

AP POWER SECTOR - AT A GLANCE					
Sl. No.	Parameter	Unit	As on 31.03.2021 (Provl)	Added during FY 2021-22	As on 30.09.2021 (Provl)
I	Installed Capacity (As per Share)				
	a) A.P.GENCO				
	1 Thermal	MW	3410.00		3410.00
	2 Hydel	MW	1797.60		1797.60
	AP Power Development Corp. Ltd	MW	1440.00		1440.00
	TOTAL A.P.GENCO (except Solar) & APPDCL	MW	6647.60		6647.60
	1. GGPP	MW	216.82		216.82
	b) Private Sector				
	1 IPPs	MW	1321.32	-400.00	921.32
	2 Small Hydro	MW	102.6	2.35	104.95
	3 Wind *	MW	4083.57		4083.57
	4 Bagasse , Bio-mass Co-Generation projects & Bio mass	MW	443.65	-30.50	413.15
	5 Others (Waste Heat+ Muncipal waste)	MW	46.16		46.16
	6. Total Solar	MW	3992.63	103.00	4095.63
	TOTAL PRIVATE SECTOR	MW	9989.93	-325.15	9664.78
	c) Share from Central Sector	MW	1980.63	-0.12	1980.51
	Total (A.P.GENCO + Private + Central)	MW	18834.98	-325.27	18509.71
II	Energy Generated (cumulative)		During FY 2020-21 (Provl)	During Sept-21	During FY 2021-22 upto 30.09.2021 (Provl)
	1 Thermal	MU	16441.18	1532.36	10256.68
	2 Hydel	MU	5681.81	471.87	1617.03
	APGENCO TOTAL	MU	22122.99	2004.23	11873.71
	Generation (Wind)	MU	6407.04	978.61	5293.84
	Generation (Solar)	MU	6950.74	605.55	3829.82
	Generation (Other NCEs)	MU	810.81	64.29	409.98
	Generation (Others)	MU	26698.56	2120.04	13744.83
	Total Generation	MU	62990.14	5708.43	35152.18
	Maximum demand during the year (At Generation Terminal)	MW	11193 MW on 16/03/2021	10445 MW on 16/09/2021	11618 MW on 02/04/2021
	Max. grid consumption during the Year	MU	199.93 MU on 10/05/2019	212.37MU on 17.09.2021	223.99 MU on 02/04/2021
	Per capita consumption	Kwh	1203 (FY2019-20)		1198 (FY2020-21)
III	TRANSMISSION				
	Transmission Lines		As on 31.03.2021 (Provl)	Added During FY 2021-22	As on 30.09.2021(Provl)
	a) 400 kV	Ckm	5436.73	-	5436.73
	b) 220 kV	Ckm	11761.53	49.00	11810.53
	c) 132 kV	Ckm	11879.92	268.24	12148.16
	Sub - stations				
	a) 400 kV	Nos.	16	-	16
	b) 220 kV	Nos.	100	2	102
	c) 132 kV	Nos.	225	5	230
	TOTAL	Nos.	341	7	348
	MVA ADDED (Including Augmentation)	MVA	53940.5	1513.5	55454.00
	LOSSES		During FY2020-21 (Provl.)	During Sept-2021 (Provl.)	During FY2021-22 (Provl.)
	Transmission Losses	%	2.6	2.67	2.84
	Distribution Losses	%	7.31	6.38	7.44
	T & D Losses	%	9.49	8.68	9.87

AP POWER SECTOR - AT A GLANCE					
IV	DISTRIBUTION		As on 31.03.2021 (Provl)	Added during FY 2020-21	As on 30.09.2021 (Provl)
	DISCOM's Lines				
	d) 33 kV	km	29403.83	532	29935.83
	e) 11 kV	km	269171.45	3931	273102.45
	f) LT	km	322577.08	774	323351.08
	TOTAL		622180.46	4209	626389.36
	DISCOM's Sub - stations				
	d) 33 kV(Reconcilled)	Nos.	3194	27	3221
	Distribution Transformers (including RESCO)	Nos.	1058732	14318	1073050
	Consumers Served				
	I) Domestic	Nos.	1,52,71,450	2,19,610	1,54,91,060
	II) Commercial & others	Nos.	16,82,728	62,623	17,45,351
	III) Industry	Nos.	1,32,771	1,570	1,34,341
	IV) Institutional	Nos.	3,32,072	3,525	3,35,597
	V) Agriculural Services & related	Nos.	19,15,680	32,383	19,48,063
	L.T.Total	Nos.	1,93,34,701	3,19,711	1,96,54,412
	H.T.Total	Nos.	13,727	310	14,037
	Grand Total	Nos.	1,93,48,428	3,20,021	1,96,68,449
V	FINANCE		As on 31.03.2021	During FY 2021-22	As on 30.09.2021
1	Revenue Demand	Crs	26894.13	15946.85	42840.98
	Revenue Collections	Crs	25082.45	14334.39	39416.84
	Revenue Demand (Outstanding) (i)-(ii)	Crs	1811.68	1612.46	3424.14
			As on 31.03.2021	Dues During FY 2021-22	As on 30.09.2021
2	Powe Purchase Dues to Generators	Crs	10288.00	3804.40	14092.40
	CASH FLOW				
3	AP DISCOMS RECEIPTS	Crs	25244.12	15049.00	40293.12
	AP DISCOMS PAYMENTS	Crs	25287.24	14998.00	40285.24
4	AP TRANSCO RECEIPTS	Crs	1707.91	1052.64	2760.55
	AP TRANSCO PAYMENTS	Crs	1908.39	1202.53	3110.92
			(Opening Balance) As on Sept 2021	Subsidy Received in Sept- 2021	(Closing Balance) As on Sept 2021
5	Govt Subsidy Receivables	Crs	13215.28	(499.99)	12715.29
			Demand (OB) related to Govt Depts as on 01.09.21	Collections from Govt Depts in Sept- 2021	Demand(CB) related to Govt Depts as on 09/21
6	State Government HoDs wise CC Charges Arrears	Crs	12656.31	402.73	12253.58
VI	Human Resources Information		As on 31.03.2020	Added/Retired During FY 2020-21	As on 31.03.2021
1	APTRANSCO EMPLOYEES	Nos	2157	(19)	2138
	OUT SOURCING EMPLOYEES	Nos	6001	6	6007
2	APSPDCL EMPLOYEES	Nos	8205	4054	12259
	OUT SOURCING EMPLOYEES	Nos	7084	429	7513
3	APEPDCL EMPLOYEES	Nos	9780	(206)	9574
	OUT SOURCING EMPLOYEES	Nos	4170	99	4269
4	APCPDCL EMPLOYEES	Nos	8002	(311)	7691
	OUT SOURCING EMPLOYEES	Nos	3727	569	4296
TOTAL AP Transco & DISCOMs EMPLOYEES		Nos	28144	3518	31662
TOTAL AP Transco & DISCOMs OUT SOURCING EMPLOYEES		Nos	20982	1103	22085
The AP Genco, AP Transco and DISCOMs Achievements during the year 2020-21 and 2021-22 upto September-21 are given above. The installed capacity in Andhra Pradesh is 18509.71 MW as on 30.09.2021					

Charges & Losses

AP Transco - Transmission Tariff (Rs./kW/MONTH) & Losses (%)															
Voltage ↓	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
Tariff	119.28			138.88			154.54			173.79			188.38		
Loss	3.10			3.08			3.06			3.03			3.00		
Peak Demand (MW)	11450			12219			13209			14315			15539		

AP SLDC Annual Fee and Operating Charges															
Voltage ↓	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
Annual Fee (Rs./MW/Year)	1917.48			2838.01			3792.02			4997.87			6382.27		
Operating Charge (Rs./MW/Month)	2146.34			2058.18			2086.32			2150.21			2235.65		

Wheeling Tariff (Rs./kVA/MONTH) - APEPDCL															
Voltage ↓	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
33 kV	45.24			48.38			54.73			59.51			61.92		
11 kV	349.71			375.94			427.5			467.43			489.07		
LT	591.25			637.42			726.98			797.29			836.76		

Wheeling Losses (%) corresponding to entry and exit - APEPDCL															
Drawn ↓	Supply at														
	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV
LT	4.01	7.08	9.67	3.99	7.01	9.60	3.97	6.95	9.52	3.95	6.88	9.45	3.93	6.81	9.37
11kV	7.08	3.20	5.90	7.01	3.15	5.84	6.95	3.10	5.78	6.88	3.05	5.73	6.81	3.00	5.67
33 kV	9.67	5.90	2.70	9.60	5.58	2.78	9.52	5.78	2.77	9.45	5.73	2.76	9.37	5.67	2.75

Wheeling Tariff (Rs./kVA/MONTH) - APSPDCL & APCPDCL															
Voltage ↓	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
33 kV	61.16			64.11			69.34			75.44			79.48		
11 kV	432.38			447.58			478.38			514.76			536.83		
LT	657.79			675.84			717.35			766.95			795.08		

Wheeling Losses (%) corresponding to entry and exit - APSPDCL & APCPDCL															
Drawn ↓	Supply at														
	FY2019-20			FY2020-21			FY2021-22			FY2022-23			FY2023-24		
	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV	LT	11kV	33kV
LT	4.26	7.39	10.35	4.23	7.31	10.23	4.20	7.24	10.11	4.17	7.16	9.99	4.14	7.08	9.87
11kV	7.39	3.27	6.37	7.31	3.22	6.27	7.25	3.17	6.17	7.16	3.12	6.07	7.08	3.07	5.98
33 kV	10.35	6.37	3.20	10.23	6.27	3.15	10.11	6.17	3.10	9.99	6.07	3.05	9.87	5.98	3.00

TARIFF FOR RETAIL SALE OF ELECTRICITY DURING FY2021-22 (APSPDCL, APEPDCL and APCPDCL)									
Category	Consumer Category	LT SUPPLY		↔ Billing Unit	HT SUPPLY				
		Fixed / Demand Charges per month (Rs./HP or kW)	Energy Charges (Rs./Unit)		Fixed / Demand Charges per month (Rs./kVA)	Energy Charges			
						11 kV	33 kV	132 kV & above	
I	DOMESTIC								
	(A) : Domestic (Telescopic)								
	Group A :								
	0-50	10	1.45	kWh	-	-	-	-	
	51-75	10	2.60	kWh	-	-	-	-	
	Group B: Consumption < 225 units during the billing month								
	0-50	10	2.60	kWh	-	-	-	-	
	51-100	10	2.60	kWh	-	-	-	-	
	101-200	10	3.60	kWh	-	-	-	-	
	201-225	10	6.90	kWh	-	-	-	-	
	Group C: Consumption > 225 units during the billing month								
	0-50	10	2.65	kWh	-	-	-	-	
	51-100	10	3.35	kWh	-	-	-	-	
	101-200	10	5.40	kWh	-	-	-	-	
	201-300	10	7.10	kWh	-	-	-	-	
	301-400	10	7.95	kWh	-	-	-	-	
	401-500	10	8.50	kWh	-	-	-	-	
	Above 500 units	10	9.95	kWh	-	-	-	-	
	Consumers whose consumption is more than 500 units per month can opt for smart meters and ToD rebate of Rs.1 per unit is applicable for such consumers for the consumption between 10 AM to 12 Noon.								
	(B) : Townships, Colonies, Gated Communities, and Villas		-	kVAh	75	7.00	7.00	7.00	
	II	COMMERCIAL & OTHERS							
		(A) : Commercial							
		(i) Minor 0-50 Units	55/kW	5.40	kWh/kVAh	-	-	-	-
(ii) Major									
0-50		75/kW	6.90	kWh/kVAh	475	7.65	6.95	6.70	
51-100			7.65	kWh/kVAh					
101-300			9.05	kWh/kVAh					
301-500			9.60	kWh/kVAh					
Above 500 units			10.15	kWh/kVAh					
Time of Day tariff (TOD)-		-	-	kWh/kVAh		8.65	7.95	7.70	
Peak (6 PM to 10 PM)									
(iii) Advertising Hoardings		100/kW	12.25	kWh/kVAh	-	-	-	-	
(iv) Function halls / Auditoriums			12.25	kWh/kVAh	-	12.25	12.25	12.25	
(B) : Startup power		-	12.25	kWh/kVAh	-	12.25	12.25	12.25	
(C) : Electric Vehicles / Charging Stations		-	6.70	kWh/kVAh	-	6.70	6.70	6.70	
(D) : Green Power	-	12.25	kWh/kVAh	-	12.25	12.25	12.25		

TARIFF FOR RETAIL SALE OF ELECTRICITY DURING FY2021-22
(APSPDCL, APEPDCL and APCPDCL)

