Ⅲ. 資 料 集

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5．ＡＰ州電力事情（ＡＰＳＥＢ発行）

सत्यमेव जयते

भारत सरकार Government of India
वित्त मंत्रालय Ministry of Finance
आर्थिक कार्य विभाग Department of Economic Affairs

नई दिल्ली/New Delhi, ... 19

No.7/1/98 Jap. 13.02.1998

NOTE VERBALE

The Ministry of Finance of India presents its compliments to the Embassy of Japan and, with reference to the Embassy's Note Verbale No.5/65/97 dated July 23, 1997 inviting proposals for preparation of detailed project reports under the Technical Cooperation Programme of the Government of Japan, has the honour to say that this Ministry would be grateful if the Embassy could kindly consider the enclosed proposal on Study for Reinforcement of Transmissioin and Distribution Network System in Andhra Pradesh.

The Ministry of Finance of India avails itself of this opportunity to renew to the Embassy the assurances of its highest consideration.

The Embassy of Japan,
New Delhi.

Copy to:

1. Ministry of Power,
(Shri PI Suvrathan, Jt. Secy.)
Shram Shakti Bhavan,
New Delhi, w.r.t. your D.O.No.12/3/96 EA(Vol.II) dated 10th February, 1998.

2. Mr. T. Tanaka,
Deputy Resident Respresentative,
JICA,
New Delhi.

3. Mr. D.M. Mulay,
First Secretary,
Embassy of India,
Tokyo.

THE STUDY FOR REINFORCEMENT OF TRANSMISSION AND DISTRIBUTION NETWORK SYSTEM IN ANDHRA PRADESH

TERMS OF REFERENCE

1. BACKGROUND

The Andhra Pradesh power sector is to implement steadily the reform of the power sector under the assistance of World Bank.
Then, it is quite essential to improve the weak point of power sector in transmission and distribution system in order to achieve the said reform and restructuring taking into consideration possible privatization in the future.

2. SCOPE OF SERVICES

Scope of services is as follows;

I. Improvement of efficiency in Transmission and Distribution sector

(1) Present status and constraints of Transmission and Distribution sector

a) Design criteria and configuration of distribution system
b) Mapping of Distribution network.
c) Automation of Distribution.
d) Energy and facilities management systems.
e) Renovation and upgradation of Transmission network.
f) Quality control measures.
g) Communication system management.

(2)Support in increasing of efficiency in power sector, especially transmission and distribution field.

a) Strategy for restructuring
b) Revision of design criteria and master plan for reinforcement of Distribution of network.
c) Institutional strengthening measures

(3)Project management

a) Project scheduling and management
b) Project monitoring
c) Economic and financial analysis.

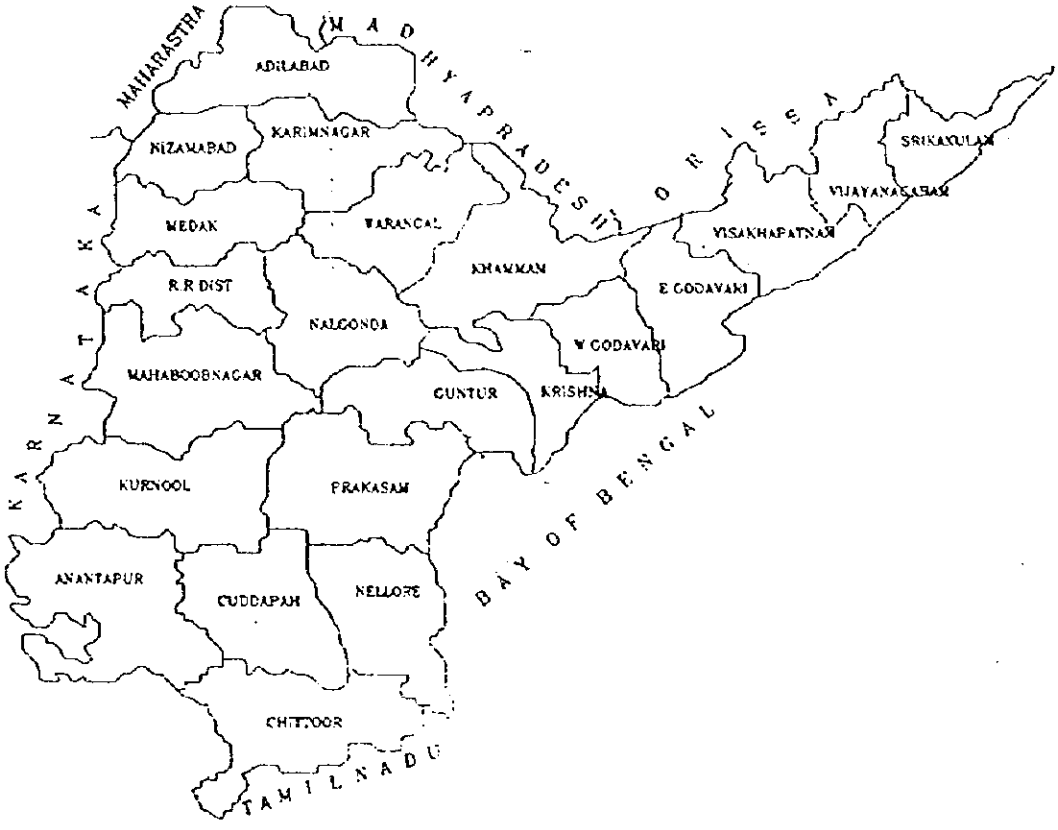
II. Detailed studies

a) Billing & metering and revenue improvement (Process Reengineering)
b) Energy auditing
c) Standardization of construction practices for Transmission and Distribution networks

III. Training and technology transfer

a) Technology transfer for modernizing of operation and maintenance of Transmission and Distribution networks
b) Training and capacity building including assessment of training needs for upgrading skills

2 . Location Map of Andhra Pradesh State



事前質問事項に対するAPSEBの回答

Study Item			Opinions & Realities of AP
Network Planning	Network Configuration and Capacity	Supplied voltage (electric system) and contract demand (kW)	240V(Single phase 2 & 3 wire systems) - up to 3kW 415V(Three phase 4 & 5 wire systems) - up to 75HP(56 kW) 11kV(Three phase 3 wire system) neutral grounded - above 75HP and up to 1500kVA 33kV(3 phase 3 wire system) neutral grounded - above 1500kVA and up to 5000kVA
		Network configuration (high voltage)	Mostly Overhead, Underground system adopted for high demand density areas of cities, like Hyd. & Visakhapatnam. Interlinking lines are also provided to assure reliability.
		Conditions of accident occurrence as prerequisite	For 33kV & 11kV systems, segregation of faulty section is taken care of with minimum interruption to healthy sections. In case of LT lines, the CSP DTrs are provided with breakers to trip the line in case of faults.
		Transformer capacities and supply range	Transformer capacities and supply range are determined load wise in certain areas.
		Is the low voltage network standardized?	Voltage of the network is overhead with LT lines being Single phase 2 or 3 wire, 3-phase 4 or 5 wire systems and the networks are standardized. REC standards are adopted in case of rural networks.
	Scope of Loads	Scope of loads in systems and sections	Load of the system or a section is estimated based on the different categories of consumers catered and the No. of transformers installed. There are defined norms for a section to be managed by the lower most officer in the management hierarchy i.e. Section Officer.
		Scope of current values in systems and sections	The current values in a particular section depends on the total load catered to the different consumers in that section. Distribution automation is in the process of implementation in the Board. SCADA in Hyderabad city is already under implementation.
	Network Planning and Design Policies	Scope of currents in transformers	Whenever overloading of DTRs is suspected, on line measurements of currents is done and necessary corrective measure taken. In the case of 33kV SS, the transformer capacity is augmented suitably to cope up with existing demand and future load growth.
		Conversion of peak values	Peak values are measured at 33kV voltage levels and whenever the loads are exceeding the loading capacity of the feeder or the transformer capacities are suitably augmented or reconfiguration/reconductory of the network is also done.

		Distribution substation, distribution line capacity	In 33/11 kV substations, the following Power Transformer capacities are used on the load conditions. 1.6MVA 3.15MVA 5MVA 8MVA or a combination of the above. The length of a distribution line and the conductor to be used for the line are determined based on the load on the line. The voltage regulations are maintained for quality as per the rules at proper voltage level. In general, the following conductors are used in the distribution network. 33kV-100 sq.mm AAA Conductor 11kV-50 sq.mm AAA Conductor for main line & 30 sq.mm AAA Conductor for spur line LT-30 sq.mm AAA Conductor for phase & 20 sq.mm AAA Conductor for neutral
		Status of voltage control	Voltage adjustments are done by adjusting transformer taps in 33kV substations (Up to plus 25%) wherever necessary, boosters and line capacitors are also installed at appropriate places both in substations and in lines to improve voltage profile. Both switched and fixed capacitors are used, in areas of high density of agricultural loads, LT capacitors of capacities 50kVA, 45kVA & 30kVA at DTR secondary.
		Are equipment and devices standardized? (size) Are specifications defined? Quality control method for purchased equipment	All the equipment are purchased as per Indian Standard specifications. All the required tests are performed on the prototype, which will be inspected by Board's Engineers before acceptance. There is a separate quality control cell for this purpose.
Facilities Management	Concept on Facilities Management	Management of equipment; year of manufacturing and installing, manufacturer Management of places for setting up Customer & facility-related management	The process of computerization of inputs of all the distribution facilities, lines, power transformers, DTRs, meters, No. of services etc. has been taken up. DTR coding, DTR structure coding, consumers Master already done. Computerized system studies of the distribution system is also being done, whenever necessary. System Improvement Projects are being formulated by utilizing the DISBUT software developed by the Board.
	Map Management Method	Managing method	Computerized digital mapping of the distribution network is being done.
Operation & Maintenance	Visual & Other Inspection Safety Regulations	Basic concept Cycles	All the distribution facilities have standardized maintenance schedules which includes periodical physical visual inspections, also. The cycles or periodicity varies for each equipment.
Investment Management	Facilities Budget	Is a budget made for each of construction purposes?	Yes
		Are investment targets (unit price per subject) managed?	Yes

	Profit-and-Loss Budget	Is investment managed for repair construction and improvement construction?	Necessary budget is provided for R&M and improvements separately.
	Construction Fee Charged to Customers	Has any construction fee charged to a new customer?	Yes. Every new customer has to pay necessary service line charges & Development charges as per stipulations made from time to time.
Supply Reliability & Services	Voltage	On voltage maintaining standards	LT +/- 6% 11kV & 33kV +6% to -9%
		On checking method for voltage maintenance	Voltage levels are checked periodically.
	Reliability	Concept and status	In urban areas, the outages are attended to promptly. In rural areas, the time taken for attending the outages & restoration of supply varies from area to area depending on the time of receipt of information and accessibility of the areas.
		Status of power loss	Consequent to removal of meters for agricultural services due to introduction of flat rate tariff in 1982, assessment of T&D losses was made based on billed energy in respect of all consumers other than agricultural and estimated energy consumption for agricultural consumers based on connected loads and no. of hours of supply. However, this method of estimation includes commercial losses getting mixed up with estimated agricultural energy. For the year 1996-97 the overall T & D losses are estimated at 33.66%. The agricultural consumption was estimated based on sample metering. The technical losses are estimated to be 22% and commercial losses of about 11%. The commercial losses include pilferage, incorrect metering, billing and direct tappings by agricultural consumers and in slums and weaker section colonies. Energy audit is being done to identify the causes for high technical & commercial losses and measures are being taken for reducing the technical losses to optimum level and minimize commercial losses by conducting periodical intensive inspection of services, replacement of stuck up and burnt meters, sealing of meters and imposing stringent penalties in the erring consumers. The process of amendment to the existing Legal provision is under way.
		Measures against power loss	
To Secure Income	Facilities Division	Division of service lines and internal lines	All electric lines up to consumers meter (including the meter) belong to the Board.
		Set-up places and seals of watt-hour meters	The meters are installed at accessible places in the premises of the customer and are properly sealed by the numerical seals. The board recently amended the terms and conditions of supply making it obligatory for the consumer to fix the meter in the first room of the house.
	Watt-hour meter	Accuracy	LT Domestic, Commercial, 1-phase or 3-phase: Whole current Electric mechanical meters CL-2 Accuracy (Error limit +/- 2%)
		Type	Static meters of CL-1 accuracy (+/- 1%)

Construction Works	Works System	Are works done by contracting them out or under the direct management?	Mixed i.e. departmental and by contract
	Equipment	Safety factor	Code of safety Rules are available for strict implementation.
		Work efficiency factor	Efforts are made on a continuous basis to improve work efficiency by motivating the people and/or by providing improved equipments.
	Structure of Working Force		The standard work force consist of a Line Inspector, one or two Linemen and 3 or 4 Asst. Linemen.
Staff Training	Training Center	Applicable occupation for training	Engineering staff, Accounting staff, Personnel staff and Lines staff are being trained.
		Training period	Extensive training for 1 week to 6 weeks including field visits.
		Training facilities	One Corporate Training Institute at Hyderabad and the Lines Staff Training centres at Hyderabad, Warangal, Vijayawada, Cuddapah and Visakhapatnam.
	Construction and Repair Skill Certification System	Applicable occupation	All the Line Staff working in Distributions i.e. Linemen, Asst. Linemen and Jr. Linemen are given jog oriented training.
		Certifying Methods	Verifying the skills and related knowledge by conducting Tests and Interviews, the achieved skills are acknowledged and certified.
Others	Contract Form	Classification	Necessary contract agreement forms are designed for different categories of consumers.
	Demand Estimation	Method	Demand estimation by studying the past trend and expected new services, specially high value services expected by Global and Spatial forecasting techniques.
	Protective Methods of Distribution Network		High voltage distribution line: over current relay earth fault relay Distribution transformer: High voltage fuse Low voltage distribution line: Low voltage fuse Service line: Wire fuse Indoor distribution line: Low voltage fuse, line breaker
	Measures against Distribution Network Faults		Necessary protective relays & breakers are provided for in 33kV SSs in case of 33kV or 11kV network faults. After the fault isolation the fault is located in the fault section and rectified suitably depending upon the type of fault. In case of LT faults, the fault is located and rectified on receipt of complaints from the consumers.

Summary of Activities of Multi- and Bi- lateral Aid Organizations toward Power Sector Reform of State of AP

1. Andhra Pradesh Power Sector Reform assisted by World Bank

Program	*Service & Schedule*	*Finance Source*	*Consultant*	*Progress & Information*
1. Consultancy for developing regulatory & legal frame-work and tariff structure for regulatory commission	・assist. of establishment of independent regulatory commission ・reduction of subsidy ・establishment of regulatory system ・others ・2 years	W/B	To be decided. ICICI for financial restruct-uring	Letters of invitation issued to short listed firms.
2. Consultancy for ①Corporatization & Commercializa-tion, ②Asset valuation & and other financial issue ③H.R.D (4)Legal services	・assist preparation o f corporatization program ・asset and debt valuation of APSEB ・others ・2 years	UK-DfiD	Contracted with Dr.N.B. Mishra, M.G. Rawaehavetran. S.K. Mohapatra, and some more are expected.	DfiD will start working soon.
3. Consultancy for ①Load forecast & investment planning, (2)Technical interface requirements, ③Distribution system reconstruction, ④Tariff issues	・short/long-term investment plan ・load forecasting ・Demand Side Management ・technical interface ・distribution system re-configuration ・others ・1 year	Canada-CIDA (Energy Infrastruoture Services Project)	SNC-Lavalin (Canada)	Preliminary inception report prepared. Consultant will start working soon.
	・Demand Side Management of Chittoor and Karimnagar Districts as case studies. 5,500 agri-cultural pump sets will be changed from LVDC to HVDC.	Government of Norway (15 Cr. Rs. in grant)	unknown	Services on-going. Treated as environment improvement project.
4. Consultancy for privatization of distribution	・prepare guidelines for privatization of distribution ・prepare information memorandum ・advertising ・prepare bidding evaluation system ・others ・2 years	Not decided.	To be decided.	
5. Areas and TOR for consultancy which are not finalized yet. ①commercial system of SEB & successor companies ②implementation management of physical investment	・metering, billing, collection ・implementation management of transmission and distribution projects (total amount, 2.5 billion US$)			

Ⅱ. AP State's Own Initiative

①Integrated Systems Improvement Scheme	・33kv sub-transmission lines of Warangal ・33kv sub-transmission lines of HUDA and TUDA ・distribution line and 33kv sub-stations	W/B thru REC(540 M. Rs.) W/B thru PFC(600 M. Rs.) Suggested for Japanese involve-ment and assistance. (Documents prepared by Mr.Kutty, Member Secretary, APSEB and entrusted to Mr.Gulaty of W/B in New Delhi.)	unknown unknown	Includes 11 sub-projects. HUDA: Hyderabad Urban Dev. Authority TUDA: Tirupathi Urban Dev. Authority Suggested thru W/B at the meeting with JIBCC-Special Committ. for Industrial Infra. Develop. on Nov. 13' 97 in Tokyo. 6 districts out of 23 have been identified and the projects have been implemented under OECF Loan, on-lent thru REC.
②Renovation & modernization of existing plant & equip. ③Efficiency improvement of existing plant & equipment ④Improvement of auxiliary loss				

Ⅲ. Other Cooperation Activities

①Energy efficiency	・distribution control in Hyderabad incl. mapping ・agricultural distribution system supporting 3 Districts (Mahbubnagar, Nalgonda, Khammam) (80 Cr. Rs.), and SCADA System in Hyderabad.	UK-DfiD(40 million Stg£) (out of this, 5 million Stg£ for SCADA System in Hyderabad City.)	East Midlands Electricity (Mr. Robert Byatt, Resident Project Manager)	10 million Stg£ out of 40 million Stg£ is now under negotiation. Establishment of SCADA System is going on, taking another 6 months for completion.

