum)		450/KW Rs. 50000.00
j. EHT		Rs. 450/KW

\* AS per B.O., 2004/97 (Plng: Com. 3482/97 dated 9-9-97.

## UNDERGROUND CABLE CONNECTIONS (11KV)

### B.O. No. 2110/2000 (Plg. Com.4073/200)

### Thiruvananthapuram dt. 23.08.2000

1. The U.G. Cable can be provided at the cost of the consumer
2. The Cable shall conform to ISS 70 98.
3. The laying and end terminals at the consumer's cost.
4. The maintenance and replacement of defective cable and end terminals shall be done at the consumer's cost. The KSE Board will not be responsible for delay in restoration of supply due to above.
5. The departmental and development charge based on estimate will be collected by the Board.
6. Service connection charge and security deposit shall be connected.
7. A separate clause incorporating all conditions shall be included in the HT agreement.

<b>Processing Fees</b>	
I. Processing Fee to be collected in advance for according sanction for installation of Generator.	
Category	Rate
Upto 5 KVA	Rs. 100
Upto 10 KVA	Rs. 500
Above 10 KVA upto 50 KVA	Rs. 1000
Above 50 KVA upto 100KVA	Rs. 2000
Above 100 KVA	Rs. 3000

**II. Processing Fee to be collected in advance from the prospective consumer for power allocation.**

<b>Category</b>	<b>Rate</b>
Power Allocation for 10 KVA to 50 KVA	Rs. 100
Power Allocation for 51 KVA to 150 KVA	Rs. 500
Power Allocation for 151 to 1000 KVA	Rs. 5000
Power Allocation for 1001 to 6000 KVA	Rs. 10,000
Above 6000 KVA (EHT Power Allocation)	Rs. 15,000

### **ENERGY METER. RENTAL CHARGES**

<b>Sl. No</b>	<b>Description</b>	<b>Rate Rs. per rate month of part there of</b>
1.	For Service connection provided with single phase meter	10/-
2.	For 3 phase meters	20/-
3.	For 3 phase CT meters	75/-

### **PART II**

#### **SCHEDULE OF SERVICE AND MISCELLANEOUS CHARGES**

<b>1. Application Fee:</b>	<b>Rs:</b>
(a) Service connection	50.00
(b) Power Allocation	
1. L.T	10.00
2. H.T	100.00
3. E.H.T	500.00
(c) Line Extension	10.00
(d) Realignment of lines, shifting of posts etc., for individual benefits	10.00
(e) Hire & Hire Purchase of Materials	10.00

Note : 1. Application for Voltage Improvement and mass petition for line extension are exempted from Application Fee  
 2. A petition signed by four or more petitioners shall be considered as a mass petition.

<b>II. Rental charges vide para 19:</b>		
	SinglePhase Ps./Mt.	Three phase Ps./Mt.
Monthly rental charges :		
1. Overhead service line beyond weather proof service (35 Meter clear span)	10	70
2. Insertion of Post	Rs./Post 1.00	Rs./Post 1.00
<b>III. Reconnection Fee :</b>		
Leviable only if there is physical disconnection of service. Interest for belated payment is leviable only if the consumer fails to pay the amount on or before the due date fixed.		
<b>(a) Consumer's under Tariff/LT</b>		
1. When the supply to installation remains disconnected for a Rs. 30/- less than six months for non-payment of electricity charges		
2. When the period of above disconnection exceeds six months for non-payment of electricity charges or at the request of the consumer or when the disconnection is effected due to faults in the installation or due to non-compliance with the Rs. 100/- provisions in the Conditions of Supply of Electrical Energy, even if the period of disconnection is less than six months (inclusive of testing fee.)		
<b>(b) H.T/E.H.T</b>	H.T Rs	E.H.T Rs
1. When the supply to the installation remains disconnected for non-payment of electricity charges for a period not exceeding six months	250.00	500.00

2. Period of disconnection due to default in payment or at the request of the consumer for a period not exceeding six months (including Testing Fee)	350.00	750.00
3. The supply to the installation is disconnected due to fault of installation or due to the failure on the part of the consumer to comply with the provision of the Conditions of Supply of Electrical Energy (including Testing Fee)	500.00	1000.00
<b>IV Testing Fee :</b>		
<b>(a) The first test and inspection of a new installation shall be carried out free of charge</b>		
If any further test and or inspection becomes necessary owing to any fault in the installation or to non-compliance with the Conditions of Supply or for testing for extensions, the charges payable in advance for each additional test and or inspection shall be	LT Single Phase LT Three Phase HT E.H.T	25.00 50.00 200.00 500.00
<b>(b) Periodical testing at consumer's request per test for meters</b>		<b>Rs.</b>
(i) Single Phase Meter		50.00
(ii) Poly Phase Meter (without CT)		100.00
(iii) TOD Meter		400.00
(iv) CT/PT Unit or CT Unit/PT Unit separately		250.00
<b>(c) Transformer Oil</b> First Sample of Oil		<b>Rs.</b> 80.00 Per Sample
<b>V. Miscellaneous Charges</b>		
(a) Changing or Moving a meter board		Actuals + centage charge

# TENDER FOR WORKS/SUPPLIES

## 1. Cost of Tender forms.

(B.O. No. 2873/99 (TC2(B) 1179/99/24. 12.99s)

Probable Amount of contract (PAC) Rs	Cost of Tender Form Original Copy Rs	Addl. Copy Rs.
Upto 50,000	150+ST @ 4%	100 + ST @ 4%
50001 - Upto 6 lakhs	400 + ST	200 + ST
Above 6-15 lakhs	700 + ST	400 + ST
Above 15-50 lakhs	1000 + ST	500 + ST
Above 50-100 lakhs	2000 + ST	1000 + ST
Above 100 lakhs	3000 + ST	1500 + ST

## II Publication of Tender/Quotation notice - Norms to be adopted

**BO (FB) No. 169/2005 (T.A. 32)/Advt. 2004-05 dt 13-1-05**

Sl. No.	PAC	Mode of publicity
I.	For work/supply costing PAC upto and including Rs. 1,50,000/- which are earmarked for petty contractors in Distribution Divisions and for works costing upto Rs. 1,50,000/- in Transmission and Generation Wing.	No Publication in the dailies. Notices on the Notice Board in the O/o the Assistant Engineer, Asst. Executive Engineer, Exe. Engineer of KSE Board and Panchayat & Village Office with notices to the registered petty contractors.
II.	-do from Rs. 1,50,000/- to Rs. 10,00,000/-	One Malayalam Daily having wide circulation in the District & KSEB website, Government website.
III.	-do from Rs. 10,00,000/- to Rs. 50,00,000/-	Two Malayalam dailies, one having wide circulation in the State and another in the district & KSEB website, Government website.
IV.	Above Rs. 50,00,001/- and supplies	Two Malayalam dailies having wide circulation in the State and one English daily in the country & KSEB website, Government website.