Category	Consumer Category	LT SUPPLY		↔ Billing Unit	HT SUPPLY			
		Fixed / Demand Charges per month (Rs./HP or kW)	Energy Charges (Rs./Unit)		Fixed / Demand Charges per month (Rs./kVA)	Energy Charges		
						11 kV	33 kV	132 kV & above
III	INDUSTRY							
	(A) : Industry (General)#	75/kW	6.70	kWh/kVAh	475	6.30	5.85	5.40
	Time of Day tariff (TOD)- Peak (6 AM to 10 AM & 6 PM to 10	-	-			7.30	6.85	6.40
	Time of Day tariff (TOD) - Off Peak (10 PM to 6 AM)	-	-			5.30	4.85	4.40
	Industrial Colonies	-	-	kWh/kVAh	-	7.00	7.00	7.00
	(B) : Seasonal Industries (off- season)	75/kW	7.45	kWh/kVAh	475	7.65	6.95	6.70
	(C) : Energy Intensive Industries	-	-	kWh/kVAh	-	5.80	5.35	4.95
	(D) : Cottage Industries up to 10HP *	20/kW	3.75	kWh	-	-	-	-
	# - Rice mills and Pulverising units are permitted up to 150 HP in LT and as per the tariff mentioned in the terms and conditions.							
IV	INSTITUTIONAL							
	(A) : Utilities(Street Lighting, NTR Sujala Pathakam, CPWS	75/kW	7.00	kWh	475	7.65	6.95	6.70
	(B) : General Purpose	75/kW	7.00	kWh/kVAh	475	7.95	7.25	7.00
	(C) : Religious Places							
	(i) < 2 kW	30/kW	4.80	kWh	-	-	-	-
	(ii) > 2 kW	30/kW	5.00	kWh/kVAh	30	5.00	5.00	5.00
	(D) : Railway Traction	-	-	kVAh	350	5.50	5.50	5.50
	V	AGRICULTURE & RELATED						
(A) : Agriculture								
(i) Corporate farmers		200/HP	-	-	-	-	-	-
(ii) Non-Corporate farmers		-	-	-	-	-	-	-
(iii) Salt farming units up to 15 HP		-	2.50	kWh	-	-	-	-
(iv) Sugarcane crushing		-	-	-	-	-	-	-
(v) Rural Horticulture Nurseries		-	-	-	-	-	-	-
(vi) Floriculture in Green House		75/kW	4.50	kWh/kVAh	-	-	-	-
(B) : Aquaculture and Animal Husbandry		30/kW	3.85	kWh/kVAh	30	3.85	3.85	3.85
(D) : Agro Based Cottage Industries up to 10 HP		20/kW	3.75	kWh	-	-	-	-
(E) : Government / Private Lift Irrigation Schemes		-	-	kVAh	-	7.15	7.15	7.15
Note:	(i) Temporary Supply: There is no separate category for temporary supply. However, Temporary supply can be released against each category with respective terms and conditions applicable and it shall be billed at the rate and other conditions specified in this order.							
	(ii) Categories not defined in either HT-Supply or LT-Supply shall be billed at the rates specified in Category - II (A)							
	(ii) Commercial – Major							

ANSI codes for Protection functions

Device No.	Description	Device No.	Description
2	Timer	60	Voltage (or) Current Unbalance Relay
12	Over Speed Relay	63	Gas Operated Relay
21	Under impedance Relay	64N/87N	Restricted Earth Fault Relay
24 (99)	Over flux Relay	67	Directional Phase Overcurrent Relay
25	Synchro-check Relay	67N	Directional Earth Fault Relay
27	Undervoltage Relay	68	Power Swing Blocking Relay
30	Annunciator Relay	72	DC Circuit breaker
32	Directional Power Relay	74	Alarm Relay
37	Phase Undercurrent Relay	76	DC over current relay
38	Bearing Protective	78	Pole Slipping/Out-of-Step Relay
40	Loss of Excitation Relay	79	Auto Reclose Relay
45	DC over voltage	80	Supply Supervision Relay
46	Negative phase sequence/ Unbalance load Relay	81	Frequency Relay
47	Phase Reversal Relay	86	High Speed Master Trip/Lockout Relay
49	Thermal Overload Relay	87	Differential Relay
50BF/50Z	Breaker Failure Relay	94	Anti Pumping Contactor in the Circuit Breaker
50DD	Current Disturbance Detector	95	Trip Circuit Supervision Relay
50	Non-Directional Instantaneous Overcurrent Relay	Generally used Ferrule Codes	
50N	Non-Directional Instantaneous Earth Fault Relay		
50_2	Negative Sequence Instantaneous Overcurrent Relay	Code	Purpose
51	Non-Directional Time delay Overcurrent Relay	A	CT Core used for Main protection
51N	Non-Directional Time delay Earth Fault Relay	B	CT Core used for Bus bar Protection
51_2	Negative Sequence Time delay Overcurrent Relay	C	CT Core used for Backup protection
51R	Locked/Stalled Rotor Relay	D	CT Core used for Meetering
52	AC circuit breaker	E	Used in PT Circuits
53	Exciter or DC generator relay	H	Used in AC Circuits
59	Overvoltage Relay	J	Main D.C Supply
		K	Used in Control / Protection Circuits
		L	Used in Indication / Annunciation
		M	Used in Motor Circuits
		N	Used in OLTC Circuits
		P	Busbar / LBB Protection DC Circuits

GENERATOR PROTECTION

Classification	Types of Fault
Class A	This Covers all electrical protections for faults within the generator unit in which generator field breaker, generator and turbine should be tripped.
Class B	This covers all mechanical protection of the turbine in which turbine will be tripped first and following this generator will trip on reverse power / low forward power protections.
Class C	<p>This covers elctrical protection for faults in the system in which generator will be unloaded by tripping of generator breaker only. The unit will come to house load operation and the UAT will be in service. Various protection of this class :</p> <p>D 220 KV (HV side of generator transformer bus bar protection)</p> <p>D Generator Transformer HV side breaker pole discrepancy.</p> <p>D Generator negative phase sequence protection.</p> <p>D Generator Transformer over current/Earth fault protection</p> <p>D Reverse power protection without turbine trip.</p>

NORMAL FAULTS IN GENERATOR

External Faults	Over loading, Unbalance loading, Short circuit, Earth fault,
Internal Faults	Phase to Phase faults in winding, Phase to Earth faults.
Faults related to Sub systems i.e; Stator, Rotor, Prime mover, Excitation System, Voltage Regulator, Governor, Cooling System.	Under voltage, Over voltage, Under frequency, Reverse Power, Loss of excitation, Low-forward power.

GENERATOR PROTECTION SCHEMES

Functions	Steam & Gas Turbines			Hydro Turbines		
	Small (<10MVA) Medium	(10-100MVA) Large >100MVA	Small <10MVA Medium	10- 100MVA Large	>100MVA	
Differential	Y	Y	Y	Y	Y	Y
95% Stator E/F	Y	Y	Y	Y	Y	Y
100% Stator E/F	N	Y/N	Y	N	Y/N	Y
Inter turn faults	Y	Y	Y	Y	Y	Y
Backup impedance	N	Y	Y	N	Y	Y
Voltage controlled O/C	Y	N	N	Y	N	N
Negative Sequence	Y	Y	Y	Y	Y	Y
Field failure	Y	Y	Y	Y	Y	Y
Reverse power	Y	Y	Y	Y	Y	Y
Pole slipping	N	N	Y	N	N	Y
Over load	N	N	N	Y	Y	Y
Under frequency	Y	Y	Y	Y	Y	Y
Dead machine	N	N	Y	Y	Y	Y
Rotor Earth Fault	Y	Y	Y	Y	Y	Y
Over fluxing	N	Y	Y	N	Y	Y
Note : Y - Yes, N - No						

Protection in 33KV,132KV & 220KV Substations

Device	Protection Provided	Inputs from
33KV Feeder	Non Dir:O/L & E/L Protection with Instantaneous Element and 3 Seconds NI Curve	33KV Feeder CTs - Protection Core - 5P10 Class
33KV Generation Feeders at Receiving end	Directional O/L & E/L Protection with Instantaneous Element and 3 Seconds NI Curve	33KV Feeder CTs - Protection Core - 5P10 Class and PT supply from 33KV Bus PT - Protection Core - 3P Class
132KV Feeders	Main Protection: Numerical Distance Protection	132KV Feeder CTs: PS Class and 132KV Bus PT: 3P Class
	Back up: Dir. O/L & E/L Protection with 3 Seconds NI Curve	132KV Feeder CTs: 5P20 Class and 132KV Bus PT: 3P Class
220KV Feeders	Main-1 Protection: Numerical Distance Protection	220KV Feeder CTs: PS Class and PT Supply from 220KV Bus PT: 3P Class with change over facility on to feeder CVTs
	Main-2 Protection: Numerical Distance Protection (Main-1 & Main-2 relays should be different Makes)	220KV Feeder CTs: PS Class and PT Supply from 220KV Feeder CVT: 3P Class with change over facility on to BUS PTs
132/33KV Power Transformers	HV side: Non Dir. O/L & Dir. E/L Relay with instantaneous element in the O/L Relays and 3 Second NI Curve	Protection Core in the HV CTs: 5P20 Class and PT Supply also for Dir. E/F Relay from 132KV Bus PT: Protection Core. Class:3P
	LV side: Non Dir. O/L & E/L Relay with 3 Second NI Curve	Protection Core in the LV CTs: 5P20 Class
	Differential Protection	Special Protection Core both in the HV & LV CTs: PS
	HV Over Flux Protection	PT Supply from 132KV Bus PT Protection Core. Class:3P
	Alarms: Buchholz, HV/LV Wnd. Temp (90° C to 100° C), Oil Temp.(80° C to 90° C) and MOG	
	Trips: Buchholz, OLTC Buchholz (OSR), HV/LV Wnd.Temp.(100° C to 110° C), Oil Temp.(90° C to 100° C) and PRV	
220/132KV Power Transformers	HV side: Non Dir. O/L & Dir. E/L Relay with instantaneous element in the O/L Relays and 3 Second NI Curve	Protection Core in the HV CTs: 5P20 Class and PT Supply also for Dir. E/F Relay from 220KV Bus PT: Protection Core. Class:3P
	LV side: Non Dir:O/L & Dir:E/L Relay with 3 Second NI Curve	Protection Core in the HV CTs: 5P20 Class and PT Supply also for Dir. E/F Relay from 132KV Bus PT: Protection Core. Class:3P
	Differential Protection	Special Protection Core both in the HV & LV CTs: PS
	HV& LV Over Flux Protection	PT Supply from 220KV, 132KV Bus PT Protection Core. Class:3P
	Alarms: Buchholz, HV/LV Wnd. Temp (90° C to 100° C), Oil Temp.(80° C to 90° C) and MOG	
	Trips: Buchholz, OLTC Buchholz (OSR), HV/LV Wnd.Temp.(100° C to 110° C), Oil Temp.(90° C to 100° C) and PRV	
Bus Bar Protection	Bus Differential Protection with Internal (or) External LBB	All the feeder CTs, PTR HV CTs and CTs in Bus Coupler Circuit. PS Class.

400KV PROTECTION

For Line	21L1 & 21L2 59-1 & 59-2	Redundant non Switched Line Distance Protection with carrier aided Scheme. (with Different Make/ Manufacturer) Over Voltage Stage -1 110% Over Voltage Stage -2 120% to 140 %
For Cable	87C1 & 87C2	Redundant Phase Segregated Line Differential Protection with B/U Line Distance Scheme. (with Different Make/Manufacturer)
For ICT	87T1 & 87T2 67HV & 67LV 99HV & 99LV	Redundant ICT Differential Protection. Main1: Phase Segregated, Biased, Low Impedance, Three Winding Differential Protection Using Conventional CTs. Main2: Phase Segregated, Unbiased, Either Low/ High Impedance, Three Winding Differential Protection Using Bushing CTs. B/U: Backup Directional O/C & E/F Protection on Both Sides of ICT. B/U: Backup Over flux Protection on Both sides of ICT.
For Reactor	87R1 & 87R221R	Redundant Reactor Differential Protection. Main1: Phase Segregated, unbiased, Low Impedance, Two Winding Differential Protection. Main2: Either Phase Segregated/ Restricted Earth Fault High Impedance Differential Protection. B/U: Backup single step Polarized 'MHO' or Impedance, Distance relay suitable for measuring Phase to Ground.
Additional Protection	87 TEED-1 87 TEED-2	As per the requirement/ Necessity TEED Protection is provided. TEED1: High Impedance TEE Differential Protection. TEED2: Low Impedance TEE Differential Protection.
For Bus Bar	50Z LBB + 87BB	Phase Segregated, Low Impedance, Bus Bar Differential Protection with Check feature and inbuilt LBB/BFR/CBF Protection. Normally Distributed Architecture Bus Bar Protection is preferable. Centralised Architecture also acceptable with standalone LBB Protection.
Bay Control Unit	BCU	Each Bay Provided with One BCU & Ethernet Switch.
A/R+Sync	79+25	Auto reclosure with synchrocheck now part of BCU
SAS	IEC 61850	SAS using Distributed Control Rooms/ Bay Kiosks/ Portable Relay Rooms/Switch Yard Control Rooms
400 KV Bus Arrangement		ONE AND HALF BREAKER (i) 3CT Method (iv) 5CT Method (ii) 4CT Method (v) 6CT Method (iii) 6CT Method (vi) 8CT Method APTRANSCO Standardly follows 4CT Method.
Disturbance Recorder		Inbuilt function of Main1 & Main2 Protections of Line, ICT, Reactor & Bus Bar (BPUs.)
Event Recorder & Alarms		Inbuilt function of all IEDs (BCUs/BPUs) in a Bay and communicate to SAS.