資料出所：インド電力研究会

No.	District	F/S の有無	ファイナンス	日本側に対するサジェスチョン(注 1)	JICA 調査候補(注 2)
1	Warangal	有	OECF	○	
2	Nizamabad	〃	〃		
3	Kurnool	〃	〃	○	
4	Anantapur	〃	〃	○	
5	Cuddapah	〃	〃		
6	Chittoor	〃	〃		
7	Mahaboobnagar	〃	Dfid		
8	Nalgonda	〃	〃		
9	Khammam	〃	〃		
10	Adilabad	〃	OECF を予定	○	
11	Karimnagar	〃	〃	○	◎
12	Guntur	〃	〃	○	
13	Prakasam	〃	〃	○	
14	Nellore	〃	〃	○	
15	Medak	無	未定	○	◎
16	Ranga Reddy(注 3)	〃	〃	○ (注 4)	
17	Krishna	〃	〃		
18	West Godavari	〃	〃		
19	East Godavari	〃	〃		
20	Visakhapatnam	〃	〃		◎
21	Vizianagaram	〃	〃		
22	Srikakulam	〃	〃		
23	Hyderabad City	〃	〃	○ (注 4)	◎

(注 1) 平成 9 年 11 月 13 日開催された世銀とのワークショップにおいて世銀経由日本側に協力依頼のあった地域 (Integrated System Improvement Project)。

(注 2) 平成 10 年 3 月に実施した JICA プロ形成ミッション時にインド側より提示を受けた地域。

(注 3) Ranga Reddy は Hyderabad 近郊の農村地区。

(注 4) DfiD が SCADA システム実施中。

Integrated System Improvement Scheme対比表

District	日本側に対するサジェスチョン地域（注1）		Proposed for External Aid	
			System	Project
Warangal				*OECFによる承認済み事業（注 2）*
	132 KV Substation	1 No.	Warangal-A	33/11 KV
	132 KV Line	10 Km.	Warangal-B	33/11 KV
	33 KV Substations	10 Nos.	Warangal	Restructuring of Chelpur-Parkal
	33 KV Line	200 Km	Nekkonda-B	33/11 KV
	33 KV Line	300 Km	Raghunathapalli	33/11 KV
		and other related works	Mustyal	33/11 KV
			Waddakothapalli	33/11 KV
	Project Cost	*Rs. 265 millions*	Chityal	33/11 KV
			Madikonnda	33/11 KV
Kurnool				OECFによる承認済み事業
	33 KV Substations	8 Nos.	Kurnool	132 KV
	33 KV Line	93 Km.		AP州の申告によるOECF／REC承認済み事業
	11 KV Line	97 Km.		33/11 KV Substations 8 Nos.
	11 KV, 600 KVAR Capacitors	28 Nos.		33 KV Lines 90 Km
	11 KV AV Boosters	1 Nos.		11 KV Lines 54 Km
		and other related works		Reinforcement of 33 KV Lines 83 Km
				Reinforcement of 11 KV Lines 123 Km
	Project Cost	*Rs. 122 millions*		600 KVAR switched shunt Capacitors 8 Nos.
				11 KV AV Boosters 1 No.
				Project Cost Rs. 131.6 millions（注 3）
Anantapur				OECFによる承認済み事業
	33 KV Substations	6 Nos.	Gooty	132 KV
	33 KV Line	168 Km.	Anatapur	Augmentation of 132 KV
	11 KV Line	147 Km.		AP州の申告によるOECF／REC承認済み事業
	11 KV, 600 KVAR Capacitors	51 Nos.		33/11 KV Substations 16 Nos.
	11 KV AV Boosters	7 Nos.		33 KV Lines 262 Km
		and other related works		11 KV Lines 295 Km
				Reinforcement of 33 KV Lines 130 Km
	Project Cost	*Rs. 308 millions*		Reinforcement of 11 KV Lines 446 Km
				600 KVAR switched shunt Capacitors 122 Nos.
				11 KV AV Boosters 12 Nos.
				Project Cost Rs. 425.1 millions

District	日本側に対するサジェスチョン地域（注1）	Proposed for External Aid	
		System	Project
Chittoor		OECFによる承認済み事業	
		Puttur	Augmentation of 132 KV
		Tirupathi	Augmentation of 132 KV
		Chittoor	33 KV
		Madanapally	Augmentation of 132 KV
		AP州の申告によるOECF／REC承認済み事業	
			33/11 KV Substations 30 Nos.
			33 KV Lines 505 Km
			11 KV Lines 340 Km
			600 KVAR switched shunt Capacitors 210 Nos.
			11 KV AV Boosters 64 Nos.
			Project Cost Rs. 731.4 millions
Nizamabad		OECFによる承認済み事業	
		Nizamabad South	Augmentation of 132 KV
		Nizamabad North	Augmentation of 132 KV
		AP州の申告によるOECF／REC承認済み事業	
		Bichkonda	132/33/KV SS 1 No.
			132 KV Lines 30 Km
			33/11 KV Substations 23 Nos.
			33 KV Lines 284 Km
			11 KV Lines 337 Km
			600 KVAR switched shunt Capacitors 307 Nos.
			Project Cost Rs. 556.3 millions
Cuddapah		OECFによる承認済み事業	
		Yerragunta	132 KV
		Rajampet	132 KV
		Cuddapah	132 KV
		AP州の申告によるOECF／REC承認済み事業	
		Balpamur	132/33/KV SS 1 No.
		Vontinnilta	132/33/KV SS
		Thimmayyagaripalli	132/33/KV SS
			132 KV Lines 85 Km
			33/11 KV Substations 27 Nos.
			33 KV Lines 380 Km
			11 KV Lines 510 Km
			Reinforcement of 11KV Lines 400 Km
			600 KVAR switched shunt Capacitors 180 Nos.
			11 KV AV Boosters 5 Nos
			Project Cost Rs. 814.9 millions

District	日本側に対するサジェスチョン地域(注1)		Proposed for External Aid	
			System	Project
Karimnagar				Submitted to REC for External Aid
	132 KV Substation	1 No.	Ellanthakunta	132/33/KV SS 1 No.
	132 KV Line	2 Km.		
	33 KV Substations	24 Nos.		132 KV Lines 2 Km
	33 KV Line	336 Km		33/11 KV Substations 24 Nos.
	11 KV Line	420 Km		33 KV Lines 336 Km
	600 KVAR Capacitors	44 Nos.		11 KV Lines 420 Km
		and other related works		Reinforcement of 33 KV Lines 447 Km
				Reinforcement of 11KV Lines 218 Km
	Project Cost	*Rs. 781 millions*		600 KVAR switched shunt Capacitors 44 Nos.
				11 KV AV Boosters 2 Nos.
				Project Cost Rs. 651.0 millions
Adilabad				Submitted to REC for External Aid
	132 KV Substation	2 Nos.	Indravelly	132/33/KV SS 1 No.
	132 KV Line	65 Km.	Dasturabad	132/33/KV SS 1 No.
	33 KV Substations	14 Nos.		
	33 KV Line	228 Km		132 KV Lines 65 Km
	11 KV Line	180 Km		33/11 KV Substations 14 Nos.
	600 KVAR Capacitors	3 Nos.		33 KV Lines 288 Km
		and other related works		11 KV Lines 180 Km
				Reinforcement of 33 KV Lines 100 Km
	Project Cost	*Rs. 480 millions*		Reinforcement of 11KV Lines 48 Km
				600 KVAR switched shunt Capacitors 3 Nos.
				11 KV AV Boosters 2 Nos.
				Project Cost Rs. 399.8 millions
Prakasam				Submitted to REC for External Aid
	33 KV Substations	16 Nos.		33/11 KV Substations 19 Nos.
	33 KV Line	305 Km		33 KV Lines 305 Km
	11 KV Line	260 Km		11 KV Lines 260 Km
	600 KVAR Capacitors	9 Nos.		Reinforcement of 33 KV Lines 140 Km
		and other related works		Reinforcement of 11 KV Lines 240 Km
				600 KVAR switched shunt Capacitors 9 Nos.
	Project Cost	*Rs. 435 millions*		11 KV AV Boosters 1 No.
				Project Cost Rs. 362.6 millions

District	日本側に対するサジェスチョン地域(注1)		Proposed for External Aid	
			System	Project
Nellore				Submitted to REC for External Aid
	132 KV Substation	1 No.	Podalakur	132/33/KV SS 1 No.
	132 KV Line	28 Km.		
	33 KV Substations	12 Nos.		132 KV Lines 28 Km
	33 KV Line	153 Km		33/11 KV Substations 12 Nos.
	11 KV Line	205 Km		33 KV Lines 152.5 Km
	600 KVAR Capacitors	35 Nos.		11 KV Lines 205 Km
		and other related works		Reinforcement of 33 KV Lines 64 Km
				Reinforcement of 11KV Lines 226 Km
	Project Cost	*Rs. 480 millions*		600 KVAR switched shunt Capacitors 35 Nos.
				11 KV AV Boosters 1 No.
				Project Cost Rs. 324.3 millions
Guntur				Submitted to REC for External Aid
	132 KV Substation	2 No.	Tadikond	132/33/KV SS 1 No.
	132 KV Line	20 Km.	Narsaraopet	132/33/KV SS 1 No.
	33 KV Substations	14 Nos.		
	33 KV Line	190 Km		132 KV Lines 22 Km
	11 KV Line	299 Km		33/11 KV Substations 14 Nos.
	600 KVAR Capacitors	11 Nos.		33 KV Lines 191 Km
		and other related works		11 KV Lines 299 Km
				Reinforcement of 33 KV Lines 54 Km
	Project Cost	*Rs. 575 millions*		Reinforcement of 11KV Lines 185.3 Km
				600 KVAR switched shunt Capacitors 11 Nos.
				11 KV AV Boosters 2 Nos.
				Project Cost Rs. 439.0 millions
Hindupur (Anantapur)				Submitted to REC/OECF but not Considered for Funding
				33/11 KV Substations 6 Nos.
				33 KV Lines 168 Km
				11 KV Lines 147 Km
				Reinforcement of 33 KV Lines 70 Km
				Reinforcement of 11KV Lines 222 Km
				600 KVAR switched shunt Capacitors 51 Nos.
				11 KV AV Boosters 7 Nos.
				Project Cost Rs. 280.2 millions

District	日本側に対するサジェスチョン地域(注1)	Proposed for External Aid	
		System	Project
Nandyal (Kurnool)		Submitted to REC/OECF but not Considered for Funding	33/11 KV Substations 4 Nos. 33 KV Lines 42 Km 11 KV Lines 11 Km Reinforcement of 11KV Lines 59 Km 600 KVAR switched shunt Capacitors 23 Nos. Project Cost Rs. 46.9 millions
Adoni (Kurnool)		Submitted to REC/OECF but not Considered for Funding	33/11 KV Substations 4 Nos. 33 KV Lines 51 Km 11 KV Lines 86 Km Reinforcement of 11KV Lines 41 Km 600 KVAR switched shunt Capacitors 5 Nos. 11 KV AV Boosters 7 Nos. Project Cost Rs. 63.5 millions
Medak 〔F/S無し〕	132 KV Substation 1 No. 132 KV Line 10 Km. 33 KV Substations 10 Nos. 33 KV Line 200 Km 11 KV Line 300 Km *Project Cost* *Rs. 265 millions*		
Ranga Reddy 〔F/S無し〕	132 KV Substation 1 No. 132 KV Line 10 Km. 33 KV Substations 10 Nos. 33 KV Line 200 Km 11 KV Line 300 Km *Project Cost* *Rs. 265 millions*		

District	日本側に対するサジェスチョン地域(注1)		Proposed for External Aid	
			System	Project
Hyderabad City 〔F/S無し〕	33 KV Substations 33 KV Line a)UG Cable b)OH Line 11 KV Line a)UG Cable b)OH Line *Project Cost*	9 Nos. 2.84 Km 13.2 Km 20 Km 17 Km and other related works *Rs. 265 millions*		

(注 1) 平成9年11月13日開催された世銀とのワークショップにおいて世銀経由日本側に協力依頼のあった地域
Integrated System Improvement Scheme

(注 2) Rural Electrification Corporationを転貸金融機関とするOECFのTwo Step Loan
(L/A No.: ID-P66 Power System Improvement and Small Hydro Electric Project)を利用するもの。

(注 3) Cost Data 1994-95

資料出所：インド電力研究会

T & D LOSSES AS PERCENTAGE OF AVAILSILITY

Sl.	Name of the State	1992-93	1993-94	1994-95	1995-96 (RE)	1996-97 (AP)
1	2	3	4	5	6	7
1.	Andhra Pradesh	19.17	19.05	18.94	18.50	18.00
2	Assam	21.00	20.83	31.93	26.99	25.00
3.	Bihar	20.50	19.00	24.03	22.00	21.00
4.	Delhi (DESU)	23.43	30.32	31.65	20.00	20.00
5.	Gujarat	21.13	21.27	20.02	20.00	20.00
6.	Haryana	25.36	25.54	26.14	26.13	26.00
7.	Himachal Pradesh	18.51	17.31	17.41	17.39	16.53
8.	Jammu&Kashmir	45.25	47.73	46.87	43.25	41.98
9.	Karnataka	18.70	18.60	18.60	18.40	18.20
10.	Kerala	21.00	20.17	20.09	19.00	18.00
11.	Madhya Pradesh	22.24	20.23	19.02	19.00	18.50
12.	Maharashtra	16.38	15.83	15.93	15.50	15.20
13.	Meghalaya	12.20	10.67	16.04	14.33	14.09
14.	Orissa	23.51	17.06	23.02	22.00	21.00
15.	Punjab	18.70	18.46	18.32	18.20	18.10
16.	Rajasthan	24.47	25.18	26.88	22.00	22.00
17.	Tamil Nadu	17.50	17.25	16.90	17.00	17.00
18.	Uttar Pradesh	24.10	23.20	22.64	21.00	20.00
19.	West Bengal	23.69	22.38	21.12	20.02	19.48
	Average : (a)	19.80	19.40	19.50	18.50	18.10
	II EDs					
1.	Arunachal Pradesh	34.90	31.60	31.00	31.00	30.30
2.	Goa	20.80	21.80	26.20	25.00	22.20
3.	Manipur	22.50	22.50	22.00	21.50	20.87
4.	Mizoram	28.05	28.06	27.97	27.02	26.04
5.	Nagaland	32.43	31.54	30.80	30.05	29.01
6.	Pondicherry	16.00	15.50	15.00	14.50	14.00
7.	Sikkim	21.79	21.51	21.18	20.07	19.55
8.	Tripura	30.49	30.01	29.99	29.50	29.00
	Average : (b)	21.60	21.80	23.10	22.60	21.30

STATE WISE PLANT LOAD FACTOR OF THERMAL POWER STATIONS

Rank	Seb/Utility	1992-93	1993-94	1994-95	1995-96	1996-97	Change
	SEBs						
1.	Andhra Pradesh	65.00	68.70	70.10	78.16	78.14	-0.02
2.	Rajasthan	77.00	81.00	75.60	73.70	75.60	1.90
3.	Tamil Nadu	65.20	69.00	68.30	76.10	72.30	-3.80
4.	KPCL	49.40	66.90	64.90	67.70	70.20	2.50
5.	OPGC	34.50	35.50	--	67.00	69.40	2.40
6.	Maharashtra	59.70	64.10	61.20	64.90	68.70	3.80
7.	Punjab	58.30	63.50	56.80	55.00	65.70	10.70
8.	Gujarat	61.60	60.40	60.50	65.30	64.80	-0.50
9.	Madhra Pradesh	52.50	56.10	58.20	58.70	62.30	3.60
10.	WBPDC	58.10	68.20	60.40	57.60	56.50	-1.10
11.	Uttar pradesh	50.50	50.20	44.10	47.30	49.10	1.80
12.	Haryana	49.90	40.50	44.70	42.90	47.70	4.80
13.	Delhi	54.00	48.90	53.90	52.70	41.70	-11.00
14.	West Bengal	31.10	40.50	41.20	34.60	39.20	4.60
15.	DPL	--	--	26.40	26.50	29.50	3.00
16.	Assam	24.30	19.90	26.80	27.00	27.10	0.10
17.	Bihar	25.20	24.40	20.90	17.40	15.30	-2.10
	Central Sector						
1.	NTPC	68.80	77.30	76.60	78.80	77.00	-1.80
2.	NLC	56.40	55.30	60.40	67.60	70.30	2.70
3.	DVC	32.30	42.30	38.20	33.70	35.60	1.90
	Private Sector						
1.	CESC	67.50	71.40	73.90	76.70	73.60	-3.10
2.	BSES	--	--	--	55.30	73.20	17.90
3.	TEC	--	--	60.70	72.80	68.80	-4.00
	All India			60.00	63.00	64.40	1.40

* Change over previous year

A.P. -PROGRESS IN INSTALLED CAPACITY

(MW)

Year	State Sector		Joint Sector	Private Sector				Share from Central Sector	Total
	Hydel	Thermal	Gas	Hydel (Mini)	Wind	Co-Gen.	Gas		
1	2	3	4	5	6	7	8	9	10
1990-91	2452	1613	66	..	..	..	..	762	4893
1991-92	2453	1613	100	..	..	..	..	807	4973
1992-93	2515	1613	100	..	..	..	..	852	5080
1993-94	2596	2033	100	..	..	..	..	897	5626
1994-95	2658	2453	100	..	3	..	..	897	[illegible]
1995-96	2659	2453	100	3.75	41.85	..	..	897	
1996-97	2659	2703	212.5	5.75	51	2.75	232.7	897	

Derated Capacity as on 31.3.1997 is (6764 - 22) 6742 MW

Note : - AP Share from Central Generation Stations reduced from 897 to 885 MW consequent to deration of MAPS.
KTPS - B Stn. was derated to 210 MW from 220 MW.
State Sector Hydel includes 2 MW Wind from 1994-95 onwards.

