3.7 Identified Problems and Solutions

3.7.1 Frequency

As described in the previous chapter, the Andhra Pradesh system operated in severe low frequency conditions in May 2002, but this cannot be solved only using APTRANSCO because the Southern India Grid including the system operates at the same frequency. Low frequency problems in the Southern India Grid were considered problems by the Central Electricity Regulatory Commission in March 2002. Since the ABT was enforced in January 2003, the frequency has been maintained by 49.0 Hz or more.

Sustained low frequency operation or wide frequency variation causes damage to the electrical equipment of power plants as well as that of consumers. In power plants, this kind of operation may damage not only auxiliary equipment such as motors and pumps, but also turbines and generators. Low frequency also decreases the security level of power system operation.

The quality of products of a number of process industries such as rolling mills is heavily dependent on the quality of supply. Poor quality power supply not only results in reduced life of equipment, but also in poor quality products. In case of irrigation pumps, the total operating hours of the pumps increases for pumping the same amount of water if the frequency of operation is low.

To advance the industry with advanced technology in the area, it is necessary to supply electricity with a stabilized frequency. For this, APTRANSCO/APCPDCL are required to establish an organization to supply a stable electricity supply by strengthening power generating facilities and promoting Demand Side Management (DSM) with the cooperation of customers.

3.7.2 Voltage

The voltage of the distribution system is decided by the voltage of the upper stream transmission system. The voltages of domestic and industry feeders remain within the specified level and no problem is observed at this moment. For agriculture feeder, it is considered that distance is comparatively long and load is fluctuated so a large voltage variation is occurred. APCPDCL is recommended to make efforts continuously to maintain the voltages and reduce the distribution losses with suitable distribution of the loads and the reactive power sources. (Also please refer to Chapter 5)

3.7.3 Number of Outages

Analysis results show that some feeders stopped 100 times or more in 2002/03 and proper countermeasures have to be taken.

Table 3.8 shows the major causes of outages and considerable countermeasures for reducing the number of outages which were obtained through the analysis of outage records and discussions with APCPDCL.

Table 3.8 Major causes of outages and considerable countermeasures

Causes	Description	Temporary measures	Permanent measures
Tree contact to the conductors		Reexamination of range and opportunity of trees cutting.	Adoption of insulated conductors for the span where there is a probability of tree contact to the conductor.
Bird contact to the charging parts			Adoption of insulated conductors
Loose conductors	Short circuit at the mid-span due to excess of sag.	(1)Adjustment of sag of a conductor. (2)Adoption of spacer.	(1) Insert the pole at the mid-span for reducing sag. (2) Increase the phase clearance. (3) Adoption of insulated conductors.
Bad connection of joint parts	Poor contact of twist type jointing.		Adoption of compression type clamp.
Inferiority of insulators		Exchange with excellent one	
Contamination of insulators	Due to salt or dust of factories.	Cleaning of insulators.	Adoption of longer leakage path insulators.

An insulated conductor is considered an effective means for reducing the number of outages. They should be used in locations where contact between trees and conductors is unavoidable by cutting trees or contact of conductors at the mid span is not solved by adjustment of their sagging.

Troubles of joints of conductors/jumpers frequently occur, but they can be solved by the adoption of compression type clamps instead of the twist type joint used at the moment. The average number and duration of a customer per year in Japan where insulated conductor and compressed type clamp are used are 0.2 times and 25 minutes, respectively.

As pointed out in 3.6.3(4), Details of Unknown Causes and Equipment, approximately 51 % of outages are classified as OTH/OTH that is equipment and cause of outages is not identified. However, the number of outages cannot be reduced if their cause is not known. Therefore, APCPDCL should take actions such as making an accurate record of the outage and perform a patrol of distribution facilities as much as possible to identify the condition of equipment and cause of fault and make a preventive plan for recurrence of the same troubles. If the number of outages is reduced the duration of outages will also decrease as a result, the burden on the maintenance crew will also decrease, and therefore, it can be utilized for preventive maintenance and can result in improvement in the quality of maintenance.

3.7.4 Duration of Outages

Approximately 98 % of outages are restored within 120 minutes in the RBAN case (See 3.6.3(3)) and the cases in which duration of outages was prolonged are not particularly significant large. However, APCPDCL has to try hard in the future to reduce the duration of outages.

3.7.5 Overload

The monitoring of the overload of the transformers is carried out by the section office continuously and the same procedures are necessary to maintain carefully. (Refer to 5.7 Recommendations of Chapter 5)

3.7.6 Correspondence to DISTRIBUTION CODE

Since the DISTRIBUTION CODE will be enforced in 2004, APCPDCL must establish a system corresponding to it as soon as possible. Figure 3.25 shows the flow of required quality control work for it.

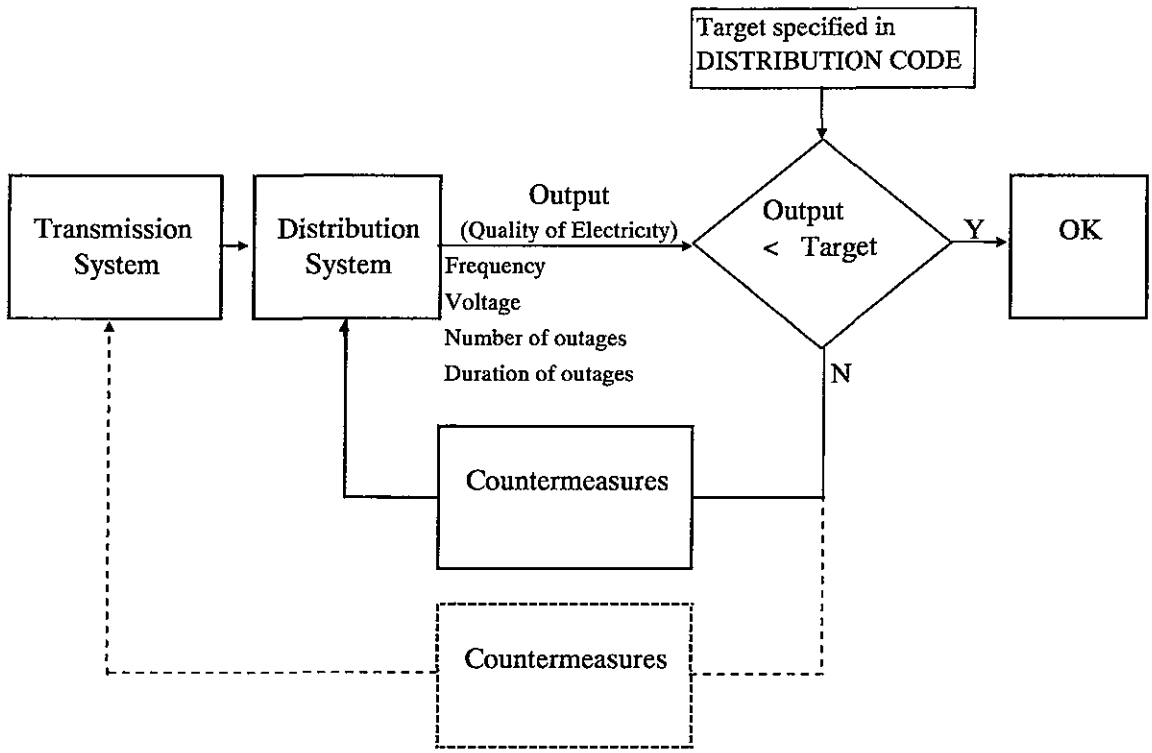


Figure3.25 Quality control flow for DISTRIBUTION CODE

When output from the distribution system (frequency, voltage, number and duration of interruptions) is compared with the target (regulations of DISTRIBUTION CODE) and the former does not satisfy the latter, it is necessary to take action in pursuit of the cause.

For this reason, understanding the output of the distribution system and the setup of target are indispensable. Although the target of outages may not be specified in the DISTRIBUTION CODE for the time being such as the GRID CODE, APCPDCL should to setup an in-house target and try to supply better quality electricity to the consumers than at present.

The concrete step is;

(a) Data collection and its analysis for understanding the output from the distribution system

(b) Setup the target value, if any

(c) Planning and execution of the countermeasures, if system output does not satisfy the specified level. (Target)

It is necessary to carry out systematic analysis of outage records especially.

(1) Category

Analysis of the outage records shows that the applied categories differ depending on the persons in charge. For example, the same outage is classified into the three categories, such as scheduled maintenance, emergency maintenance and others so it should be follow the common philosophy of the

office.

(2) Coding System for Remarks

Some times, the descriptions of remarks include very useful information for data analysis. Therefore, feeder name, equipment, cause of outage, pole no., etc which are included in description of remarks will be converted to a suitable codes and used as data of analysis.

(3) Format of Duration of Outages

APCPDCL uses the following format of "the hour" (xx h, xx m, xx s), for duration of outages, but this system is not suitable for more than 24 hours. The study team suggests applying "minutes" for analysis. GRID CODE also uses "minutes."

(4) Review of CODE LIST

CODE LIST attached in Annex 3.2 should be reviewed/ revised as per the present situation.

(5) Application to other districts

Regarding the data analysis, the similar system is to be applied to other districts.

(6) Data Centers

For utilization of this system effectively, setup data centers in the corporate office and districts and these are linked with a communications channel, for example by Internet. It is necessary to train required personnel in parallel to the above.

In addition, out-sourcing should be considered if it takes some time for preparation of the required system and training of the personnel.

3.7.7 Others

(1) Operation and Maintenance Manual

An operation and maintenance manual in conformity with the DISTRIBUTION CODE that will be applied from 2004 should be arranged as soon as possible. The same will be distributed to all the offices concerning operation including substations and should be made so that the personnel in charge of the substation share common knowledge and a sense of thoroughness.

(2) Rearrangement of low voltage wiring

The present arrangement of a low voltage wiring, especially the branch part to customers, is very disorderly and management must be difficult. Rearrangement of the same wiring is suggested.

(3) Safety Measures to the Public

It is observed that a passer-by may often unconsciously touch the bare energized terminals/wires of a low -voltage distribution/switch box which its cover is kept opened and, in the rural area, some transformers are installed near the ground surface and charged parts are exposed without protective covers so that the general public may touch them easily.

Especially, in case the equipment is installed in or near a public road, it is recommended to take suitable measures urgently to prevent people approaching to the energized parts of the said equipment such as to install a fence surrounding the transformer or close the cover of the same box.

3.8 Recommendations

The study team found some problems through the study on the quality of electricity, frequency, voltage, number and duration of outages, in Range Reddy and Medak and presents suggestions to solve them.

Regarding the frequency, it is out of control for APCPDCL and no serious problems are observed for the voltage.

(1) Correspondence to the DISTRIBUTION CODE

Since the DISTRIBUTION CODE deliberated now by APERC is due to be enforced in 2004, it is necessary that to construct a system to collect and analyze the data efficiently and train the necessary personnel as soon as possible.

(2) Reduction of the Number of Outages

Analysis results show that some feeders stopped 100 times or more in 2002/03 and proper countermeasures have to be taken to reduce this number. It is recommended to use insulated conductors in locations where contact between trees and conductors cannot be preventing by cutting along or contact of conductors at the mid span that is not solved by adjustment of sagging.