LINE PROTECTION	ICT PROTECTION	REACTOR PROTECTION
GROUP-A MAIN1(21L1) PROTECTION M1 BUILT IN FUNCTIONS O/V STAGE-1(59) PROTN D/T CHANNEL-1 RECD	GROUP-A ICT DIFF (87T1) PROTN ICT HV B/U (67HV) PROTN ICT HV O/F (99HV) PROTN OIL TEMP HIGH TRIP	GROUP-A DIFF(87R1) PROTN B/U IMP 21R RELAY OIL TEMP HIGH TRIP PRD TRIP PRD TRIP
GROUP-B MAIN2(21L2) PROTECTION M2 BUILT IN FUNCTIONS O/V STAGE-2(59) PROTN D/T CHANNEL-2 RECD	GROUP-B ICT DIFF (87T2) PROTN ICT LV B/U (67LV) PROTN ICT LV O/F (99LV) PROTN BUCHHOLZ TRIP OLTC BUCHHOLZ TRIP WDG TEMP HIGH TRIP HIGH OIL LEVEL TRIP	GROUP-B DIFF(87R2) PROTN BUCHHOLZ TRIP WDG TEMP HIGH TRIP HIGH OIL LEVEL TRIP FIRE PROTECTION TRIP

96: High Speed Master Trip Relay for LBB & Bus Bar Protection

EARTHING

Provision of adequate earthing system in a substation is very important for safety of the operating personnel as well as for proper system operation and performance of the protection devices.

Earthing is broadly divided as (a) system earthing (connection between part of plant in an operating system like neutral of a power transformer winding and earth), and (b) equipment earthing (safety grounding) connecting bodies of equipment to earth.

EHV SS	less than 0.5 ohm
33 kV SS	less than 1 ohm
Distribution transformer	less than 5 ohms
Tower footing	less than 10 ohms

Touch Potential: is the difference in voltage between the object touched and the ground point just below the person touching the object when ground currents are flowing.

Step Potential: is the difference in voltage between two points, which are one metre apart along the earth when ground currents are flowing.

When a fault occurs at a tower or substation, the current will enter the earth. Based on the distribution of varying resistivity in the soil a corresponding voltage distribution will occur. The voltage drop in the soil surrounding the grounding system can present hazards for personnel standing in the vicinity of the grounding system. Personnel "stepping" in the direction of the voltage gradient could be subjected to hazardous voltages. In case of step potential electric current will flow if a difference in potential exists between the two legs of a person.

Soil resistivity and layering plays a major role in how hazardous a fault occurring on a specific site may be. High soil resistivity tends to increase step potentials. A high resistivity top layer and low resistivity bottom layer tends to result in the highest step voltages close to the ground electrode. The low resistive bottom layer draws more current out of the electrode through the high resistivity layer, resulting in large voltage drops near the electrode.

When a fault occurs at a tower or substation, the current will pass through any metallic object and enter the earth. The personnel "touching" an object in the vicinity will be subjected to those touch

voltages which may be hazardous. For example if a person happens to be touching a high-voltage tower leg when a fault occurs, the current would travel down the tower leg into the person's hand and through vital organs of the body.

Mitigating Step and Touch potential hazards is usually accomplished through.

- 1) Reduction in the Resistance to Ground of the grounding system.
- 2) Proper placement of ground conductors
- 3) The addition of resistive surface layers

One of the simplest methods of reducing step and touch potential hazards is to wear Electric Hazard Shoes. Another technique is addition of more resistive surface layers. Often a layer of crushed rock is added to a tower or substation to provide a layer of insulation between personnel and the earth. This layer reduces the amount of current that can flow through a given person and into the earth. Weed control is another important factor, as plants become energized during a fault and can conduct hazardous voltages into a person. Asphalt is an excellent alternative, as it is far more resistive surface than crushed rock, and weed growth is not a problem.

Earthing system of a substation comprises of a mesh of earthing strips (earth mat) buried at a depth of at least 600mm below ground, supplemented with number of earth electrodes/ground rods at suitable points. In wet season, earth mat works as substation earth and in dry season earth electrodes have predominance as substation earth. Individual electrodes shall be designed in such a way that the earth resistance of each electrode is less than 3 ohms.

All the non-current carrying metal parts of the equipment in the substation should be connected to the earthing mat so as to ensure that under fault conditions, none of these parts is at a potential higher than that of the earthing mat. Ground rods maintain low value of resistance under all weather conditions which is particularly important for installations with high system earth fault currents.

Periphery of earth mat in the switchyard should be laid with 75x8 / 100x16 mm MS flat so as to cover all pole structures and all metallic parts. Internal vertical and horizontal sections may be 50x6 / 75x8 mm MS flat.

Earthing of neutral terminal of power transformers shall be done at two points. One earth flat of size 75x8mm MS flat is directly connected to the earth pit and the earth pit in turn is connected to the earth mat. Second earthing of neutral is made to the earth mat with the support of 75x40x6mm MS channel.

Bodies of all equipment and metal structures should be connected 50x8mm MS flat to two sides of the earth mat diagonally opposite.

All the neutral points of equipment should be provided with independent earth for the different systems. Each of these earthed points should be interconnected with the station earthing mat by two different diagonally opposite connectors to avoid common mode failure.

Bodies of all the equipments, cable sheath and non-current carrying metal parts, All extraneous metal frameworks not associated with equipment (structures, poles etc), Battery mid-point, tertiary winding and control panel are also connected to the earth mat by Copper or GI strips.

Methods for reduction of earth resistance:

Sodium chloride (NaCl), coke and sand are the most common, popular and Economical chemicals which are used to bring down the resistivity of soil. Aluminium sulphate is another chemical equivalent to sodium chloride. Other effective chemicals like Magnesium sulphate, calcium chloride or potassium chloride when mixed with soil brings down the resistivity, but is costlier. Use of multiple electrode system, deep driven rod system, counterpoise earthing etc. are some of the other methods to reduce

the earth resistance. Bentonite compound reduces the earth mat resistance to $\frac{1}{4}$ level of its original. Bentonite consists of clay which when mixed with water swells many times of its own volume. It absorbs moisture from the soil and retains it for a long time. Hence frequent watering to earth electrodes is not necessary. Bentonite may be used as a back fill material to surround vertical electrodes and also used to bed horizontal electrodes to improve the overall earth resistance. Bentonite treatment of soil results in appreciable reduction of resistance and low resistance remains constant over number of years. This is particularly more useful in soils where resistivity is too high i.e. 300 ohm-meters and above.

Earth Mat - notes for 132kV & 220kV Substation

- 1) Crushed rock surface with 150 mm thick ness shall be provided over entire area of the switch yard/transformer yard.
- 2)Main Earth mat shall be minimum of 75 x 8 mm size of MS flat at a depth of 0.6 meters and outer l peripheral conductor shall be 100 x 6 mm size MS flat at depth of 0.6 mtr. The arrangement of MS Flats in both directions shall be in vertical position and all joints by welding with the support of cleats. All Welded joints shall be painted with zinc rich epoxy paint.
- 3) Grid shall be laid in both longitudinal and lateral direction, with spacing depending on soil resistivity and area of Mats spreading. However the spacing shall be corrected towards lower side to make it uniform depending on the length and width of mat spreading area.
- 4) The MS Flat (conductors) should be surrounded by at least 150 mm of non-corrosive soil of fine texture, firmly rammed.
- 5) Peripheral grounding electrodes / rods l/spikes 8 nos. (Minimum) shall be of 28 mm diameter rod and length of 3 meters shall be driven vertically at corners l outer inter connection of length and width conductors to peripheral earth grid conductor.
- 6) Earth mat spread area shall be maintained minimum depending on the Soil resistivity and Spacing.
- 7) 125 mm diameter and 2.75 meter length CI Pipes shall be fixed with treatment of coke and salt as per IS 3043 in the yard as per requirement.
- 8) Drip Watering of earth pits may be provided through PVC conduit pipes to all earth pits of yard.
- 9) Avoid laying of MS flat cross over or touching the power / control cables. Wherever earth conductors cross over or are laid touching power or control cables they should be insulated with PVC tape or sleeve to avoid possible puncturing of cable sheath arising from high voltage transients on earth conductors.

Note:- For Earth Mat design in 132KV & 220KV Substations please go through Circular Memo No: CE/Const-I/DE/Designs/D.No:63/2014/Dt: 21.02.2014 and CBIP Manual No: 311.

**Electrical Clearances to be maintained for Overhead Lines as per
CEA Safety regulations 2010 & other manuals.**

Sl. No.	Description	Nominal System Voltage / Line Voltage				
		400KV	220KV	132KV	33kv	11kV and Below
1)	Minimum Ground Clearance from the bottom most conductor. (However lines along/across the street min 5.5/5.8 mtrs)	8.84	7.00	6.10	5.20	4.6
2)	Vertical clearance from top of the buildings / bridges etc., to the bottom most conductor	7.3	5.8	4.9	3.73	2.5
3)	Horizontal clearance from top of the buildings / bridges etc., to the bottom most conductor	5.6	3.8	2.9	2.03	1.2
4)	National highway crossings by taking maximum height of trucks as 4.75 mtrs as per Motor act and vertical clearance as per sl. No. 2	12.5	11.0	10.10	8.73	7.5
5)	Power Line crossing (clearance of Higher Voltage among crossing lines shall be considered)	5.49	4.58	3.05	2.44	2.44
For crossing 500kV Direct Current line 6.79 mtr clearance to be maintained for all 400kV and below lines						
6)	Communication Lines crossing	4.48	3.05	2.75	2.44	2.44
7)	Railway Lines crossing outside Station-at OHE Structure	18.26	16.46	15.56	14.66	By Cable
	Railway Lines crossing outside Station-at Midspan	15.434	14.524	12.994	12.384	By Cable
	Railway Lines crossing outside Station-at OHE Structure for <u>Double container</u>	19.96	18.16	17.26	16.36	By Cable
	Railway Lines crossing outside Station-at Midspan for <u>Double container</u>	17.134	16.224	14.694	14.084	By Cable
As per Advance Correction Slip No. 18. dated January, 2009 of IR. Ensure from railway dept for changes if any.						
8)	Minimum Electrical clearance from Live conductor to Earthed metal part, at Tension strings and Double suspension string and for jumpers with nil swing angle.	Nil - 3.05 20° -3.05 40° - 1.86	2.13	1.53	0.33	0.33
9)	Minimum Electrical clearance from Live conductor to Earthed metal part, for suspension strings at each swing angle	Nil - 3.05 22° - 3.05 44° - 1.86	Nil - 2.13 15°-1.98 30°-1.83 45°-1.675	Nil-1.53 15°-1.53 30°-1.37 45°-1.22 60°-1.07	Nil-0.33 15°-0.33 30° - 0.33 45°-0.33 60°- 0.33	0.33
10)	Minimum Phase to Phase vertical distance	8	5.1	4	2	1
11)	Minimum midspan vertical distance between top conductor and earthwire	9.00	8.50	6.10	-	-
12)	Shielding angles and no. of earth wires	20°/ 2 nos.	30°/ 1 no.	30°/ 1 no.	-	-
Note: All dimensions are in mtrs						

Standard BAY/BUS Width in Mtrs

SI No	Description	400KV	220KV	132KV	33KV	11KV
1	Bay Width	27.00	17.00	12.20	5.00	3.50
2	Bus Width	27.00	17.00	11.00	4.70	3.50
3	Phase to Phase	7.00	4.50	3.60	1.40	0.92
4	Phase to Earth	6.50	4.00	3.10	0.60	-
5	400KV					
	Line Bay Length	58.50	Vertical Phase to Ground			8.00
	Tie Bay Length	44.00	Height of Jack Bus			28.00
	Transformer Bay Length	58.50	Height of Main Bus			15.50