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A.P. - PROGRESS IN INSTALLED CAPACITY (MW)

Year	State Sector		Share from Central Sector	Total
	Hydel	Thermal		
1	2	3	4	5
1959-60	124	89	..	213
1960-61	124	89	..	213
1961-62	119	94	..	213
1962-63	119	94	..	213
1964-65	148	144	..	292
1965-66	153	139	..	292
1966-67	153	259	..	412
1967-68	273	361	..	634
1968-69	273	342	..	615
1969-70	278	337	..	615
1970-71	268	337	..	605
1971-72	268	400	..	668
1972-73	268	400	..	668
1973-74	268	400	..	668
1974-75	268	620	..	888
1975-76	383	620	..	1003
1976-77	498	620	..	1118
1977-78	723	840	..	1563
1978-79	838	840	..	1678
1979-80	838	1050	..	1888
1980-81	1038	1260	..	2298
1981-82	1038	1260	..	2298
1982-83	1488	1248	..	2736
1983-84	1653	1248	54	2955
1984-85	1963	1193	162	3318
1985-86	2173	1193	202	3568
1986-87	2402	1193	234	3829
1987-88	2422	1193	299	3914
1988-89	2422	1193	577	4192
1989-90	2422	1403	717	4542

ENERGY BALANCE SHEET FOR 1996-97

S.No	Item	Energy (MU)	
1	2	3	
1.	Units Generated		
	a) Hydro	7909.29	
	b) Thermal	16719.76	
	c) Wind	0.71	
	Total (Gross)		24629.76
2.	Units Consumed in Station Auxilaries		
	a) Hydro	59.99	
	b) Thermal	1530.58	1590.57
3.	Units sent out (1-2)		23099.19
4	Units received from other States and Sources :		
	i) Purchases and Import :		
	a) NTPC, NLC, NPC	6964.16	
	b) Madhya Pradesh	6.21	
	c) Western Region	--	
	d) Eastern Region	289.57	
	e) A.P. Gas Power Com.	122.05	
	f) Purchases from private sector	457.62	
	g) Captive Power Plants	273.42	
	Total Purchase	8113.03	
	ii) Units Wheeled		
	a) APGPCL	489.64	
	b) NTPC	344.17	
	c) Wind, Mini hydel & others	46.19	
	Total Wheeled	880.00	
	Total 4 (i+ii)		8993.03
5.	Units handled by the System		32092.22
	Units exported to other States		
	a) Madhya Pradesh	40.48	
	b) Eastern Region	0.45	
	c) Pondicher	21.68	
	Total Exports		62.61
	Units Sold		
	Low Tension Excl. Agricultural	6174.15	
	Agricultural	7835.13	
	Total L.T.	14009.28	
	HT units billed by		
	a) APGPCL	415.00	
	b) NTPC	291.00	
	c) Wind, Mini hydel & others	45.00	
	Sub-total	751.00	
	d) Wheeling	129.00	
	e) APSEB	6784.59	
	Total HT	7664.59	
	Total Sales (LT + HT)	21673.87	
6.	f) Colony consumption	12.00	
	g) Energy assessed in theft, pilferage, back billing	61.81	
	II. Totl (F + G)	73.81	
7.	Total Sales (I + II)		21747.68
8.	Total sales + Export (6+7)		21810.29
9.	Units Lost in the system (5 - 8)		10281.93
10.	Percentage of Losses (9/5 x 100)		32.04 **

** Technical and commercial

INSTALLED CAPACITY IN ANDHRA PRADESH AS ON 31-10-1997

S.No.	Name of the Power House	District	No. of Units x Capacity MW		Installed capacity MW
1	2	3	4		5
	THERMAL				
1.	Kothagudem 'A'	Khammam	4x60		240
2	Kothagudem 'B'	Khammam	2x110		220
3.	Kothagudem 'C'	Khammam	2x110		220
4.	Kothagudem 'D'	Khammam	1x250		250
5.	Ramagundem 'B'	Karimnagar	1x62.5 or say 63		63
6.	Nellore	Nellore	1x30		30
7.	Vijayawada	Krishna	6x210		1260
8.	R.T.P.P	Cuddapah	2x210		420
	TOTAL THERMAL				2703
II	HYDEL :				
1.	Machkund Interestate project with Orissa	Orissa	3 x 17) 3 x 23)	(AP Share)	80
2.	T.B. Station Interstate project with Karnataka	Karnataka	4 x 9) 4 x 9)	(AP Share)	58
3.	Nizam Sagar	Nizamabad	2 x 5		10
4.	Upper Sileru	Visakhapatnam	4 x 60		240
5.	Donkarayi	East Godavari	1 x 25		25
6.	Lower Sileru	Khammam	4 x 115		460
7.	Srisailam	Kurnool	7 x 110		770
8.	Nagarjunasagar Right Canal PH	Guntur	3 x 30		90
9.	Nagarjunasagar	Guntur & Nalgonda	1 x 110) 7 x 100)		810
10.	Nagarjunasagar Left Canal P.H.	Nalgonda	2 x 30		60
11.	Pochampad	Nizamabad	3 x 9		27
12.	Penna Ahobilam	Ananthapur	2 x 10		20
III.	Mini Hydel				
1.	State Sector				7
2.	Private Sector				7.75
	Total Hydel				2664.75
IV.	Wind				
1.	State sector				2
2.	Private sector				52.74
					54.74
1.	VIJJESWARAM - Joint Venture of APSEB with M/s. AP Gas Power Corpn. Ltd.		West Godavari		212.5
2.	Jegurupadu (GVK - Pvt. Sector)		East Godavari		216.0
3.	Kakinada (Spectrum - Pvt Sector)		East Godavari		130.0
					567.5
V.	CO-GENERATION				
1.	Gouthami Solvents (Pvt. Sector)				2.75
VI.	Share from Central Sector Projects :				
1.	N.T.P.C. Ramagundam (Karimnagar)	3 x 200 3 x 200		(A.P. Share)	580
2.	M.A.P.P.				40
3.	Neyveli				277
	Total Central Sector				897
	GRAND TOTAL (I TO VI)				6889

AGRICULTURAL PUMPSETS ENERGISED (DISTRICT-WISE) AND PENDING APPLICATIONS AS ON 31.3.1997

Figures in Numbers

Sl. No.	Name of the District	Pending Applications	Pumpsets Energised (including R.E Co-operatives)
1	2	3	4
1.	Srikakulam	2907	16754
2.	Vizianagaram	7149	16901
3.	Visakhapatnam	3528	18513
4.	East Godavari	8561	27741
5.	West Godavari	15006	49070
6.	Krishna	9033	36284
7.	Guntur	16101	29612
8.	Prakasam	16989	46919
9.	Nellore	9062	80652
10.	Chittoor	25270	172978
11.	Cuddapah	8452	71724
12.	Ananthapur	8469	78015
13.	Kurnool	10966	59034
14.	Hyderabad	0	1003
15.	Rangareddy	4206	75677
16.	Mahaboobnagar	42665	123491
17.	Medak	9839	121515
18.	Nizamabad	30964	125532
19.	Nalgonda	26845	156496
20.	Adilabad	25507	49207
21.	Karimnagar	31272	197253
22.	Warangal	64195	187537
23.	Khammam	14706	49295
	Total	391692	1791203

LINES AND DISTRIBUTION TRANSFORMERS EXISTING AS ON 31-3-1997

S.No.	District	LENGTH IN CIRCUIT KM							[illegible]
		220 KV	132 KV	66 KV	33 KV	11 KV	L.T	TOTAL	
1	2	3	4	5	6	7	8	9	10
1.	Srikakulam	..	119.60	..	710.69	3600.96	8470.62	12901.87	2758
2.	Vizianagaram	40.19	420.00	..	456.00	3860.35	9346.43	14122.97	2025
3.	Visakhapatnam	494.36	358.80	..	1246.52	4165.30	11522.95	17787.93	4092
4.	East Godavari	360.44	334.72	..	844.03	4757.74	12261.41	18558.34	6133
5.	West Godavari	162.06	300.72	..	1101.79	5999.90	1767.03	24731.5	9110
6.	Krishna	345.66	242.58	..	894.95	5708.05	15416.97	22608.21	6031
7.	Guntur	485.00	576.00	..	1310.20	6386.81	10199.10	18957.11	5133
8.	Prakasam	535.00	449.50	..	1222.81	6863.06	16977.38	26047.75	4966
9.	Nellore	585.35	235.10	..	1169.[illegible]	7723.51	16611.25	26325.2	6180
10.	Chittoor	114.15	439.25	43.95	1200.04	8230.98	26902.55	36930.92	9033
11.	Cuddapah	503.80	382.25	102.75	985.32	5367.11	10823.04	18164.87	5623
12.	Ananthapur	394.85	605.09	117.20	1816.90	10749.49	22074.12	35757.65	7452
13.	Kurnool	531.50	449.80	..	1467.34	6958.69	15627.16	25034.49	6168
14.	Hyderabad	138.88	77.02	8.00	447.34	1656.72	4199.82	6527.78	5731
	(U.G. Cable)	..	..	..	34.55	244.00	..	278.55	
15.	Ranga Reddy	254.40	516.98	..	1000.74	7209.30	19935.08	28916.5	7636
16.	Mahaboobnagar	405.40	449.23	..	1487.55	10111.45	22717.80	35171.43	7612
17.	Medak	96.20	516.90	..	1270.77	7508.68	17731.20	27123.75	7288
18.	Nizamabad	170.00	479.20	..	1026.12	6391.91	18180.65	26247.88	8056
19.	Adilabad	..	361.52	80.00	890.34	7539.52	16190.88	25062.26	4134
20.	Warangal	52.00	633.83	..	1145.09	8665.98	28471.61	38968.51	10228
21.	Karimnagar	258.00	1112.46	..	1218.45	6933.81	33239.40	42762.12	7316
22.	Khammam	783.75	560.30	..	976.93	6195.12	14536.36	23052.46	5019
23.	Nalgonda	666.40	520.90	..	1588.39	10579.57	29023.40	42378.66	10300
	Total for A.P.	7377.39	10141.75	351.90	25512.85	153408.01	397626.81	594418.7	140071

HYDEL RESERVOIR PARTICULARS

S. No.	Name of the Reservoir	Level in Ft.	F.R.L Storage TMC Ft.	Live Storage at FRL in T.M.C. Ft.	Storage equivalent in MU
1	2	3	4	5	6
1.	Jalaput	2750	34.27	31.52	531
2	Balimela	1516	127.6	99.44	895
3.	Guntawada	1360	4.3	3.62	65
4.	Donkarayi	1037	16.52	12.87	153
5.	Srisailam	885	308.06	253.06	1392
6.	Nagarjunasagar	590	408.24	212.16	1166
7.	Nizamsagar	1405	17.8	16.96	34
8.	T.B. Dam	1633	115.68	109.81	211
9.	Pochampad	1091	112.02	81.19	162

INSTALLED CAPACITY - ALL INDIA

MW

Sl.No.		As on 31st March, 1997 (Provisional) Hydel	(%)	Thermal	(%)	Nuclear	(%)	Total
A.	STATE SECTOR							
1.	Andhra Pradesh	2655.9	51.0	2551.5	49.0	--	--	5207.4
2.	Assam	2.0	0.3	595.2	99.7	--	--	597.2
3.	Bihar	164.9	9.3	1603.5	90.7	--	--	1768.4
4.	Delhi (DESU)	--	--	653.6	100.0	--	--	653.6
5.	Gujarat	487.0	9.1	4841.5	90.9	--	--	5328.5
6.	Haryana	883.9	49.6	896.4	50.4	--	--	1780.3
7.	Himachal Pradesh	288.6	100.0	0.1	0.0	--	--	288.7
8.	Jammu & Kashmir	184.1	50.3	181.8	49.7	--	--	365.8
9.	Karnataka	2409.6	71.3	967.9	28.7	--	--	3377.5
10.	Kerala	1491.5	100.0	--	--	--	--	1491.5
11.	Madhya Pradesh	845.9	21.9	3017.9	78.1	--	--	3863.8
12.	Maharashtra	1780.2	17.8	8247.0	82.2	--	--	10027.2
13.	Meghalaya	186.7	96.4	7.1	3.6	--	--	193.8
14.	Orissa	1271.9	75.2	420.0	24.8	--	--	1691.9
15.	Punjab	1798.9	51.2	1712.0	48.8	--	--	3510.9
16.	Rajasthan	967.5	48.8	1013.5	51.2	--	--	1961.0
17.	Tamil Nadu	1947.7	38.4	3119.4	61.6	--	--	5067.1
18.	Uttar Pradesh	1504.6	24.8	4570.2	75.2	--	--	6074.7
19.	West Bengal	96.5	2.7	3478.9	97.3	--	--	4575.4
	Sub - Total (A)	18967.3	33.4	37877.4	66.6	--	--	56844.7
B	EDs							
1.	Arunachala Pradesh	23.6	59.8	15.8	40.2	--	--	39.4
2.	Goa	0.1	--	0.1	--	--	--	0.2
3.	Manipur	2.6	21.6	9.4	78.4	--	--	12.0
4.	Mizoram	3.4	13.8	21.1	86.2	--	--	24.4
5.	Nagaland	3.2	46.9	3.6	53.1	--	--	6.8
6.	Pondicherry	--	--	--	--	--	--	0.0
7.	Sikkim	30.9	92.0	2.7	8.0	--	--	33.6
8.	Tripura	16.0	23.1	53.4	76.9	--	--	69.4
9.	Andaman & Nicobar Islands	--	0.0	29.5	100.0	--	--	29.5
10.	Lakshdeep	--	0.0	5.4	100.0	--	--	5.4
	Sub - Total (B)	79.7	36.1	140.9	63.9	--	--	220.6
C	CENTRAL SECTOR							
1.	NLC	--	0.0	2070.0	100.0	--	--	2070.0
2.	DVC	144.0	5.9	2307.5	94.1	--	--	2451.5
3.	NEEPCO	150.0	47.2	167.5	52.8	--	--	317.5
4.	NPC	--	0.0	--	0.0	2225.0	100.00	2225.0
5.	NHPC	1635.0	100.0	0.0	0.0	--	--	1635.0
6.	NTPC	--	0.0	17524.0	100.0	--	--	17524.0
	Sub - Total (C)	1929.0	7.4	22069.0	84.2	2225.0	8.5	26223.0
	Grand Total	20976.0	25.2	60087.3	72.1	2225.0	2.7	83288

COMPARISON OF PROPERTIES OF AMORPHOUS METAL AND CRGO STEEL)

S No	Properties		Amorphous Metal	CRGO Silicon Steel
1	Density	g/cm	7.15	7.65
2	Specific resistance		130	45
3	Saturation flux density	Tesla	1.56	2.03
4	Typical core loss Watt Per Kg at 5C Hz Tesla		0.20	0.90
5	Thickness	mm	0.025	0.27
6	Spece factor		0.80	0.97
7	Brittleness		Higher	Lower
8.	Availabe form		Ribbon/Foil(Standard) Sizes - 106mm, 142.2 170.2mm, 213.4mm)	Sheet/Roll
9.	Annealing temperature	deg.C	360	810
10	Annealing atmosphere		Inert gas	Inert gas
11.	Special annealing requirement		Magnetic field annealing	—

KVA	Number of Phases	NO-LOAD LOSS (WATT)	
		Amorphouse Core Tranformer	CRGO Core Tranformer
10	1	10	40
15	1	15	60
25	3	25	100
63	3	45	180
100	3	60	260

AMORPHOUS CORE DISTRIBUTION TRANSFORMERS

30

Transmission and Distribution losses in India is about21%of the generated energy. Every effort will have to be made in this context to reduce these losses so that the existing generation and Transmission and Distribution system can be sued to feed more loads. The no-load loss of the Distribution Transformer is of great importance since these are present even when the transformer is under no-load conditions. The use fo amorphous metal in place of CRGO steel for the transformer core reduces the no load loss (Core loss) of the transformer by approx. 75%. Thus the of Amorphons core Transformers saves energy and there by conserve resources.