Troubles of joints of conductors/jumpers occur frequently and they will be solved by an adoption of a compression type clamp instead of the twist type joint used at the moment.

In the RBAN system, approximately 51 % of outages are classified as OTH/OTH which is equipment and the cause of outages is not identified. However, the number of outages cannot be reduced if their cause remains unknown. Therefore, APCPDCL should take actions such as making an accurate record of outages and perform a patrol of distribution facilities as much as possible to identify the equipment and cause of faults and make a preventive plan for recurrence of the same problems.

(3) Operation and Maintenance Manual

An operation and maintenance manual that in conformity with the DISTRIBUTION CODE that will be applied from 2004 should be arranged as soon as possible. The same will be distributed to all offices concerning operation including substations and should be made even so that the personnel in charge of the substation attain common knowledge and a sense of thoroughness.

(4) Rearrangement of Low Voltage Wiring

The present arrangement of a low voltage wiring, especially the branch part to the customers, is very disorderly and management must be difficult. Rearrangement of the same wiring is suggested.

(5) Safety Measures for the Public

It is often observed that the low-voltage energized parts are exposed without protective covers so that the general public may touch them easily, therefore, it is recommended to take suitable measures urgently to prevent people from being injured.

Note:
One CD-R is separately attached for reference;
JICA O & M Data (Data used for preparation of the report)
Text (How to analyze the data)

Annextures

Annex 3.1 Form of Data Collection of Outage Records
Annex 3.2 Code List of Substations and Feeders
Annex 3.3 Frequency Records in May and November 2002 and 2003
Annex 3.4 Records of Voltage Measurement at the End-customers of Model Feeders
Annex 3.5 Summary of Outage Records Collected

Annex 3.1 Form of Data Collection of Outage Records

Interruption Records (due to Fault and Maintenance)

132kV System	No	Sub-system		Substation		Feeder/equipment		Category	Y	M	D	Time	No of Trips	Duration of Interruption (Min)	Unsupplied energy (kWh)	Relay operated			Auto-reclos alternative supply	Location from SS(km)	Cause		Remarks	Notes
		33	11	kV	Name	kV	Name									Main	Back-up	Others			Trigger	Equip't		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)

Low Voltage Interruption Records (due to Fault and Maintenance)

132kV System	No.	33 kV Substation	11 kV Feeder	11/0.4 kV Transformer	Equipment/Feeder		Y	M	D	Time	No of Trips	Duration of Interruptions (Min)	Unsupplied energy (kWh)	Protection operated		Location from TR(km)	Cause		Remarks
		Name	Name	Name	kV	Name								Main	Others		Trigger	Equip't	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)

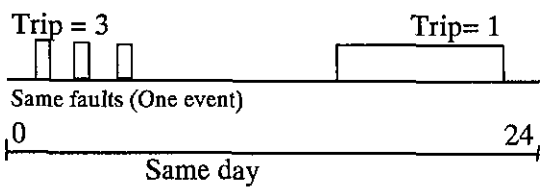
How to fill in Outage Form

Important note to fill in the form;

(1) For sorting, each outage should be filled in one(1) row.
(2) Same column should be filled in a same format. (Mixed use of digits and characters is not allowed)
(3) At least, same code system should be applied in a circle.

Note on each column

Column No
(1) Code name of 132/33 kV substation. District name R or M + Code name .Common for all the circles.
(2) Serial no. Each outage is given specified number and no change will be allowed after fixed the number..
(3),(4) Blank
(5) Voltage class of substation (Digit)
(6) Code name of substation .
(7) Voltage class equipment/feeder troubled. (Digit)
(8) Code name of equipment/feeder troubled. (Refer to note)
(9) Category of feeder
(10) Year 2002 .....2, 2003.....3 (Digit)
(11) Month (Digit)
(12) Day (Digit)
(13) Time of an outage started. Time of 24 hour system (Digit): Minute (Digit)
(14) No. of trips in a event (Digit). One(1) is preferable.
(15) Duration of an outage (Digit)
(16) Unsupplied energy during the outage, if available. (Digit)
(17),(18),(19) Protective device operated in code name. (Refer to note)
(20) Recloser has operated. (Y or N)
(21) Distance from substation (Digit)
(22) Cause of outage (Refer to note)
(23) Equipment damaged or maintained. (Refer to note)
(24) Supplementary information, if any
(25) Memorandum, if any



NOTE on Columns:

Code name of equipment (8)

For easy sorting of kind of equipment, first character indicates major Equipment, for example, F: feeder,
TR: Transformer, CB: Circuit breaker, etc. ( ) shows information to identify the equipment, code name of feeder, if any

Relay (17)(18)(19)

DIR	: *Power direction relay*
OC	: Over-current relay
OCG	: Over-current ground relay
DF	: Differential relay
UV	: Under-voltage relay
F	: Power fuse
UK	: Un-known

Cause of interruption (22)

BW	: Bad weather, heavy rain/ strong wind
LTG	: Lightning
CNT	: Contamination of insulator
INS	: Deterioration of insulator
ERE	: Improper erection/maintenance
OBS	: Contact of obstacles
PUB	: Mistake of 3rd party
WOK	: Mistake of worker
ZSM	: Scheduled maintenance
ZEM	: Emergency (extraordinary) inspection
OTH	: Others

L/R(LR) : Load relief
L/C : Line clear = *ZEM*

Equipment (23)

SYS	: 132 kVand above system
POL	: Supporting structure
INS	: Insulator
COND	: Conductor
JNT	: Joint of conductors
BUS	: Substation bus
TR	: Transformers
CB	: Circuit breaker
SWG	: Switchgear (LA,PT,CT.DS, etc.
RLY	: Protective relay
AUX	: Auxiliary circuit
DC	: Battery, charger,DC circuit
OTH	: Others

Annex 3.2 Code List of Substations and Feeders

Ranga Reddy (1/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Dharmasagar	RHA	Chevella	F(CHE)	Chevella	CHE	Chevella	SHE			
2	(S)						Starchik	STA			
3							Kothapally	KOT			
4							Alur	ALU			
5							Gundala	GUN			
6							Mudimiyal	MUD			
7			Moinabad	F(MOI)	Moinabad	MOI	Moinabad	MOI			
8							S.P.Steels	SPS			
9							Peddamangalaram	PED			
10							Kankamamidi	KAN			
11							Himayathnagar	HIM			
12							Surangal	SUR			
13			Pargi	F(PAR)	Manneguda	MAN	Super Dairy	SUP			
14							Chenngamul	OHN			
15							Pudur	PUD			
16							Merzapur	MER			
17					Pargi	PAR	Pargi Town	PAR			
18							Rakamcherla	RAK			
19							Shadnagar	SHA			
20							Roopkhanpet	ROO			
21							Gandi singaram	GAN			
22			Shabad	F(SHA)	Shabad	SHA	Shabad	SHA			
23							Nagarkunta	NAG			
24							Polaram	POL			
25							Sardarnagar	SAR			
26					Tallapally	TAL	R.Dosado	RDO			
27							Rudraram	RUD			
28							Tallapally	TAL			

Ranga Reddy (2/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Ibrahimpatnam	RIBR	Ibrahimpatnam	F(IBR)	Ibrahimpatnam	IBR	Ibrahimpatnam	IBA			
2	(S)						Sheriguda	SHE			
3							Elimmedu				
4							Raipole				
5			Kandukur	F(KAN)	Kandukur	KAN	Kandukur	KAN			
6							Gudur	GUD			
7							Pulimamidi	PUL			
8							Bachepally	BAC			
9							Nednoor	NED			
10							Mucherla	MUC			
11					Rachaloor	RAC	Rachaloor	BAC			
12							Gundavally	GUN			
13							Thimmmmmarpur	THI			
14							Lemur	LEM			
15											
16			Mall	F(MAL)	Bodakonda(Unmanned	BOD	Bodakonda	BOD			
17							Yellamma Tanda	YEL			
18					Mall	MAL	Mall	MAL			
19							Nallavally	NAL			
20							Kothapally	KOT			
21			Manchal	F(MAN)	Dandumailaram	DAN	Dandumailaram	DAN			
22							Nerapally	NER			
23							Mukkunoor	MUK			
24					Manchal	MAN	Manchal	MAN			
25							Nomula	NOM			
26							Japal	JAP			
27							Arutla	ARU			
28							Tallapallyguda	TAL			
29			Turkayamzal	F(TUK)	Turkayamzal	TUR	Turkayamzal	TUR			
30							Manneguda	MAN			
31			Yacharam	F(YAC)	Yacharam	YAC	Yacharam	YAC			
32							Medipally	MED			
33							Gungal	GUN			
34							Chintapatla	CHI			
35							Chowderpally	CHO			
36							Nandivanaparthy	NAN			

Ranga Reddy (3/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Medehal	RMED	Aliabad	F(ALI)	Aliabad	ALI	Bavileela	BAV			
2	(N)						S.V S Milla	SVS			
3							Turkapally	TUR			
4							Aliabad	ALI			
5							Tumkunta	TUM			
6							Jaganguda	JAG			
7					Medicity	MED	Medicity	MED			
8							Pudur	PUD			
9							Rajbllaram	RAJ			
10					ICICI	ICI	ICICI	ICI			
11							Bharath Bio-Tech	BHA			
12			Bandamadaram	F(BAN)	Bandamadaram	BAN	Srirangavaram	SRI			
13							*Nutankal*	*NUT*			
14							Rallapur	RAI			
15			G P.Pally	F(GPP)	G.P.Pally	GPP	IDA	IDA			
16							G P Pally	GPP			
17							Maisammaguda	MAI			
18							Doolapally	DOO			
19					Kompally	KOM	Kompally	KOM			
20							Jeedimelta	JEE			
21							Jayabheri	JAY			
22			Keshavaram	F(KES)	Keshavaram	KES	Uddamarri	UDD			
23							Anantharam	ANA			
24							Laxmapur	LAX			
25					Koltur	KOL	Koltur	KOL			
26					Thumukunta	THU	Nalsar	NOL			
27							Shameerpet	SHA			
28							Thumukunta	THU			
29			Medehal	F(MED)	Medehal	MED	IDA I	ID1			
30							IDA II	ID2			
31							Medcal Town	MED			
32							Kandlakoya	KAN			
33							Medchal Rural	MER			
34							Yellampet	YEL			
35							Ravalkole	RAV			
36			*Shapurnagar*	*F(SHA)*	*Aleap*	*ALE*	*Pragathinagar*	*PRA*			
37							Aleap	ALE			

Ranga Reddy (4/18 - 1)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Moulali	RMOU	L.G.Mint	F(LGM)	Cherlapally	CHE	Nagaram	NAG			
2	(N)						Rampally	RAM			
3							Kurppa	KUR			
4							IDA Phse-I	ID1			
5							IDA Phase-II	ID2			
6							ECIL	ECI			
7					Keesara	KEE	Keesara	KEE			
8							Cheryal	CHE			
9			Moulali	F(MOU)	Malkajgiri	MAL	Suryanagar	SUR			
10							Anandbagh	ANA			
11							Durganagar	DUR			
12							Mahitkbarjunanagar	MAL			
13					Moulali	MOU	HMT	HMT			
14							HCL	HCL			
15							Meerpet	MEE			
16							Mirzalaguda	MIR			
17							Spectra	SPE			
18							Malkajgiri	MAL			
19							Moulali	MOU			
20							Flash Butt	FLA			
21			Nacharam	F(NAC)	Mallapur	MLL	A.P.Foods	APF			
22							Bell	BEL			
23							IDA Mallapur Phase-II	IDA			
24							Mallapur(V)	MAL			
25					Nacharam	NAC	NILE	MIL			
26							Laxmi starch	LAX			
27							Telephone Exchange	TEL			
28							*Indian Extrusion*	*IND*			
29							Multi Steel	MUL			
30							Sanjay Re-Roll	SAN			
31							Tunggabhadra	TUN			