- b. To delegate the powers to publish tender notices/advertisements as given below

Sl. No.	Nature of work	Name of Officer
I.	Works and supplies of above Rs. 1,50,001/- to Rs. 10 lakh (upto Rs. 1,50,000/- no publication in dailies	Deputy Chief Engineer, Circle office concerned. Advertisements shall be published after clustering the same on weekly basis. The advertisements shall be released in windowns of size 3 x 2 columns as per Government order No. 01/04/I&PR dated 02.01.2004. Separate windowns shall be provided for each work/supply under each Circle/Division/Sub Division.

- c. To publish the advertisement as per alphabetic order priority of the newspaper.
- d. Rules for publishing tender notices for sale of scrap items, special work and for works and supplies above Rs. 10.00,000/- will continue as existing now.
- e. Deputy Chief Engineers giving the advertisement are authorized for making payment of advertisement charges at lowest commercial rates (LCR) approved by the Board.

## EARTHING

### 1. Earth Resistance

Earth resistance in ohms (max.)

(a) Large Power Station	0.5
(b) Major substations	1.0
(c) Small substations	2.0
(d) Distribution line	10.0
(e) Tower footing resistance	10.0

### 2. Size of Copper conductor for Earth

(Max. Earth fault current is caused when a single phase to earth fault occurs)

$$I = \frac{\text{Fault MVA}}{\sqrt{3} \times \text{Voltage}}$$

$$\begin{aligned} \text{Cross sectional Area of Copper in mm}^2 &= 0.054 I \sqrt{t} \text{ for rivetted joint} \\ &= 0.0044 I \sqrt{t} \text{ for braced joint} \end{aligned}$$

- I- max fault current in Amps  
(Highest among the current at different Voltage level)
- t - Duration of current flow in seconds (3 to 5)

### 3. Plate Earthing

- (a) Large Power stations and major substations                      120 x 120 x 1.25 cm cast iron plates
- (b) Small stations    60 x 60 x 0.94 cm cast iron plates.  
60 x 60 x 0.315 cm copper plates  
60 x 60 x 0.63 cm steel plates

*Plates to be buried vertically in pits and surrounded by finely divided coke, crushed coal or charcoal at least 15 cm all round the plates. Plates should not be less than 8 m apart and should be buried at sufficient depth to ensure that they are always surrounded by moist earth*

### 4. Pipe Earthing

- (a) Large Power stations and major sub stations                      Cast iron pipes 15.2 cm dia  
3.048 m long and  
not less than 1.27 cm thick.
- (b) Small sub stations    GI pipes 5.08 cm in dia and  
3.048 m long.

*Pipes to be placed vertically at intervals of not less than 12.2 m in large stations and 1.83 m in the case of small stations.*

### 5. Earth connections

- (a) Main and subsidiary earth connections                      Cross section not less than 161 mm<sup>2</sup>
- (b) Branch connections    Cross section not less than 64.5 mm<sup>2</sup>

### 6. Measuring of Earth resistivity

(Wenner's four electrode method) Earth resistivity in ohm meters

- r                      =    2 p S R
- S                      =    distance between successive electrode in meters the  
(20 times the depth of burial of the electrode)
- R                      =    Earth megger reading ohms.

## 7. Range of Soil Resistivity

Soil condition	Resistivity in W
Severely Corrosive	0.25
Moderately Corrosive	25 - 50
Mildly Corrosive	50 - 100
Very Mildly Corrosive	Above 100

## 8. Maximum permissible current density at an earth electrode

$$I_d = 7.75 \times 10^3$$

r t

r = Earth resistivity in W

t = duration of fault current in seconds.

## 9. Current density

(Bare conductor with no risk of fire 3 second rating)

Copper	-	118 A/mm <sup>2</sup>
Aluminium	-	73 A/mm <sup>2</sup>
Steel (GI)	-	46 A / mm <sup>2</sup>

## 10. Electrode Resistance

(i) Plate =  $(r/4)$  ohms

(ii) Pipe or Rod =  $(100r/2\pi l) \log_e (41/d)$  ohms

(iii) Strip or Conductor =  $(100r/2\pi l) \log_e (2l^2/wt)$  ohms

Where

r = earth resistivity in W m

A = Area of Plate in m<sup>2</sup>

l = length in cm

d = dia of Pipe or rod in cm

w = depth of burial of strip electrode in cm

t = w = width of strip or twice the dia of circular conductor in cm

## STATUTORY CLEARANCE - OH LINES

Voltage level	Above Ground				From Buildings		Between Conductors
	Across any Street	Along any Street	Other Areas		Vertical	Horizontal	
			Bare	Insulated			
	M	M	M	M	M	M	
230 & 400 V	5.791	5.486	4.572	3.963	2.439	1.219	1.219
11 KV	6.096	5.791	4.572	3.963	3.658	1.219	1.829
22 KV & 33 KV	6.096	5.791	5.182	-	3.658	1.829	2.439
66 KV	6.096	6.096	6.096	-	3.963	2.134	3.048
110 KV	6.402	6.402	6.402	-	4.573	2.744	3.048
220 KV	7.012	7.012	7.012	-	5.488	3.659	3.048
400 KV	8.841	8.841	8.841	-	7.622	5.793	3.048

For EHV lines, the clearance above ground, shall not be less than 5.182 metre plus 0.305 metre for every 33 KV or part there of by which the voltage of the line exceeds 33KV. Provided that the minimum clearance along or across any street shall not be less than 6.096 metres.