TECHNOLOGY IS CHANGING THE WORLD OF ELECTRICITY METERING UTILITIES HAVE TO GENERATE REVENUE AS WELL AS POWER. THIS MAKES THE ROLE OF METERING AND CUSTOMER SERVICE MORE CRITICAL THAN EVER BEFORE.

Features	Electro Mechanical	Electronic Meter
Versatile and Flexible to suite the requirement	Not possible	Possible
Reliability	High failure rate Regular maintenance	Negligible failure rate No maintenance required
Tamper Susceptibility	Very easy	Extremely difficult.
Reading and Billing	Manual, time consuming	Automatic and fast Improves billing time.
Recording of Consumtpion	No recording	Can record half hour data up to six weeks.
Multi-tariff Billing with one meter.	Not possible	Possible
Ease of Testing/ Calibration	Calibration & Adjustment required	Very easy to test. calibration required.
Sustained Accuracy	Drifts quite rapidly due to moving parts, wear and tear	Highly accurate. No moving parts. Sustained accuracy guaranteed.
Effect of voltage Fluctuation, Temperature Unbalance etc	Affects the accuracy of the meter.	No measurable effect.
Types of Information given	Many different instructments required for different types of parameters	Provides comprehensive information on electricity usage
Burden	High burden, upto 15 VA	Very low burden, less than 2VA
Remote Metering and Computer Communication capability	Not possible	Possible

TARIFFS

As per Section 49 and 79(1) of Electricity Supply Act. 1948. the Electricity (Supply Amendment Act 1953 the Board is required to carry on its operations under this Act as far as possible without loss and adjust the charges accordingly from time to time

Tariffs in the Board were revised with effect from 1st August 1996 :

The tariff structure of the Board of various High Tension and Low Tension Consumers is given below

HIGH TENSION (HT) TARIFF

Applicable for Supply of electricity to H.T. consumers with a contracted Demand of 70 KVA and above / or having a connected Load exceeding 75 HP

Category	particulars KVA/Month	Demand charges /KWh	Energy charges
I	Industrial	Rs. 140/-	
	i) For 1st 1 Lakh units per month		Rs. 2.55
	ii) For next 1 Lakh units per month		Rs. 2.85
	iii) Balance Units during the month		Rs. 3.05
	Energy minimum - 50 units per kVA of billing demand		
II	Other than those covered under other HT categories	Rs. 140/-	
	For all Units consumed during the month		Rs. 3.00
	Energy minimum - 25 units per KVA of billing demand		
III	Power Intensive Industries with CMD of 1000 KVA & above	Rs. 140/-	
	i) For 1st Lakh units per month		Rs. 2.55
	ii) For next 1 Lakh per month		Rs. 2.85
	iii) Balance Units during the month		Rs. 3.05
	Energy minimum - 403.325 units per KVA of billing demand		
IV	Irrigation and agriculture	--	Rs. 400/- peryear per HP of connected load
V	Railway Traction	No demand charges	
	For all units consumed during the month		Rs. 3.40
	Energy minimum - 32 units per KVA of contracted maximum demand		
Vi	Township and residential colonies	No demand charges	
	for all units consumed during the month		Rs. 2.00
	Energy minimum - 25 units per KVA contracted maximum demand		

NOTE : Billing Demand means recorded max demand during the month or 80% of the contracted demand whichever is higher

SURCHARGE FOR LOW POWER FACTOR

The Power factor of the consumers installation shall not be less than 0.85. If the Power Factor falls below 0.85 during any month, the consumer shall pay a surcharge of two percent on the amount of that month's bill (excluding demand charges and customer charges) for each 0.01 (decimal naught one) fall in the power factor.

FUEL COST ADJUSTMENTS

The above tariffs are applicable at an average cost of coal and oil ex-bunkers at the Thermal Generating Stations of the Board at Rs. 808/- per metric tonne and Rs. 5972/- per Kilo Litre respectively. If the cost of coal and/ or oil increase beyond the limits specified above all L.T. Category - III consumers shall pay additional amounts for the energy billed as indicated below.

a. For every increase of Rs. 1/- per Metric Tonne in the average cost of coal ex-bunkers at the Thermal Generating Stations of the Board over and above Rs. 808/- per metric tonne an additional charge of 0.14 paise per unit of energy consumed will be levied.

b. For every increase of Rs. 10/- per Kilo litre in the average cost of oil ex-bankers at the Thermal Generating Stations over and above Rs. 5972/- per Kilo Litre an additional charge of 0.007 paise per unit of energy consumed will be levied.

c. The FCA is to be paid as per the above formula as and when notified by the Board At the end of each financial year i.e. 31st March, the Board will workout the fuel cost adjustment based on actuals and final adjustments either for shortfall or excess will be made in October consumption month of succeeding year.

LOW FENSION (L.T.) TARIFF

Category	Consumption per Month	Rate / Unit
1. (Domestic)	First 50 Units	80 Paise
	For all Units if the consumption exceeds 50 units but up to 100 units	120 Paise
	For all units if the consumption exceeds 100 units but upto 200 units	165 Paise
	For all units if the consumption exceeds 200 units but upto 300 units	210 Paise
	For all units if the consumption exceeds 300 Units but upto 400 Units	240 Paise
	For all units if the consumption exceeds 400 Units	265 Paise
	Subject to minimum charges for :	
	Single phase supply	Rs. 15/-
	Three phase supply	Rs. 150/-

Category	Consumption per Month	Rate / Unit
II (Non - Dom. & Commercial	0-100 Units	275 paise
	Above 100 Units	375 paise
	Subject to monthly minimum charges for	
	Single phase supply	Rs. 65/-
	Three phase supply	Rs. 200/-
III (Industrial)	First 500 Units	250 paise
	Next 1500 Units	275 paise
	Balance Units in the month	300 paise
	Fixed charges per HP of contracted load or connected load which ever is higher subject to a minimum for 5 HP	Rs. 15/- per month
IV. (a) (Cottage industries)	For all units	120 paise
	Fixed charges / month / HP of connected load subject to a minimum for 3 HP	Rs. 10/-
IV. (b) (Dhobighats)*	Upto 3 HP	Rs. 150/- per HP/Year
	Above 3 HP and upto 5 HP	Rs. 250/- per HP/Year
	Above 5 HP and below 10 HP	Rs. 350/- per HP/Year
	10 HP and above	Rs. 400/- per HP/Year
V. (Agricultural) *	Upto 3 HP	Rs. 150/- per HP/Year
	Above 3 HP and upto 5 HP	Rs. 250/- per HP/Year
	Above 5 HP and below 10 HP	Rs. 350/- per HP/Year
	10 HP and above	Rs. 400/- per HP/Year

Note : The above tariff will be reduced by Rs. 50/- per HP per year in DPAP areas excluding registered irrigation command arears for all cpacities of pumpsets below 10 HP.

VI. (LOCAL BODIES)		
A : Street Lighting		
i) a) For Panchayat (Minor)	Upto 250 Units/month/Panchayat	Free
	bove 250 Units/month, for all units	100 paise
i) b) For Panchayats (Major)	For all units	100 paise
ii) For Municipalities	For all units	120 paise
iii) For Corporations	For all units	140 paise

Category	Consumption per Month	Rate / Unit
B : PWS Schemes		
i) a) For Panchayat (Minor)		Free
i) b) For Panchayats (Major)		Corresponding Agricultural Tariff
ii) For Municipalities		Corresponding Industrial LT / HT tariff
iii) For Corporations		Corresponding Industrial LT/HT tariff
Minimum charges		Rs. 2/- per point per month for Panchayat Rs. 6/- per point per month for Municipalities and Corporations
VII. (General Purpose)	For all units	200 paise
	Minimum Charges :	
	a) For Single phase supply	Rs. 50/-
	b) For Three phase supply	Rs. 150/-
VIII. (L.T. Temporary supply)	(i) For all categories other than Irrigation and Agriculture For all Units	400 paise
	Minimum Charges :	
	a) Per KW or part thereof of contracted loac for first 30 days or part thereof	Rs.100/-
	b) Per KW or part thereof of contracted load for every subsequent period of 15 days of part thereof	Rs. 60/-
	(ii) Irrigation and Agriculture For all units	100 paise
	Minimum Charges :	
	a) Per HP of contracted load for the first 30 days of part thereof	Rs. 100/-
	b) Per HP of contracted load for every subsequent period of 15 days of part thereof	Rs. 50/-

DISTRIBUTION TRANSFORMERS

Sl No	Capacity in KVA	Current Amps HV	Current Amps LV	Protection HV T.C. Wire S.W.G. HG for Gap 205 mm	Protection LV T.C. Wire S.W.G.	Protection MCCB Rating No amps	No Load Losses in W	Full Load Losses in W	% Impedance	Total Tr weight in KG	Qty of oil in Lit.	LT Cable single core PC Cable in Sq mm
(1)	(2)		(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)	(11)
1	10	1.56	43.48	38	1X13	1X40	40	225	3.25	135	39	25
2	15/15	2.35	65.20	32	1X17	1X65	60	275	3.25	165	41	50
3	25	1.31	33.40	38	1X20	1X30	130	650	4	345	110	50
4	50	2.62	66.70	35	2X20	2X35	195	920	4.5	500	180	2X70
5(a)	63	3.31	84.00	35	2X18	2X40	160	1230	4.5	503	165	2X95
5(b)	63CSP	3.31	84.00	35	2X18	—	160	1230	4.5	512	175	2X95
6	75	3.93	100.00	33	2X18	2X55	280	1230	4.5	870	310	2X95
7(a)	100	5.25	133.34	33	2X17	2X65	260	1760	4.5	600	220	2X120
7(b)	100 CSP	5.25	133.34	33	2X17		260	1760	4.6	700	240	2X120
8	160	8.40	213.34	28	2X14	2X95	400	2400	4.5	1000	320	2X120
9	200	10.5	288.80	24	HRC Fuse	2X135	615	2600	5.0			2X185
10	250	13.12	333.40	23	Switch	2X160	680	4200	5.0	1700	500	2X185
11	315	16.53	420	23		2X200	680	4200	5.0	1700	500	2X185
12	500	26.24	666.7	20		2X300	1200	6400	5.0	1900	560	2X185

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L.T. SERVICE CONNECTION AND METERING

Sl No	Connected Load in KW/H.P.	Current in Amps	Type of connection	Size of PVC single Core aluminium Cable Core in mm	MCBs rating in Amps	Meter rating in Amps	Permissible accuracy	Periodicity of Testing Meters	Carrier GI Wire (SWG No.)
	I. GENERAL SUPPLY UPTO 15 AMPS.								
1.	Upto 1 KW	4	S 2 wire 240 volt	1.5	4	2.5-10	± 2%	5 year	10
2.	Above 1 KW and upto 2 KW	8	S 2 wire 240 volt	2.5	4	2.5-10	± 2%	5year	10
3.	Above 2 KW and upto 4 KW	15	S 3 wire 240 volt	4.0	15	5-20	± 2%	5 year	10
	II. MOTIVE POWER SUPPLY ABOVE 1.5 HP.								
1.	Above 1.5 HP and up to 2KW/3HP	3	3 dia 4 wire 415 volt	2.5	5	10-20	± 2.5%	3 years	10
2.	Above 2KW/3HP and upto 4 KW/5HP	6		4.0	8	10-20	± 2.5%	3 years	10
3.	Above 4 KW/5HP and upto 7.5KW/10HP	14.50	"	6.0	15	10-20	± 2.5%	3 years	8
4.	Above 7.5KW/10HP and upto 11KW/15HP	21	"	10.0	25	10-20	± 2.5%	3 years	8
5.	above 11KW/15HP and upto 28KW/38HP	45	"	25.0	40	10-20	± 2.5%		
6.	Above 28KW/38HP and upto 43KW/58HP	70	"	50.0	80	10-20	± 2.5%	3 years	6
7.	Above 43KW/58HP and upto 56KW/75HP	95	"	70.0	95	10-20	± 2.5%	3 years	6
8.	Above 56KW/75HP	"	H.T.	-	-	-	± 2.0%	1 year	-

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CONDUCTOR CHARACTERSTICS BASED ON I.S.398/1961

ELECTRICAL CHARACTERSTICS						MECHANICAL CHARACTERSTICS			
		Equivalent	Resistance at 20°C	Approx. Amp. Carrying Capacity		Strands	Conductor		
Code Name	Cu Wire SWG	Coacon Al. Area Sq. Inch /mm²	Ohm/ K.m	40°C	45°C	Al/St & Dia in mm each	Dia in mm each	Wt.in Kg/ Km.	Approx Ultimate tensile Strength Kg.
ALL ALUMINIUM CONDUCTORS									
ROSE	8	0.02/ 20.0	1.361	116	106	7/1.96	5.88	58	362
DAISY	7	0.025/ 25.56	1.071	133	123	7/2.21	6.63	73	485
IRIS	6	0.030/ 33.0	0.850	150	138	7/2.48	7.44	92	582
PANSY	4	0.040/ 42.0	0.677	178	165	7/2.78	8.34	116	730
ANT	3	0.05 52.00	0.544	204	189	7/3.10	9.30	144	862
ASTER	2	0.055 66.96	0.422	239	198	7/3.51	10.53	184	1157
A.C.S.R. CONDUCTORS									
SQUIRREL 02	8	13/ 20.7	1.374	115	107	6/1 2.11	6.33	85	771
WEASEL 03	6	20/ 31.2	0.911	150	09	6/1 2.59	7.77	128	1136
FERRET 04	4.5	24/ 41.8	0.679	181	168	6/1 3.0	9.00	171	1503
MINK 06	2	40/ 62.3	0.456	234	217	6/1 3.66	10.98	255	2107
RACCOON 0.075	1	48/ 77.80	0.365	270	250	6/1 4.09	12.27	318	2746
DOG 0.1	2/0	65/ 103.6	0.275	325	300	6/7 4.72 1.57	14.15	394	3299
TIGER 0.125	3/0	80/ 128.0	0.222	382	354	30/7 2.36	16.62	604	5758
WOLF 0.15	4/0	95/ 154.2	0.184	430	398	30/7 2.59	18.13	727	6880
LYNX 0.175	6/0	110/ 179.0	0.158	475	440	30/7 2.79	19.53	844	7950
PANTHER 0.2		130/ 207.0	0.137	520	482	30/7 3.0	21.00	976	9127
LION 0.220		140/ 237.5	0.1[illegible]	555	515	30/7 3.18	22.26	1097	10210
GOAT 0.3		195/ 316.5 [illegible]	0.089	680	630	30/7 3.71	25.97	1492	13780

33 KV CLASS POWER TRANSFORMERS

Sl.No.	Capacity in KVA	Current H.V.	Amps L.V.	Protection H.V. T.C.wire	Protection L.V. T.C.wire	No Load Losses in W	Full Load Losses in W	% Impedance	Tr.w Tr. Weight in Kgs.	Qty. of Oil in litres
1.	500	9.50	28.25	26	21	[illegible]	[illegible]	4.5	4500	1750
2.	750	12.75	38.36	27	19	[illegible]	[illegible]	5.0	[illegible]	[illegible]
3.	1000	17.50	52.50	22	18	2200	11400	6.0	6832	2410
4.	1500/1600	28.50	78.73	20	15C.B.	3000	16000	6.0	5770	1710
5.	3000/3150	52.50	157.50	16	C.B.	4500	2300	7.00	10902	2990
6.	5000	87.46	262.40	13	C.B.	6400	36000	7.00	12200	3350
7.	7500	131.00	393.00	C.B.	C.B.	8000	47000	7.00	16650	4600
8.	8000	140.00	420.00	C.B.	C.B.	8500	52000	8.00	17250	5250

APSEBEA

ESTIMATED CURRENT RATINGS FOR COPPER & ALU. CONDUCTORS VIR,PVC OR POLYTHENE INSULATED CABLES (SINGLE. TWIN. THREE & FOUR CORE)

Standard Copper Conductor			Continuous current rating * Amps. (Subject to Voltage Drop)					Standard Alu. conductor	
Area (Square inches)	Area (Sq. mm.)	Strand Inches)	In conduit troughing or casing 2 S.C. cable	Bunched in free air or open trench		One Twin Core DC or A.C.	One 3/4 Core Cable Balanced 3 Phase	Area Sq. mm	Strand dia. mm
				2 S.C. cable	3 or 4 S.C. cable				
0.0015	1.00	1/.044	5	5	5	5	5	-	-
0.002	1.25	3/0 029	10	10	10/9	10	8/7	1.5	1/1.40
0 003	2,00	3/0.36	15	15	13/12	15	10/11	2.5	1/1.80
0.0045	3.00	7/0.029	20	20	15	20	15	-	-
-	-	-	20	20	17	20	14	4	1/2.24
-	-	-	27	27	24	27	19	5	1/2.80
0.007	4.50	7/0.036	28	28	25	28	20	-	-
-	-	-	34	34	31	34	24	10	1/3.55
0.01	6.75	7/.044	36	36	32	36	25	-	-
0.0145	10.00	7/.052	43	43	39/38	43	30	16	1/1.70
0.0225	14.00	7/.034	53	53	48	53	37	-	-
-	-	-	59	59	54	59	42	25	7/2.24
0.03	18.00	19/.044	62	62	56	62	43	-	-
-	-	-	69	69	62	69	48	35	7/2.50
0.04	25.00	19/.052	74	74	67	74	52	-	-
-	-	-	91	91	82	91	62	50	7/3.00
									19/1.80
0.06	40.00	19/0.64	-	97	88	97	68	-	-
0.075	50.00	19/0.72	-	123	107	115	78	-	-
-	-	-	-	134	118	118	82	70	19/2.24
-	-	-	-	153	138	135	94	95	19/2.50
0.10	65.00	19/.083	-	160	140	140	98	-	-
0.12	70.00	37/.064	-	177	158	158	109	-	-
-	-	-	-	184	170	162	114	120	37/2.06
0.15	95.00	37/.072	-	205	185	180	126	-	-
-	-	-	-	210	185	181	127	150	37/2.23
-	-	-	-	246	216	209	146	185	37/2.50
0.2	130.00	37/.083	-	250	220	218	153	-	-
-	-	-	-	290	248	240	169	225	37/2.80
0.25	160.00	37/.093	-	293	260	252	178	-	-
0.3	200.00	87/.103	-	334	295	284	199	-	-
-	-	-	-	354	302	289	202	300	61/2.50
0.4	260.00	61/.093	-	425	360	342	240	-	-
-	-	-	-	435	372	-	-	400	61/3.00
0.5	325.00	61/.103	-	480	410	-	-	-	-
-	-	-	-	480	411	-	-	500	91/2.65
-	-	-	-	565	484	-	-	625	91/3.00
0.7	500.00	91/.103	-	610	520	-	-	-	-
1.0	670.00	127/.103	-	740	630	-	-	-	-

* Rating at Ambient temperature 30°

For Ambient Temperature other than 30°C, the current ratings should be multiplied [illegible] Viz 25°C/1.13, 35°C/.86, 40°C/.69, 45°C/.47.