Ranga Reddy (4/18 - 2)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
32	Moulali	RMOU	NGRI	F(NGR)	NGRI	NGR	Kalyanpuri	KAL			
33	(N)						S O I	SOI			
34							Penguintextiles	PEN			
35							H M T	HMT			
36							Habsigunda	HAB			
37							NGRI	NGR			
38					Mohan Nagar	MOH	Laxmi Nagar	LAX			
39							Kothapet	KOT			
40			Sainikpuri	F(SAI)	Sainikpuri	SAI	Kushaiguda	KUS			
41							Kamalanagar	KAM			
42							A S Rao nagar	ASR			
43							Neredmet	NAR			
44							Sainikpuri	SAI			
45							Kapra	KAP			
46							Yapral	YAP			
47			Uppal	F(UPP)	Uppal	UPP	Boduppal	BOD			
48							Indl Ghatkesar	IND			
49							Door Darshan	DOO			
50							Navabharath	NAV			
51							Uppal	UPP			
52							Gangappa	GAN			
53							Ramanthpur	RAM			

Ranga Reddy (5/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Puttapahad	RPUT	Doma	F(DOM)	Dirsampally	DIR	Mallepally	MAL			
2	(S)						Brahamapally	BRA			
3							Badempally	BAD			
4							Dirsampally	DIR			
5					Doma	DOM	Doma	DOM			
6							Baspally	BAS			
7							Palepally	PAL			
8			Puttapahad	F(PUT)	Chowdapur	CHO	Chowdapur	OHO			
9							Majidpur	MAJ			
10							Marikal	MAR			
11					Puttapahad	PUT	Puttapahad	PUT			
12							Rusumpally	PUS			
13							Nancherla	NAN			
14							Kulkacherla	PUL			
15			Salkarpet	F(SAL)	Salkarpet	SAL	Pagidiyal	PAG			
16							Gandeed	GAN			
17							Salkarpet	SAL			

Ranga Reddy (6/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
	Rama										
1	Chandrapuram	MRAM	Chandanagar	F(CHA)	Chandanagar	CHA	Taranagar	TAR			
2	(Medak)		(N)				Chandanagar	CHA			
3							Hafeezpet	HAF			
4							Miyapur	MIY			
5			Gachibowli	F(CAC)	Gachibowli	GAC	Lingampally	LIN			
6			(N)				Gachibowli	GAC			
7							Kothaguda	KOT			
8							University	UNI			
9							Alind	ALI			
10			Gridhar Ispot	F(GRI)	Garge Steels	GAR	Garge Steels	GAR			
11			(S)				Vanasthalipuram	VAN			
12			Shankarpally	F(SHA)	Donthanpally	DON	Maharajpet	MAH			
13			(S)				Janwada	JAN			
14					Shankarpally	SHA	Shankarpally	SHA			
15							Parwada	PAR			
16							Kondekal	KON			
17							Dhobipet	DHO			
18					SJB TUBES	SJB	Indl feeder	IND			
19							Mokila	MOK			

Ranga Reddy (7/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Shaprunagar	RSHA	AFA-I	F(AF1)	D.P.PALLY	DPP	Gagillapur	GAG			
2	(N)		(N)				Dundigal	DUN			
3							Bowrampet	BOW			
4							Satyamcomputers	SAT			
5			Jeedimetla-I	F(JE1)	Jeedimetla-I	JE1	Phase-I	PH1			
6			(N)				Phase-II	PH2			
7							Phase-V	PH5			
8							Subhashnagar	SUB			
9							Agarwal Foundry	AGA			
10							Virco	VIR			
11							Sudarshan Drugs	SUD			
12							******				
13			Jeedimetla-II	F(JE2)	Jeedimetla-II	JE2	Gajuralaramaram	GAJ			
14			(N)				Kompally	KOM			
15							Suraram	SUR			
16							Phase-III	Ph2			
17							Phase-IV	PH4			
18							Phase-V	PH5			
19			Shaprunagar	F(SHA)	Ushamullapudi	USH	Ushamullapudi	USH			
20			(N)				Shaprunagar	SHA			
21							Gajuralaramaram	GAJ			
22							Chandragiricolony	CHA			

Ranga Reddy (8/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Shivarampally	RSHI	Gaganpahad	F(GAG)	Gaganpahad	GAG	Manage	MAN			
2	(S)						Shivashakthi	SHI			
3							Jai Bhavani	JAI			
4							Rajendranagar	RAJ			
5							Gaganpahad	GAG			
6							NPA	NPA			
7			Ibrahimbagh	F(IBR)	Ibrahimbagh	IBR	Osmansagar	OSM			
8							Military-I	MI1			
9							Military-II	MI2			
10							Peddamangalram	PED			
11					APPA	APP	Himayathsagar	HIM			
12							Police Academy	POL			
13							Aziznagar	AZI			
14			N P.A	F(NPA)	N.P.A	NPA	Kattedan	KAT			
15							Sivarampally	SIV			
16							N P.A	NPA			
17							Shastripuram	SHA			
18							Upparipally	UPP			

Ranga Reddy (9/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Tandur	RTAN	Basheerabad	F(BAS)	Basheerabad	BAS	Basheerabad	BAS			
2	(S)						Agnoor				
3							Neelapally				
4					Yallal	YAL	Yallal	YAL			
5							Bennur	BEN			
6							Devnoor				
7					Laxminarayanpur	LAX	Chennaram	CHE			
8							Laxminarayanpur	LAX			
9							Dennur	DEN			
10			Karankote	F(KAR)	Karankote	KAR	Karankote	KAR			
11							Ogipur	OGI			
12			Tandur	F(TAN)	Tandur	TAN	Kodengal	KOD			
13							Water Works	WAT			
14							Adikcherla	ADI			
15							Antaram	ANT			
16							Chengole	CHE			
17							Tandur Old	TAN			
18			Turimamidi	F(TUR)	Peddamul	PED	Peddamul	PED			
19							Kandavally	KAN			
20							Jangaon	JAN			
21							Kotepally	KOT			
22					Turimamidi	TUR	Turimamidi	TUR			
23							Tatepally	TAT			
24							Bentaram	BEN			
25			Vikarabad	F(VIK)	Dharur	DHA	Dharur	DHA			
26							Kukkinda	KUK			
27							Gutkepally	GUT			
28					Vikarabad	VIK	Vikarabad+P Press	VIK			
29							AnanthGiri Gutta	ANA			
30							Sivareddypet	SKA			
31							Ekamamidi	EKA			

Ranga Reddy (10/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Bandlaguda	RBAN	Abdullapurmet	F(ABD)	Abdullapur	ABD	Abdullapurmet	ABD			
2	(N)		(S)				Sanghi	SAN			
3							Anajpur	ANA			
4					Film City	FLM	Film City	FLM			
5					Peddamberpet	PED	Peddamberpet	PED			
6							Taramathipet	TAR			
7			Ghatkesar	F(GHA)	Narapally	NAR	Medipally	MED			
8			(N)				Prathapapsingram	PRA			
9			Hayathnagar	F(HAY)	Hayathnagar	HAY	Mansurabad	MAN			
10			(S)				Mother dairy	MOT			
11							High Court Colony	HCC			
12							Autonagar	AUT			
13							L.B.Nagar	LBN			
14							AIR	AIR			
15							Sirs	SIR			
16							Hayathnagar	HAY			
17			Vanasthalipuram	F(VAN)	Vanasthalipuram	VAN	Vanasthalipuram	VAN			
18			(S)				Bairamalguda	BAL			
19							Injapur	INJ			
20					Bandlaguda	BAN	Ajkapuri	AKA			
21							Nagole	NAG			
22							GSI	GSI			
23							Huda	NUD			
24							Kothapet	KOT			
25							Saroornagar	SAM			
26							Kamalanagar	KAM			

Ranga Reddy (11/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Chandrayanagutta	RCHA	Champapet	F(CHA)	Champapet	CHA	Siulthanvala	SIU			
2	(S)						Champapet	CHA			
3							Karmanghat	KAR			
4							Balapur	BAL			
5							Meerpet	MEE			
6			Kattendan	F(KAT)	Kattendan	KAT	Kattendan-I	KT1			
7							Kattendan-II	KT2			
8							Kattendan-III	KT3			
9							Kattendan-IV	KT4			
10							Balapur	BAL			
11			Maheswaram	F(MAH)	Maheswaram	MAH	Maheswaram	MAH			
12							Lemur	LEM			
13							Ghatpally	GHA			
14							Timmalur	TIM			
15							Nagaram	NAG			
16					Mamidipally	MAM	Pahadisharif	PAH			
17							Thukkunguda	THU			
18					Mankal	MAN	Mankal	MAN			
19							IDA	IDA			
20			Shamshabad	F(SHA)	Shamshabad	SHA	Om Jaibhavani	OMJ			
21							Shamshabad	SHA			
22							Narkoda	NAR			
23							Habeebullanagar	HAB			
24							*****				
25					Shapurkalan	SHP	Indl feeder	IND			
26							Palmakunta	PAL			
27							Gandiguda	GAN			
28							Shapurkalan	SHA			

Ranga Reddy (12/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Erragadda	CERR	Kukatpally	F(KUK)	Kukatpally	KUK	Kukatpally	KUK			
2	(Hyderabad)						Hydernagar	HYD			
3							Air force	AIR			
4							Venkatecohwaranngar	VEN			
5							Bhagyanagar	BHA			
6							JNTU	JNT			
7							KPHB	KPH			

Ranga Reddy (13/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Ghanapur	RGHA	Ghatkesar	F(GHA)	Ghatkesar	GHA	NTPC	NTP			
2	(N)						Medipally	MED			
3							Syndicate	SYN			
4							Ghatkesar	GHA			
5							Keesara	KEE			
6							Edulabad	EDU			
7							Aushapur	AUS			

Ranga Reddy (14/18)

	220/132/33 kV Substation		*33 kV Feeder*		*33/11kV Substation*		*11 kV Feeder*			*0.4 kV Line*	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Jublee Hills	CJUB	CMC	F(OMC)	ESCI	ESO	Guchibowli	GUC			
2	(Hyderabad)						Nanakramguda	NAN			
3							ESCI	FSC			
4					IIIT	III	IIIT	III			

Ranga Reddy (15/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Kothur	HKOT	Kothur	F(KOT)	Ameerpet	AME	Ameerpet	AME			
2	(Mahbubnagar)						Collur	COL			
3							Dubbacherla	DUB			

Ranga Reddy (16/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Mehaboobnagar	HMEH	Salkarpet	F(SAL)	Mohmmadabad	MOH	Noncherla	NON			
2	(Mahbubnagar)						Mohmmadabad	MOH			