### Safety working clearance in out-door substation

Highest System Voltage (KV)	Safety Working Clearance (Metres)
12	2.6
36	2.8
72.5	3.1
145	3.7
245	4.3
420	6.4
800	10.3

Clearance applicable for elevations up to 1000 M

Minimum Clearance between OH lines crossing each other (in metres)						
Sl.	Voltage	11-66KV	110-132KV	220KV	400KV	800KV
1.	Low & Medium	2.44	3.05	4.58	5.49	7.94
2.	11-66 KV	2.44	3.05	4.58	5.49	7.94
3.	110 - 132 KV	3.05	3.05	4.58	5.49	7.94
4.	220 KV	4.58	4.58	4.58	5.49	7.94
5.	400 KV	5.49	5.49	5.49	5.49	7.94
6.	800 KV	7.94	7.94	7.94	7.94	7.94

## Clearance between OH power lines and Railway tracks/structures

Voltage	Broad Gauge		Metre & Narrow Gauge		Min Clearance between conductors and any Railway structure
	Inside station area	Outside station area	Inside station area	Outside station area	
	m	m	m	m	
Upto and including 11 KV	10.0	7.6	8.6	6.3	2.90
Above 11 KV including 33 KV	10.0	7.6	8.8	6.4	2.90
Above 33 Kv Including 66KV	10.3	7.9	9.1	6.7	3.20
Above 66 KV including 110 KV	10.6	8.2	9.5	7.0	3.51
For 220 KV	11.2	8.8	10.0	7.6	4.11
For 400 KV	13.14	10.97	12.19	9.76	6.25

## RIGHT OF WAY CLEARANCE

EHT line KV	Recommended width of right of way (m)	Min. Clearance between conductors and trees. (m)
33 & 11		
66	18	3.4
110	22	3.7
220	35	4.6
400	52	5.5

Note:- R-O-W clearance are same for plains and forest areas as per Forest (Conservation) Act 1980

### Clearance over Rivers

Minimum 3.048 m over the highest flood level for river which are not navigable. For navigable rivers clearance to be fixed in relation to the tallest mast in consultation with the navigational authorities.

### Clearance from supporting structure for another line

- (a) Low or medium voltage lines : 1.219 m
- (b) High voltage lines : 1.829 m
- (c) EHV lines : 2.744 m

### Vertical clearance between lines and guard wires

- (a) L.T. : 1.219 m
- (b) Voltage up to 66 KV : 1.219 m
- (c) For 110 KV : 1.829 m

- Note : -
- (i) Every guard wire shall be securely bound to earth at each point where its electrical continuity is broken.
  - (ii) Guard wire shall have an actual breaking load of not less than 635 kg and shall be galvanised.
  - (iii) The earth resistance should not exceed 10 ohms

## ACRONYMS

PCC	Power Control Center	SMC	Sheet Moulded Compound
PDB	Power Distribution Board	SSB	Sub Switch Board
PE	Protective Earthing	SWG	Standard Wire Gauge
PF	Power Factor	THP	Total Harmonic Distortion
PI	Polarisation Index	TMS	Time Multiplier Setting
PLC	Programmable Logic Control	TOD	Time of Day
PMCC	Power & Motor Control Center	TRC	Tariff Regulatory Commission
PT	Potential Transformer	UG	Under Ground
PVC	Poly Vinyl Chloride	UPS	Uninterrupted Power Supply
RCCB	Residual Current Circuit Breaker	USS	Unitised Sub-station
REF	Restricted Earth Fault	VA	Voltage Ampere
RF	Radio Frequency	VCB	Vacuum Circuit Breaker
RTD	Resistance Temperature Device	VWF	Variable Voltage Variable Frequency
SDF	Switch Disconnect Fuse	WTI	Winding Temperature Indicator
SEC	Specific Energy Consumption	CLPE	Cross Linked Polyethylene
SHF/SF6	Super Hexa Fluoride		

## ACSR CONDUCTORS

Code Name	A1	Steel		Overall dia		Nominal A1 - area mm <sup>2</sup>	Current ratings above ambient Amps	UTS in KN	Weight kgs/km
	No.	dia	No	dia (mm)	mm				
Mink	6	3.66	1	3.66	10.9	63.06	167	22.05	255
Dog	6	4.72	7	1.57	14.1	105.2	254	33.1	394
Tiger	30	2.36	7	2.36	16.5	131.50	296	57.9	604
Wolf	30	2.59	7	2.59	18.1	158.10	343	68.75	727
Lynx	30	2.79	7	2.79	19.5	183.90	385	79.45	844
Panther	30	3.00	7	3.00	21.0	211.70	427	90.95	976
Kundah	42	3.49	7	1.94	26.7	402.90	726	95.50	1277
Finch	54	3.64	19	2.18	32.8	564.00	1000	182.3	2129
Moose	54	3.53	7	3.53	31.7	528.50	1000	164.3	2004

## DISC INSULATORS FOR EHT LINES

Voltage (KV)	Normal Suspension		Normal Tension	
	No. of Discs	UTS (KN)	No. of Discs	UTS (KN)
66	5	45	6	50
110	7	70	8	70
220	14	90	15	120
400	23	115	2 x 23	165

## DISTANCE OF DAMPERS FROM SUPPORTS

Conductor	Distance from point of support	
	First Dampers ('p'cms)	Second damper ('p'cms)
Mink	61	122
Dog	84	168
Tiger	99	198
Wolf	107	213
Lynx/Panther	114	229
Kundah	137	279

## ARCING HORN GAPS

Tower	Arcing Horn gap in mm for Voltage		
	66KV	110KV	220KV
Yard strain gantry	432	686	1200
Terminal Tower	381	635	1150
Second Tower	407	661	1200
Third Tower	432	686	1225
Fourth Tower	456	712	1250
Other Towers	700	965	1840

## CURRENT RATING OF 11 KV CABLES XLPE Cables (Aluminium Conductors)

Normal area of Conductors in mm <sup>2</sup>	Current rating (Amps)			
	Three - Core Cables		Single - Core Cables	
	In Ground	In Air	In Ground	In Air
50	125	135	140	175
70	155	170	170	215
95	155	205	205	255
120	210	240	230	300
150	235	275	260	335
240	305	375	330	460
300	345	425	370	520
400	380	485	425	615

## PVC Cable

No. Cores and cross Secional Area mm <sup>2</sup>	Approx. overall dia mm	Approx. netwt. of Cables kg/km	Max.d.c. resistance at 20°C	Current Ratings	
				In ground Amps (max)	In Air Amps (Max)
3x25	43.0	2400	1.102	70	69
3x35	45.0	2500	0.8846	83	82
3x50	44.5	2380	0.6143	98	100
3 x 70	46.1	2800	0.4068	120	125
3x95	48.4	3080	0.3262	145	150
3x120	50.9	3510	0.2471	160	170
3x150	52.6	3830	0.2090	185	195
3x185	59.1	5000	0.1337	225	245
3x240	62.6	5430	0.1155	235	255