RECOMMENDED MAINTENANCE SCHEDULE FOR TRANSFORMERS

Item to be inspected	Inspection Notes	Frequency	Action required
a) Ambient Temperature	-	Daily	-
b) Winding Temperature and Oil Temperature	Check the temperature	Daily	Shut down transformer and investigate if found abnormal
c) Load and Voltage	Check against rated figures	Daily	-
d) Oil level	-	Weekly	If low top up with dry oil, examine transformer for leakage
e) Oil level in Bushings	-	Weekly	If low, top up with dry oil, examine transformer for leakages
f) Relief Diaphragm	-	Monthly	Replace if cracked or broken
g) Dehydrating breather	Check for air passage. colour of the Agent	Monthly	If found pink change by spare charge or old charge may also be reactivated.
h) Bushing	Examine for cracks and dirt.	Quarterly	Clean or replace.
i) Oil	check for dielectric strength and water contents.	Half Yearly	Take suitable action to restore quality of oil.
j) Cooler fans, bearings motor and controls mechanism	Lubricate bearings, check gearbox, examine contacts, controls and inter locks.	Half yearly	Replace burnt or worn contacts or other parts.
k) Oil in cooler	Test for pressure	Half yearly	-
l) Oil in transformer	Check for sludge	Yearly	Filter or replace.
m) Oil filled Bushing	Test Oil	yearly	Filter or replace.
n) Gasket	-	yearly	Tighten bolts evenly.
o) Cable Box	Check for ceiling arrangements, examine compound cracks.	yearly	Replace.
p) Relays, alarm and circuit.	Examine Relays and alarm contacts.	yearly	Clean components, replace contact and fuses if necessary
q) Earth resistance	-	yearly	Take suitable action if resistance is high.
r) O.L.T.C. overhauling	Check O.L.T.C. R.T.C.C. to proper functioning	Quarterly	Clean and grease all moving contacts. Check oil in diverter arrangements.
s) Buchholz Relay	Check contats and floats	Monthly	Rectify or replace defective contacts.
t) I.R. test of Winding	Measure by megger	Yearly	Take suitable action if found low
u) Overall inspection including lifting of core	-	Once in 5 Years	Wash by hoisting down with clean dry oil.
v) Sludging	Oil for all values	Once in 10 Years	Replace if test values are not attained.

COMMON DEFECTS NOTICED AND THE CAUSE

Part	Defects	Causes
1) Tank	a) Leakage of oil	Corrosion /mechanical damage - Gaskets worn Out -
	b) Deformation	Excessive Internal pressure -
	c) Overheating	Improper Circulation of cooling oil and/or inadequate ventilation.
2) Radiators	a) Leakage of oil	Corrosion /mechanical damage - Gaskets worn Out -
	b) Deformation	Excessive Internal pressure -
	c) Overheating	Improper Circulation of cooling oil and/or inadequate ventilation.
3) Conservator	a) Leakage of oil	Corrosion /mechanical damage - Gaskets worn Out -
	b) Deformation	Excessive Internal pressure -
	c) Overheating	Improper Circulation of cooling oil and/or inadequate ventilation.
4) Breather	Inefective	Inlet choked - silicagel saturated.

5) Explosion	Glass broken	Mechanical
6) Core	a) Loose	Bolts loosening up -
	b) Increased losses	Change in characteristics due to heating -
	c) Excess Noise	Vibration of stampings.
7) Winding	a) Short-Circuited	Overloading - Air bubbles - Loss of insulation -
	b) Loosening	Shrinkage displacement - Overheating
	c) Insulation brittle.	decomposition
	d) Open Circuited	burnt out.
8) Oil	a) Discolouration	Contamination -
	b) High Acidity	Increased moisture -
	c) Low B.D.V.	Decomposition -
	d) Sludge	chemical action with other parts
9) Terminal Bushing	a) Breakage	Strain -
	b) Leakage oil.	Gasket Worn out - Loose fit.
10) Tap Switch	a) Inoperative Broken lever	Maloperation -
	b) Burnt contact	Insulation failure - Failure of operating mechanism -
	c) Short Circuit	Overheating.

OVER LOADING OF TRANSFORMERS

1) INFLUENCE OF AMBIENT ON LOADING FOR NORMAL LIFE EXPECTANCY :

Average ambient temperatures should cover periods of time not exceeding 24 hours with maximum temperatures not more than 10°C greater than average temperatures for air and 5°C for water. Table gives the increase or decrease in rated loads for other than average daily ambients of 30°C C for air and 25°C for water It is recommended that 5°C margin be used when applying the factor from table. It is to be pointed out that the increase or decrease obtained from table is quite conservative.

Loading on Basis of Ambient Temperature

Type of cooling	Percent of Rated KVA Decreased load for each degree C higher temp.	Increased load for each degree C lower
Self cooled OA	1.5	1.0
Water cooled OW	1.5	1.0
Forced air cooled OA/FA-OA/FA/FA	1.0	0.75
Forced oil cooled FOA-FOW or OA/FOA/FOA	1.0	0.75

Loading on the basis of ambient temperature with louds permitted by above table will give approximately the same life expectancy as if transformers were operated at name plate rating and standard ambient temperature over the same period.

The above table covers a range in ambient of 0°C to 50°C for cooling air and upto 35°C for cooling water.

2) LOADING ON BASIS OF SHORT-TIME LOADS ABOVE RATING.

Transformers may be operated 95°C average continuous temperature for short times provided they are operated for much longer periods at temperatures below 95°C This is due to the fact that thermal aging is a cumulative process. This permits loads above rating to be safely carried under specified conditions.

TYPES OF FAULTS AGAINST WHICH BUCHHOLZ RELAY GIVES SUCCESSFUL PROTECTION

Visible or Audible alaram (Upper Float actuates)	Trip circuit operates (Lower Float actuates)
1) Core bolt insulation failure	1) Short circuit between phases
2) Short circuited core laminations	2) Winding earth fault
3) Bad electrical contacts	3) Winding short circuit
4) Local overheating	4) Puncture of bushings.
5) Loss of oil due to leakage	
6) Ingress of air into the oil system.	

GAP SETTINGS :

System voltage KV RMS	Gap on transformer bushing inches (mm)	Gap on terminal tower inches (mm)	Gap on next three approach towers inches (mm)
220	45 (1145)	44 (1120)	44 (1120)
110	25 (635)	23.5 (600)	24.5 (625)
66	15.5 (395)	13 (330)	14 (355)
33 and below	No gaps	No gaps	No gaps

STANDARD MINIMUM CLEARANCES : OUT DOOR

	For equipments and rigid conductor in air		Phase to Phase spacing in isolator and switches	
Voltage Kv	Phase to Phase inches (mm)	Phase to earth inches (mm)	Isolator inches (mm)	Switches with arcing horns inches (mm)
220	132 (3350)	66 (1675)	132 (3350)	156 (3960)
110	66 (1675)	40 (1015)	84 (2135)	120 (3050)
66	48 (1220)	30 (760)	60 (1525)	84 (2135)
33	36 (915)	24 (610)	30 (760)	48 (1220)
22	24 (610)	18 (460)	30 (760)	42 (1070)
11	18 (460)	12 (305)	24 (610)	36 (915)
04	15 (380)	12 (305)		

INDOOR CLEARANCES FOR ENCLOSED BUSBARS AND CONNECTIONS IN AIR WHERE THE SPACE BETWEEN CONDUCTORS IS NOT FILLED WITH ANY INSULATING MEDIUM LIKE COMPOUND ETC.

Rated voltage KV	Min. clearance in inches (mm)	
	Between phases	Phase to earth
33	14 (355)	8 3/4 (225)
22	9 1/2 (240)	5 1/2 (140)
11	7 (180)	4 1/2 (115)

CLEARANCE BETWEEN LINES AND GUARD WIRES

The vertical clearance between the guard wire and any conductor under maximum sag shall be as under

i) L.T. Voltages - - 4' (1.219 meters)

ii) High Voltage upto 33 Kv - 4' (1.219 meters)

Every guard wire shall be securely bound to earth at each point where its electrical continuity is broken Guard wires shall have an actual breaking load of not less than 1400 lbs. (635 kgs.) and shall be galvanised. The earth should be efficiently maintained and the earth resistance should not exceed 10 Ohms

The sizes of the guard wire are following as under

i) Railway crossing — a) 7/10 SWG for Longitudinal wires
b) 6 or 8 SWG for cross lacing.

ii) Road Crossing / Telephone — No. 8 S.W.G. wire

EQUIVALENT SPACING OF CONDUCTORS

Line voltage	Single circuit
33 kv & 22 kv	5' (1530 mm)
11 kv	4' (1220 mm)
LT Vertical	10' (260 mm)
Horizontal	9' (230 mm)

APSEBEA

RAILWAY CROSSINGS

MINIMUM CLEARANCE BETWEEN OVERHEAD POWER LINES AND RAILWAY TRACKS/STRUCTURES

Transmission lines Xing Rly. tracks Way leave charges (rent) payment condition warved (Ministry of Irrigation & Power Govt. of India. New Delhi's Lr. No. EL-11-17 (27) 69 dt. 6-1-73)	Upto & inclu. 650 V (Feet) Metre	Above 650 V to 33 KV (Feet) Metre	Above 33 KV to 66 KV (Feet) Metre	Above 66 KV to 110 KV (Feet) Metre	Above 110 KV to 165 KV (Feet) Metre	Above 165 KV (Feet) Metre
BROAD GAUGE (1.673 m)						
Outside station limits	(23 1/2) 7.16	(25) 7.62	(26) 7.92	(27) 8.23	(28) 8.53	(29) 8.84
Inside station limits (Unearthed neutral)	(31 1/2) 9.60	(33) 10.06	(34) 10.36	(35) 10.67	(36) 10.97	(37) 11.28
Earthed neutral	(23 1/2) 7.16	(33) 10.06	(34) 10.36	(35) 10.67	(36) 10.97	(37) 11.28
METER GAUGE (1.0 m)						
Outside station limits	(20) 6.10	(21) 6.40	(22) 6.71	(23) 7.01	(24) 7.32	(25) 7.62
Inside station limits (Unearthed neutral)	(27 1/2) 8.31	(29) 8.84	(30) 9.14	(31) 9.45	(32) 9.75	(33) 10.06
Earthed neutral	(20) 6.10	(29) 8.84	(30) 9.14	(31) 9.45	(32) 9.75	(33) 10.06
NARROW GAUGE (2 1/2 ft.) (0.762 m)						
Outside station limits	(20) 6.10	(20) 6.10	(21) 6.40	(22) 6.71	(23) 7.01	(24) 7.32
Inside station limits (Unearthed neutral)	(26 1/2) 8.08	(28) 8.53	(29) 8.84	(30) 9.14	(31) 9.45	(32) 9.75
Earthed neutral	(20) 6.10	(28) 8.53	(29) 8.84	(30) 9.14	(31) 9.45	(32) 9.75
NARROW GAUGE (2 ft.)						
Outside station limits	(20) 6.10	(20) 6.10	(20) 6.10	(21) 6.40	(22) 6.71	(23) 7.01
Inside station limits (Unearthed neutral)	(25 1/2) 7.77	(27) 8.23	(28) 8.53	(29) 8.84	(30) 9.14	(31) 9.45
Earthed neutral	(20) 6.10	(27) 8.23	(28) 8.53	(29) 8.84	(30) 9.14	(31) 9.45
Min. clearance between conductors and any Railway Structure	(8) 2.44	(9 1/2) 2.90	(10 1/2) 3.20	(11 1/2) 3.51	(12 1/2) 3.81	(13 1/2) 4.11

MAXIMUM PERMISSIBLE SPANS (IN METERS) FOR TYPICAL LINES

Particulars	75 kg/M² Wind pressure	100 kg/M² Wind pressure
33 KV lines over 9.1 M.PSCC poles with Dog/Raccon ACSR Conductor	75	75

Sl. No	Particulars	75 Kg/M² WP/ (140 Kg. Wt) 8 M.PSCC poles	100 Kg/M² (200 Kg. Wt.) 8 M.PSCC poles
B) i)	11 KV lines over 8.0 M PSCC poles with ACSR Conductor		
	a) Rabbit (7/3.35)	65	70
	b) Weasel (7/2.59)	80	90
	c) Squirrel (7/2.11)	100	90
ii)	6.3 KV single phase line over 8.0 M.PSCC poles with ACSR conductor (HVD system)		
	a) Weasel (7/2.59)	110	110
	b) Squirrel (7/2.11)	110	110
iii)	L.T. 3Ø 5 wire (Vertical formation) lines over 8 M PSCC pole with ACSR conductor		
	a) 3 X Rabit + 2 X Squirrel	54.5	67
	b) 3 X Weasel + 2 X Squirrel	65.5	67
	c) 5 X Squirrel	67	45
iv)	L.T. 3 Ø 4 wire line :		
	a) Rabbit (7/3.35)	62.5	66.5
	b) Weasel	77.5	82.5
	c) Squirrel (7/2.11)	91	100
v)	L.T. 1 Ø 3 wire :		
	a) Weasel (7/2.59)	67	67
	b) Squirrel (7/2.11)	67	67
vi)	L.T. 1Ø 2 wire :		
	a) Squirrel (7/2.11)	67	67
	b) Squirrel (City)	45	45

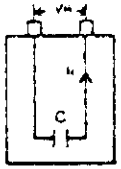
CAPACITORS SLECTION OF ASSOCIATED EQUIPMENT

KVAr	Current (amps) rating at 415 V	Current (amps) rating at 440V	Cable Size in MM sq. Al.	Cable Size in MM sq. Cu	Fuse Rating HRC (Amp.)	Fuse Rating Tinnec Cu. Wire (SWG)	Switch gear rating
1	1.39	1.31	1.5	1.5	4	33	15
2	2.78	2.62	1.5	1.5	6	32	15
3	4.17	3.94	1.5	1.5	10	29	15
4	5.56	5.25	1.5	1.5	10	26	15
5	6.95	6.56	2.5	2.5	15	24	15
6	8.34	7.87	4.0	2.5	15	23	30
7.5	10.43	9.84	4.0	40	20	22	30
10	13.91	13.12	10.0	6.0	25	20	30
12.5	17.39	16.40	10.0	10.0	35	19	63
15	20.86	19.68	16	10.0	50	18	63
20	27.82	26.24	25	16.0	50	18	63
25	34.78	32.80	35	25.0	63	16	63
30	41.74	39.36	50	35.0	80	14	100
40	55.65	52.48	70	50	100	13	100
50	69.56	65.61	95	70.0	125	-	160
75	104.3	98.41	185	150.0	200	-	200
100	139.12	131.21	240	240.0	250	-	250

Note: The protection of Capacitors should be provided by delayed action fuses which must be capable of carrying about 1.7 times the current for which the capacitor is rated. The above figures are an approximate guide only and the current at which tinned copper fuse will blow will depend upon the type & Construction of fused holder in which the wire is used. Therefore fuse selection is left to the discretion of the users.