Ranga Reddy (17/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0.4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Sadasivpet	MSAD	Mominpet	F(MOM)	Marpally	MAR	Patlur	PAT			
2	(Medak)						Marpally	MAR			
3							Sripuram	SRI			
4					Mominpet	MOM	Mominpet	MOM			
5							Barwada	BAR			
6							Enkatala	ENK			
7					Nawabpet	NAW	Havabpet	HAV			
8							Arkatala	ARK			
9							Dulmamidi	DUL			

Ranga Reddy (18/18)

	220/132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder			0 4 kV Line	
	Name	Code	Name	Code	Name	Code	Name	Code	Category	Name	Code
1	Bollaram	MBOL	*****	F(**)	Reddy Labs	RL1	(HT)				
4	(Medak)				*Reddy Diagonostic*	*RED*	*(HT)*				
5					Reddy Labs	RL2	(HT)				
7					Kukatpally	LUK	***				
8							***				
9							***				

Medak (1/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
1	Siddipet	MSID	Rampur	F(RAM)	Rampur(Nangnoor)	RAM	Paiamakulu	PAI	
2							Narmeta	NAR	
3							Badojpadga	BAD	
4					Mittapally	MIT	Bakrichepyal	BAK	
5							Watsol (I)	WAT	
6							Velkatoor	VEL	
7					Kondamrajpally	KON	Kodarajampally	KOD	
8							Katha	KAT	
9					Narmetta	NAM	Narmetta	NAR	
10					*Ponnal*	*PON*	*Ponal*	*PON*	
11							Rangampally	RAM	
12			Duddeda	F(DUD)	Duddeda	DUD	Bandram	DAN	
13							Deddeda	DED	
14							Velkatta	VEL	
15					Medinipur	MED	Mangote	MAN	
16							Kukunurpally	KUK	
17							Lakdarama	LAK	
18					Kondapak	KON	Kondapak	KON	
19							Nacharam	NAC	
20					Marpadaga	NAR			
21			Tornal	F(TOM)	Tornal	TOM			
22					Irkode	IRK	Irkode	IRK	
23					Chiiapur	CHI			
24					Pothareddypet	POT	Pothareddypet	POT	
25							Thalapally	THA	
26			Dubbak	F(DBB)	Pedda Gundavally	PED	Peddagundavelly	PED	
27							Dumpalapally	DUM	
28					Dubbak	DUB	Dubbaka	DUB	
29							*Lachapet*	*LAC*	
30							Habsipur	HAB	
31							Chellapur	CHE	
32					Ragothampally	RAG	Raghqthampally	RAG	
33							Ramakkapet	RAM	
34							Gosanpaily	GOS	
35							Akaram	AKA	
36					PeddaChikode	RED	Chekode	CHE	
37							Potharam	POT	
38							Achmaipally	ACH	
39					Challapur	CHA			
40					Dharmajipet	DHA	Dharmajipet	BHA	
41							Lachapet	LAC	
42			Raghavapur	F(RAG)	Raghavapur	RAG	Narayanraopet	NAR	
43							Chintamadaka	CHI	
44							Pulkur	PUL	
45					Laxmidevpally	LAX	Laxmidevipally	LAX	
46							Machapur	MAC	
47					Gurrale Gondi	GUR	Gurralagondi	GUR	
48							*Jakkapur*	*JAK*	
49					Kammarlapally	KAM	Allipur	ALL	
50							Waterworks	WAT	
51							Kammarlapaily	KAM	
52					Machapur	MAC	Machapur	MAC	
53			Pedda Kodur	F(RED)	Narsapur(Shiddipet	NAR	Lingareddypally (I)	LIN	
54							Market Yard (U)	MAR	
55							Narsapur (I)	NAR	
56							Karim Nagar Road	KAR	
57					Peddakodur	PED			
58					Meddipally	MED	Ibrahimnagar	IBR	
59							Medipally	MED	
60							Ananthasagar	ANA	

Medak (2/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
61					Thornal	THO	Tornal	TOR	
62							Timmapur	TIM	
63					Nedipally	NED			
64					Condipally	CON			
65	Thukkapur	MTHU	Dommat	F(DOM)	Dommat	DOM	Dommat	DOM	
66							Suranpally	SUR	
67					Doulthabad	DOU	Inddupriyal	IND	
68							Konnaipally	KON	
69							Doultabad	DOU	
70					Chittapur	CHI	Dharmajipet	DHA	
71							Chittapur	CHI	
72							Mothey	MOT	
73					Peddachpyal	PED			
74			Thukkapur	F(THU)	Thukkapur	THU	Togita	TOG	
75							Yellareddypet	YEL	
76							Y. G. Kistapur	YGK	
77							Pouce Station	POU	
78			Mirdoddi	F(MIR)	Mirdoddy	MIR	Mirdoddy	MIR	
79							Mallepally	MAL	
80							Andha	AND	
81					Mettu(Bandarpapply)	MET			
82					Gudikandula	GUD	Gudikandula	GUD	
83					Jangampally	JAN	Jangapally	JAN	
84							Veerareddypally	VEE	
85					Peddachepyal	PED			
86					Khajipur	KHA	Khajipur	KHA	
87			Ligapur	F(LIG)	Lingapur	LIN	Lingapur	LIN	
88							Venkatraopet	VEN	
89					Raipole	RAI	Raipole	RAI	
90							Thirmalapur	THI	
91							Thmmakpally	THM	
92							Anajpur	ANA	
93							Kothapally	KOT	
94					Pallepahad	PAL	Pallepahad	PAL	
95							Vemulghat	VEM	
96	Gajwel	MGAJ	Gajwel	F(GAJ)	Gajwel	GAJ	Dharmareddypall	DHA	
97			Jagadevpur	F(JAG)	Jagadevpur	JAG	Jagadevpur	JAG	
98							Itikyal	ITI	
99							Allirajpet	ALL	
100					Kodakandla	KOD	Kodakandla	KOD	
101							Mohank K/S(I)	MOH	
102							Kuknoor Pally	KUK	
103							Burugpally	BUR	
104					Munigadapa	MUN	Munigadapoa	MUN	
105							Basvapur	BAS	
106					Ganeshpally	GAN	Ganeshpally	GAN	
107					Pregnapur	PRE	Pregnapur	PRE	
108							Serigiipally	SER	
109			Ahmedipur	F(AHM)	Ahmedipur	AHM	Ahmedipur	AHM	
110							Pidched	PID	
111					Bejgoam	BEJ	Bejgoan	BEJ	
112							Plingareddypally	PLI	
113					Gurralasofa	GUR	Waddepally	WAD	
114							Ramaram	RAM	
115							Machaipally	MAC	
116					BangllaVenkatapur	BAN	B. Venkatapur	BE	
117							Yelkal	YEL	
118							Muktmamasanpally	MUK	

Medak (3/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
119			Mulugu	F(MUL)	Mulugu	MUL			
120					Vntimamidi	ONT			
121					Thunkıkalsa	THU	Tunkıkalsa	TUN	
122							Narsapur	NAR	
123					Kokkonda	KOK			
124			Gowraram	F(GOW)	Gowraram	GOW	Paamulaparthy	PAA	
125							Pathur	PA1	
126							Pathur	PA2	
127							Navodaya	NAV	
128							Wargal	WAR	
129							Express	EXP	
130					Markook	MAR			
131	Chegunta	MCHE	Chegunta	F(CHE)	Chegunta	CHE	Checunta	CHE	
132							Karnalpally	KAR	
133							Reddypally	RED	
134							Volluru	VOL	
135			Yeldurthy	F(YEL)	Yeldurthy	YEL	Yeldurthy	YEL	
136							Uppulingapur	UPP	
137							Shetpally	SHE	
138					Suraram	SUR	Chandampet	CHA	
139							Suram	SUR	
140					Konapur	KON	Konapur	KON	
141					Nizampet	NIZ	Nızampet	NIZ	
142							Chelmada	CHE	
143							Maskal	MAS	
144							Kalwakunta	KAL	
145					Mangalparthy	MAN			
146									
147			Bonale	F(BON)	Bonala	BON	Bonala	BON	
148							B Kondapur	BKO	
149					Narlapur	NAR	Narlapur	NAR	
150							Venkatapur (K)	VEN	
151					Nızmpur	NIZ			
152	Minpur	MMIN	Mınpur	F(MIN)	Minpur	MIN	Minpur	MIN	
153							Kodpak	KOD	
154		(NPDCL)	Nizampet						
155			Podochanpal	F(POD)	Podochanpally	POD	Podchanpally	POD	
156							Gandharpally	GAN	
157			Narsingi	F(NAR)	Narsingi	NAR	Narsıngi	NAR	
158							Narsampally	NAP	
159							Sankapur	SAN	
160							Vallebapur	VAL	
161					Tekmal	TEK	Ellapally	ELL	
162							Tekmal	TEK	
163					Kodapak	KOD			
164	Kowdipally	MKOW	Ch.Ghanpur	F(CHG)	Ch.Ghanpur	CHG			
165					Engandia	ENG			
166									
167			Kowdıpally	F(KOW)	Kowdipally	KOW	Kowdıpally	KOW	
168							Devaıpally	DEV	
169							Mohobad	MOH	
170			Venkatraopet	F(VEN)	Venkatraopet	VEN			
171			Amsanpally	F(AMS)	Amsanpally	AMS	Amsanpally	AMS	
172							Kongode	KON	
173	Medak	MMDK	Medak	F(MDK)	Medak	MDK	Medak T-I(U)	MD1	
174							Medak T-II(U)	MD2	
175							Komtur	KM	
176							Ausalapally	AUS	
177							Balanagar	BAL	
178							Kuchanpally	KUC	
179							Nagapur	NAG	
180							H Ghanapur	HGH	

Medak (4/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
181			NSF	F(NSF)	NSF(Mombojipally	NSF			
182					Pillikottala	PIL			
183			Shankarampe	F(SHA)	Shankarampet	SHA	Shankrampet	SHA	
184							Jangarai	JAN	
185							Maadoor	MAA	
186					Shalipet	SHL	Shalpet	SHL	
187			B.B.Pur	F(BBP)	B.B.Pur	BBP	B. Boopathipally	BBP	
188							Burugupally	BUR	
189							Sardana	SAR	
190					Wadi	WAD	Wadi	WAD	
191							Dhupsinghthanda	DHU	
192			Ramayampet	F(RAM)	Ramayampet	RAM	Ramayampet	RAM	
193							Konapur	KON	
194							D. Dharmaram	DDH	
195							Akkannapet	AKK	
196					Laxmapur	LAX	Laxmapur	LAX	
197							Tunigandla	TUN	
198							Industl (I)	IND	
199							Katryal	KAT	
200					Pathur	PAT	Pathur	PAT	
201							Shamnapur	SHA	
202	Narayankhed	MNAR	Narayankhed	F(NAR)	Narayankhed	NAR	Abbenoa	ABB	
203							Rayalamadgu	RAY	
204							Regode	REG	
205							Pipri	PIP	
206							Narayankhed	NAR	
207			Shankarampe	F(SHA)	Shankarampet	SHA	Shankrampet	SHA	
208							Mizampet	MIZ	
209							Velur	VEU	
210							Alladurg	ALL	
211							Regode	REG	
212					Bodagattu	BOD			
213			Kalher	F(KAL)	Kalher	KAL	Kalher	KAL	
214							Kanapoor	KAN	
215							Mardi	MAR	
216					Sanjeeveraopet	SAN	Sanjeevaraopet	SAN	
217							Kadpal	KAD	
218					Bachepally	BAC	Bacheppally	BAC	
219							Ramreddypet	RAM	
220			Poosalpahad	F(POO)	Poosalpahad	POO	Mandoor	MAN	
221							Shapur	SHA	
222					Borancha	BOR	Dhanwar	DHA	
223							Nap	NAP	
224			Waser		Waser	WAS			
225					Tadakal	TAD			
226	Manoharabad	MMAN	Masaipet	F(MAS)	Masaipet	MAS	Masaipet	MAS	
227				er			Lingareddypally	LIN	
228							PD Shivanur	PDS	
229					Islampur	ISL	Islampur	ISL	
230					Nacharam	NAC	Nacharam	NAC	
231							Vallur	VAL	
232					Chandaipet	CHA	Chandaipet	CHA	
233							Makkarajpet	MAK	
234			Toopran	F(TOO)	Toopran	TOO	Toopran	TOO	
235							Ravelly	RAV	
236							Padalpally	PAD	
237							Asian Coffee (I)	ASI	
238					Gonepally	GON	Gonepally	GON	
239							Ramunipatla	RAM	