## Distribution Transformers

KVA	Full Load		Minimum size of LT cable mm <sup>2</sup>	Total wt. (kg)	Qty. of Oil (Litres)	Neutral Earthing conductor (Cu)
	HT (Amps)	LT (Amps)				
63*	3.3	84	70	470	140	25x3mm
100	5.25	133.3	95	645	205	25x3mm
160	8.40	213.3	185	935	255	25x3mm
200	10.49	266.7	300	1065	280	25x3mm
250	13.12	333.3	2x185	1190	345	25x3mm
400*	21	533.3	3x300	1840	390	38x3mm
500	26.2	666.6	3x400	1960	430	25x6mm
630	33	840.0	4x400	2450	600	31x6mm
750	39.36	1000.0	-	2815	645	31x6mm
800	42.00	1067.0	-	2925	660	
1000	52.50	1333.0	-	3270	725	
1250	65.60	1666.5	-	4730	850	

\*63-250 KVA aluminium Winding \*\* 400-1250 Copper Winding

## L T leads and Fuses for Distribution Transformers

Transformer Capacity (KVA) units	Full load Amps		Fuse Wire SWG		Size of SC Aluminium LT cable (mm)	Size of G.I Pipe to be used (Amps)	Size of fuse Units
	11KV	433V	11 KV	433V (Sq.mm)			
25	1.31	33.4	3	21	25		100
50	2.62	66.7	33	18	50	50	100
				or			
63	3.32	84.5	33	2 of 20	95	-	200
100	5.25	133.5	32	2 of 18	185	75	200
				or			
200	10.50	267.0	26	2 of 16	2 Circuits	2 of 75	2x200 each
				2 of 15			

## Size of Earth Leads (Transformer Neutral Point Earthing)

Transformer rating KVA	Electrolytic bare copper conductor or strip	Insulated (PVC) Single core stranded Aluminium	Galvanised Iron Conductor or strip
50 & below	8 SWG	16 Sq. mm	25 mm x 3mm
75	8 SWG	25 Sq. mm	40 mm x 6mm
100	4 SWG	35 Sq. mm	40 mm x 6mm
150	2 SWG	70 Sq. mm	40 mm x 6 mm
200	25 mm x 1.5 mm	95 Sq. mm	40 mm x 6 mm
250	25 mm x 1.3 mm	150 Sq. mm	40 mm x 6 mm
300	25 mm x 6 mm	300 Sq. mm	40 mm x 6 mm
500	25 mm x 6 mm	300 Sq. mm	40 mm x 6 mm
750	25 mm x 6 mm	300 Sq. mm	40 mm x 6 mm

Note :

Above 500 KVA only copper/aluminium strips to be used

Above 750 KVA size of earth lead to be determined as per IS: 166/1967

### Standard size of cables and earthing conductors

#### (i) Generators

Generator capacity in KVA	Cable size (mm <sup>2</sup> ) PVC/APVC	Earthing Conductor
15	10	10 SWG
63	50	4 SWG
100	95	2/25 x 3
160	185	25 x 3
200	2 x 120	25 x 3
250	2 x 185	25 x 3
400	2 x 400 / 3 x 300	25 x 3
500	3 x 400 / 4 x 300	25 x 3

## (ii) Motors

Motor rating HP	Back up fuse		Aluminium Cable size mm <sup>2</sup>	Earthing Conductor	
	DOL Starting	Assisted Starting		CU	Aluminium mm <sup>2</sup>
Upto 5	25	25	4	10SWG	25
6 to 10	35	25	6	10SWG	25
11 to 17.5	50	35	10	10SWG	25
18 to 20	63	53	16	10SWG	25
21 to 25	80	63	25	10SWG	25
26 to 30	100	65	26	6SWG	25
31 to 40	120	100	35	6SWG	25
41 to 50	160	100	50	6SWG	25
51 to 60	200	120	70	4SWG	25
61 to 75	200	120	95	4SWG	25
76 to 100	250	200	185	2 SWG	25

### Assumptions

1. Cut-off value of the back up HRC Fuses is taken for deciding size of earthing conductors of motors
2. Short time rating of cable suggested are based upon the cut-off value of the back up HRC Fuses
3. Overload protection of the cables suggested for motor is supposed to be offered by over load relays in the motor starters.
4. Values given above are for length within 75 to 100m. If more, voltage drop to be taken into account and suitable size to be chosen.

### Fuse Ratings

#### (i) Domestic Services

Load in Watts	T.C Wires SWG	Fuse rating Amps	Fusing current Amps
500	39	2.5	4
1000	35	5.0	8
1500	32	7.0	11
2000	29	10.0	16
2500	28	12.0	18
3000	27	13.0	23
4000	23	20.0	38

**(ii) \*Three - Phase AC Motors**

**Maximum Permissible rating in KW**

Rated current of fuses Amps	Direct-on-line started squirrel-cage, motors Starting current = 6 x rated current; (Starting period 5 sec)		Slip-ring motors and star-delta started squirrel-cage motors Starting current = 2 x rated current; (Starting period - 15 sec)	
	220	380 V	220 V	380 V
2	0.17	0.3	0.43	0.75
4	0.42	0.72	1	1.7
6	0.63	1.1	1.55	2.7
10	1.25	2.2	2.6	4.5
20	2.7	4.8	5.5	9.5
36	5.1	8.7	10	17.5
50	7.5	13	14.5	25
63	9.5	16.5	18	31
80	15	25	24	41
100	16.5	34	31	53
160	32	55	49	85
200	38	65	62	107
250	57	99	81	140
300	105	180	132	225
500	129	225	155	

**LT Capacitors**

Transformer rating	Load KVAR for switching ON capacitor bank	Load KVAR for switching OFF capacitor bank
25 KVA One step (9 KVAR)	13	10
63 KVA 1st step (9KVAR)	13	10
2nd step (9KVAR)	22	19
3rd step (9KVAR)	31	28
100 KVA		

1st step (9KVAR)	13	10
2nd step (9KVAR)	22	19
3rd step (9KVAR)	31	28
4th step (9KVAR)	40	37

**Recommended Capacitors for P.F. Improvements.  
(i) Induction Motors (LT)**

Sl. No.	Total Motor Rating HP				KVAR insisted
1	Upto	3			1
2	Above	3	Upto	5	2
3	Above	5	Upto	7.5	3
4	Above	7.5	Upto	10	4
5	Above	10	Upto	15	5
6	Above	15	Upto	20	6
7	Above	20	Upto	25	7.5
8	Above	25	Upto	30	10
9	Above	30	Upto	40	12
10	Above	40	Upto	50	14
11	Above	50	Upto	60	18
12	Above	60	Upto	80	22
13	Above	80	Upto	100	25
14	Above	100	Upto	130	35