USEFUL FORMULAS FOR POWER CAPACITOR

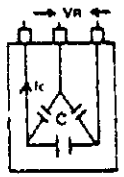
(a) FOR SINGLE PHASE



Ic = 1000 KVAr / VR

C = KVAr.10^12/ FVR^2

(b) FOR THREE PHASE



Ic = 1000. KVAr/(3.VR

C=KVAr. 10^9/4. ft. f. VR2

Ic = Capacitor Current

C = Capacitance in MFD

VR = Rated Voltage

CAPACITORS TO BE INSTALLED FOR MOTORS

KVAR rating of the Capacitors for various RPM of the motors.

Sl No.	Rating of individual motor	750 RPM	1000 RPM	1500 RPM	300 RPM
1	3HP	1	1	1	1
2	5HP	2	2	2	2
3	7.5HP	3	3	3	3
4	10 HP	4	4	4	4
5	15 HP	6	5	4	4
6	20HP	8	7	6	5
7	25HP	9	8	7	6
8	30HP	10	9	8	7
9	40HP	13	11	10	9
10	50HP	15	15	12	10

For Welding sets upto 10 KVA: The capacity of capacitor in KVAR should numerically be equivalent to KVA rating of the set

MAINTENANCE SCHEDULE OF STATION EARTHS INCLUDING TRANSFORMERS AND L.A. EARTS

Sl. No.	Item of maintenance	Periodicity
	[illegible] resistance	Monthly
	Checking the earth connections of joints	Monthly
	Watering of sub-station earths	Daily
	Watering of distribution transformer earths	Thrice a week

MAINTENANCE SCHEDULE OF LIGHTNING ARRESTERS

S. No.	Item of maintenance	Periodicity
1.	Cleaning, examination for cracks damaged glaze	Half yearly
2.	Checking gap settings	- do -
3.	Charging oxide film arrestors	Quarterly or earlier during shut downs
4.	Checking of lightning line and earth connections	- do -
5.	Checking earth resistance	- do -
6.	Checking the corrosion of metal base and cap	Annual
7.	Checking the lightning grading rings on H.V. arresters	- do -

MAINTENANCE SCHEDULE OF STORAGE BATTERIES

S. No.	Items of maintenance	Periodicity
1.	Taking specific gravity and voltage of Pilot cells	Daily
2.	Checking specific gravity and voltage of each cell:	Before and after charging
	a) Lead-acid cell	(Weekly when trickle charger exists)
	b) NiCAD cell	Monthly
3.	Cleaning of terminals applying vaseline and topping up with distilled water	Weekly for lead-acid batteries
4.	Overhaul of NiCAD battery	Yearly or as recommended by manufacturers
5.	Leakage test by lamp or voltmeter method	Each Shift
6.	Checking all connections of charger and battery for tightness	Quarterly

TROUBLE SHOOTING

NATURE OF TROUBLE	WORK ATTENDED
1. Non working of bell	a. Loose connections. b. Disturbing of bell adjustment. c. Burning of bell coil. d Alarm D.C. Fuse blown
2. Failure of trip healthy indication	a. Fusing of bulb. b. Loose connections. c. Resistance found open circuited. d. Alignment of Aux. contacts of C.B. getting disturbed.
3. Non working of O.L.T.C. Control	a. Failure of A.C. b. Failure of Aux. Transformer 220/110V. c. Putting Remote/Local switch on local-Non operation from remote. d. Contact problem in Lower/raise button. e. Tripping of miniature ckt. breaker of A.C. motor.
4. Non auto start of compressors	a. Pressure switch faulty. b. Loose connection.
5. Non tripping of feeder breaker.	a. Loose connection. b. Open circuit of trip coil. c. Mechanical trouble. d. Alignment of Aux. contacts of C.B. getting disturbed.
6. Noise in C.T.	a. Open circuit of secondary C.T. circuit. b. Loose connection in C.T. secondary ckt.
7 Spring charging motor does not start	a. Failure of A.C. supply. b. Failure of limit switch/C.B. Aux. switch. c. Defective motor.
8. Non closing of breaker	a. Loose connection. b. Open circuit in closing coil. c. Mechanical trouble. d. Alignment of Aux contacts of C.B. getting disturbed. e Spring was not charged. f. Non resetting of trip/master relay. g. Non closing from remote and if local/remote switch on.
9. Flash overs and damage to the wiring	a. Failure of insulation. b. Short circuit to lizard/rats etc.
10. Tripping of transformer on differential.	a. Failure of L.A. b. Loose connection c. Providing improper core C.T.s. d. Failure of L.V. cable box e. Failure of C.T. f. Fairture of insulators within differential zone. g. Magnetising in-rush current in case of DDT type relay.
11. "Flashor on" without fault	a. D.C. leakage.
12. Tripping of transformer on buchholz	a. Due to oil surge. b. Due to moisture/water inside the connection Box c. Improper operation of buchholz relay. d. Shorting off terminal due t o failure of bakelite plates. e. Low oil level.
13 Low oil level indication on panel was appearing continuously	a. D.C. leakage. b sticking of low oil level pointer c. Rain water inside the connection box
14 Flag not resetting	a. Mechanical defect.
15 Non resetting of bell.	a. Accept switch faulty. b. D C. leakage. c Aux. relay faulty.
16. Non resetting of indication	a. D.C. leakage. b Push button faulty
17. Non tripping of OCBs from remote end.	a. The local/remote switch on local position. b. Loose connection. c. Trip/close switch faulty. d. Alignment of Aux. contact of C.B. getting disturbed.
18 Capacitor bank tripping.	a. Faulty capacitor unit. b. Blowing of H T. fuse of capacitor unit.
19. Tripping of breaker without indication	a. Due to shorting of DC (+) ve. b. Leakage of D.C. c. Due to low pressure.
20. Continuous ringing of bell	a. D.C. leakage. b. Adjustment of Aux. Relay-contact is disturbed.
21. Abnormal noise in current transformer	a. Winding is open
22 Mal-operation of relay	a. Defects in relay
23. Battery charger not working	a. Failure of transformer b. Failure of diode. c. Failure of A.C. supply d. Switch faulty
24. Transformer cooling fans auto start/not working	a. Defects in Temp. Indicator b. Defects in contactor c. Loose connection
25. Indication lamp not indicating	a. Fusing of lamp b. Defects in Aux. switch. c. Loose connections.
26 Semaphor not woking	a Defects in Aux. switch. b. Loose wire. c. Semaphor coil burnt. d. Non availability of Aux. contactor for isolator.

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CLEARANCES

OPEN TYPE OUTDOOR SWITCHGEAR AND BUSBAR CONNECTIONS :

Rated KV	Min. clearance to earth in air inches (mm)	Min. clearance between phase in air inches (mm)	Safety sectional clearance inches (mm)
Not exceeding			
6.6	5.5 (140)	7(180)	120 (3050)
11	7 (180)	9(230)	120 (3050)
22	11 (280)	13 (330)	108 (2745)
33	15 (380)	17 (430)	109 (2770)
66	27 (685)	31 (790)	120 (3050)
110	34 (865)	39 (990)	132 (3350)
132	43 (1070)	48 (1220)	138 (3505)
220	70 (1780)	81 (2060)	168 (4280)

BUS BAR CLEARANCE IN MM IN OIL OR COMPOUND.

Rated Voltage between phases or poles kv	Min. clearance to earth inches (mm)	Min. clearance between phase inches (mm)
upto 0.6	0.5 (12)	0.5 (12)
3.3	0.5 (12)	0.75 (20)
6.6	0.75 (20)	1.0 (25)
11	1.0 (25)	1.5 (40)
22	1.75 (45)	2.5 (65)
33	2.50 (65)	3.5 (90)

CLEARANCE (IN MM) IN AIR INDOOR SWITCHGEAR

Rated Voltage KV	Min. length of Insulator inches (mm)	Min. clearance to earth inches (mm)	Min. Clearance between conductors inches (mm)
Upto 0.415	3/4 (20)	5/8 (16)	3/4 (20)
0.6	3/4 (20)	3/4 (20)	3/4 (20)
3.3	2 (50)	2 (50)	2 (50)
6.6	3.5 (90)	2.5 (65)	3.5 (90)
11	5 (125)	3 (75)	5 (125)
15	6 (150)	4 (100)	6.5 (165)
22	8 (200)	5.5 (140)	9.5 (240)
33	12 (305)	8.75(220)	14.0 (350)

PHASES OR BETWEEN CONNECTIONS OF SAME PHASES SEPARABLE ELECTRICALLY FROM EACH OTHER PHASE AND EARTH CLEARANCES IN CABLE BOXES.

Rated Voltage between phases	Min. clearance to earth inches (mm)	creepage distance to earth over cable end inches (mm)	Min. clearance between phases inches (mm)
upto and including 11 kv	2 (50)	5 (125)	2 (50)
Above 11 kv and upto and including 22 kv	3 (75)	6.5 (165)	4 (100)
Above 22 kv and upto and including 33 kv	4 (100)	8 (200)	5 (125)

APSEBEA

GUIDELINES FOR INSTALLATION OF METERING EQUIPEMENTS FOR RELEASING THE CONNECTIONS TO HT CONSUMERS

A) HT CONSUMER TO BE CONNECTED ON HT SIDE (TV METER)

1) Firstly the C.T.P.T. unit & T.V. meter which was to be installed should be got tested in testing laboratory. before installation and the suitable test certificate should be available with Asst. Engineer/ADE concerned
2) As per contract demand of consumer C.T. ratio of C.T P.T. unit should be used : e. for every 500 KVA C.D. the C.T. ratio should not exceed 30/5 amp.
3) Metering equipment should be enclosed in separate vermin proof box with sealing arrangement and box should be earthed properly.
4) For C.T. connections PVC 3.20 guage wire with proper colour code (i.e. red and blue) should be used.
5) For P.T. connections flexible or auto cable of proper colour code (i.e. redd, yellow, blue) should be used and it shouldbe connected through proper capacity of HRC fuses, points to be earthed should be properly earthed.
6) All the C.T. & P.T. connections should be given through 3 phase and 3 wire test terminal block.
7) C.T. & P.T. connections should be given as per drawing and marking on C.T.P.T. Unit.
8) 'L' of C.T. (R&B) should be earthed properly at test terminal block.
9) After releasing the connection & during monthly reading, the voltages should be checked at meter terminal only in case P.T. fuses are disturbed it should be seen that they are properly fitted.

B) HT CONSUMER TO BE CONNECTED ON LT SIDE (LTMD METER)

1) The L.T.C.T.'s & LTMD & RKVAh meter which are to be used should be got tested inteating laboratory before installation.
2) Proper C.T. ratio should be used depending upon the consumer's load i.e. for 100 KVA C.D. 150/5 amp. C.T. ratio should be used.
3) Seperate box with sealing arrangement for enclosing the C.T.s should be used Box should be earthed properly
4) The C.T.s should be connected/taken through incoming cable such that M(P1) should be towards source side and L(P2) should be towards load side
5) CT connections should be done as per drawings
6) Proper colour code wires (red, yellow,blue) should be used for C.T. & P.T.connections.
7) Use of PVC 3.20 guage wire for CT Connectionsand auto cable or flexible wire wire for, PT connections.
8) 5 A HRC fuses should be used for P.T. circuit.
9) All CT and PT wires should be connected through 3 phase, 4 W test terminal block.
10) All the metering equipments should be enclosed in a seperate box with sealing arrangement and box should be earthed properly
11) C.T. to be used should have MM/BM/CM or 1% class of accuracy and its rated burden per phase should be 15 VA as per I.S.S. 2705.
12) RKVAh meter of proper capacity should be installed for assessment of P.F.
13) If RKVAh meter is installed it is necessary to check the phase sequence.
14) 'L' of L.T C.s should be earthed at test terminal block.
15) After releasing the connection please confirm the availabuity of voltage at meter terminal cover (ph-phase, phase-neutral)

C) PRELIMINARY CHECKING WHEN IN SERVICE :

In order to confirm the proper connections please confirm the direction of rotation of meter dial of (TV. KWh & RKVAh) by removing the fuses one by one.

a) If correct connections as made the direction will be forward with all the PT fuses in circuit.

b) In case of T.vvector meter removal of ether of the fuses i.e. R or B phase, and incase of LTMD meter removal of any one of the three fuses, i.e. RY. or B phase the meter will slow down. But will rotate in forward direction provided load P.F. is lagging.

V A BURDENS OF DIFFERENT METERS : (IS 4201 - 1967)

	Instrument	V A Burden
1)	Ammeter	3 VA
2)	Current Coils of Wattmeter and P.F. meter	5 VA
3)	Current Coils of KWh, RKVAh meter	5 VA

C.T. SECONDARY SHOULD NEVER BE KEPT OPEN CIRCUITED : If the C.T. secondary is open circuted whole primary current becomes magnetising current producing high flux, inthe core gets saturated, loasing the trSansformer action. This high flux will produce very high induced voltage in the secondary puncturing the insulation of the winding

C.T. ACCURACY : Current transformers used for metering purpose should have sufficient accuracy at rate primary and secondary currents. The accuracy is not of much importance for higher currents than the rated values. However for protection purpose accuracy is not of ... ch importance at rated currents. Accuracy is required at higher current i.e higher knee point voltage is ... ial.

EFFECTS OF WRONG CONNECTIONS ON ENERGY REGISTRATION

I. 3Ø - 4 WIRE METERS

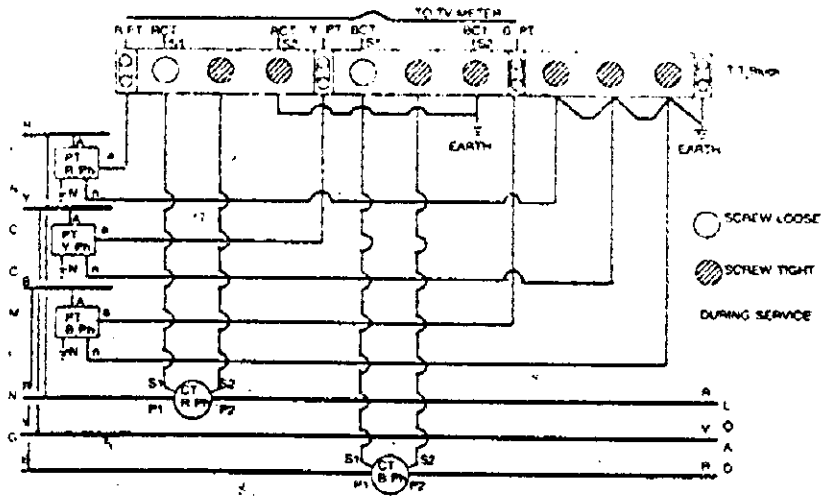
Sr. No.	Meter Terminal Connections	% of Energy Registered at Diff. P.F.					
		Theoretical Analysis			Practical Test Results		
		U.P.F.	0.8 PF	0.5 PF	U.P.F	0.8 PF	0.5 PF
1.	Normal Connection	100	100	100	100	100	100
2.	R Ph CT not connected	66	66	66	66	66	66
3.	y PH CT not connected	66	66	66	66	66	66
4.	B Ph CT not connected	66	66	66	63.7	66	62.5
5.	R Ph CT Polarity Reverse	33	33	33	36.6	37	31
6.	Y Ph CT Polarity Reverse	33	33	33	33	33	31
7.	B Ph CT Polarity Reverse	33	33	33	36.6	39	37
8.	Interchange of R & Y Ph C.T., Y., & B PhCT, & B & R Ph C.T.	0	0	0	0	0	0
9.	R Ph PT Fuse missing	66	66	66	63.6	62.5	56
10.	Y Ph PT Fuse missing	66	66	66	60	62.5	56
11.	B Ph PT Fuse missing	66	66	66	60	66	62.5
12.	R & Y, Y & B, B & R PT leads interchanged	0	0	0	0	0	0
II.	3Ø - 3 WIRE METERS						
1.	Normal connection	100	100	100	100	100	100
2.	R Ph CT not connected	50	71	100	50.5	68.2	100
3.	B Ph CT not connected	50	28.4	0	51.5	30	0
4.	R CT Polarity Reverse	0	43.28	100	0	44	100
5.	B CT Polarity Reverse	0	43.28	100	0	40.0	100
6.	R & B CT Inter changed	0	0	0	0	0	0
7.	R Ph PT Fuse missing	50	71	100	52.1	72.7	100
8	B Ph PT Fuse Missing	50	28.4	0	51.5	36.7	0
9.	Y PH PT Fuse missing	50	50	50	51.5	48	45
10	R & Y, Y & B, B & R PT leads interchanged	0	0	0	0	0	0

ERROR LIMITS FOR CLASS OF ACCURACY

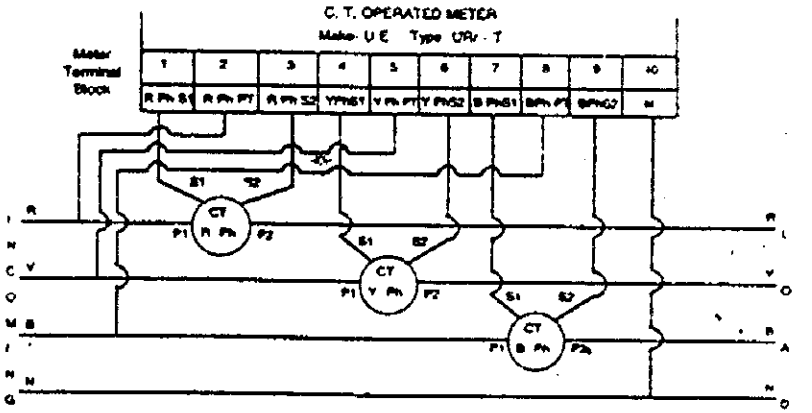
(Ref. IS-2705)

Class	% Current Error at Percentage of rated Current				Phase displacement in Minutes at			
	10%	20%	100%	120%	10%	20%	100%	120%
0.1	±0.25	±0.2	±0.1	±0.1	±10	±8	±5	±5
0.2	±0.5	±0.35	±0.2	±0.2	±20	±15	±10	±10
0.5	±1.0	±0.75	±0.5	±0.5	±60	±45	±30	±30
1.0	±2.0	±1.5	±1.0	±1.0	±120	±90	±60	±60

BLOCK CONNECTION DIAGRAM BY USING SINGLE PHASE C.T's AND P.T's FOR H.T. CONSUMER



CONNECTION DIAGRAM FOR C.T. OPERATED ENERGY METER



ELECTRONICS TRIVECTOR METER

1. DUKE ARNICS MODEL - RTK-3 :

The display on the LCD module, when the Mode/Function switch is operated, is as follows.