Medak (5/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
240			Manoharabad	F(MAN)	Manoharabad	MAN	Kucharam	KUC	
241							Mulugu	MUL	
242			Kallakal	F(KAL)	Kallakal	KAL	Kallakal	KAL	
243							K. P Steel (I)	KPS	
244							Karan Textile (I)	TEX	
245			Shivampet	F(SHI)	Shivampet	SHI	Shivampet- I	SH1	
246							Shivampet-II	SH2	
247							Donthy	CDN	
248							Indl Feeder	IND	
249							Pambanda	PAM	
250					Sikindlapur	SIK			
251	Gummadidala	MGUM	Gummadidal	F(GUM)	Gummadidala	GUM	Kanukunta	KAN	
252							Abgrobel (I)	ABG	
253							Bell Remedies (I)	BEL	
254			Narsapur	F(NAR)	Narsapur	NAR	Narsapur	NAR	
255							K. Maddor	KMA	
256							Narayanpur	NAR	
257							Avancha	AVA	
258							Reddypally	RED	
259					Kothapet	KOT	Kothapet	KOT	
260							Lingojigda	LIN	
261	220/132 kv		Jinnaram		Jinnaram	JIN			
262	(RRS)				Dundigal	DUN			
263					Gaddapotaram	GAD			
264			(RRS)						
265	Bollaram	MBOL	Kukatpally	F(KUK)					
266			Bachepally	F(BAC)					
267			Shathavachana	F(SHA)					
268			Bollaram		Bollaram-I	BO1	Soubhagya	SOU	
269							Pavan	PAV	
270					Bollaram-II	BO2	Charminar	CHA	
271							Vipla	VIP	
272							Kottam	KOT	
273							Rupa	RUP	
274	132/11kV Bollaram								
275	Zaheerabad	MZAH	Zaheerabad	F(ZAH)	Zaheerabad	ZAH	Zaheerabad - I	ZA1	
276							Zaheerabad - II	ZA2	
277							Ranjole	RAN	
278							Aligole .	ALI	
279			Mannapur	F(MAN)	Mannapur	MAN	Hottab	HOT	
280							Manapur	MAN	
281							Gopanpally	GOP	
282							Magdoompally	MAG	
283					Malchelma	MAL	Malchelma	MAL	
284							J. Malkapur	JMA	
285							Parsapally	PAR	
286					Satwar	SAT	Satwar	SAT	
287			Jarasangam	F(JAL)	Jarasangam	JAL	Kuppanagar	KUP	
288							Jeerrlapally	JEE	
289							Raikode	RAI	
290			Hadnoor	F(HAD)	Hadnoor	HAD	Rejintal	REJ	
291							Hadnoor	HAD	
292							Nyalkal	NYA	
293							Mamidgi	MAM	
294					Chalki	CHA	Raghavapur	RAG	
295							Chalki	CHA	
296							Nap W.W.	NAP	
297					Raikode	RAI	Raikode	RAI	
298							Pampad	RAM	
299							Pipalpally	PIP	
300					Metalkunta	MET	Metalkunta	MET	
301							Rajol	RAJ	

Medak (6/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
302	Jogipet	MJOG	Jogipet	F(JOG)	Jogipet	JOG	Jogipet	JOG	
303							Dakoor	DAK	
304							Dhanura	DHA	
305							Posanpet	POS	
306							Shankarmpet	SHA	
307			Chitkul	F(CHI)	Chitkul	CHI	Chitkul	CHI	
308					Seelampally	SEE	Seelampally	SEE	
309							Faizabad	FAI	
310			Gadipeddapu	F(GAD)	Gadipeddapur	GAD	Gadipeddapur	GAD	
311							Muslapur	MUS	
312					Alladurg	ALL	Alladurg	ALL	
313							Chilvera	CHI	
314					Medikonda	MED	Alladurg	DRG	
315							Devanoor	DEV	
316							Khadiraad	KHA	
317			Laximisagar	F(LAX)	Laximisagar	LAX	Laxmisagar	LAX	
318							Pothirepdypally	POT	
319					Talelma	TAL			
320	Pashamailaram	MPAS	Isnapur	F(ISN)	Isnapur	ISN	Patodia	PAT	
321							Muthangi	MUT	
322							Ida - I	ID1	
323							Ida - II	ID2	
324							Rudraram	PUD	
325							Widia	WID	
326			SOL	F(SQL)	SOL	SQL	Sol Town	SQL	
327							Dexo	DEX	
328					Inole	INO	P. Kanjarla	PKA	
329							Indresham	IND	
330						EPI			
331			Manjeera Water	F(WAT)	E P IP(Pashamailaram)	EPI			
332			*INOX*	*F(INO)*					
333	R.C.Puram		Gachibowli						
334			Patancheru						
335			Ambuja						
336			Manjeera W.W.						
337			NSL						
338			Annapurna Foils		Annapurna Foils	ANN			
339					MIG	MIG			
340					Kollur	KOL			
341			Chandanagar		Chandanagar	CHA			
342					Ashoknagar	ASH			
343					Giridhar Ispat	GIR			
344	Sadasivpet	MSAD	Jogipet	F(JOG)	Nizampur	NIZ	Nizampur	NIZ	
345							Venkatapur	VEN	
346					Mudaipet	MUD	Singoor	SIN	
347							Mudimanikyam	MUD	
348							Pulkal	PUL	
349					Sultanpur	SUL	Sultanpur	SUL	
350							Korpole	KOR	
351			Manjeera	F(MAN)					
352			MRF	F(MRF)					
353		(RRS)	Vikarabad	F(VIK)					
354			Kohir	F(KOH)	Kohir	KOH	Kohir	KOH	
355							Nagireddypally	NAG	
356							Sajjapur	SAJ	
357					Digwal	DIG	Chintalghat	CHI	
358							Digwal	DIG	
359							Global Bluk Drugs	GLO	

Medak (7/7)

	132/33 kV Substation		33 kV Feeder		33/11kV Substation		11 kV Feeder		
	Name	Code	Name	Code	Name	Code	Name	Code	Category
360			Munipally	F(MUN)	Munipally	MUN	Budhera	BUD	
361							Khammampally	KHA	
362							Jackwell	JAC	
363					Athmakur	ATH	Athemakur	ATH	
364							Yellaram	YEL	
365			Priyadarshini	F(PRI)					
366	132/11kV Sadasivpet								
367	Kandi	MKAN	Sangareddy-I	F(SR1)	Sangareddy-I	SR1	Sangareddy - I	SR1	
368							Sangareddy - II	SR2	
369							Sangareddy - III	SR3	
370								KAL	
371							Kandi	KAN	
372							Kolsa	KOS	
373							Water Works	WAT	
374					Rajampet	RAJ	Kalabcur (Filter bed)		
375					Sangareddy-II	SR2	Sangareddy - I	SA1	
376							Sangareddy - II	SA2	
377							Sangareddy - III	SA3	
378					Kondapur	KON	Kondapur	KON	
379							Marepally	MAR	
380							Gangaram	GAN	
381					Malkapur	MAL	Malkapur	MAL	
382							Mundevunipally	MUN	
383							Pepsi	PPS	
384					Ismailkanpet	ISM	Ismailkhanpet	ISM	
385							Arutla	ARU	
386							Erdanoor	ERD	
387			HFC-I	F(HF1)	Cheriyal	CHE	Kandi	KAN	
388							Kalvemula	KAL	
389							Indrakaram	IND	
390							Cheriyal	CHE	
391			HFC-II	F(HF2)	TurakalaKhanapur	TUR	Borpatra	BOR	
392							Doultabad	DOU	
393							Indl	INL	
394					Hathnoora	HAT	Hathnoora	HAT	
395							Gondaraipally	GON	
396							Sikindlapur	SIK	
397					Nasthipur	NAS			
398			BharathStrips	F(BHA)					
399			Isnapur	F(ISN)					
400			BDL	F(BDL)	BDL	BDL			
401					Nangigama	NAN			
402			Alkabir	F(ALK)					

Annex 3.3 Frequency Records in May and November 2002 and 2003

(Hz)

Day	May-02-2002		Nov-02-2002		May-02-2003		Nov-03-2003	
	Max	Min	Max	Min	Max	Min	Max	Min
1	47.78	47.75	49.71	49.44	50.65	49.42	49.85	49.10
2	47.92	47.87	50.84	49.29	50.38	49.62	50.25	49.70
3	47.96	47.88	50.25	50.00	50.40	49.73	50.15	49.60
4	47.95	47.86	50.75	48.58	50.62	49.48	50.10	49.30
5	47.86	47.84	50.00	49.96	50.75	49.64	50.15	49.50
6	47.86	47.81	50.44	50.17	50.34	49.25	50.25	49.20
7	48.01	47.82	50.41	49.13	50.14	49.14	50.50	49.50
8	48.50	47.87	49.67	49.59	50.32	49.64	49.85	49.40
9	48.53	47.88	50.72	49.75	50.26	49.50	50.50	49.55
10	47.86	47.86	50.25	49.77	49.95	49.15	50.25	49.40
11	50.01	47.86	50.86	48.65	50.50	49.85	50.20	49.55
12	47.96	47.83	50.77	48.69	50.21	49.60	50.32	49.50
13	47.90	47.80	49.05	48.61	50.25	49.75	50.20	49.45
14	47.90	47.81	49.06	48.88	50.70	49.65	50.15	49.50
15	47.99	47.78	49.40	49.31	50.42	49.12	50.20	49.65
16	48.24	47.95	49.09	48.84	50.35	49.32	50.10	49.75
17	49.70	48.10	49.87	49.37	50.24	49.30	50.25	49.34
18	49.76	47.77	49.95	49.42	50.18	49.22	49.85	49.42
19	47.88	47.84	49.54	49.38	50.15	48.65	50.00	49.50
20	47.90	47.87	49.36	49.16	50.23	49.43	49.85	49.42
21	47.88	47.86	49.83	48.95	50.56	49.50	49.95	49.25
22	47.86	47.83	49.25	49.16	50.10	49.26	50.12	49.32
23	47.84	47.84	49.71	49.35	50.35	49.15	50.15	49.52
24	48.02	47.95	49.15	48.95	49.82	49.32	50.12	49.62
25	47.96	47.77	49.97	49.79	50.28	49.45	49.85	49.42
26			49.42	48.90	50.50	49.48	50.05	49.52
27	48.82	47.89	49.35	49.07	50.25	49.50	50.20	49.30
28	50.00	47.90	49.39	49.09	50.22	49.45	50.15	49.35
29	48.85	48.16	49.54	49.25	49.85	49.00	50.05	49.40
30	48.55	47.86	49.62	49.33	49.80	49.10	50.25	49.60
31	49.05	47.88	-	-	49.78	49.21	-	-
Max.	50.01	48.16	50.86	50.17	50.75	49.85	50.90	50.17
Min.	47.78	47.75	49.05	48.58	49.78	48.65	49.10	48.58
Ave.	48.34	47.87	49.84	49.26	50.28	49.38	49.84	49.26
SD	0.680	0.080	0.560	0.420	0.256	0.255	0.560	0.420
%Max	49.69	48.03	50.95	50.51	50.78	49.88	51.00	50.50
%Min	47.00	47.70	48.74	48.45	49.77	48.88	48.70	48.50