Location of Lightning Arrestors

SI No	Rated System Voltage	Highest System Voltage (KV)	Arrestor Rating in KV	BIL KV Peak	Max. Distance Between LA & Transformer Bushing Terminal in Mtrs
1	11 KV	12	9	85	12
2	33 KV	36	30	200	18
3	132 KV	145	120	550/650	3.5 to 4 Mtrs (Close to Transformer)
4	220 KV	245	198	900/1050	3.5 to 4 Mtrs (Close to Transformer) in 220KV SS. 11Mtrs in 400KV SS
5	400 KV	420	336		14

Motor Full-Load Ampers

Horse Power	3-Ph AC Squirrel-Cage & Wound-Rotor		Single Phase AC
	230V	460V	230V
1/6			2.2
1/4			2.9
1/2	2	1	4.9
3/4	2.8	1.4	6.9
1	3.6	1.8	8
1.5	5.2	2.6	10
2	6.8	3.4	12
3	9.6	4.8	17
5	15.2	7.6	28
7.5	22	11	40
10	28	14	50
15	42	21	
20	54	27	
25	68	34	
30	80	40	
40	104	52	
50	130	65	
60	154	77	
75	192	96	
100	248	124	

CAPACITOR RATINGS

The recommended capacitor rating for direct connection to ac (50 Hz) induction motors is given in the table below (IS. 7752 / 1995)

Rated out-put of Motors (HP)	Capacitor rating in KVAR when motor speed is					
	3000 rev/min.	1500 rev/min	1000 rev/min	750 rev/min.	600 rev/min	500 rev/min
3	1	1	1.5	2	2.5	2.5
5	2	2	2.5	3.5	4.0	4.0
7.5	2.5	3.0	3.5	4.5	5.0	5.5
10	3.0	4.0	4.5	5.5	6.	6.5
15	4.0	5.0	6.0	7.5	8.5	9.0
20	5.0	6.0	7.0	9.0	11.0	12.0
25	6.0	7.0	9.0	10.5	13.0	14.5
30	7.0	8.0	10.0	12.0	15.0	17.0
50	11.0	12.5	16.0	18.0	23.0	25.0
75	16.0	17.0	21.0	23.0	29.0	32.0
100	21.0	23.0	26.0	28.0	35.0	40.0
150	31.0	33.0	36.0	38.0	48.0	55.0
200	40.0	42.0	45.0	47.0	60.0	67.0
250	46.0	50.0	53.0	55.0	68.0	76.0

GENERAL INFORMATION

Allowable Current Densities : (For copper) :

Bus Bars (Indoor & enclosed) 116 amps/cm²

Bus Bars (outdoor) 186 amps/cm²

For aluminium bus bars, 75% of the above values may be taken

Insulation resistance of windings of power transformers.

Rated Voltage of Minimum safe insulation resistance in megohms the winding

	30°C	40°C	50°C	60°C
66 KV and above	600	300	150	75
33 KV	500	250	125	65
6.6 KV & 11 KV	400	200	100	50
Below 6.6 KV	200	100	50	25

Dielectric strength of Transformer Oil in Service (IS : 1866 / 1978)

Characteristic	Equipment Voltage	Suggested initial frequency of tests	Permissible limits	To be recondit- ioned	Test method
1	2	3	4	5	6
Breakdown Voltage	>170KV >70 to 170 KV <70 KV	Immediately prior to energising, then after 3months and after every year	>50KV >40KV >30 KV	Less than the value specified in Col.2	IS : 6792 of 1972 (2.5 mm Gap)

USEFUL TRANSACTION CODES IN SAP FOR FIELD ENGINEERS IN DISCOMs

T-Code in PS Module

T-code	Purpose
ZESTIMATE	Create, change and display of Estimate and sending for Approval (WBS).
ZPSP(or)ZPSA009	WBS Estimate Print.
CV01N	Document attachment.
ZCSCALL	List of CSC Applications in SAP.
ZAPGROUP	Applications Grouping.
ZDP	Demand notice print.
ZPR	1. Payments received against an application & 2. List of work orders ready for release(if 100% paid)."
ZPAYMENT	Demand vs collection against WBS.
ZCSCWBS	List of Applications pending without creating estimates.
ZDEMAND	Demand entry after revised estimate sanction (for released wos)
ZCSC	List of CSC Tcodes
ZAPDROP_INSAP	Application drop from SAP pending list.
ZAP_REQ	Request for Application from CSC to SAP.
ZPAYMENT_DUE	Allowing of Work order (for Govt works) with payments pending.
ZRS	Reservation Printout and Material drawl printout (upgraded ZMSTORE8)
ZCN25	Confirmation on work completion.
ZIA	Initial Accounts (WBS/PM order plan /actual printout).
CJ13	Work order Actuals (Material drawls and labour postings).
ZCJ13	Work order Actuals against Asset Devolutions & Receipts.
ZPSWORKORDER	Work order printout.
ZMATALT	Alternative materials for WBS.
ZPSCHANGE	Triggering for revised estimate and project type change.

ZSPSR	Work order handing over.
ZTURNKEY	Turnkey approval in SAP.
CJ30	Original Budget for WBS structure (from DE to Section level WBS)
CJ37	Supplement for WBS structure (from DE to Section Level WBS)
CJ38	Return Budget forWBS structure (from Section to DE level WBS)
ZAB	Available Budget
ZBUDGET	Budget for work order
CJ31	Display Budget Value.
ZDASHBOARD	Dashboard report. (Speed report on open work orders, pending Application & etc.)
ZWBS	WBS open work orders report.
ZMI	Material Indent (Material requirement in open work orders and stock position at stores)
ZOD	"Order documents (Purchase requisition Nos. and etc.), unbilled work orders in a section "& billed work orders in an agreement."
ZWF	List of estimates pending for approval
ZDEV	Devolutions plan and actual report
ZMSTORE14	Material _ cost data price and store price.
ZMSTORE11	Material Stock position in stores.
ZWBSSTATUS	Approval process status.
S_ALR_87013532	WBS_Plan and actual report.
CN52N	List of Materials in the WBS / Network.
CN43N	WBS overview report.
CN46N	Identifying of Network (against WBS).
CN47N	Identifying of Network activities (against WBS / Network).
CNB1	Purchase Requisition information.
CJ18	Budget Line items
ZOLD_ORD	Migrated work order details (4.7 ver to 6.0 ver)
ZCP	Migrated work order / Applications / PO / Agmt. (CPDCL to SPDCL)

USEFUL TRANSACTION CODES IN SAP FOR FIELD ENGINEERS IN DISCOMs

T-Code in PM Module

T-code	Purpose
IW31	CREATION OF PM ORDER
IW32	Change in PM ORDER
ZIW32	Release/Closing of PM order
ZPMOP	Pmorder PrintOut
IW33	Display PM order
IW39 / ZIW39	List of PM orders
ZAB	To Know the Available Budget to PM order
ZIW21	Creation of Failure / Devolution Notification
IW22	Release/Changes in Notification
ZPMNP	Notification PrintOut
IW23	Display Notification
IW29	List of Notifications
ZDTR	To know the Notification No against CSC Complaint
ZIE02	Change equipment from one FL to Other FL
IE02	To change EQ Make and SI.No
IE03	Display Equipment
IH08	List of Equipment Display
ZEQU	Replaced DTR updation against Failure
ZEQC	Energisation of New DTR
ZIL01	Creation of new FL
IL03	Display Functional Location
IH06	List of Functional Locations Display
ZFLEQ	To know blank DTR Location
ZFLEQABSTRACT	Section wise Cap wise DTRs
ZEQI	Issue of DTR from SPM
ZEQR	Receipt of DTR to SPM/STORES
IW22	Creation of PM10 Order
IW41	Consumption of Materials against PM10 Order
CN52N	To know the Material Planned & Actual posting
ZMPMR	To know the PR NO, To know billed/ Unbilled PM order
IW44	Final Confirmation of Group of PM10 Orders
MSRV6	To know the total Services cost against PRs
ZPMAGMT	Generation of DTR Repair Bill
ZPMAGMTR	Print Out of Bill

T-Code in MM Module

T-code	Purpose
MM60	List of Materials
AC06	List of Services
MKVZ	List of Vendors
ME51N	Creation of Purchase Requisition(ZO&Mestimate)
ME52N	Change of Purchase Requisition(ZO&Mestimate)
ME53N	Display of Purchase Requisition(ZO&Mestimate)
ZMPR7	PurchaseRequisition Print out
ME54N/ME55	Release of Purchase Requisition(ZO&Mestimate)
ME31K	Creation of Contract Agreement
ME32K	Change of Contract Agreement
ME33K	Display of Contract Agreement
ME35K	Release of Contract Agreement
ME21N	Creation of ServicePO
ME22N	Change of ServicePO
ME23N	Display of ServicePO
ME29N	Release of ServicePO
ML81N	Creation of Service Entry Sheet
ML84	Display of Service Entry Sheet
ML85	Release of Service Entry Sheet
VL10D	Creation of OBD
VL02	Change in OBD
VL03N	Display of OBD
VL71	Print Out of OBD
MB51	Details of material postings and labour postings.
MB52	To know the Material Stock
MB5B	To know the stock consumption in given dates
ZMSTORE3	Ground Balance Stock Storage Location wise
ZMSTORE10	Details of Material transactions against Network /PM order and Section.
ZMSTORE14	Material Plan Price and Stores Price
ZMSTORE16	To know the List of OBD against PO
ZMSTORE11	Plant wise Material Stock
ZMSTORE15	Consumption Report
S_ALR_87012180	List of customers

APTRANSCO SAP T CODES (PS/MM/QM MODULES)

TCode	TRANSACTION TEXT	TCode	TRANSACTION TEXT
AC06	SERVICE MASTER SELECTION	ZLOABUDREP	LOA BUDGET AGAINST A SCHEME
CJ20N	CREATE/VIEW SCHEME/ PROJECT	ZLOCSCHREP	LOC BUDGET AGAINST A SCHEME
CJ9ECP	CREATE DETAILED ESTIMATE	ZMM_CPLAN_REP	CENTRAL PLANNING REPORT
CJ13	PROJECT ACTUAL COST LINE ITEM REPORT	ZMM_CPLAN_UPLOAD	CENTRAL PLANNING UPLOAD
CN41N	WBS STRUCTURE OVERVIEW	ZMM_CQA	CONTRACT QUANTITY ABSTRACT
CN42N	OVERVIEW PROJECT DEFINITION	ZMM_DEV_PRINT	DEVOLUTION ORDER PRINT OUT
CN43N	WBS ELEMENTS OVERVIEW	ZMM_FORM13	FORM-13 SELECTION
IM01	CREATION OF CONTROL PERIOD	ZMM_FORM13PRINT	FORM-13 PRINTOUT
IM22	CREATION OF POSITION ID	ZMM_STO	DEVOLUTION ORDER CREATION (BACK GROUND)
IM32	BUDGET LOADING FOR POSITION ID	ZMM_STOCK	STOCK REPORT AGAINST A MATERIAL AND PLANT
IM52	BUDGET LOADING FOR SCHEME	ZMM_TRANSFERPOSTING	TRANSFER POSTING THROUGH EXCEL
IMA11	CREATE APPROPRIATION REQUEST	ZMMR_PRICE_REPORT	PRICE VARAIATION REPORT FOR MATERIALS
MB51	MATERIAL TRANSACTION HISTORY	ZPS_APR_CHANGE	T-CODE FOR MBOOK APPROVER CHANGE
MB52	MATERIAL STOCK AGAINST PLANT/STORAGE LOCATION	ZPS_CLAIMREPORT	SCHEME WISE EXPENDITURE
MBBS	PROJECT STOCK VALUE	ZPS_CONT_ACCE	MBOOK CONTRACTOR ACCPETANCE REPORT
ME21N	CREATE PURCHASE ORDER	ZPS_DI_CHECK	INBOUND DELIVERY REPORT
ME22N	CHANGE PURCHASE ORDER	ZPS_GST_REPORT	TOTAL GST REPORT
ME23N	DISPLAYPURCHASE ORDER	ZPS_MAT_ACCT	TRANASCTION FOR OVER MATERIAL ACCOUN
ME29N	RELEASE PURCHASE ORDER	ZPS_MBOOK_ABST	MBOOK ABSTRACT REPORT
ME2J	PURCHASE ORDERS AGAINST A SCHEME	ZPS_MBOOK_DIS	MBOOKS ISSUED AGAINST A PURCHASE ORDER
ME41/ME47/ZRFQ	REQUEST FOR QUOTATION (RFQ)	ZPS_PR_UPLOAD	ROW WORK ESTIMATE UPLOAD
ME51N	CREATE PURCHASE REQUISITION	ZPS_PROJ	PURCHASE ORDERS AGAINST A PURCHASE GROUP
ME52N	CHANGE PURCHASE REQUISITION	ZPS_SE_LOCK	SERVICE ENTRY LOCK RELEASE
ME53N	DISPLAY PURCHASE REQUISITION	ZPS_SEIGN_CHRG	TCODE FOR SEIGNIORAGE CHARGES
ME54N	RELEASE PURCHASE REQUISITION	ZPS_SEMATACNT	SE WISE MATERIAL ACCOUNT
ME5J	PURCHASE REQUESTIONS AGAINST A SCHEME	ZPS_SEREPORT	TCODE FOR MBOOK SERVICE ENTRY STATUS
MIGO	GOODS RECEIPT AND OTHER MATERIAL TRANSACTIONS	ZPS_SERPV	PRICE VARIATION FOR SERVICES (CEMENT AND STEEL)
ML81N	CREATE SERVICE ENTRY	ZPS_SUP_UPL	SUPPLEMENTARY ITEMS UPLOAD
MM03	DISPLAY MATERIALS	ZPS_TNOTE	PS MODULE TNOTE FORM
MM60	MATERIAL MASTER SELECTION	ZPS_TWRSCH_UPLOAD	TOWER UPLOAD
QA32	RESULTS RECORDING AND USAGE DECISION	ZPSPOSHR	EMPLOYEE HIERARCHY REPORT
S_ALR_87013558	BUDGET/ACTUAL/COMMITMT/ REM.PLAN/ASSIGNED	ZQM_DI_REPORT	INBOUND DELIVERY REPORT
VL03N	OUTBOUND DELIVERY DISPLAY	ZQM_INSP	CREATE INSPECTION LOT
VL31N	INBOUND DELIVERY (DI)	ZTOWGR1	GOODES RECEIPT OF TOWER (103)
XD03	DISPLAY CUSTOMER DETAILS	ZTOWGR2	GOODES RECEIPT OF TOWER (RESULTS RECORDING/USAGE DECISION)
XK03	DISPLAY VENDOR DETAILS	ZQM_QA01	CREATION OF MULTIPLE LOTS
ZBOMDISPLAY	BILL OF MATERIAL AGAINST TOWERS/SS STRUCTURES	ZQM_QE01	RESULTS RECORDING UPLOADING
ZFIRCV	RECOVERIES REPORT AGAINST PURCHASE ORDER	QA14	CHANGING THE INSPECTION LOT QUANTITY