**(ii) Welding Transformer (LT)**

Sl. No.	Rating In KVA				KVAR insisted
1.				1	1
2				2 & 3	2
3				4	3
4.				5 & 6	4
5.				7	5
6.				8	6
7.				9 & 10	7.5

8.				11	8
9.				12	9
10.				13 & 14	10
11.				15	11
12.				16	12
13.				17 & 18	13
14.				19	14
15.				20	15
16.	Above	20	Upto	22	16
17.	Above	22	Upto	24	17.5
18.	Above	24	Upto	26	18
19.	Above	26	Upto	28	20
20.	Above	28	Upto	30	21
21.	Above	30	Upto	35	24
22.	Above	35	Upto	40	27.5
23.	Above	40	Upto	45	32.5
24.	Above	45	Upto	50	35

### VOLTAGE REGULATION CALCULATION

The voltage regulation on HT lines and LT lines can be calculated using moment method. Compute the moments on the particular line with reference to the feeding point or tapping point KVA KM

$$\text{Voltage regulation (Percent)} = \frac{\text{KVA KM} \times \text{RC}}{\text{DF} \times 100}$$

Where RC is the regulation constant as per the tables given below

DF is the Diversity factor ( to be assumed based upon field conditions)

#### Regulation Constants

**Case 1 (a) HT (11KV) line with conductor spacing 1.5 M (RC per 100 KVA km)**

Power Factor	Conductor size (ACSR)			
	Mink 6/1/3.66	Rabbit 6/1/3.35	Weasel 6/1/2.59	Squirrel 6/1/2.11
Unity	0.0405	0.0482	0.0808	0.1219
0.9	0.0499	0.0571	0.0869	0.1244
0.8	0.0509	0.0574	0.0841	0.1178
0.7	0.0504	0.0561	0.0798	0.1094

**Case (b) HT (11 KV) Line with conductor spacing 0. 912 (RC per 100 KVA km)**

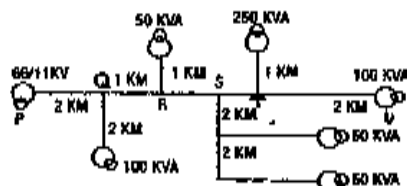
Power Factor	Conductor size (ACSR)			
	Mink 6/1/3.66	Rabbit 5/1/3.35	Weasel 6/1/2.59	Squirrel 6/1/2.11
Unity	0.0405	0.0492	0.0808	0.1219
0.9	0.0488	0.0559	0.0858	0.1233
0.8	0.0494	0.0558	0.0827	0.1162
0.7	0.0485	0.0543	0.0760	0.1072

Case2. LT 3 Phase(415 V) line with conductor spacing 0. 438 M (RC per KVA km)

$$\text{Regulation} = \frac{\text{KVA km} \times \text{RC}}{\text{DF}}$$

Power Factor	Conductor Size (AAC)					
	7/3.91	7/3.66	7/3.4	7/3.1	7/2.79	7/2.21
Unit	0.2129	0.2438	0.2813	0.3393	0.4172	0.6672
0.9	0.2654	0.2940	0.3291	0.3923	0.4547	0.6833
0.8	0.2718	0.2979	0.3296	0.3780	0.4427	0.6478
0.7	0.2699	0.2931	0.3214	0.3644	0.4217	0.6027

**A Sample Calculation for 11 KV Line**



Total load on the line = 600KVA

Total KVA-KM

Portion PQ = 600 x 2 = 1200

Portion QR = 500 x 1 = 500

Portion RS = 450 x 2 = 900

Portion ST = 350 x 2 = 700

Portion TU = 100 x 2 = 200

Total 3500

Considering the P.F. as 0.8 and conductor size 6/1/2.11 then Regulation constant as per table is 0.1178

$$\text{Voltage regulation of the line at fag end} = \frac{3500 \times 0.1178}{2.5 \times 100} = 1.65\%$$

(assuming Diversity Factor 2.5)

Allowable Voltage Regulation

(a) HT: +6 % or - 9 %

(b) LT: - 6 %

## FAULT LEVEL CALCULATION

Equations:

1. System % impedance =  $\frac{\text{Base MVA} \times 100}{\text{Fault MVA}}$
2. Fault MVA =  $\frac{\text{Base MVA} \times 100}{\text{Total \% Impedance upto the point}}$
3. % impedance at Base MVA =  $\frac{\% \text{ Imp. at rated MVA} \times \text{Base MVA}}{\text{Rated MVA}}$
4. % Line Reactance =  $\frac{\text{Line reactance} \times \text{Base MVA} \times 100}{\text{KV}^2}$
5. Inductance of the line for Equilateral spacing =  $(2 \log D/r + 0.4) 101 \text{ l/m}$   
where D-spacing between conductor  
r radius of conductor

### *Typical Example on Fault Level Calculation*

#### 110/11 KV substation

110/11 KV Transformers 2 Nos. Capacity 12.5 MVA, % Impedance 9.7 Fault level at 110 KV Bus: 1070 MVA (From KSEB fault Study)

Take Base MVA as 100

$$\begin{aligned} \text{System \% Impedance (Source Impedance)} &= \frac{\text{Base MVA} \times 100}{\text{Fault MVA}} \\ &= \frac{100 \times 100}{1070} = 9.345\% \\ \text{\% Impedance of the Transformers at base MVA} &= \frac{9.7 \times 100}{12.5} = 77.6\% \\ \text{Since Transformers are in Parallel effective impedance} &= \frac{77.6}{2} = 38.8\% \\ \text{Fault Level at 11 KV bus} &= \frac{\text{Base MVA} \times 100}{\% Z \text{ upto 11 KV bus}} \\ &= \frac{100 \times 100}{(9.345 + 38.8)} \\ &= \frac{100 \times 100}{48.15} = 207.68 \text{ MVA} \\ &\text{Say } 208 \text{ MVA} \\ \text{Fault Level at 11 KV side (IS)} &= \frac{208 \times 10^6}{\sqrt{3} \times 11000} = 10.9 \text{ KAmps} \end{aligned}$$

#### *Fault Level on 433 V side*

Let a 11 KV feeder be fed from the sub station through O/D line of 4 kms length. Conductor ACSR Hacoon 118 Sq. mm spacing 1 metre