Source : LDC, APTRANSCO

Note: SD stands for Standard Deviation

Annex 3.4 Records of Voltage Measurement at the End-customers of Model Feeders

(Volt)

Day	Off peak (3 o'clock)						Day peak (11 o'clock)						Night peak (20 o'clock)					
	Transformer			Customer			Transformer			Customer			Transformer			Customer		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
2	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
3	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
4	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
5	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
6	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
7	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
8	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
9	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
10	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
11	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
12	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
13	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
14	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
15	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
16	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
17	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
18	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
19	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
20	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
21	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
22	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
23	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
24	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
25	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
26	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
27	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
28	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
29	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
30	240	240	240	235	235	235	235	236	235	228	228	227	230	230	230	220	220	220
31																		
Max.	240	240	240	235	235	235	235	236	235	228	228	227	230	230	230	220	220	220
Min.	240	240	240	235	233	235	235	236	235	228	228	227	230	230	230	220	220	220
Ave.	240.0	240.0	240.0	235.0	233.1	235.0	235.0	236.0	235.0	228.0	228.0	227.0	230.0	230.0	230.0	220.0	220.0	220.0
SD	0.0002	0.0002	0.0002	0.0002	0.3653	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
%Max	240.0	240.0	240.0	235.0	233.8	235.0	235.0	236.0	235.0	228.0	228.0	227.0	230.0	230.0	230.0	220.0	220.0	220.0
%Min	240.0	240.0	240.0	235.0	232.4	235.0	235.0	236.0	235.0	228.0	228.0	227.0	230.0	230.0	230.0	220.0	220.0	220.0

Note) SD: Standard deviation

Low Voltage Distribution

Nov. 2003

33/11 kV Kothapet Substation
11 kV Kamalanagar feeder

Transformer TN14 (315 kVA)

Customer : Mr. Vijetra Shelters (#1)

(Volt)

Day	Off peak (3 o'clock)						Day peak (11 o'clock)						Night peak (20 o'clock)					
	Transformer			Customer			Transformer			Customer			Transformer			Customer		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
2	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
3	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
4	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
5	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
6	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
7	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
8	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
9	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
10	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
11	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
12	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
13	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
14	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
15	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
16	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
17	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
18	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
19	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
20	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
21	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
22	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
23	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
24	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
25	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
26	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
27	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
28	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
29	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
30	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
31																		
Max.	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
Min.	238	238	239	234	233	234	235	234	235	230	229	230	230	230	229	219	220	220
Ave.	238.0	238.0	239.0	234.0	233.0	234.0	235.0	234.0	235.0	230.0	229.0	230.0	230.0	230.0	229.0	219.0	220.0	220.0
SD	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
%Max	238.0	238.0	239.0	234.0	233.0	234.0	235.0	234.0	235.0	230.0	229.0	230.0	230.0	230.0	229.0	219.0	220.0	220.0
%Min	238.0	238.0	239.0	234.0	233.0	234.0	235.0	234.0	235.0	230.0	229.0	230.0	230.0	230.0	229.0	219.0	220.0	220.0

Note) SD: Standard deviation

Low Voltage Distribution

Nov. 2003

33/11 kV Kothapet Substation
11 kV Kamalanagar feeder

Transformer TN11 (250 kVA)

Customer : Sanscript College (#2)

Low Voltage Distribution

Nov. 2003

33/11 kV Kothapet Substation
11 kV Kamalanagar feeder

Transformer TN23 (315 kVA)

Customer : Mr. K. Ramulu (#3)

(Volt)

Day	Off peak (3 o'clock)						Day peak (11 o'clock)						Night peak (20 o'clock)					
	Transformer			Customer			Transformer			Customer			Transformer			Customer		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	240	239	240	230	230	230	240	233	235	220	220	220	230	232	230	218	220	218
2	240	241	240	230	230	230	240	230	233	220	220	220	230	232	230	218	220	218
3	240	241	240	230	228	228	235	233	235	220	220	220	230	232	230	218	220	218
4	241	240	240	230	229	228	234	230	233	220	220	220	228	229	228	218	220	218
5	241	240	240	228	229	229	234	230	233	220	220	220	228	229	228	218	220	218
6	240	240	240	230	230	230	235	233	235	220	220	220	228	229	228	218	220	218
7	240	240	240	230	230	230	230	230	231	220	220	220	230	232	230	220	222	220
8	240	240	240	230	230	230	233	232	230	220	220	220	230	232	230	220	222	220
9	240	240	240	230	230	230	233	232	230	220	220	220	230	232	230	220	222	220
10	240	240	240	231	230	230	234	230	233	220	220	220	230	232	230	220	222	220
11	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
12	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
13	238	238	238	230	230	230	230	230	229	220	220	220	230	232	230	220	222	220
14	240	240	240	228	230	230	230	230	229	220	220	220	230	232	230	220	222	220
15	240	240	240	230	230	230	233	232	230	220	220	220	230	232	230	220	222	220
16	240	240	240	230	230	230	233	232	230	220	220	220	230	232	230	220	222	220
17	240	240	239	230	228	230	230	230	229	220	220	220	230	232	230	220	222	220
18	240	240	240	230	230	230	230	230	229	219	220	220	230	232	230	220	222	220
19	240	241	241	230	230	230	235	233	235	220	220	220	230	232	230	220	222	220
20	240	240	240	230	230	230	235	233	235	220	220	220	230	230	230	220	224	220
21	240	240	240	230	230	230	234	230	233	219	220	220	230	232	230	220	222	220
22	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
23	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
24	241	241	242	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
25	241	241	241	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
26	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
27	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
28	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
29	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
30	240	240	240	230	230	230	234	230	233	220	220	220	230	232	230	220	222	220
31																		
Max.	241	241	242	231	230	230	240	233	235	220	220	220	230	232	230	220	224	220
Min.	238	238	238	228	228	228	230	230	229	219	220	220	228	229	228	218	220	218
Ave.	240.1	240.1	240.0	229.9	229.8	229.8	233.7	230.8	232.3	219.9	220.0	220.0	229.8	231.6	229.8	219.6	221.7	219.6
SD	0.521	0.5833	0.615	0.548	0.551	0.531	2.333	1.223	1.953	0.254	2E-04	2E-04	0.61	0.964	0.61	0.814	0.922	0.814
%Max	241.1	241.2	241.2	231.0	230.9	230.9	238.3	233.2	236.2	220.4	220.0	220.0	231.0	233.5	231.0	221.2	223.5	221.2
%Min	239.0	238.9	238.8	228.8	228.7	228.8	229.2	228.4	228.5	219.4	220.0	220.0	228.6	229.7	228.6	218.0	219.9	218.0

Note) SD: Standard deviation

(Volt)

Day	Off peak (3 o'clock)						Day peak (11 o'clock)						Night peak (20 o'clock)					
	Customer #6			Customer #8			Customer #6			Customer #8			Customer #6			Customer #8		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	265	266	265	265	264	267	249	250	250	248	249	250	246	247	247	247	245	248
2	265	266	265	265	264	267	249	250	249	249	249	250	247	247	246	247	248	248
3	263	267	265	265	265	268	249	250	249	249	249	250	247	247	246	248	248	248
4	263	267	265	263	265	268	250	250	249	250	249	250	248	248	246	248	248	249
5	263	268	266	263	265	268	250	250	250	250	249	250	248	248	247	248	248	249
6	263	268	266	263	266	267	250	250	250	250	249	250	248	247	247	248	249	250
7	265	268	266	264	266	267	250	251	249	251	249	250	248	247	246	248	249	250
8	265	266	267	264	265	267	249	251	249	251	249	250	249	248	246	249	249	250
9	265	266	267	264	265	266	249	251	250	251	249	250	248	248	246	249	250	251
10	263	266	266	265	266	266	250	251	250	251	249	250	248	248	247	248	250	251
11	263	265	265	265	266	265	250	250	250	249	249	250	247	247	246	248	249	249
12	264	265	265	265	265	264	250	250	249	248	250	249	247	246	247	247	250	249
13	264	266	266	265	265	264	250	250	249	248	250	249	249	246	245	247	250	249
14	265	266	265	266	266	264	249	250	249	248	250	249	249	246	245	248	250	249
15	265	265	265	266	266	265	249	250	249	249	250	251	250	247	246	248	249	250
16	265	265	266	265	265	265	249	250	249	249	250	251	250	247	246	249	249	250
17	266	264	266	265	265	264	249	250	250	249	250	251	251	247	246	249	249	251
18	266	263	264	265	265	264	249	250	250	249	250	251	251	248	245	249	250	251
19	266	263	264	264	265	264	250	249	250	250	250	251	251	248	245	249	250	250
20	265	263	263	264	264	264	250	249	251	250	250	251	250	248	246	248	250	250
21	265	262	263	264	264	265	250	249	251	250	250	251	249	247	246	248	249	249
22	265	263	263	263	264	265	249	251	251	250	250	250	249	247	247	248	249	250
23	265	264	262	263	263	264	249	251	251	250	249	250	248	247	246	248	249	251
24	266	265	262	263	263	263	250	251	251	250	249	249	247	247	245	249	250	249
25	266	262	262	263	263	263	249	249	249	250	249	249	248	248	248	248	248	248
26	266	263	262	264	263	263	249	250	249	250	249	250	249	249	249	248	249	249
27	267	263	262	263	263	263	248	250	249	250	249	250	251	250	250	249	249	249
28	267	265	266	263	263	263	248	248	248	250	249	249	249	249	250	250	249	250
29	267	265	265	263	263	263	248	248	249	250	249	249	255	255	255	255	256	255
30	267	265	265	264	263	263	248	248	249	250	250	250	253	254	254	255	255	255
31																		
Max.	267	268	267	266	266	268	250	251	251	251	250	251	255	255	255	255	256	255
Min.	263	262	262	263	263	263	248	248	248	248	249	249	246	246	245	247	245	248
Ave.	265.0	265.0	264.6	264.1	264.5	265.0	249.3	249.9	249.6	249.6	249.4	250.0	249.0	247.9	247.0	248.7	249.4	249.9
SD	1.287	1.7221	1.564	0.973	1.106	1.712	0.691	0.8847	0.814	0.89	0.498	0.695	1.93	1.999	2.414	1.863	1.942	1.668
%Max	267.5	268.4	267.7	266.0	266.7	268.3	250.6	251.6	251.2	251.4	250.4	251.4	252.8	251.9	251.8	252.3	253.2	253.2
%Min	262.5	261.6	261.6	262.2	262.3	261.6	247.9	248.2	248.0	247.9	248.4	248.6	245.2	244.0	242.3	245.0	245.6	246.6

Note) SD: Standard deviation

Low Voltage Distribution

Nov. 2003

11kV Kattedan #2 Line

Customer #6 (3 phase)
Chocolate Factory
Customer #8(3 phase)
Jaya & Company

Meter Serial No.: APE13611
Measuring Item:
Transformer Sub Station:
Place of Measuring: Malkapur Sub Station, Malkapur Feeder
Measuring item: Voltage (V)

Note)
shows data adopted cells.