	SELECT MODE		SELECT FUNCTION
1.	Demand values	:	1. Real time clock, current Demand and M.D.
2.	M.D information	:	1. current M.D and time of its occurance 2. M.D at last reading 3. M.D. at 2 readings ago 4. M.D. at 3 readings ago 5. M.D. at 4 readings ago 6. M.D. at 5 readings ago
3.	No. of M.D. resets	:	1. No. of M.D. resets (readings) since meter installation upto date.
4.	Consumption details	:	1. Real consumption (KWH) 2. Reactive consumption (KVARh) – lag P.F. 3. Reactive consumption (KVARh) – lead P.F. 4. Apparent consumption (KVAh)
5.	Real time clock	:	1. Current Date & Time
6.	Phase values	:	1. Red phase voltage, current and P.F. 2. Yellow phase voltage, current and P.F. 3. Blue phase voltage, current and P.F.
7.	C.T. Error	:	1. Where CT's are connected wrongly reverse flow warning is displayed. as "REVERSE-FLOW".
8.	Total demand values (Instantaneous parameters)	:	1. Total KW, value 2. Total KVAR value 3. Total KVA value 4. Frequency

II. SECURE MAKE :

LED TEST	- 8 -	KVAH registered	- A -
Real time	- t -	Cumulative M.D.	- C -
Raising M.D.	- — -	Frequency	- f -
Reset count no	- n -	Power factor	- p -
KWH registered	- U -	Power on hour	- h -
KVARH registered	- r -	Man M.D.	- d -

REGULATION CONSTANTS FOR OVERHEAD H.T. & L.T. LINES THREE PHASE 50 CYCLES PER SECOND PER 100 KVA PER KM

Phase to Phase Voltage	Conductor Size	Equi-valant Copper area in sq. mm	Equi-valant Spacing in metres	Resis-tance at 400C in Ohms /km	"Reac-tance in Ohms/ km	Percentage regulation constant for lagging P.F.		
						0.8	0.9	Unity
415 V	Rose 7/1.96 mm AAC	13	0.483	1.472	0.3396	85	85.5	85.5
415 V	Gnat 7/2.21 mm AAC	16	0.483	1.1566	0.3330	65.33	68.90	67.08
415 V	Ant 7/3.31 mm AAC	30	0.483	0.5879	0.3115	38.16	38.57	34.14
11KV	Squirrel 7/2.11 mm ACSR	13	0.914	1.475	0.390	0.1169	0.1237	0.1219
11 KV	Weasel 7/2.59mm ACSR	20	0.914	0.977	0.3820	0.0840	0.0871	0.0815
11 KV	Ferret 7/3.0 mm ACSR	25	0.914	0.730	0.3760	0.0671	0.0680	0.0606
11 KV	Mink 7/3.66 mm ACSR	40	0.914	0.490	0.3650	0.05049	0.04958	0.04144
22 KV	Weasel 7/2.59 mm ACSR	20	1.066	0.977	0.3920	0.0212	0.0218	0.0204
22 KV	Ferret 7/3.0 mm ACSR	25	1.066	0.730	0.3860	0.0169	0.0171	0.0152
22 KV	Mink 7/3.66 mm ACSR	40	1.066	0.490	0.3800	0.0129	0.0126	0.0102
33 KV	Weasel 7/2.59 mm ACSR	20	1.371	0.977	0.4085	0.0095	0.0098	0.0091
33 KV	Ferret 7/3.0 mm ACSR	25	1.371	0.730	0.0430	0.0076	0.0077	0.0067
33 KV	Mink 7/3.66 mm ACSR	40	1.371	0.490	0.3980	0.0058	0.0057	0.0045

* Reactance of ACSR conductor is taken at 155 Amps/sq. cm.

Example :

% Voltage Regulation = (Es-Er)/Es X 100
Where Es = Sending end voltage.
Er = Receiving end voltage.
Er = Es - (IR Cos∅ + IX Sin∅)
Percentage voltage regulation at B for 11 KV feeder of Squirrel Conductor.
KVAkm between B & A = 500 X 2 = 1000
KVA km between A&SS = 1000 X 1 = 1000
Total KVA km = 1000 + 1000 + 1 = 2000
% Regulation = Total KVA km X Constant from table /100
= 2000X0.1237/100 = 2.474% (This should not exceed ± 6% for LT & ± 12% for HT)

CABLE FAULT LOCATION TECHNIQUES

The process of cable fault location comprises of four distinct, but interrelated stages viz :

1. Testing for detection of the nature of fault.
2. Conditioning/burning of fault, for location.
3. Prelocation : Approximate location based on changed electrical relationship due to fault.
4. Pinpoint location.

The nature of faults commonly experienced in practice are :

1. Core to armour/metallic sheath fault (earth fault)
2. Core to core faults, short circuits between phases.
3. Total break of one conductor, open circuit fault.
4. High resistance fault.
5. Flashing or intermittant faults.

The methods of fault location for H.T. cables can be categorised as :

1. Conventional methods.
2. Modern methods.

The following are some conventional methods :

1. Murray loop method.
2. Varley loop method.
3. Fisher loop test.
4. Fall of potential method.

Some modern methods are as mentioned below :

1. Pulse echo method
2. Impulse current method.

The conventional methods are basically variation of common wheatstone bridge. To find the cable fault by H.T. bridge, it is necessary to have atleast one core healthy and should be continuous through out the length. Following is the procedure to find the fault by H.T. bridge.

1. Short circuit the faulty and healthy core at one end of cable.
2. Make the proper connection.
3. Aply D.C. voltage so that 20 to 40 ma current will pass and adjust the potentiometer so that the null point will be shown on glavanometer.
4. Fault lenght = $\frac{\text{slide wire reading X21}}{100}$

   L = Lenght of cable.

1. PULSE ECHO METHOD : In this mehod, a low voltage short duration pulse is injected in the cable and time taken by the pulse to travle to the fault point, where change in insulation occur, and back is measured. Limitation of this method is, only short circuit faults i.e., zero resistance to earth and open circuit faults can be located.
2. IMPULSE CURRENT METHOD : The impulse method uses the current trasients which are created when an impulse Generator is connected into a faulty cable. Faults are located by defecting direct reflections of applied impulse from fault or from the transients created by break down of the spark gap.

   After prelocating fault by above methods, it is then pinpointed by use of acoustic detector.

TIPS FOR DISTRIBUTION SYSTEM IMPROVEMENT

Remember that energy losses in HT and LT lines is nearly 65% of the total loss. It requires large resources and comprehensive planning to reduce losses in EHT lines whereas everybody working in distribution has got full scope to reduce the HT/LT loss. A KWH saved is equivalent to a KWH extra generated.

a) Verify whether Transformer is of adequate capacity. Be guided only by the Tong Tester reading during peak hours. Reduction of capacity of a transformer by 100 KVA reduces the energy losses (by way of iron losses) by 3,000 - 3,500 units per year. The reduction in capital cost would be of the order of Rs. 12,000.

b) Avoid circuitous routing of H.T. and L.T. lines. Direct lines with laterals will minimise the length and also reduce line losses.

c) Ensure that the capacity of the conductor is adequate. Check the current carrying capacity and the voltage regulation. Propose reconductoring or duplicating the lines wherever necessary.

d) Provide 2 or more circuits for each Transformer in different directions for better regulation and reduction in losses. Properly grade the fuses. Balance the loads in each phase for better operation.

e) Location of Tr. Centre is important, avoid extension of LT lines in one direction only. Either shift the transformer to the load centre or rearrange the LT distribution by shifting the cut points to bring the Transformer to the Load Centre. This saves the distribution losses too.

f) Avoid lengthy LT distribution. Two 100 KVA Transformers located near clusters of load will be a better arrangement than a 200 KVA Tr. catering a large area.

g) Extended HT lines and minimise LT lines to save losses. Current in 11 KV line will be 1/27th of an LT line. So the losses in HT line will be 1/630th of the LT line.

h) Verify the tap position of Transformer. Optimum Tap position ensures better voltage. Higher voltage results in lower line current and lesser losses.

INCOME TAX : 1997 - 98

i)	Up To Rs. 40,000	NIL
ii)	Rs. 40,001 to 60,000	10% of excess over Rs. 40,000/-
iii)	Rs. 60,001 to 1,50,000	2,000 + 20% excess over Rs. 60,000/-
iv)	Rs. 1,50,001 and above	20,000 + 30% excess over 1,50,000
	Standard Deduction :	33.33% Subject to maximam of Rs. 20,000/-

READY RECKNOER FOR MONTHLY CONSUMPTION

(1000 watts used for 1 hr. = 1 KWH = 1 Unit)

Type of Appliances	Wattage	No. of Units for month of 30 days No. of hrs. per day: 1/2	1	2	3	4	5	6	7	8	9	10	11
Lamp	25	0.375	0.75	1.5	2.25	3	3.75	4.5	5.25	6.0	6.75	7.5	8.25
	40	0.6	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	10.8	12	13.2
	60	0.9	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.02	18	19.8
	75	1.125	2.25	4.5	6.75	9	11.25	13.5	15.75	18	20.25	22.5	24.75
	100	1.5	3	6	9	12	15	18	21	24	27	30	33
Ceiling Fan 36"	50	0.75	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5
48"	50	0.75	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5
50"	60	0.9	1.8	3.6	5.4	7.2	9	10.8	12.6	14.4	16.2	18	19.8
60"	70	1.5	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21	23.1
Table fan 16", 14", 12"	40	0.6	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12	13.2
Electric Iron	550	8.25	16.5	33	49.5	66	82.5	99	115.5	132	148.5	165	181.5
	750	11.25	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247.5
Dhobi Iron	1000	15	30	60	90	120	150	180	210	240	270	300	330
Geyser (2KW)	2000	30	60	120	180	240	300	360	420	480	540	600	660
1 ph. (3KW)	3000	45	90	180	270	360	450	540	630	720	810	900	990
3 ph. (6KW)	6000	90	180	360	540	720	900	1080	1260	1440	1620	1800	1980
storage Type Heater 1kw	1000	15	30	60	90	120	150	180	210	240	270	300	330
1.2 kw	1200	18	36	72	108	144	180	216	252	288	324	360	396
1.5 kw	1500	22.5	45	90	135	180	225	270	315	360	405	450	495
Immersion Rod	550	8.25	16.5	33	49.5	66	82.5	99	115.5	132	148.5	165	181.5
	750	11.25	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247
	1000	15	30	60	90	120	150	180	210	240	270	300	330

1998

RATING OF ELECTRICAL EQUIPMENTS

SI. NO.	KW RATING	MCCB	CONTACTOR	O/L RELAY RANGE	CABLE SIZE
1.	0.37	30A	30A	0.5-1	4X6
2.	0.55	30A	30A	1.0-2.0	4X6
3.	0.75	30A	30A	1.0-2.0	4X6
4.	1.1	30A	30A	1.5-3.0	4X6
5.	1.5	30A	30A	2-4	4X6
6.	2.2	30A	30A	3.0-6.0	4X6
7.	3.7	30A	30A	6-12	4X6
8.	5.5	30A	30A	6-12	4X6
9.	7.5	30A	30A	10-16	4X10
10.	9.3	30A	30A	12-24	4X10
11.	11.0	60A	30A	16-32	4X16
12.	16.0	60A	63A	16-32	3 1/2X25
13.	18.5	60A	63A	24-45	3 1/2X25
14.	22.0	60A	63A	24-45	3 1/2X50
15.	30.0	100A	125A	32-63	3 1/2X50
16.	37.0	100A	125A	50-90	3 1/2X95
17.	45.0	200A	125A	50-90	3 1/2X120
18.	55.0	200A	170A	70-110	3 1/2X150
19.	75.0	250A	170A	100-200	3 1/2X185
20.	90.0	400A	300A	100-200	2(3 1/2X120)
21.	110.0	400A	300A	150-300	2(3 1/2X120)
22.	132.0	630A	400A	150-300	2(3 1/2X150)
23.	160.0	630A	400A	20-400	2(3 1/2X185)
24.	200.0	800A	630A	315-500	3(3/12X150)

MOTOR CURRENT

H.P.	SINGLE PHASE SUPPLIES VOLTAGE							TWO-PHASE SUPPLIES VOLTAGE					H.P.
	110	200	220	230	240	250	400	200	220	250	400	500	
1/2	2.69	1.48	1.34	1.28	1.23	1.18	.738	.715	.650	.572	.358	.286	1/2
1/4	4.66	2.56	2.32	2.22	2.13	2.04	1.28	1.18	1.07	.945	.590	.472	1/4
1/2	7.77	4.27	3.88	3.72	3.56	3.42	2.14	1.86	1.71	1.51	.943	.755	1/2
1/4	10.4	5.72	5.20	4.97	4.77	4.57	2.86	2.59	2.36	2.07	1.29	1.03	1/4
1	13.2	7.25	6.59	6.30	6.04	5.80	3.63	3.33	3.03	2.66	1.66	1.33	1
1 1/2	19.2	10.5	9.60	9.19	8.80	8.45	5.28	4.91	4.46	3.92	2.45	1.96	1 1/2
2	25.4	14.0	12.7	12.2	11.7	11.2	7.00	6.48	5.89	5.19	3.24	2.59	2
2 1/2	31.5	17.3	15.7	15.0	14.4	13.8	8.65	8.02	7.29	6.41	4.01	3.21	2 1/2
3	37.3	20.5	18.6	17.9	17.1	16.4	10.3	9.50	8.63	7.59	4.75	3.79	3
4	48.5	26.7	24.3	23.2	22.2	21.4	13.4	12.3	11.2	9.86	6.16	4.93	4
5	59.2	32.6	29.6	28.3	27.1	26.0	16.3	15.1	13.7	12.0	7.52	6.02	5
6	69.4	38.2	34.7	33.2	31.8	30.6	19.1	17.7	16.1	14.2	8.85	7.07	6
7	79.6	43.8	39.8	38.1	36.5	35.0	21.9	20.2	18.4	16.2	10.1	8.10	7
7 1/2	84.4	46.4	42.2	40.3	38.7	37.1	23.2	21.5	19.5	17.2	10.7	8.58	7 1/2
10	109	59.8	54.4	52.0	49.9	47.9	29.9	27.7	25.2	22.1	13.8	11.1	10
12 1/2	134	73.5	66.8	63.9	61.2	58.8	36.8	34.0	30.9	27.2	17.0	13.6	12 1/2
15	157	86.5	78.6	75.2	72.1	69.2	43.3	40.0	36.4	32.0	20.0	16.0	15
20	205	113	103	96.1	94.0	90.4	56.4	52.2	47.5	41.8	26.1	20.9	20
25	253	139	127	121	115	111	69.6	64.1	58.5	51.5	32.2	25.8	25
30	300	165	150	143	137	132	82.5	76.2	69.3	61.0	38.1	30.5	30