Energy losses & measures for reducing line losses

Computation of energy losses

- Energy losses = Energy Drawls – Energy Sales
 - Power (KW) p = $\sqrt{3}VIC\cos\phi$
 - I = $P/\sqrt{3}VC\cos\phi$
 - Losses = $3I^2R$
 - Energy losses = $\frac{P^2 R}{V^2 \cos^2 \phi}$
- Where P = Active Power in KW
 R = Resistance of the conductor
= $\rho l/A$
Where ρ = Resistivity of the conductor
 l = Length of line
 A = Area of cross section of the conductor
- V = Applied Voltage
 $\cos \phi$ = Power Factor

Measures for reducing line losses

1) BY reducing flow of load current (Energy Losses $\propto P^2$)

- Construction of new substations.
- Bifurcation of 33KV lines feeding more than 200Amps (or) having more than 4Nos 33/11KV substations on a single 33KV feeder.
- Bifurcation of 11KV lines feeding more than 150Amps in rural areas and 100Amps in urban areas.
- Energisation of additional DTRs for reducing the load on the over loaded DTRs
- Replacing the higher capacity DTRs such as 315KVA, 250KVA, 160KVA DTRs with 100KVA DTRs.
- Installing amorphous core DTRs (or) low loss CRGO core DTRs in urban areas.
- Providing 2Nos LT feeders for all DTRs.
- Conversion of single phase 3 wire LT line to 3phase 5 wire line.

2) By reducing the resistance of the conductor (Energy Losses $\propto R$)

- Reinforcement of old conductor with higher size conductors.
- Replacement of all the old zero copper conductors with AAAC conductors
- By reducing the length of lines.

3) By improving the voltage profiles (Energy Losses $\propto 1/V^2$)

- High voltage distribution system with 3Phase DTRs for agricultural loads and single phase DTRs for lighting supply.
- All the measures taken for system improvements helps to improve the voltage profiles.
- By maintaining 11.4KV at 11KV BUS in the 33/11KV substations improves the metered sales of lighting loads and reduces the load current of inductive loads.

4) By improving the power factor through reactive power compensation (Energy Losses $\propto 1/\cos \phi$)

- By providing capacitors at the agricultural motors.
- By providing LT shunt capacitors in the LT lines.
- By providing 600KVAR capacitor banks in the 11KV feeders.
- By providing 2MVAR capacitor banks at the 11KV BUS in 33/11KV substations.
- By providing 5/7.2MVAR capacitor banks at the 33KV BUS in 33/11KV substations (or) EHT substations.

- ❖ The benefits of the functioning of the capacitor starts from its location towards the source.

For example: The capacitor provided to the agricultural motor reduces the load current of the motor, LT lines, DTRs, 11KV feeders, 33/11KV Power Transformers and 33KV lines etc..

5) Measures for demand raising in HT and LT services:

- All the measures taken for demand raising in HT and LT services which include technical and commercial aspects, improves the metered sales, which ultimately reduces the line losses.

6) Other aspects:

- Providing AB cables in theft prone areas.
- Segregation of agricultural services from domestic feeders.
- Providing meters (or) ALMs for agricultural services, which cannot be segregated.
- Removing single phase DTRs in municipalities and Mandal headquarters.
- Rectification of red hot spot etc., in the lines and at equipment's.
- In rural feeders having 1/3rd arrangements all the 1Phase DTRs are to be equally distributed in each phase to reduce line losses.
- Providing street light phase wherever not available helps to install meters so as to properly bill the street light service consumption.

KVAH BILLING AND POWER FACTOR CORRECTION

An improvement of the power factor of an installation presents several technical and economic advantages such as

♦ Reduction of losses (P, kW) in cables

- ♦ Losses in cables/Conductors are proportional to the current squared, and are measured by the kWh meter of the installation.
- ♦ Reduction of the total current in a conductor by 10% for example, will reduce the losses by almost 20%.

♦ Reduction of Voltage drop

- ♦ Power factor correction capacitors reduce or even cancel completely the (inductive) reactive current in upstream conductors, thereby reducing or eliminating voltage drops.

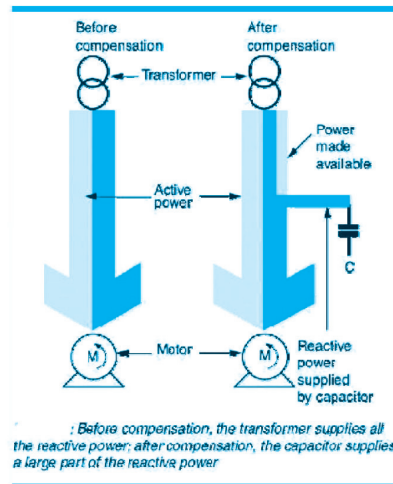
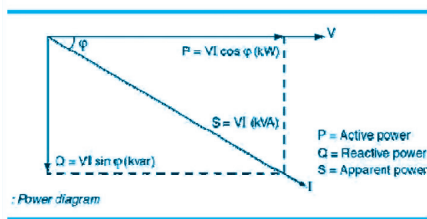
♦ Increase in available Power

- ♦ By improving the power factor of a load supplied from a transformer, the current through the transformer will be reduced, thereby allowing more load to be added. In practice, it may be less expensive to improve the power factor (1), than to replace the transformer by a larger unit.

♦ Reduced in Electricity Bills

- ♦ Demand saving.
- ♦ Loss saving
- ♦ Avoidance of penalties.

Note: Over compensation will produce a voltage rise at the capacitor level.



Example 1 :

A consumer is utilizing a load of 2 kW with single phase load of 240 volts and the power factor recorded is 0.5. Enumerate the difference of KVAH billing with respective to KW billing if the consumer is utilizing the above load on an average of 5 hours per day.

The consumer utilized power can be calculated as

$$\begin{aligned} \text{Active power} &= VI \cos \phi \\ 2 &= 0.240 \times I \times 0.5 \end{aligned}$$

$$\begin{aligned}
 I &= 2/(0.240 \times 0.5) \\
 I &= 16.67 \text{ A} \\
 \text{Apparent Power} &= VI \\
 &= 0.240 \times 16.67 \\
 &= 4 \text{ KVA}
 \end{aligned}$$

Billing pattern of Consumer

$$\begin{aligned}
 \text{KWH Billing} &= 2 \times 5 \times 30 = 300 \text{ units} \\
 \text{KVAH Billing} &= 4 \times 5 \times 30 = 600 \text{ units}
 \end{aligned}$$

Note : The consumer billed units will be doubled when compared to the normal billing i.e KWH billing due to the low power factor.

Example : 2

An HT Installation recorded maximum demand is 562 KVA with an average power factor of 0.8. Calculate the saving in demand charges and improvement in power factor if the consumer is suggested to connect 200 KVAR

Apparent power = 562 KVA

Real Power = 562 KVA \times 0.8 = 450 KW.

Reactive power = $\sqrt{(\text{Apparent Power})^2 - (\text{Real Power})^2} = 337 \text{ KVAR}$ It is suggested to connect the capacitor bank of 200 KVAR

Net KVAR of consumer = 337-200 = 137 KVAR.

Consumer Max demand recorded is

$$\begin{aligned}
 \text{Apparent Power} &= \sqrt{(\text{Real Power})^2 + (\text{Reactive Power})^2} \\
 &= \sqrt{(450)^2 + (137)^2} \\
 &= \sqrt{202500 + 18769} \\
 &= \sqrt{221269} \\
 &= 471 \text{ KVA}
 \end{aligned}$$

Saving in Demand Charges = 562 KVA - 471 KVA = 91 KVA Power factor = 450/471 = 0.96

Improvement in Power factor is 0.96 from 0.8.

Average power factor values for the most commonly-used equipment and appliances.

Equipment and appliances			cos φ (PF)
■ Common induction motor	loaded at	0%	0.17
		25%	0.55
		50%	0.73
		75%	0.80
		100%	0.85
■ Incandescent lamps			1.0
■ Fluorescent lamps (uncompensated)			0.5
■ Fluorescent lamps (compensated)			0.93
■ Discharge lamps			0.4 to 0.6
■ Ovens using resistance elements			1.0
■ Induction heating ovens (compensated)			0.85
■ Dielectric type heating ovens			0.85
■ Resistance-type soldering machines			0.8 to 0.9
■ Fixed 1-phase arc-welding set			0.5
■ Arc-welding motor-generating set			0.7 to 0.9
■ Arc-welding transformer-rectifier set			0.7 to 0.8
■ Arc furnace			0.8

DETAILS OF 400 KV DC Twin Moose TRANSMISSION LINES FOR ZONE-3

Type of Tower	Height in mm upto bottom X-arm	Base width in mm at CL	sturcture weight (Kgs.)		Total Weight (Kgs.)	Bolts, Nuts and washer weight (Kgs.)	Grand Total (Kgs.)
			MS	HT			
DA type Tower (0 -2 deg)							
Stub for DA			30	313	343	11	354
+18M & +25M Stub			82	331	413	6	419
Normal Tower for DA	25800	12000	6103	3281	9383	358	9741
+3M for DA	28800	12951	1378	250	1628	52	1680
+6M for DA	31800	13902	2210	474	2684	93	2777
+9M for DA	34800	14852	2822	736	3558	105	3663
+12M for DA	37800	15803	5437	951	6388	183	6571
+18M for DA	43800	17704	9573	1468	11041	278	11319
+25M for DA	50800	19922	14556	2088	16644	409	17053
DB type Tower (0 -15 deg)							
Stub for DB			28	725	753	20	773
Normal Tower for DB	21580	14000	10066	5775	15841	508	16349
+3M for DB	24580	15182	2499	483	2982	66	3048
+6M for DB	27580	16363	3412	929	4341	106	4447
+9M for DB	30580	17545	4532	1449	5981	150	6131
+18M for DB	39580	21090	10835	2861	13696	321	14017
+25M for DB							
DC type Tower (15 -30 deg)							
Stub for DC			28	1090	1118	24	1142
+18M Stub for DC			28	1354	1382	25	1407
+25M Stub for DC							
Normal Tower for DC	21580	14000	9438	8111	17549	543	18092
+3M for DC	24580	15182	2504	627	3131	70	3201
+6M for DC	27580	16363	3380	1177	4557	110	4667
+9M for DC	30580	17545	4687	1768	6455	159	6614
+12M for DC	33580	18728	8631	2339	10970	290	11260
+18M for DC	39580	21090	16334	3898	20232	407	20639
+25M for DC					0		0
DD type Tower (30 -60 deg and deadend)							
Stub for DD			192	1062	1254	31	1285
+18M Stub for DC							
+25M Stub for DC							
Normal Tower for DD	22000	15000	12870	9229	22099	653	22752
+3M for DD	25000	16264	2326	1864	4190	75	4265
+6M for DD	28000	17430	4282	2068	6350	127	6477
+9M for DD	31000	18791	5454	2911	8365	177	8542
+12M for DD	34000	20055	9795	3686	13481	253	13734
+18M for DD	40000	22583	17457	5305	22762	400	23162
+25M for DD	47000	25532	27086	7290	34376	622	34998