-1.0 indicates ALL POTENTIALS MISSING

DATE	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
2003/5/9	190.9	190.9	193.2	186.3	184	179.4	-1	-1	-1	-1	257.6	246.1	243.8	246.1	246.1	-1	-1	255.3	253	195.5	195.5	190.9	193.2	197.8
2003/6/9	195.5	197.8	193.2	188.6	188.6	184	-1	-1	-1	-1	246.1	246.1	232.3	239.2	243.8	248.4	248.4	248.4	184	188.6	188.6	190.9	188.6	190.9
2003/7/9	190.9	190.9	190.9	248.4	248.4	257.6	248.4	248.4	250.7	239.2	239.2	-1	-1	-1	-1	-1	-1	-1	197.8	190.9	190.9	190.9	193.2	193.2
2003/8/9	193.2	193.2	193.2	250.7	250.7	246.1	255.3	250.7	243.8	230	-1	-1	-1	-1	-1	-1	-1	-1	190.9	190.9	190.9	188.6	190.9	193.2
2003/9/9	193.2	193.2	190.9	243.8	241.5	236.9	239.2	241.5	234.6	220.8	-1	-1	-1	-1	-1	-1	-1	-1	186.3	188.6	188.6	188.6	190.9	193.2
2003/10/9	190.9	188.6	188.6	184	243.8	239.2	248.4	239.2	225.4	220.8	179.4	174.8	-1	-1	-1	-1	-1	-1	184	188.6	188.6	190.9	193.2	193.2
2003/11/9	190.9	190.9	188.6	250.7	243.8	234.6	243.8	241.5	225.4	220.8	-1	-1	-1	-1	-1	-1	-1	-1	186.3	186.3	188.6	190.9	193.2	188.6
2003/12/9	190.9	190.9	190.9	241.5	239.2	230	239.2	239.2	255.3	234.6	243.8	-1	-1	-1	-1	-1	-1	-1	184	186.3	188.6	190.9	190.9	193.2
13/09/2003	190.9	190.9	188.6	250.7	253	248.4	243.8	243.8	230	223.1	232.3	-1	-1	-1	-1	-1	-1	248.4	184	184	186.3	188.6	190.9	193.2
14/09/2003	193.2	193.2	193.2	186.3	186.3	184	-1	-1	-1	-1	255.3	232.3	234.6	243.8	241.5	239.2	243.8	248.4	184	190.9	190.9	188.6	190.9	190.9
15/09/2003	190.9	190.9	188.6	181.7	181.7	177.1	-1	-1	-1	-1	241.5	225.4	236.9	239.2	234.6	236.9	241.5	241.5	184	188.6	188.6	190.9	190.9	193.2
16/09/2003	193.2	190.9	190.9	186.3	184	-1	-1	-1	-1	-1	234.6	227.7	227.7	241.5	234.6	234.6	239.2	243.8	181.7	186.3	186.3	188.6	188.6	188.6
17/09/2003	190.9	188.6	188.6	181.7	179.4	-1	-1	-1	-1	-1	239.2	223.1	220.8	234.6	234.6	236.9	243.8	250.7	188.6	188.6	186.3	188.6	188.6	190.9
18/09/2003	190.9	190.9	188.6	184	181.7	-1	-1	-1	-1	-1	234.6	232.3	232.3	241.5	241.5	243.8	246.1	248.4	184	186.3	186.3	188.6	188.6	190.9
19/09/2003	188.6	193.2	197.8	188.6	-1	156.4	-1	-1	-1	-1	234.6	241.5	239.2	246.1	246.1	248.4	253	250.7	190.9	193.2	197.8	200.1	190.9	193.2
20/09/2003	190.9	195.5	202.4	190.9	193.2	188.6	-1	-1	-1	-1	248.4	236.9	234.6	241.5	234.6	236.9	241.5	246.1	188.6	190.9	195.5	195.5	195.5	197.8
21/09/2003	200.1	200.1	195.5	246.1	250.7	250.7	253	246.1	248.4	253	259.9	-1	-1	-1	-1	-1	-1	-1	193.2	197.8	197.8	193.2	197.8	197.8
22/09/2003	197.8	202.4	202.4	255.3	257.6	257.6	259.9	266.8	273.7	271.4	246.1	-1	-1	-1	-1	-1	-1	-1	190.9	184	193.2	190.9	193.2	197.8
23/09/2003	197.8	195.5	195.5	269.1	271.4	262.2	262.2	259.9	262.2	253	259.9	-1	-1	-1	-1	-1	-1	-1	193.2	193.2	190.9	193.2	193.2	190.9
24/09/2003	190.9	190.9	190.9	266.8	271.4	264.5	259.9	255.3	239.2	236.9	241.5	-1	-1	-1	-1	-1	-1	-1	181.7	193.2	195.5	195.5	197.8	200.1
25/09/2003	193.2	200.1	195.5	248.4	248.4	250.7	253	255.3	246.1	241.5	246.1	-1	-1	-1	-1	-1	-1	-1	184	188.6	195.5	195.5	195.5	195.5
26/09/2003	193.2	193.2	193.2	257.6	262.2	259.9	259.9	259.9	259.9	253	236.9	-1	-1	-1	-1	-1	-1	-1	190.9	186.3	186.3	190.9	193.2	193.2
27/09/2003	190.9	193.2	190.9	271.4	273.7	271.4	271.4	264.5	241.5	236.9	236.9	-1	-1	-1	-1	-1	-1	-1	184	186.3	188.6	188.6	190.9	188.6
28/09/2003	186.3	188.6	188.6	186.3	184	184	-1	-1	-1	-1	255.3	253	248.4	248.4	246.1	248.4	255.3	264.5	193.2	188.6	188.6	190.9	193.2	193.2
29/09/2003	193.2	190.9	190.9	184	184	181.7	-1	-1	-1	-1	243.8	243.8	239.2	241.5	248.4	243.8	253	257.6	188.6	190.9	188.6	186.3	193.2	193.2
30/09/2003	190.9	188.6	186.3	181.7	181.7	179.4	-1	-1	-1	-1	262.2	246.1	248.4	246.1	230	253	250.7	253	188.6	262.2	218.5	190.9	190.9	190.9
2003/1/10	188.6	188.6	186.3	181.7	179.4	174.8	-1	-1	-1	-1	239.2	220.8	234.6	234.6	232.3	232.3	-1	-1	255.3	257.6	184	188.6	184	190.9
2003/2/10	190.9	188.6	188.6	179.4	181.7	181.7	-1	-1	-1	-1	241.5	225.4	223.1	236.9	234.6	230	239.2	241.5	188.6	188.6	188.6	190.9	193.2	197.8
2003/3/10	195.5	193.2	193.2	188.6	184	179.4	-1	-1	-1	-1	236.9	239.2	241.5	243.8	243.8	248.4	255.3	257.6	179.4	186.3	186.3	188.6	190.9	193.2
2003/4/10	190.9	193.2	190.9	186.3	184	181.7	-1	-1	-1	-1	246.1	239.2	243.8	239.2	243.8	243.8	246.1	-1	181.7	184	186.3	188.6	188.6	190.9
									6	10	3	10	7	1	1	38								

Load survey data from 05-09-03 to 04-10-03 30 days

Annex 3.5 Summary of Outage Records Collected

Summary of Outage Records Collected for 2002/03 (1/4)

	132 kV System (Mother substation)	33 kV feeder	33 kV substation	11 kV feeder	Cause recorded		Number of outages			Duration of outages (Min)			Remarks
					Cause	Equipment	33 kV	11 kV	Total	33 kV	11 kV	Total	
1	HKOT		AME	AME	x			14	14		3,158	3,158	
	(Kothur)			COL	x			30	30		4,645	4,645	
				DUB	x			21	21		6,330	6,330	
2	HRAM		SHA	DHO	x			25	25		3,135	3,135	
				KON	x			15	15		1,720	1,720	
				PAR	x			48	48		4,176	4,176	
				SHA	x			40	40		2,305	2,305	
3	MRAM		GAR	VAN	x			50	50		-	-	
	(R.ama Chandrapuram)		SHA	DHO	x			25	25		3,135	3,135	
				KON	x			15	15		1,720	1,720	
				PAR	x			48	48		4,176	4,176	
				SHA	x			40	40		2,305	2,305	
			SJB	IND	x			2	2		295	295	
				MOK	x			130	130		12,816	12,816	
			SHAM	HAB	x			45	45		3,582	3,582	
				NAR	x			48	48		4,792	4,792	
				OMJ	x			25	25		2,082	2,082	
				SHA	x			69	69		4,633	4,633	
4	MSAD	VKB			x		77		77	2,292		2,292	
	(Sadasivpet)		MAR	KAL	x			24	24		5,755	5,755	
				MAR	x			17	17		1,403	1,403	
				PAT	x			43	43		6,468	6,468	
				SRI	x			21	21		4,254	4,254	
			MOM	BAR	x			59	59		7,123	7,123	
				ENK	x			127	127		17,296	17,296	
				MOM	x			10	10		676	676	
				MPT	x			11	11		675	675	
				MRP	x			1	1		45	45	
				MVP	x			125	125		13,435	13,435	
			NAW	ARK	x			174	174		5,453	5,453	
				NAW	x			13	13		490	490	
				PUL	x			283	283		10,588	10,588	
5	MKAN		MAL	MAL	x		444	524	968	51,854	101,618	153,472	
	(Kandi)			MUN	x			675	675		103,335	103,335	
				TWN	x			157	157		22,190	22,190	
				KOT	x			150	150		29,710	29,710	
			KON	KON	x		279	356	635	47,240	5,767	53,007	
				TER	x			261	261		63,918	63,918	
				MAR	x			477	477			0	
				BAN	x			430	430		105,351	105,351	
6	MNAR		BOR	BPR	x		679	154	833	70,462	4,135	74,597	
	(Narayankhed)			DHA	x			213	213			0	
				NAP	x			191	191		2,731	2,731	
			POO	MAN	x		599	518	1,117	68,575	33,829	102,404	
				SHA	x			373	373		33,168	33,168	
				GUD	x			21	21		3,239	3,239	
			KAL	MAR	x		422	368	790	52,640	89,540	142,180	
				KAL	x		422	348	770	52,640	88,895	141,535	
				KAN	x		422	360	782	52,640	88,466	141,106	
7	MSAD	JOG			x		169		169	16,797		16,797	
	(Sadasivepet)	KOH			x		156		156	15,779		15,779	
		MRT			x		22		22	2,825		2,825	
		PSML			x		24		24	1,220		1,220	
		MAN			x		87		87	4,315		4,315	
		MUN			x		119		119	9,173		9,173	
		VIK			x		167		167	13,071		13,071	
			SAD	SAD	x		72	395	467	4,739	26,987	31,726	
				BUD	x		63	169	232	4,876	5,690	10,566	
				TSM	x		63	192	255	4,876	6,849	11,725	
				MAN	x		71	789	860	5,068	119,433	124,501	
		JOG	NIZ	NIZ	x		113	156	269	11,840	5,245	17,085	
				VEN	x		143	197	340	16,740	12,295	29,035	
		MUN	MUN	MUN	x		220	261	481	17,504	2,253	19,757	
			CHA	ATH	x		190	147	337	22,433	5,248	27,681	
				YEL	x		144	194	338	14,956	6,101	21,057	
8	RBAN	F(VAN)			x	x	81		81	3,747		3,747	
	(Bandlaguda)		ABD	ABD	x	x		122	122		5,730	5,730	
				ANA	x	x		42	42		2,920	2,920	
				SAB	x	x		1	1		950	950	
				SAN	x	x		47	47		3,400	3,400	