APSEBEA

Type of Appliances	Wattage	No. of Units for month of 30 days No. of hrs. per day											
		1/2	1	2	3	4	5	6	7	8	9	10	11
	1500	22.5	45	90	135	180	225	270	315	360	405	450	495
Stove	750	11.25	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	247
	1000	15	30	60	90	120	150	180	210	240	270	300	330
Cooker	1500	22.5	45	90	135	180	225	270	315	360	405	450	495
Toaster	1000	15	30	60	90	120	150	180	210	240	270	300	330
Mixer Big	200	3	6	12	18	24	30	36	42	48	54	60	66
Mixer small	50	0.75	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5
Air Conditioner 1.4 kw	1400	21	42	84	126	168	210	252	294	336	378	420	462
1 Ton " 1.8kw	1800	27	54	108	162	216	270	324	378	432	486	540	594
Refrigirator													
small (1/4HP)	200	3	6	12	18	24	30	36	42	48	54	60	66
Electrolux	300	4.5	9	18	27	36	45	54	63	72	81	90	99
Washing machine	200	3	6	12	18	24	30	36	42	48	54	60	66
Cloth Drier/Spin Drier	200	3	6	12	18	24	30	36	42	48	54	60	66
Radiator	1000	15	30	60	90	120	150	180	210	240	270	300	330
Elect. Clock	5	0.075	0.15	0.3	0.45	0.6	0.75	0.9	1.05	1.2	1.35	1.5	1.65
Radio	50	0.75	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5
T.V.	150	2.25	4.5	9	13.5	18	22.5	27	31.5	36	40.5	45	49.5
Electric Kettle	750	11.25	22.5	45	67.5	90	112.5	135	157.5	180	202.5	225	267
	1000	15	30	60	90	120	150	180	210	240	270	300	330
Oven 2 plates 3 kw	3000	45	90	180	270	360	450	540	630	720	810	900	990
3 plates 5 kw	5000	75	150	300	450	600	750	900	1050	1200	1350	1500	1650
Cooking Range 5 kw	5000	75	150	300	450	600	750	900	1050	1200	1350	1500	1650
Radiogram	100	1.5	3	6	9	12	15	18	21	24	27	30	33
Tape Recorder	50	0.75	1.5	3	4.5	6	7.5	9	10.5	12	13.5	15	16.5

REFERENCE TABLE

AMPS FOR MVA

MVA	11KV	22KV	33KV	66KV	132KV	220KV	400KV
1	52.5	26.25	17	8.7	4.3	2.2	1.4
2	105	52.50	35	17.5	8.7	4.4	2.9
3	157.5	78.75	52	26.2	13.0	6.6	4.8
4	209.9	104.95	70	35.0	17.5	8.7	5.7
5	262.4	131.20	87	43.7	21.9	10.9	7.2
6	314.9	157.45	105	52.5	26.2	13.1	8.7
7	367.4	183.70	122	61.2	30.6	15.3	10.6
8	419.9	209.95	140	70.0	35.0	17.5	11.5
9	472.4	236.20	157	78.7	39.4	19.7	13.0
10	524.9	262.15	175	87.0	43.7	21.9	14.4
11	577.4	288.70	192	96	48.1	24.0	15.9
12	629.8	314.90	210	105	52.6	26.2	17.3
13	682.3	341.15	227	114	56.9	28.4	18.6
14	734.8	367.40	245	122	61.2	30.6	20.2
15	787.3	393.65	262	131	65.6	32.8	21.6
16	839.8	419.90	280	140	70.0	35.0	23.8
17	892.3	446.15	297	149	74.3	37.1	24.5
18	944.8	472.40	315	157	78.7	39.4	26.0
19	947	496.50	332	166	83.1	41.5	27.4
20	1050	525.00	350	175	87.5	43.7	28.9
25	1312	656.00	437	219	109	54.7	36.8
30	1575	787.50	525	262	131	65.6	43.3
35	1837	918.50	612	309	153	76.5	50.5
40	2099	1049.50	700	350	175	87.5	57.7
45	2362	1181.00	787	394	197	98.4	65.0
50	2624	1312.00	875	437	218	109.3	72.2
60	3149	1574.50	1090	525	262	131.2	86.6
70	3674	1837.00	1225	612	306	153	101
80	4199	2099.50	1400	700	350	175	115
90	4724	2362.00	1575	787	394	197	130

MVA FOR AMPERES

Amps	11KV	22KV	33KV	66KV	132KV	220KV	400KV
1	.019	.038	.057	.114	.229	.381	.69
2	.038	.076	.114	.229	.457	.762	1.39
3	.057	.114	.171	.343	.686	1.143	2.08
4	.076	.114	.171	.343	.686	1.143	2.08
5	.095	.190	.286	.572	1.143	1.905	3.46
6	.114	.228	.343	.686	1.372	2.286	4.16
7	.133	.266	.400	.800	1.600	2.667	4.85
8	.152	.304	.457	.915	1.829	3.048	5.54
9	.171	.342	.514	1.028	2.058	3.429	6.23
10	.191	.382	.571	1.143	2.286	3.810	6.93
11	.210	.420	.629	1.257	2.515	4.192	7.62
12	.229	.458	.686	1.372	2.744	4.573	8.31
13	.248	.496	.743	1.486	2.972	4.954	9.01
14	.267	.534	.800	1.600	3.201	5.335	9.70
15	.286	.572	.857	1.715	3.429	5.716	10.39
16	.305	.610	.915	1.829	3.658	5.097	11.08
17	.324	.648	.972	1.943	3.887	6.478	11.78
18	.343	.686	1.029	2.058	4.115	6.859	12.47
19	.362	.724	1.086	2.172	4.344	7.240	13.16
20	.381	.762	1.143	2.286	4.573	7.621	13.86
25	.476	.952	1.429	2.858	5.716	9.526	17.32
30	.572	1.144	1.715	3.429	6.859	11.432	20.78
35	.657	1.334	2.000	4.001	8.002	13.337	24.25
40	.762	1.525	2.286	4.573	9.145	15.242	20.71
45	.857	1.714	2.572	5.144	10.288	17.147	31.18
50	.953	1.906	2.858	5.716	11.432	19.053	34.64
60	1.143	2.286	3.429	6.859	13.718	22.863	41.57
70	1.334	2.668	4.001	8.002	16.004	26.674	48.50
80	1.524	3.048	4.573	9.145	18.290	30.484	55.42
90	1.715	3.430	5.144	10.288	20.557	34.295	62.35

ARSTEEL

MOTOR CURRENT

THREE PHASE SUPPLIES

H.P.	VOLTAGE												H.P.
	190	200	220	240	250	346	380	400	415	440	500	550	
1/2	.870	.827	.751	.689	.661	.478	.435	.413	.398	.376	.331	.300	1/2
1/4	1.44	1.36	1.24	1.14	1.09	.788	.718	.682	.657	.620	.545	.495	1/4
1/2	2.30	2.18	1.98	1.82	1.74	1.26	1.15	1.09	1.05	.990	.871	.792	1/2
1/4	3.15	3.00	2.72	2.50	2.39	1.73	1.58	1.50	1.44	1.36	1.20	1.09	1/4
1	4.05	3.85	3.50	3.21	3.08	2.22	2.02	1.92	1.85	1.75	1.54	1.40	1
1 1/2	5.98	5.68	5.16	7.73	4.54	3.28	2.99	2.84	2.74	2.58	2.27	2.06	1 1/2
2	7.88	7.48	6.80	6.24	5.98	4.32	3.94	3.74	3.60	3.40	3.00	2.72	2
2 1/2	9.74	9.25	8.41	7.71	7.40	5.35	4.87	4.62	4.46	4.20	3.70	3.36	2 1/2
3	11.5	11.0	9.96	9.15	8.79	6.34	5.78	5.48	5.29	4.29	4.39	3.98	3
4	15.0	14.2	12.9	11.9	11.4	8.25	7.50	7.12	6.87	6.48	5.70	5.18	4
5	18.3	17.4	15.7	14.5	13.9	10.1	9.16	8.70	8.39	7.90	6.96	6.32	5
6	21.5	20.4	18.6	17.0	16.4	11.8	10.7	10.2	9.85	9.30	8.18	7.43	6
7	24.6	23.4	21.2	19.5	18.7	13.5	12.3	11.7	11.2	10.6	9.34	8.50	7
7 1/2	26.1	24.8	22.6	20.6	19.8	14.3	13.1	12.4	11.9	11.3	9.94	9.02	7 1/2
10	33.6	31.9	29.0	26.6	25.5	18.5	16.8	15.9	15.4	14.5	12.8	11.6	10
12 1/2	41.3	39.2	35.7	32.7	31.4	22.2	20.6	19.6	18.9	17.8	15.7	14.3	12 1/2
15	48.6	46.2	42.0	38.5	36.9	26.7	24.3	23.1	22.3	21.0	18.5	16.8	15
20	63.4	60.2	54.7	50.1	48.2	34.8	31.7	30.1	29.0	27.4	24.1	21.9	20
25	78.2	74.2	67.5	62.0	59.5	42.9	39.1	37.2	35.8	33.8	29.7	27.0	25
30	92.6	88.0	80.0	73.4	70.5	50.9	46.3	44.0	42.4	40.0	35.2	32.0	30

STEEL CONVERSION TABLE

Description			Size mm.	Wt. per metre Kg.	Sectional Area in Sq. Cm.
R.S. JOISTS:	ISLB	125	125X75	11.9	15.12
	ISLB	150	150X80	14.2	18.08
	ISLB	175	175X90	16.7	21.30
	ISMB	125	125X75	13.0	16.60
	ISMB	150	150X80	14.9	19.00
	ISMB	175	175X90	19.3	24.62
CHANNELS:	ISLC	75	75X40	5.7	7.26
	ISLC	100	100X50	7.9	10.02
	ISLC	125	125X65	10.7	13.67
	ISLC	250	250X100	28.0	35.65
	ISMC	75	75X40	6.8	8.67
	ISMC	100	100X50	9.2	11.70
	ISMC	125	125X65	12.7	16.19
ANGLES:	ISA	25-25	25X25X3.0	1.1	1.41
	ISA	40-40	40X40X3.0	1.8	2.34
	ISA	50-50	50X50X6.0	4.5	5.68
	ISA	65-65	65X65X6.60	5.8	7.44
			65X65X8.0	7.7	9.76
			65X65X10.0	9.4	12.00
	ISA	75-75	75X75X6.0	6.8	8.66
			75X75X8.0	8.9	11.38
			75X75X10.0	11.0	14.02
	ISA	100-100	100X100X10.0	14.9	19.03

ROUND BARS

Dia mm	Wt/M kgs.	Sectional area sq.mm.
6	0.22	0.28
8	0.39	0.50
10	0.62	0.79
12	0.89	1.13
14	1.21	1.54
16	1.58	2.01
18	2.05	2.54
20	2.47	3.14
22	2.98	3.80
25	3.85	4.91
28	4.83	6.16
32	6.31	8.04
36	8.00	10.18
40	9.87	12.27

FLATS AND PLATES

Section mm.	Wt/M kgs.	Section mm.	Wt/M kgs.
25x6	1.2	75x8	4.7
25x10	2.0	75X10	5.9
35x6	1.6	75x12	7.1
35x10	2.8	75x20	11.8
40x6	1.9	100x10	7.8
40x8	2.5	100x12	9.4
40x10	3.1	100x16	12.6
45x6	2.1	100x20	25.7
45x10	3.5	150x16	18.8
45x12	4.2	150x25	29.4
50x6	2.4	200x10	15.7
50x8	3.1	200x12	28.8
50x10	3.9	200x25	39.2
50x12	4.7	250x12	23.6
50x16	6.3	250x20	39.2
65x10	5.1	250x25	49.1
65x12	6.1	300x12	28.3
65x20	10.12	900x8	42.4

WEIGHTS OF DIFFERENT MATERIALS

SL.	NAME OF MATERIAL		SIZE		APPROX. WEIGHT IN KGS.	
1.	CONDUCTORS					
	Raccoon ACSR		7/4.09		319 Kgs.	Per KM
	Rabbit ACSR		7/3.35		214 Kgs.	"
	Dog ACSR		6/4.72 (AL)			
			7/1.57 (steel)		394 Kgs.	"
	Weasel ACSR		7/2.59		128 Kgs.	"
	Ant AAC		7/3.10		145 Kgs.	"
	Gnat AAC		7/2.2		74Kgs.	"
	Squirrel ACSR		7/2.11		85 Kgs.	"
2.	33 KV 'V' CROSS ARM					
	100 X 50 mm channel		7'		21 Kg.	
3.	11 KV 'V' CROSS ARM					
	75 X 40 mm M. S. Channel		5'		11 Kgs.	
4.	3Ø L.T. CROSS ARM					
	50 X 50 X 6 M.S., Angle		4'		7 Kgs.	
5.	11 KV TOP FITTINGS					
	65 X 65 x 6 mm M.S. Angle		15"		3 Kgs.	
6.	D.P. STRUCTURE					
	1. 100 X 50 M. S. Channel	4 Nos	11'	Each 44 Feet		
	2. 75 X 40 M. S. Channel	2 Nos	11'	Each 22 Feet		
	3. 65 X 65 M.S. Channel	2 Nos	11'	Each 22 Feet		
	4. 65 X 65 M.S. Channel	2 Nos	2'	Each 4 Feet		
	5. 50 X 50 X 6 M. S. Angle	2 Nos	11'	Each 22 Feet		
		2 Nos	7'	Each 14 Feet		
		2 Nos	5'	Each 10 Feet		
		2 Nos	4'	Each 8'		
7	H.G. FUSE SET. 14 Kgs.					
8.	BACK CLAMPS					
	R.S. Joist 6X4	—	17"	Each	2.7 Kgs.	
	Stay clamps	2 Nos.	13"	Each	2.7 Kgs.	
	R.S. Joist 7X4		17 1/2"			
	Stay clamps 7X4 RSJs	2 Nos	14"	Each	2.8 Kgs.	
	PSCC poles		32"			
	Stay clamps 2 X 24'		48"			

14.	Plastering 20mm thick with CM 1:6 base coat 16 mm thick in and top coat 4 mm thick in CM 1:4		10Sqm	1.150 bags
15.	Plastering 12mm thick with base coat 8 mm thick in and top coat 4mm thick in CM 1:3 for celling CM 1:5		10sqm	1 .020 bags
16.	Pointing to basement in CM1:3		10sqm	0.60 bags
	-do-	CM 1:4	10sqm	0.45 bags
17.	Pointing to sahabad flooring in	CM 1 3	10 Sqm	0.15bags
18.	2" thick C.C. 1:2:4 flooring			
	1 1/2" C.C.1:2:4 & CP with CM 1 3		10 Sqm	3 62 bags

C & G MAKE STATIC H.T.T.V.R

THE DESCRIPTION OF PARA METERS ON SCROLLING

00	KWH
01	KVARH (LAG)
02	KVAH
03	KVA (Maximum demand) Present Maximum Demand.
04	Date of Maximum Demand.
05	Running M.D.KVA.
06	Intigration Time lapsed.
07	Intigration Time.
08	No.of M.D. resets.
09	Date of last M.D.reset.
10	Last month M.D.(M 1).
11	Cumulated Maximum Demand.
12	Instant Power Factor (with Quadrants)
13	Mains Frequency.
14	Week Day and Time.
15	Date:

THEORITICAL REQUIREMENT OF CEMENT

Sl.No.	Item of work			Unit	Cement required in bags
1.	Brick mansonry in 2nd class brick		in CM 1:4	cum	1 14 bags
	-do-	-do-	in CM 1:6	cum	0 96 bags
	-do-	-do-	in CM 1:9	cum	0 64 bags
	-do-	-do-	in CM 1:8	cum	0 72 bags
2	R.R.Masonry with		CM 1:5	cum	1.72 bags
	-do-		CM1:6	cum	1.43 bags
	-do-		CM 1:8	cun	1.98 bags
3.	C.R.S. Ist sort with		CM 1:4	cum	2 30 bags
	-do-		CM 1:5	cum	162 bags
	-do-		Cm 1:6	cum	134 bags
	-do-		Cm 1:8	cum	101 bags
4.	C.R.S. 2nd sort with		CM 1:5	cum	1.84 bags
	-do-		CM 1:6	cum	1.54 bags
	-do-		CM 1:8	cum	1.15 bags
5.	C.c.1:5:10 prop			cum	2.65 bags
	-do- 1:6:12 prop			cum	2.21 bags
6.	-do- 1:4:8 prop			cum	3.31 bags
7.	-do-1:3:6 prop			cum	4.42 bags
8.	-do-1:2:4 prop (M 150)			cum.	6.62 bags
	-do-1:1:2 prop (M 250)			cum	13.24 bags
9.	C.C.1:11/2:3 prop (M 200)				8.84 bags
	(a) 100 mm thick slab			10 sqm	6.73 bags
	(b) 115 mm thick slab			10 sqm	7.56 bags
	(c) 125 mm thick slat			10 sqm	8.40 bags
	(d) 140 mm slab			10sqm	8 45 bags
	(e) 150 mm thick slab			10 sqm	10.90 bags
	(f) 75 mm thick slab			10 sqm	7.92 bags
	(g) 75 mm Thich RCC with CM 1:3 prop			10sqm	7.32 bags
10.	Plastering 25 mm thick CM 1:3 prop			10 sqm	2.60 bags
	-do-		CM 1:4 prop	10 sqm	1.95 bags
11.	(a) Plastering 20 mm thick		CM 1:3 prop	10sqm	2.05 bags
	(b) -do-		CM 1:4 prop	10sqm	1.54 bags
	(c) -do-		CM 1:5 prop	10sqm	1.23 bags
	(d) -do-		CM 1:6 prop	10sqm	1.02 bags
	(e) 1st Coat C.M. 1:5 & 2nd coat		CM 1:3 CM 1:4	10sqm 10sqm	1.33 bags 1.10 bags
12.	Plastering 12 mm thick in		CM 1:3	10sqm	1.47 bags
	-do-		CM 1:4	10sqm	1.10 bags
	-do-		CM 1:5	10sqm	0.88 bags
13.	Plastering 12 mm thick with base coat 8 mm thick in and top coat 4 mm thick in		CM(1:6) CM(1:4)	10sqm	0.820 bags

JICA