Inductance of the line L	=	$(2 \log_e D/r + 0.5) \times 10.7 \text{ H/m}$ $= (4.608 \log_{10} D/r + 0.5) \times 10^7 \text{ H/m}$ $= 10.19 \times 10^4 \text{ H/kms}$
Inductive Reactance XL	=	$2\pi f L \leq 0.319 \text{ Ohms/km}$
For 4 kms of line	=	$0.319 \times 4 = 1.276 \text{ Ohms/km}$
For Line Reactance	=	$\frac{\text{Line reactance} \times \text{BaseMVA} \times 100}{\text{KV}^2}$ $= \frac{1.276 \times 100 \times 100}{11 \times 11} = 105.45\%$
Fault level calculated at 11 KV bus of the S/s	=	208 MVA
Source impedance	=	$\frac{\text{Base MVA} \times 100}{\text{Fault MVA}}$ $= \frac{100 \times 100}{208} = 48.08\%$
Fault level at Receiving point (11 KV)	=	$\frac{\text{Base MVA} \times 100}{\% Z \text{ upto receiving point}}$ $= \frac{100 \times 100}{(48.08 + 105.45)} = 65.13 \text{ MVA}$
Let there be two transformers: 11/433 V, 750 KVA of 4.8% reactance at the receiving point and let 1 transformer being in operation at a time.		
% Reactance of the 750 KVA Transformer at Base MVA		
=	=	$\frac{\% \text{ impedance} \times \text{Base MVA}}{\text{Rated MVA}}$ $= \frac{4.8 \times 100}{0.75} = 640\%$
Total % Reactance upto 433 V bus	=	$48.08 + 105.45 + 640 = 793.53\%$
Fault level at 433 V side	=	$\frac{100 \times 100}{793.53} = 12.60 \text{ MVA}$
Fault Current at 433 V side (Is)	=	$\frac{12.60 \times 10^3}{\sqrt{3} \times 433} = 12.60 \text{ MVA}$
Size 11KV XLPE Aluminium cable in mm <sup>2</sup>	=	$11.1 \text{ Is } \sqrt{t}$
Is	=	Fault current in Kilo Amps
t	=	Duration of fault current in seconds

## SYSTEM VOLTAGES AND COLOURS

### System Voltage and colours used for Drawing

Voltage	Colour	Voltage	Colour
400 KV	Dark Violet	11 KV or any other Gen. Voltage	Canary Yellow
220 KV	Brilliant Green	6.6/3 KV	French Blue
132/110 KV	Signal Red	415 V	Middle Brown
88 KV	Light Orange	P.T.	Black
33/22 KV	Salmon Pink	Earth	Green

## POWER FACTORS OF SOME COMMON TYPES OF LOADS

	Load	Power factor
1.	Incandescent lamps	1.00
2.	Fluorescent lamps	0.6 to 0.8
3.	Induction motors	0.8
4.	Neon signs	0.4 to 0.5
5.	Arc lamps (Cinema)	0.3 to 0.7
6.	Arc furnaces	0.85
7.	Arc welding	0.3 to 0.4
8.	Resistance welding	0.65
9.	Induction furnace	0.60
10.	Induction heating	0.85

### Definition

1. Load factor =  $\frac{\text{Average load over a designated period}}{\text{peak load in that period}}$
2. Plant factor =  $\frac{\text{Plant output}}{\text{Plant capability}}$
3. Capacity factor =  $\frac{\text{Average load on the machine}}{\text{Rated capacity of the machine}}$
4. Diversity factor
  - (i) For stations =  $\frac{\text{sum of the peaks of feeders}}{\text{Station peak}}$
  - (ii) For Transmission/ =  $\frac{\text{Connected load on the Tr/Distrn. System}}{\text{Distribution system Peak load on the Tr/Distrn.system}}$
5. Demand factor =  $\frac{\text{Maximum Demand of a system or part of a system}}{\text{Connected load of the system or part of the system}}$
6. Voltage Regulation =  $\frac{(E_s - E_r) \times 100}{E_s}$

Where

- $E_s$  = Sending end Volts  
 $E_r$  = Receiving end Volts  
 $E_s$  =  $E_s - (IR \cos f + I x \text{Sin } f)$

## G.I WIRES

SWG	Meters/Kg	kg metre
16	42.35	0.204
14	27.50	0.036
12	22.73	0.044
10	18.25	0.055
8	9.80	0.102
4	4.587	0.218

## STAY WIRE (Guy wires)

No. & Guage of wire	Over-all dia (inches)	Wt. of 1000 yds (ld)
7/8	0.480	1470
7/9	0.432	1185
7/10	0.384	938
7/12	0.312	617
7/14	0.240	421

## UNIT WEIGHT OF CONSTRUCTION MATERIALS

Descriptions	Kg / cu. metre
Cement-Ordinary & Aluminious	1440
Cement concrete Plain	2240
Sand (Dry)	1600
Sand (Wet)	1700 to 2000
Mild steel	7840
Cast iron	7200
Brass	8550
Lead	11350
Tar	1010
Aluminium	2800

## FLATS

Size (mm)	Wt (Kg/m)	Sectional are (cm <sup>2</sup> )
25x5.0	1.0	1.25
50x6.0	2.355	3.00
50x10	3.9	5.00
65x6	3.1	3.90
75x8	4.7	6.00
75x10	5.9	7.15
80x10	6.3	8.00

## EQUAL ANGLES

Designation	Size (mm x mm)	Thickness (mm)	Sec. Area (cm <sup>2</sup> )	Weight Kg/m
ISA 2020	20x20	3.0	1.12	0.9
ISA 4040	40x40	3.0	2.34	1.8
ISA 6060	60x60	5.0	5.75	4.5
ISA 8080	80x80	6.0	9.29	7.3
ISA 100100	100x100	6.0	11.67	9.2
ISA 200200	200x200	12.0	46.94	36.9

## UNEQUAL ANGLES

Designation	Size (mm x mm)	Thickness (mm)	Sec. Area (cm <sup>2</sup> )	Weight kg/m
ISA 3020	30x20	3.0	1.41	1.1
ISA 5030	50x30	3.0	2.34	1.8
ISA 10065	100x65	6.0	9.55	7.5
ISA 200100	200x100	10.0	29.21	22.9
ISA 200150	200x150	10.0	34.29	26.9