DETAILS OF 400 KV DC Twin Moose TRANSMISSION LINES FOR ZONE-3

Type of Tower	Height in mm upto bottom X-arm	Base width in mm at CL	sturcture weight (Kgs.)		Total Weight (Kgs.)	Bolts, Nuts and washer weight (Kgs.)	Grand Total (Kgs.)
			MS	HT			
DA type Tower (0 -2 deg)							
Stub for DA			11	429	440	19	459
Template for DA			2008	0	2008	45	2053
Normal Tower for DA			4553	4942	9495	362	9857
+0M for DA	25777	12574	1729	590	2319	59	2378
+3M for DA	28777	11486	1572	472	2044	53	2097
+6M for DA	31777	12473	2764	762	3526	78	3604
+9M for DA	34777	13561	3461	1073	4534	130	4664
+12M for DA					0		0
+18M for DA	43777	18496	5497	2040	7537	236	7773
+25M for DA					0		0
DB type Tower (0 -15 deg)							
Stub for DB			0	666	666	9	675
Template for DB			2802	0	2802	48	2850
Normal Tower for DB			6789	9200	15989	430	16419
+0M for DB	21630	15588	2100	982	3082	86	3168
+3M for DB	24630	16977	3252	650	3902	86	3988
+6M for DB	27630	18366	4688	1228	5916	128	6044
+9M for DB	30630	19756	5582	1953	7535	202	7737
+12M for DB	33630	21146	6258	1992	8250	199	8449
+18M for DB	42630	23925	6312	1412	7724	171	7895
+25M for DB							
DC type Tower (15 -30 deg)							
Stub for DC			0	856	856	10	866
Template for DC			3635	0	3635	57	3692
Normal Tower for DC	21580	17088	8457	10622	19079	601	19680
+0M for DC			2501	1193	3694	97	3791
+3M for DC	27030	15630	3582	642	4224	79	4303
+6M for DC	30030	17088	6552	1249	7800	135	7935
+9M for DC	33030	18546	7297	1926	9223	197	9420
+12M for DC	36030	22921	8939	2482	11421	244	11665
+18M for DC			19232	3721	22953	416	23369
+25M for DC							
DD type Tower (30 -60 deg and deadend)							
Stub for DD			0	1195	1195	14	1209
Template for DD			3833	0	3833	65	3898
Normal Tower for DD			9426	13409	22835	684	23519
+0M for DD	22000	17617	2397	1704	4101	101	4202
+3M for DD	24630	19079	3722	1099	4821	113	4934
+6M for DD	27630	20541	7156	1753	8909	176	9085
+9M for DD	30630	22035	7769	2700	10469	255	10724
+12M for DD	33630	23465	7930	3914	11844	220	12064
+18M for DD	42630	26390	11736	2646	14382	342	14724
+25M for DD							

DETAILS OF 400 KV DC Quad Moose TRANSMISSION LINES FOR ZONE-3

Type of Tower	Height in mm upto bottom X-arm	Base width in mm at CL	sturcture weight (Kgs.)		Total Weight (Kgs.)	Bolts, Nuts and washer weight (Kgs.)	Grand Total (Kgs.)
			MS	HT			
DA type Tower (0 -2 deg)							
Stub for DA			63	587	650	10	660
DA Stub for +18&25			73	620	693	10	703
Template for DA			1650	0	1650	49	1699
DA Temp for +18&25			2290	0	2290	59	2349
Normal Tower for DA			7980	6995	14975	633	15608
+0M for DA	26976	12085	1931	1281	3212	107	3319
+3M for DA	29976	12920	1865	483	2348	52	2400
+6M for DA	32976	13756	3099	897	3996	21	4017
+9M for DA	35976	14591	2730	1498	4228	33	4261
+12M for DA	38976	15426	4159	4465	8624	197	8821
+18M for DA	44976	17097	7380	3410	10790	272	11062
+25M for DA	51976	19046	11861	5075	16936	414	17350
DB type Tower (0 -15 deg)							
Stub for DB			0	1261	1261	27	1288
Template for DB			2021	157	2178	53	2231
Normal Tower for DB			7019	16270	23289	1151	24440
+0M for DB	22027	13716	2623	2434	5057	199	5256
+3M for DB	25027	14820	3830	3178	7008	259	7267
+6M for DB	28027	15924	3919	2058	5977	172	6149
+9M for DB	31027	17028	3720	2855	6575	301	6876
+12M for DB	34027	18132	8583	5776	14359	505	14864
+18M for DB					0		0
+25M for DB					0		0
DC type Tower (15 -30 deg)							
Stub for DC			0	1480	1480	36	1516
Template for DC			2190	0	2190	57	2247
Normal Tower for DC			8114	18988	27102	1335	28437
+0M for DC	22251	14118	1721	3924	5645	268	5913
+3M for DC	25251	15224	4640	3498	8138	312	8450
+6M for DC	28251	16330	3675	1970	5645	209	5854
+9M for DC	31251	17436	4569	3058	7627	276	7903
+12M for DC	34251	18542	8911	7422	16333	568	16901
+18M for DC					0		0
+25M for DC					0		0
DD type Tower (30 -60 deg and deadend)							
Stub for DD			271	1706	1977	41	2018
DA Stub for +18,+25 & +30		299	1884	2183	41	2224	
Template for DD			2335	0	2335	61	2396
Normal Tower for DD			9485	23265	32750	1535	34285
+0M for DD	14526	16984	3924	3823	7747	303	8050
+3M for DD	10500	18396	3305	6823	10128	381	10509
+6M for DD	20526	19808	6327	2905	9232	284	9516
+9M for DD	23526	21220	7755	4562	12317	388	12705
+12M for DD	26526	22632	10173	10824	20997	562	21559
+18M for DD	32526	25455	17377	10109	27486	747	28233
+25M for DD	39526	28750	21200	13694	34894	980	35874
+30M for DD	44526	31103	20671	36610	57281	1584	58865

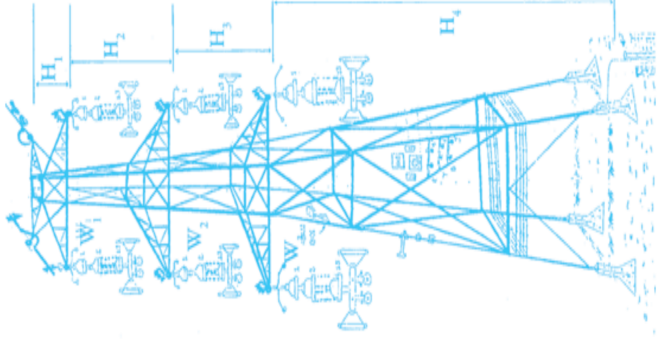
DETAILS OF 400 KV DC Quad Moose TRANSMISSION LINES FOR ZONE-5

Type of Tower	Height in mm upto bottom X-arm	Base width in mm at CL	sturcture weight (Kgs.)		Total Weight (Kgs.)	Bolts, Nuts and washer weight (Kgs.)	Grand Total (Kgs.)
			MS	HT			
DA type Tower (0 -2 deg)							
Stub for DA			80	538	618	14	632
DA Stub for +18&25			80	659	739	15	754
Template for DA			1774	0	1774	33	1807
Normal Tower for DA			7386	8516	15902	621	16523
+0M for DA	26976	12587	1912	1260	3172	126	3298
+3M for DA	10500	13467	2715	1699	4414	161	4575
+6M for DA	32976	14347	2914	1132	4046	121	4167
+9M for DA	35976	15227	3728	1569	5297	182	5479
+12M for DA	38976	16107	1025	4167	5192	125	5317
+18M for DA	44976	17867	7195	4138	11333	367	11700
+25M for DA	51976	19921	13121	5195	18316	545	18861
DB type Tower (0 -15 deg)							
Stub for DB			139	946	1085	17	1102
Template for DB			2186	0	2186	57	2243
Normal Tower for DB			7204	17046	24250	1161	25411
+0M for DB	22072	13963	3067	2215	5282	220	5502
+3M for DB	10500	15120	5021	2962	7983	258	8241
+6M for DB	28072	16279	4846	1811	6657	234	6891
+9M for DB	31072	17437	5907	2592	8499	309	8808
+12M for DB					0		0
+18M for DB					0		0
+25M for DB					0		0
DC type Tower (15 -30 deg)							
Stub for DC			0	1512	1512	31	1543
Template for DC			1929	0	1929	64	1993
Normal Tower for DC			8804	18474	27278	1318	28596
+0M for DC	22251	15218	2139	4049	6188	236	6424
+3M for DC	10500	16472	5173	3548	8721	279	9000
+6M for DC	28251	17725	5478	2405	7883	241	8124
+9M for DC	31251	18979	6558	3486	10044	326	10370
+12M for DC					0		0
+18M for DC					0		0
+25M for DC					0		0
DD type Tower (30 -60 deg and deadend)							
Stub for DD			270	1566	1836	41	1877
DD stub for +18&+25			270	1860	2130	30	2160
DD Stub for +18,+25 & +30			270	1910	2180	31	2211
Template for DD			2392	0	2392	65	2457
Normal Tower for DD			11623	22143	33766	1586	35352
+0M for DD	22026	17484	3907	4298	8205	320	8525
+3M for DD	10500	18964	3881	7293	11174	405	11579
+6M for DD	28026	20444	6899	3196	10095	312	10407
+9M for DD	31026	21924	8379	4965	13344	440	13784
+12M for DD	34026	23404	1613	10836	12449	343	12792
+18M for DD	40026	26364	21418	11095	32513	961	33474
+25M for DD	47026	29817	35728	16133	51861	1496	53357
+30M for DD	52026	32284	38482	19347	57829	1642	59471

DETAILS OF 132 KV AND 220 KV TRANSMISSION TOWERS

Voltage	Type of Tower	W ₁	W ₂	W ₃	W ₄	W ₅	W ₆	H ₁	H ₂	H ₃	H ₄	H ₅	H ₆	H ₇	Total Height	BASE Weight	Tower Weight (Normal)
132KV Multi Circuit (SAE)	K	3490	3630	3760	3980	4350	4850	4060	3950	3950	3950	4000	4050	14730	38690	8000	6455
	L	3500	3650	3800	4100	4550	5150	6100	3900	3900	3900	4050	4250	12650	38750	8700	10642
	M	3400	3450	3700	4000	4600	5350	5955	3900	3900	3950	4200	4200	12350	38455	11500	14751
220 KV Multi Circuit (SAE)	X	4205	4240	4350	4570	4990	5580	5075	4900	4900	4900	4900	4900	19390	49065	10000	9918
	Y	4500	4800	5100	5600	6500	7550	7800	5500	5500	5500	5900	5900	16780	53180	13000	16804
	Z	4550	4850	5300	5750	6200	7100	7925	5200	5200	5200	5200	5200	17450	51375	16500	26362

Voltage	Type of tower	W ₁	W ₂	W ₃	H ₁	H ₂	H ₃	H ₄	Total Height	BASE	TowerWt. (Normal)	Span	Design- ned for
132KV (Kamani)	P	3200	3280	3520	3353	3505	3505	14554	24917	4200	2927.27	320	
	R	3280	3510	4125	6000	3620	3760	12583	25963	7150	4517.52	320	Panther
	S	4150	4350	4925	7200	3900	4000	12583	27683	7750	5975.00	320	
132KV Narrow Based	60	4400	4400	4400	7550	3620	3620	12300	27090	3774	8225.64	120	Panther
220 KV L&T	A	4200	4300	4600	4865	5050	5050	19755	34720	6295	4362.63	350	
	B	4200	4200	4675	7275	4900	4950	16675	33800	8300	6894.68	350	Moose
	C	4350	4650	5175	7535	5025	5100	16675	34335	8574	8173.94	350	
	D	3000	3650	4200	7795	5050	5100	16875	34820	10730	9922.94	350	
220 KV EMC	A	4710	4920	5350	5700	5320	5390	21939	38349	7872	7239.15	400	
Twin Moose	B	4410	4630	5140	8030	4900	4960	18939	36829	10036	10993.97	400	
	C	4945	5265	5995	8955	5040	5160	18939	38094	11589	13477.21	400	Twin
	D	4530	5030	5970	9198	5230	5380	18939	38747	12975	18381.70	400	Moose
		5085	5630	6425									
220KV TSP	C	4900	5000	5500	8450	5200	5300	19085	38035		12535.94	380	
JCM (Truncated)	Susp	4850	5100	5600	5600	7000	7000	52550	72150	10402	32564.88		