## BEAMS

Designation	Size (mm)	Thickness of Flange/Web		Sectional Area (cm <sup>2</sup> )	Weight Kg/m
		mm	mm		
SJB 150	150x50	4.6	3.0	9.01	7.1
ISJB 200	200x60	5.0	3.4	12.64	9.9
ISLB 100	100x50	6.4	4.0	10.21	8.0
ISLB 175	175x90	6.9	5.1	21.30	16.7
ISLB 200	200x100	7.3	5.4	25.27	19.8
ISLB300	300x150	9.4	6.7	48.08	37.7
ISLB 350	350x165	11.4	7.4	63.01	49.5
ISLB 500	500x180	14.1	9.2	95.50	75.0
ISMB 100	100x75	7.2	4.0	14.60	11.5
ISMB 200	200x100	10.8	5.7	32.33	25.4
ISMB 300	300x140	12.4	7.5	56.26	44.2
ISMB 400	400x140	16.0	8.9	78.46	61.6
ISMB 500	500x180	17.2	10.2	110.74	86.9
ISWB 150	150x100	7.0	5.4	21.67	17.0
ISWB 200	200x140	9.0	6.1	36.71	28.8
ISWB 300	300x200	10.0	7.4	61.33	48.1
ISWB 400	400x200	13.0	8.6	85.01	66.7
ISWB 500	500x250	14.7	9.9	121.22	95.2
ISHB 150	150x150	9.0	5.4	34.48	27.1
ISHB 250	250x250	9.7	6.9	64.96	51.0
ISHB 300	300x250	10.6	7.6	74.85	58.8
ISHB 400	400x250	12.7	9.1	98.66	77.4
ISHB 450	450x250	13.7	9.8	111.14	87.2

## STEEL BARS AND SECTIONS - STANDARD DESIGNATION

Designation	Details		Example
ISRO	IS Round Bar	ISRO 6	Diameter 6 mm
ISSQ	"SQUARE Bar	ISSQ 8	Size 3 mm
ISF	"Rolled Steel Flat	10 ISF 4	Width 10 mm, thickness 4 mm
ISST	"Steel strip x 4	ISST 200	Width 100 mm, thickness 4 mm
ISA	"Eq/Unequal Angle	ISA 3020	Side 30 mm and 20 mm
ISNT	"Normal Tee	ISNT 40	Ht. & Width 40 mm
ISDT	"Deep legged Tee	ISDT 100	Ht. 100 mm (Flange width 50 mm)
ISLT	"Slit light weight Tee	ISLT 200	Ht. 200 mm (Flange width 165 mm)
ISMT	"Medium Weight Tee	ISMT 50	Ht. 50 mm (Flange Width 75 mm)
ISJC	"Junior Channel	ISJC 100	Ht. 100 mm (Flange width 45 mm)
ISLC	"Light Channel	ISLC 100	Ht. 100 mm (Flange width 50 mm)
ISMC	"Medium Channel	ISMC 100	Ht. 100 mm (Flange width 50 mm) with higher flange & web thickness
ISCG	"Channel Section	ISCG 16	Ht. 16 mm (Width 10 mm)
ISJB	"Junior Beam	ISJB 150	Ht. 150 mm (Width 50 mm)
ISLB	"Light Beam	ISLB 150	Ht. 150 mm (Width 80 mm)
ISMB	"Medium Beam	ISMB 150	Ht. 150 mm (Width 80 mm with higher flange & web thickness
ISWB	"Wide Flange Beam	ISWB 150	Ht. 150 mm (Width 100 mm)
ISHB	"Column Section H beam	ISHB 150	Ht. 150 mm (Width 150 mm)

### SLIT WEIGHT TEE BARS

ISLT 200	200x 165	8.0	12.5	36.22	28.4
ISLT 250	250 x 180	9.2	14.1	47.75	37.5

### SLIT MEDIUM WEIGHT TEE BARS

ISMT 60	60 x 60	6.0	6.5	6.85	5.4
ISMT 75	75 x 75	9.0	9.0	12.69	10.0
ISMT 100	100 x 100	10.0	10.0	18.97	14.9
ISMT 150	150 x 150	10.0	10.0	28.88	22.7

## ROUND AND SQUARE STEEL BARS

Diameter or width across Flat (mm)	Weight per metre (kg)		Sectional are (cm <sup>2</sup> )	
50	0.20	0.15	0.25	0.20
5.5	0.24	0.19	0.30	0.24
6.0	0.28	0.22	0.36	0.28
7.0	0.38	0.30	0.49	0.38
8.0	0.50	0.39	0.64	0.50
9.0	0.64	0.50	0.81	0.64
10.0	0.78	0.62	1.00	0.78
11.0	0.95	0.75	1.21	0.95
12.0	1.13	0.89	1.44	1.13
14.0	1.54	1.21	1.96	1.54
16.0	2.01	1.58	2.56	2.01
18.0	2.54	2.00	3.24	2.54
20.0	3.14	2.47	4.00	3.14
22.0	3.80	2.98	7.84	3.80
25.0	4.91	3.85	6.25	4.91
28.0	6.15	4.83	4.84	6.16
32	8.04	6.31	10.24	8.04

## RIBBED TORSTEEL

Size (mm)	Area (cm <sup>2</sup> )	Weight (kg/m)	Perimeter (cm)
6	0.283	0.222	1.86
8	0.503	0.395	2.51
10	0.785	0.617	3.14
12	1.131	0.888	3.77
14	1.539	1.208	4.40
16	2.011	1.578	5.03
18	2.545	2.000	5.65
20	3.142	2.466	6.28
25	4.909	3.854	7.85
32	8.042	6.313	10.05
36	10.179	7.990	11.31
40	12.506	9.864	12.57
50	19.635	15.410	15.71

## WEIGHTS OF SHEET METAL kg/m<sup>2</sup>

Sheet	Plate thickness in mm							
	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0
Aluminium	1.35	2.70	4.05	5.40	8.10	10.80	13.50	16.20
Zinc	3.59	7.18	10.8	14.40	21.50	28.72	35.90	43.08
Iron	3.90	7.80	11.70	15.60	23.40	31.20	39.00	46.80
Steel	4.0	8.0	12.0	16.0	24.0	32.0	40.0	48.0
Brass	4.25	8.50	12.80	17.0	25.50	34.0	42.5	51.0
Copper	4.45	8.90	13.40	17.80	26.70	35.60	44.5	53.40

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## REQUIREMENT OF CEMENT

Sl.No.	Particulars	Qty. of cement
<b>Brick Masonry</b>		
1.	Brick works in 1:4 with wire cut	[22.9 cm x 11.2 cm x 7 cm] 72 kg m <sup>3</sup>
2.	-do- 1:5 -do-	[19 cm x 9 cm x 9 cm] 58 Kg m <sup>3</sup>
3.	-do- 1:5 -do-	[22.9 cm x 11.2 cm x 7 cm] 58 Kg m <sup>3</sup>
4.	-do- 1:5 with country burnt bricks	[19 cm x 9 cm x 9cm] 69 Kg m <sup>3</sup>
5.	-do- 1:5 -do-	[22.9 cm x 11.2 cm x 7 cm] 69 Kg m <sup>3</sup>
6.	-do- 1:6 -do-	[19 cm x 9 cm x 9 cm] 58 Kg m <sup>3</sup>
7.	-do- 1:6 -do-	[22.9 cm x 11.2 cm x 7.0 cm] 78 Kg m <sup>3</sup>

**Laterite Masonry**

8.	Laterite Masonry in C.M	1:4	[44cm x 24 cm x 14 cm]	58 Kg m <sup>3</sup>
9.	-do-	1:5	[44 cm x 24 cm x 14 cm]	46 Kg m <sup>3</sup>

**Stone Masonry**

10.	Cut stone work in steps 15 to 22 cm size in C.M		1:2	62 Kg m <sup>3</sup>
11.	Cross rubble work in split stone in C.M		1:2	98 Kg m <sup>3</sup>
12.	-do-	11 sort in C.M	1:4	70 Kg m <sup>3</sup>
13.	-do-	-do-	1:5	63 Kg m <sup>3</sup>
14.	Random rubble work in cement mortar		1:4	108Kg m <sup>3</sup>
15.	-do-	-do-	1:5	86 Kg m <sup>3</sup>
16.	-do-	-do-	1:6	72 Kg m <sup>3</sup>

**Plastering**

17.	Plastering with C.M		1:3 12 mm thick one coat	66 Kg 10 m <sup>2</sup>
18.	-do-	-do-	1:3 15 mm -do-	72 Kg 10 m <sup>2</sup>
19.	-do-	-do-	1:4 12 mm -do-	54 Kg 10m <sup>2</sup>
20.	-do-	-do-	1:4 15 mm -do-	59Kg 10m <sup>2</sup>
21.	-do-	-do-	1:5 12 mm -do-	43Kg 10m <sup>2</sup>
22.	-do-	-do-	1:5 15 mm -do-	48 Kg 10m <sup>2</sup>
23.	-do-	-do-	1:6 15 mm -do-	22 Kg 10 m <sup>2</sup>

**Cement Concrete**

25.	Cement Concrete		1:1 1/2 :3	Using 20 mm nominal size 4.32 kg/10dm <sup>3</sup> broken stone.	
26.	-do-		1:3:6	-do-	2.16 kg/10dm <sup>3</sup>
27.	-do-		1:2:4	-do-	3.3 kg 10dm <sup>3</sup>
28.	-do- 1:4:8	-do-	1.62 kg 10dm <sup>3</sup>		

## Energy Consumed by common Domestic Appliances/Equipment

Electrical Appliance	Wattage Rating	Time for 1 Unit of Consumption
Cnt Bulb	25w	40 hrs/Unit
	60w	25 hrs/Unit
	100w	10 hrs/Unit
Fluorescent Tubelight 2 ft	20 w	50 hrs/Unit
Fluorescent Tubelight 4 ft	40 w	25 hrs/Unit
Night Lamp	15 w	66 hrs 40 mins/Unit
Mosquito Repellent	5 w	200 hrs/Unit
Fan	60 w	16 hrs 40 mins/Unit
Air Cooler	170 w	5 hrs 50 mins/Unit
Air Conditioner (1-15 Ton)	1500-2500 w	40 to 30 mins/Unit
Refrigerator (165 litres)	100 w	10 hrs/Unit
Mixer/Blender/Juicer	450 w	2 hrs 15 mins/Unit
Toaster	800 w	1hrs 15 mins/Unit
Hot Plate	1000-1500 w	1 hr 40 min/Unit
Oven	1000 w	1 hrs/Unit
Electric Kettle	1000-2000 w	1 hr to 30 mins/Unit
Iron	450-700 w	2 hrs 15 mins/Unit
		1 hr 25 mins/Unit
Water Heater		
1 1/2-2 litre capacity (Instant Geyser)	3000 w	20 mins/Unit
10-20 litre (storage type)	2000 w	30 mins/Unit
Immersion Heater	1000 w	1 hr/Unit
Vacuum Cleaner	700-750 w	1 hr 20 mins/Unit
Washing Machine	325 w	3 hrs/Unit
Water Pump	750 w	1 hr 20 mins/Unit
Television	60-120 w	16 to 8 hrs/Unit
Radio	15 w	66 hrs 40 mins/Unit
Video	40 w	25 hrs/Unit
Tape Recorder	20 w	50 hrs/Unit
Stereo System	50 w	20 hrs/Unit
Computer	120-500 w	

Note : Wattage rating given above are only indicative

## COMPARISON OF ALUMINIUM AND COPPER CONDUCTORS

	Aluminium	Copper
For equal resistance		
Area ratio	1.61	1
Diameter ratio (round conductors)	1.27	1
Weight ratio	0.48	1
For equal current and temperature rise		
Area ratio	1.39	1
Diameter ratio	1.18	1
Weight ratio	0.42	1
For equal diameter :		
Resistance ratio	1.61	1
Current carrying capacity	0.78	1
Weight ratio	0.3041	1

### Weight of Copper Conductors

No. 0 = 47 2Kg/km

No.4 = 244 Kg/km

No. 6 = 166 Kg/km

No. 8 = 115 Kg/km

## EARTH LEAKAGE PROTECTION

Recommended value of operating current of ELCB/RCCB in Consumer Installation

Sr. No.	Circuit/equipment/ apparatus	Rated operating Current (mA)
1.	5A switched socket outlets	30
2.	Water heaters/Coolers	30
3.	Refrigerator/Washing machine and similar apparatus	30
4.	Domestic water pumps	30
5.	Under water lighting	10
6.	15A Switched socket outlets (general purpose)	30
7.	General lighting	30/100
8.	Flood lighting	100/130
9.	Windows/ Split type Air Conditioner	100
10.	Fan coil/Air Handling units	100
11.	Package type A/C unit	100/300
12.	Chiller	100-500-1000
13.	Irrigation pump	100
14.	Electric Cooker	100
15.	Industrial machine	100/300
16.	Elevators/Escalators	300/500
17.	Neon sign	300