Annexure S.O.O.(CGM-OPN)MS.No.128, Dated: 04-08-2014
SCHEDULE - II (A.P.Gazette. No.197, Dt: 8-8-2013 of Regulation No.9 of 2013)
Suggested Modifications to Guaranteed Standards of Performance and Compensation to Consumers in case of Default by Hon'ble CM during meeting on 14-6-2014

Service Area	Suggested time standard	Compensation payable in case of violation of standard	
		Compensation payable to individual consumer if the event affects a single consumer	Compensation payable to individual consumer if the event affects more than one consumer

I. Normal fuse of calls

i. Cities and Towns	Within 4 working hours	Rs. 100 in each case of default	Rs. 50 to each consumer affected
ii. Rural areas	Within 12 working hours		

II. Overhead line / cable breakdowns

i. Cities and towns	Within 6 working hours	Rs. 100 in each case of affected	Rs. 50 to each consumer
ii. Rural areas	Within 24 working hours		

III. Underground cable breakdowns

i. Cities and towns	Within 12 working hours	Rs. 100 in each case of affected	Rs. 50 to each consumer
ii. Rural areas	Within 48 working hours		

IV. Distribution Transformer Failures

i. Cities and towns	Within 12 working hours	Rs. 200 in each case of affected	Rs. 100 to each consumer
ii. Rural areas	Within 24 working hours		

V. Period of Scheduled Outage

i. Maximum duration in a single stretch	Not to exceed 12 hours	Rs. 200 in each case of	Rs. 100 in each case of default
ii. Restoration of Supply	By not later than 6.00 PM		

VI. Voltage fluctuations

i. No.of expansion/enhancement of network involved	Within 3 Days	Rs. 100 for each day of default	Rs. 50 in each consumer affected for each day of default
ii. Up Gradation of distribution system required	Within 30 Days	Rs. 100 for each day of default	Rs. 100 in each consumer affected for each day of default
iii. Erection of Sub Station	Within the time period as approved by the Commission	Rs. 50 for each day of default	Rs. 100 in each consumer affected for each day of default

VII. Meter Complaints

i. Inspection and replacement of Slow, fast/ creeping, stuck up meters	Inspection within 3 days in towns and cities and within 5 days in rural areas and replacement within 5 days there after	Rs. 100 for each day of default	Not applicable
ii. Replace burnt meters if cause attributable to Licensee	Within 3 Days		
iii. Replace burnt meters if cause attributable to Consumer	Within 3 Days of receiving payment from consumer		

VIII. Processing of Application & intimation of relevant charges payable for new connection/sanction of additional load/Demand

i. All Cases- If connection feasible from existing network for release of supply	Within 3 working days of receipt of application	Rs. 100 for each day of default	Not applicable
ii. Network expansion / enhancement required to release of supply			
a. Release of supply - Low Tension	Within 5 Days of receiving payment from consumer	Rs. 100 for each day of default	Not Applicable
b. Release of supply - HT Tension 11 KV	Within 7 days of receipt of application		
c. Release of supply - HT Tension 33 KV	Within 20 days of receipt of application	Rs. 500 for each day of default	
d. Release of supply - Extra High Tension	Within 45 days of receipt of prescribed charges		

IX. Release of new connection/additional load upon payment of all charges

i. All cases - if connection feasible from existing network for release of supply	Within 2 days of receipt of application (along with prescribed charges) in Urban and 5 days in Rural area	Rs. 100 for each day of default	Not Applicable
ii. Network expansion / enhancement required to release of supply			
a. Release of supply - Low Tension	Within 10 days of receipt of prescribed charges	Rs. 100 for each day of default	Not Applicable
b. Release of supply - HT Tension 11 KV	Within 15 days of receipt of prescribed charges and 10 days for every additional 1 Kilometer of line		
c. Release of supply - HT Tension 33 KV	Within 90 days of receipt of prescribed charges	Rs. 500 for each day of default	
d. Release of supply - Extra High Tension	Within 180 days of receipt of prescribed charges		
e. Erection of substation required for release of supply	Within the time period approved by the commission	Rs.1000 for each day of default	

X. Transfer of ownership and conversion of services

a. Title transfer of ownership	Within 3 days along with necessary documents and prescribed fee if any	Rs. 100 for each day of default	Not Applicable
b. Change of category	Within 3 days along with necessary documents and prescribed fee if any		
c. Conversion from LT 1-ph to LT 3-ph and vice versa	Within 5 days of payment of charges by the consumer		
d. Conversion from LT 3-ph to HT and vice versa	Within 60 days of payment of charges by the consumer	Rs. 200 for each day of default	

XI. Resolution of complaints on consumer's bill

If no additional information is required	Within 24 working hours of receipt of complaint	Rs. 50 for each day of default	Not Applicable
If additional information is required	Within 7 working days of receipt of complaint		

XII. Re Connection of supply following disconnection due to non-payment of bills

i. Cities and Towns	Within 4 working hours of production of proof of payment by consumer	Rs. 100 for each day of default	Not Applicable
ii. Rural areas	Within 4 working hours of production of proof of payment by consumer		

XIII. Wrongful disconnection of service connection/levy of reconnection charges without disconnection

i. Wrongful disconnection of service connection even after payment of electricity charges due		Rs. 100 for each day of default	Not Applicable
	Not Applicable		

**ALUMINIUM CONDCUTOR STEEL REINFORCED -
ACSR, As per IS 398- Part 2 & BS**

Code Name	Nominal Area Al (Sq. mm)	Stranding and wire diameter		Overall Diameter in mm	Ultimate Tensile Strength of Conductor (kg)	Approx. Current Carrying Capacity at 40°C Ambient Temp (Amps)	Approx. Weight (kg/km)
		Aluminium (No/mm)	Steel (No/mm)				
Squirrel	20	6/ 2.11	1/ 2.11	6.33	776	90	85
Weasel	30	6/ 2.59	1/ 2.59	7.77	1136	120	128
Rabbit	50	6/ 3.35	1/ 3.35	10.25	1860	165	214
Dog	100	6/ 4.72	7/ 1.57	14.15	3305	256	394
Wolf	150	30/ 2.59	7/ 2.59	18.13	6867	335	727
Lynx	180	30/ 2.79	7/ 2.79	19.53	7945	368	844
Panther	200	30/ 3.18	7/ 3.00	21	9127	413	976
Bear	260	30/ 3.35	7/ 3.40	23.45	11310	468	1219
Zebra	420	54/ 3.18	7/ 3.18	28.62	13316	643	1621
Deer	420	30/ 4.27	7/ 4.27	29.89	18230	500	1976
Moose	520	54/ 3.53	7/ 3.53	31.77	16250	728	2002

**ALL ALUMINIUM ALLOY CONDCUTORS -
AAAC As per IS 398- Part 4**

Code Name	Nominal Area Al (Sq. mm)	Stranding and wire		Overall Diameter in mm Conductor	Ultimate Tensile Strength of Capacity at (kg)	Approx. Current Carrying 40°C Ambient Temp (Amps)	Approx. Weight (kg/km)
		Aluminium (No/mm)	Steel (No/mm)				
Weasel	34	7/2.50	-	7.5	1030	125	94
Rabbit	55	7/3.15	-	9.45	1634	165	149.2
Dog 272.86		100	7/4.26	-	12.78	2983	250
Panther240	37/2.88	-	20.16	6880	425	663.8	

PLAIN CEMENT CONCRETE (Civil Information)

Mix Proportion	Cement (Kg)	FA (m3)	CA (m3)
1:4:8	162	0.45	0.9
1:3:6	216	0.45	0.9
1:2.5:5	259.2	0.45	0.9
1:2:4	324	0.45	0.9
1:1.5:3	432	0.45	0.9

CIVIL INFORMATION

WEIGHTS OF STEEL

0.7843 kg/cm per metre

<i>Plates</i>		<i>Black Sheets</i>			<i>Chequered Plates</i>	
<i>Thickness in mm.</i>	<i>B.G.</i>	<i>Wt. per sq. metre in kg.</i>	<i>Thickness in mm.</i>	<i>Wt. per sq. in kg.</i>	<i>Thickness in mm.</i>	<i>Sq. metre in kg.</i>
3.15	10	24.70	5	39.2	7	61.1
2.50	12	19.61	7	55.0	10	84.6
2.00	14	15.69	10	78.5	12	100.3
1.66	16	12.55	12	94.2		
1.25	18	9.80	14	109.9		
1.00	20	7.84	16	125.6		
0.80	22	6.27	18	141.3		
0.63	24	4.94	20	157.0		
0.50	26	3.91	22	172.7		
0.44	28	3.10	25	196.2		

FLAT IRON-WEIGHT IN KG. PER METRE

0.7843 kg/cm² per metre of cft of Steel = 490 lbs

<i>Thickness in mm.</i>	<i>5</i>	<i>5.5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>14</i>	<i>16</i>
<i>Width in</i>	<i>mm</i>									
12	0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.3	1.5
16	0.6	0.7	0.8	0.9	1.0	1.3	1.4	1.5	1.8	2.0
20	0.8	0.9	0.0	1.1	1.3	1.6	1.7	1.9	2.2	2.5
25	1.0	1.1	1.2	1.4	1.6	2.0	2.2	2.4	2.7	3.1
32	1.3	1.4	1.5	1.8	2.0	2.5	2.8	3.0	3.5	4.0
40	1.6	1.7	1.9	2.2	2.5	3.1	3.5	3.8	4.4	5.0
50	2.0	2.2	2.4	2.7	3.1	3.9	4.3	4.7	5.5	6.3
63	2.5	2.7	3.0	3.5	4.0	4.9	5.4	5.9	5.9	7.9
80	3.1	3.5	3.8	4.4	5.0	6.3	6.9	7.5	-	10.0
100	3.9	4.3	4.7	5.5	6.3	7.8	8.6	9.4	-	12.6
125	4.9	5.4	5.9	6.9	7.8	9.8	10.8	11.8	-	15.7
160	6.3	6.9	7.5	8.8	10.0	12.6	13.8	15.1	-	20.1
200	7.8	8.6	9.4	11.0	12.6	15.7	17.3	18.8	-	25.1
250	9.8	10.8	11.8	13.7	15.7	19.6	21.6	23.6	-	31.4

SQUARE AND ROUND BARS

0.7843 kg/Cm2 per metre or 1 cft of Steel = 490 lbs

Diameter or Width (mm)	Weight per meter		Sectional Area		Perimeter	
	Square (kg)	Round (kg)	Square (cm ²)	Round (cm ²)	Square (cm)	Round (cm)
5	0.2	0.15	0.25	0.2	2	1.57
5.5	0.24	0.19	0.3	0.24	2.2	1.78
6	0.28	0.22	0.36	0.28	2.4	1.88
7	0.38	0.3	0.49	0.38	2.8	2.2
8	0.5	0.39	0.64	0.5	3.2	2.51
9	0.64	0.5	0.81	0.64	3.6	2.83
10	0.73	0.63	1	0.79	4	3.14
11	0.95	0.75	1.21	0.95	4.4	3.46
12	1.13	0.89	1.44	1.13	4.8	3.77
14	1.54	1.21	1.96	1.54	5.6	4.4
16	2.01	1.58	2.56	2.01	6.4	5.03
18	2.54	2	3.24	2.54	7.2	5.65
20	3.14	2.47	4	3.14	8.0	6.28
22	3.8	2.98	4.84	3.8	8.8	6.91
25	4.91	3.85	6.25	4.91	10	7.85
28	6.15	4.83	7.84	6.16	11.2	8.80
32	8.04	6.31	10.24	8.04	12.8	10.05
36	10.17	7.99	12.96	10.18	14.4	11.31
40	12.56	9.86	16	12.57	16	12.57
45	15.9	12.49	20.25	15.9	18	14.14
50	19.62	15.41	25	19.64	20	15.71
56	24.62	19.34	31.36	24.63	22.4	17.59
63	31.16	24.47	36.69	31.17	25.2	19.79
71	39.57	31.08	50.41	39.59	28.4	22.31
80	50.24	39.46	64	50.27	32	25.13

USEFUL NOTES ON CEMENT

- ✦ Ton of Portland Cement - 20 Bags.
 - ✦ Cubic foot of Portland Cement weights 90 to 94 lbs, when loosely filled. Average weight of 1:2:4 concrete, Cokebreexe aggregate 100 lbs. per cubic foot; Clinker aggregate 100 lbs. per cbic foot; Brick aggregate 125 lbs. per cubic foot, Ballast aggregate 145 lbs. per cubic foot.
- Average weight of 1:2:4 reinforced concrete, 150 lbs. per cubic foot
- ✦ Cubic foot of loose Portland Cement paste will make about
 - 4.1 cu. ft. of concrete mixed 1:2:4 5.1 cu. ft. of concrete mixed 1.2½:5
 - 5.8 cu. ft. of concrete mixed 1:3:6 7.5 cu. of concrete mixed 1:4:8
 - ✦ Cubic foot of loose Portland Cement neat as Cement Portland will cover about 9.5 Sq. Feet 1 inch think.
 - ✦ Cubic foot of loose Portland Cement to 2 of sand will cover 16.6 sq. feet, 1 inch. think
 - ✦ Cubic foot of loose Portland Cement of 2 of sand will cover about 29.7 sq. feet 1 inch. think.
 - ✦ Cubic foot of loose Portland Cement to 3 of sand will cover about 35.7 sq. feet 1 inch think.
 - ✦ Cubic foot of loose Portland Cement to 6 of sand will lay about 410 bricks with 3/5 inch joints and 527 bricks with 1/4 joints.

ROLLED STEEL BEAMS (Indian Standard)

Designation		Weight per metre W Kg.	Sectional area a cm²	Depth of section h mm	Width of Flange b mm	Thickness of Flange tf mm	Thickness of Web tw mm
ISJB	150	7.1	9.01	150	50	4.6	3.0
ISJB	175	8.1	10.28	175	50	4.8	3.2
ISJB	200	9.9	12.64	200	60	5.0	3.4
ISJB	225	12.8	16.28	225	80	5.0	3.7
ISLB	75	6.1	7.7	75	50	5.0	3.7
ISLB	105	8.0	10.21	100	50	6.4	4.0
ISLB	125	11.9	15.12	125	75	6.5	4.4
ISLB	150	14.2	18.08	150	80	6.8	4.8
ISLB	175	16.7	21.30	175	90	6.9	5.1
ISLB	200	19.8	25.27	200	100	7.3	5.4
ISLB	225	23.5	29.92	225	100	8.6	5.8
ISLB	250	27.9	35.53	250	125	8.2	6.1
ISLB	275	33.0	42.02	275	140	8.8	6.4
ISLB	300	37.7	48.08	300	150	9.4	6.7
ISLB	325	43.1	54.90	325	165	9.8	7.3
ISLB	350	49.5	63.01	350	165	11.4	7.4
ISLB	400	56.9	72.43	400	165	12.5	8.0
ISLB	450	65.3	83.14	450	170	13.4	8.6
ISLB	500	75.0	95.50	500	180	14.1	9.2
ISLB	550	86.3	109.97	550	190	15.0	9.9
ISLB	600	99.5	126.69	600	210	15.5	10.5
ISMB	100	11.5	14.60	100	75	7.2	4.0
ISMB	125	13.0	16.60	125	75	7.6	4.4
ISMB	150	14.9	19.00	150	80	7.6	4.8
ISMB	175	19.3	24.62	175	90	8.6	5.5
ISMB	200	25.4	32.30	200	100	10.8	5.7
ISMB	225	31.2	39.72	225	110	11.8	6.5
ISMB	250	37.3	47.55	250	125	12.5	6.9
ISMB	300	44.2	56.26	300	140	12.4	7.5
ISMB	350	52.4	66.71	350	140	14.2	8.1
ISMB	400	61.6	78.46	400	140	16.0	8.9
ISMB	450	72.4	92.27	450	150	17.4	9.4
ISMB	500	86.9	110.74	500	180	17.2	10.2
ISMB	550	103.7	132.11	550	190	19.3	11.2
ISMB	600	122.6	156.21	600	210	20.8	12.0
ISWB	150	17.0	21.67	150	100	7.0	5.4

ROLLED STEEL BEAMS (Indian Standard)

Designation		Weight per metre W Kg.	Sectional area a cm ²	Depth of section h mm	Width of Flange b mm	Thickness of Flange tf mm	Thickness of Web tw mm
ISJC	100	5.8	7.41	100	45	5.1	3.0
ISJC	125	7.9	10.07	125	50	6.6	3.0
ISJC	150	9.9	12.65	150	55	6.9	3.6
ISJC	175	11.2	14.24	175	60	6.9	3.6
ISJC	200	13.9	17.77	200	70	7.1	4.1
ISLC	75	5.7	7.26	75	40	6.0	3.7
ISLC	100	7.9	10.02	100	50	6.1	4.0
ISLC	125	10.7	13.67	125	65	6.6	4.4
ISLC	150	14.4	18.36	150	75	7.8	4.8
ISLC	175	17.6	22.40	175	75	9.5	5.1
ISLC	200	20.6	26.22	200	75	10.8	5.5
ISLC	225	24.0	30.50	225	90	10.2	5.8
ISLC	250	28.0	35.65	250	100	10.7	6.1
ISLC	300	33.1	42.11	300	100	11.6	6.7
ISLC	350	38.8	49.47	350	100	12.5	7.4
ISLC	400	45.7	58.25	400	100	14.0	8.0
ISMC	75	6.8	8.67	75	40	7.3	4.4
ISMC	100	9.2	11.70	100	50	7.5	4.7
ISMC	125	12.7	16.19	125	65	8.1	5.0
ISMC	150	16.4	20.88	150	75	9.0	5.4
ISMC	175	19.1	24.38	175	75	10.2	5.7
ISMC	200	22.1	28.21	200	75	11.4	6.1
ISMC	225	25.9	33.01	225	80	12.4	6.4
ISMC	250	30.4	38.67	250	80	14.1	7.1
ISMC	300	35.8	45.64	300	90	13.6	7.6
ISMC	350	42.1	53.66	350	100	13.5	8.1
ISMC	400	49.4	62.93	400	100	15.3	8.6

PLASTERING for 10m²

Thickness	20mm		12mm		8mm		16mm		4mm	
proportion	Cement (kg)	FA (m ³)	Cement (kg)	FA (m ³)	Cement (kg)	FA (m ³)	Cement (kg)	FA (m ³)	Cement (kg)	FA (m ³)
CM (1:2)		0.21	108	0.15	79.2	0.11	129.6	0.18	28.8	0.04
CM (1:3)		0.21	72	0.15	52.8	0.11	86.4	0.18	19.2	0.04
CM (1:4)	75.6	0.21	54	0.15	39.6	0.11	64.8	0.18	14.04	0.04
CM (1:5)	60.48	0.21	43.2	0.15	31.68	0.11	51.84	0.18		
CM (1:6)	50.4	0.21	36	0.15	26.4	0.11	43.2	0.18		

Dimensions and weight of steel tubes according the British Standard - BS 1387 : 1985

Nominal boreLight		Outside diameter		Thickness			Mass	
		Mudium / Heavy	Light	Medium	Heavy	Light	Medium	Heavy
inches	mm	mm	mm	mm	mm	mm	kg/m	kg/m
1/4	8	13.6	13.9	1.8	2.3	2.9	0.515	0.641
3/8	10	17.1	17.4	1.8	2.3	2.9	0.67	0.839
1/2	15	21.4	21.7	2	2.6	3.2	0.947	1.21
3/4	20	26.9	27.2	2.3	2.6	3.2	1.38	1.56
1	25	33.8	34.2	2.6	3.2	4	1.98	2.41
1 1/4	32	42.5	42.9	2.6	3.2	4	2.54	3.1
1 1/2	40	48.4	48.8	2.9	3.2	4	3.23	3.57
2	50	60.2	60.8	2.9	3.6	4.5	4.08	5.03
2 1/2	65	76	76.6	3.2	3.6	4.5	5.71	6.43
3	80	88.7	89.5	3.2	4	5	6.72	8.37
4	100	113.9	114.9	3.6	4.5	5.4	9.75	12.2
5	125		140.6		5	5.4		16.6
6	150		166.1		5	5.4		19.7
								21.3

ROLLED STEEL EQUAL ANGLES (Indian Standard)

Dimensions and Properties

Designation	Size A x B (mm x mm)	Thickness (mm)	Sectional Area (cm ²)	Weight Per Meter (kg)	Moduli of Section (cm ³)
ISA 2020	20 X 20	3.0	1.12	0.9	0.3
		4.0	1.45	1.1	0.4
ISA 2525	25 X 25	3.0	1.41	1.1	0.4
		4.0	1.84	1.4	0.6
		5.0	2.25	1.8	0.7
ISA 3030	30 X 30	3.0	1.73	1.4	0.6
		4.0	2.26	1.8	0.8
		5.0	2.77	2.2	1.0
ISA 3535	35 X 35	3.0	2.03	1.6	0.9
		4.0	2.66	2.1	1.2
		5.0	3.27	2.6	1.4
		6.0	3.86	3.0	1.7
ISA 4040	40 X 40	3.0	2.34	1.8	1.2
		4.0	3.07	2.4	1.6
		5.0	3.78	3.0	1.9
		6.0	4.47	3.5	2.3
ISA 4545	45 X 45	3.0	2.64	2.1	1.5
		4.0	3.47	2.7	2.0
		5.0	4.28	3.4	2.5
		6.0	5.07	4.0	2.9
ISA 5050	50 X 50	3.0	2.95	2.3	1.9
		4.0	3.88	3.0	2.5
		5.0	4.79	3.8	3.1
		6.0	5.68	4.5	3.6
ISA 5555	55 X 55	5.0	5.27	4.1	3.7
		6.0	6.26	4.9	4.4
		8.0	8.18	6.4	5.7
		10.0	10.02	7.9	7.0
ISA 6060	60 X 60	5.0	5.75	4.5	4.4
		6.0	6.84	5.4	5.2
		8.0	8.96	7.0	6.8
		10.0	11.00	8.6	8.4
ISA 6565	65 X 65	5.0	6.25	4.9	5.2
		6.0	7.44	5.8	6.2
		8.0	9.76	7.7	8.1
		10.0	12.00	9.4	9.9
ISA 7070	70 X 70	5.0	6.77	5.3	6.1
		8.0	8.06	6.3	7.3
		8.0	10.58	8.3	9.5
		10.0	13.02	10.2	11.7
ISA 7575	75 X 75	5.0	7.27	5.7	7.1
		6.0	8.66	6.8	8.4
		8.0	11.38	8.9	11.0
		10.0	14.02	11.0	13.5

<i>Designation</i>	<i>Size A x B (mm x mm)</i>	<i>Thickness (mm)</i>	<i>Sectional Area (cm²)</i>	<i>Weight Per Meter (kg)</i>	<i>Moduli of Section (cm³)</i>
ISA 8080	80 X 80	6.0	9.29	7.3	9.6
		8.0	12.21	9.6	12.6
		10.0	15.05	11.8	15.5
		12.0	17.81	14.0	18.3
ISA 9090	90 X 90	6.0	10.47	8.2	12.2
		8.0	13.79	10.8	16.0
		10.0	17.03	13.4	19.3
		12.0	20.19	15.8	23.3
ISA 100100	100 X 100	6.0	11.67	9.2	15.2
		8.0	15.39	12.1	20.0
		10.0	19.03	14.9	24.7
		12.0	22.59	17.7	29.2
ISA 110110	110 X 110	8.0	17.02	13.4	24.4
		10.0	21.06	16.5	30.1
		12.0	25.02	19.6	35.7
		15.0	30.81	24.2	43.7
ISA 130130	130 X 130	8.0	20.22	15.9	34.5
		10.0	25.06	19.9	42.7
		12.0	29.82	23.4	50.7
		15.0	36.81	28.9	62.3
ISA 150150	150 X 150	10.0	29.03	22.8	56.9
		12.0	34.59	27.2	67.7
		15.0	42.78	33.6	83.5
		18.0	50.79	39.9	98.7
ISA 200200	200 X 200	12.0	46.61	36.6	122.2
		15.0	57.80	45.4	151.4
		18.0	68.81	54.0	179.9
		25.0	93.80	73.6	243.3

MASONRY WORKS

<i>CR Masonry</i>	<i>1st Sort</i>	<i>Cement</i>	<i>FA</i>	<i>2nd Sort</i>	
	<i>CRS</i>	<i>(kg)</i>	<i>(m3)</i>	<i>Cement</i>	<i>FA</i>
				<i>(kg)</i>	<i>(m3)</i>
CM (1:6)	1.1	67.2	0.28	76.8	0.32
CM (1:5)	1.1	80.64	0.28	92.16	0.32
CM (1:4)	1.1	100.8	0.28	115.2	0.32
RR Masonry					
CM (1:6)	1.1	79.2	0.33		
CM (1:5)	1.1	95.04	0.33		
CM (1:4)	1.1	118.8	0.33		
Brick Masonry (23 x 11 x 7 cm)					
CM (1:6)	512	48	0.2		
CM (1:5)	512	57.6	0.2		
CM (1:4)	512	72	0.2		