Summary of Outage Records Collected for 2002/03 (2/4)

	132 kV System (Mother substation)	33 kV feeder	33 kV substation	11 kV feeder	Cause recorded		Number of outages			Duration of outages (Min)			Remarks
					Cause	Equipment	33 kV	11 kV	Total	33 kV	11 kV	Total	
			PED	PED	x	x		57	57		2,084	2,084	
				TAR	x	x		33	33		1,108	1,108	
			RFC	RFC	x	x		51	51		710	710	
			VAN	BAL	x	x		19	19		1,080	1,080	
				INJ	x	x		31	31		1,835	1,835	
				NGO	x	x		7	7		265	265	
				VAN	x	x		42	42		2,110	2,110	
			BAN	ALK	x	x		55	55		661	661	
				GSI	x	x		36	36		226	226	
				NAG	x	x		106	106		1,798	1,798	
			HAY	AIR	x	x		24	24		203	203	
				AUT	x	x		38	38		382	382	
				HAY	x	x		26	26		148	148	
				HCO	x	x		12	12		228	228	
				LBN	x	x		33	33		453	453	
				MAN	x	x		29	29		459	459	
				MOT	x	x		51	51		468	468	
				SIR	x	x		34	34		719	719	
			KOT	KAM	x	x		91	91		4,090	4,090	
				KOT	x	x		162	162		6,310	6,310	
				LNR	x	x		39	39		1,995	1,995	
				MAN	x	x		7	7		245	245	
				NOD	x	x		48	48		1,070	1,070	
				SAM	x	x		155	155		5,061	5,061	
9	RCHA	33 F(KAT)			x		57		57	4,684		4,684	Bus 1, TR 2 are included
	(Chandrayanagutta)		CHA	ALK & othe	x			3	3		18	18	
				BAL	x			297	297		5,185	5,185	
				CHA	x			76	76		863	863	
				KAR	x			179	179		2,554	2,554	
				LBV-I	x			1	1		2	2	
				LV-I	x			21	21		134	134	
				LV-II	x			1	1		5	5	
				MEE	x			251	251		2,606	2,606	
				SLU	x			35	35		386	386	
			KAT	KT1	x			109	109		2,456	2,456	
				KT2	x			87	87		2,547	2,547	
				KT3	x			95	95		2,319	2,319	
				KT4	x			101	101		2,553	2,553	
				BAL	x			132	132		4,151	4,151	
			MAH	GHA	x			23	23		2,583	2,583	
				LEM	x			25	25		2,115	2,115	
				MAH	x			2	2		270	270	
				NAG	x			18	18		2,007	2,007	
				TIM	x			20	20		2,480	2,480	
			MAN	IDA	x			175	175		4,895	4,895	
				MAN	x			132	132		5,579	5,579	
			SHAM	HAB	x			45	45		5,582	5,582	
				NAR	x			48	48		4,192	4,192	
				OMJ	x			25	25		2,082	2,082	
				SHA	x			69	69		4,673	4,673	
			SHP	GAN	x			4	4		215	215	
				IND	x			5	5		468	468	
				PAL	x			6	6		800	800	
				SHA	x			7	7		2,155	2,155	
10	RDHA	CHE			x		87		87	764		764	
	(Dharmasagar)	PAR			x		134		134	1,524		1,524	
		PRA			x		13		13	682		682	
		SHA			x		63		63	2,804		2,804	
			CHE	ALU	x			70	70		11,913	11,913	
				CHE	x			7	7		715	715	
				GUD	x			10	10		2,025	2,025	
				GUN	x			9	9		2,290	2,290	
				KOT	x			24	24		4,400	4,400	
				MUD	x			61	61		6,130	6,130	
				SHE	x			1	1		210	210	
				STA	x			4	4		300	300	
				(Bus)	x			1	1		120	120	
			MAN	MER	x			37	37		3,239	3,239	
				OHN	x			63	63		9,342	9,342	
				PUD	x			55	55		8,049	8,049	

Summary of Outage Records Collected for 2002/03 (3/4)

	132 kV System (Mother substation)	33 kV feeder	33 kV substation	11 kV feeder	Cause recorded		Number of outages			Duration of outages (Min)			Remarks
					Cause	Equipment	33 kV	11 kV	Total	33 kV	11 kV	Total	
				SUP	x			68	68		2,652	2,652	
			MOI	HIM	x			264	264		35,243	35,243	
				KAN	x			250	250		34,233	34,233	
				MOI	x			33	33		3,191	3,191	
				PED	x			250	250		33,300	33,300	
				SPS	x			70	70		6,110	6,110	
				SUR	x			268	268		35,168	35,168	
			PAR	GAN	x			31	31		1,434	1,434	
				PAR	x			21	21		261	261	
				ROO	x			17	17		431	431	
				RAK	x			20	20		764	764	
				SHA	x			31	31		942	942	
			SHA	NAG	x			24	24		8,945	8,945	
				POL	x			9	9		3,575	3,575	
				SAR	x			16	16		3,955	3,955	
			TAL	RAO	x			19	19		284	284	
				RDO	x			23	23		399	399	
				RUD	x			31	31		574	574	
				TAL	x			42	42		568	568	
11	RIBR (Ibrahimpatnam)		BOD	BOD	x	x		158	158		2,048	2,048	
				YEL	x	x		158	158		1,818	1,818	
			DAN	DAN	x	x		116	116		1,809	1,809	
				MUK	x	x		75	75		1,137	1,137	
				NER	x	x		133	133		1,624	1,624	
			IBR	ELM	x	x		57	57		1,028	1,028	
				IBA	x	x		134	134		2,448	2,448	
				RAP	x	x		135	135		1,935	1,935	
				SHE	x	x		90	90		2,172	2,172	
			KAN	BAC	x	x		106	106		1,159	1,159	
				GUD	x	x		60	60		868	868	
				KAN	x	x		69	69		814	814	
				MUC	x	x		90	90		1,611	1,611	
				NED	x	x		221	221		3,139	3,139	
				PUL	x	x		64	64		1,005	1,005	
			MAL	KOT	x	x		156	156		2,762	2,762	
				MAL	x	x		95	95		1,497	1,497	
				NAL	x	x		123	123		2,092	2,092	
			MAN	ARU	x	x		69	69		1,091	1,091	
				JAP	x	x		86	86		1,569	1,569	
				MAN	x	x		65	65		1,566	1,566	
				MOM	x	x		111	111		1,380	1,380	
				TAL	x	x		142	142		1,990	1,990	
			RAC	BAC	x	x		206	206		474	474	
				GUD	x	x		54	54		921	921	
				GUN	x	x		170	170		3,106	3,106	
				LEM	x	x		167	167		2,258	2,258	
				RAC	x	x		155	155		1,850	1,850	
				THI	x	x		133	133		2,190	2,190	
			TUR	MAN	x	x		126	126		1,774	1,774	
				TUR	x	x		151	151		2,621	2,621	
			YAC	CHI	x	x		91	91		1,452	1,452	
				CHO	x	x		123	123		1,861	1,861	
				CHU	x	x		26	26		395	395	
				GUN	x	x		173	173		2,583	2,583	
				MED	x	x		163	163		1,969	1,969	
				NAN	x	x		98	98		1,451	1,451	
				YAC	x	x		63	63		1,144	1,144	
12	(ROTH) ???		LNPOOR	BAN	x			215	215		6,267	6,267	
				CHR	x			268	268		10,801	10,801	
				LAX	x			176	176		1,609	1,609	
13	RPUT	CHW			x		29		29	684		684	
	(Puttapahad)	*DOM*			x		*99*		*99*	*4,344*		*4,344*	
		PUT			x		34		34	1,550		1,550	
		SAL			x		139		139	4,743		4,743	
			DMA	BSP	x			39	39		279	279	
				DMA	x			42	42		716	716	
				PLP	x			41	41		353	353	
			DSP	BRP	x			54	54		1,128	1,128	
				DSP	x			25	25		310	310	
				MLP	x			32	32		433	433	

Summary of Outage Records Collected for 2002/03 (4/4)

	132 kV System (Mother substation)	33 kV feeder	33 kV substation	11 kV feeder	Cause recorded		Number of outages			Duration of outages (Min)			Remarks
					Cause	Equipment	33 kV	11 kV	Total	33 kV	11 kV	Total	
			PUT	KUL	x			7	7		408	408	
				MAN	x			8	8		960	960	
				PUT	x			6	6		875	875	
				RUS	x			6	6		1,290	1,290	
			SKP	GAN	x			31	31		252	252	
				PGDL	x			42	42		659	659	
				SKP	x			39	39		977	977	
14	RSHI (Shivarampally)		APP	AZI	x			148	148		10,977	10,977	
				HIM	x			60	60		3,665	3,665	
				POL	x			1	1		30	30	
			GAG	GAG	x			31	31		150	150	
				JAI	x			35	35		1,033	1,033	
				MAN	x			29	29		636	636	
				NPA	x			17	17		419	419	
				RAJ	x			46	46		565	565	
				SHI	x			18	18		276	276	
			IBR	MI1	x			116	116		5,955	5,955	
				MI2	x			16	16		901	901	
				OSM	x			96	96		4,124	4,124	
				PED	x			77	77		2,236	2,236	
			NPA	KTD	x			109	109		2,456	2,456	
				SHA	x			47	47		-		
				SIV	x			102	102		2,429	2,429	
				UPP	x			132	132		4,151	4,151	
15	RTAN (Tandur)	BAS			x		206		206	8,822		8,822	
		KAR			x		107		107	6,137		6,137	
		TDR			x		1		1	10		10	
		TUR			x		101		101	3,084		3,084	
		VIK			x		58		58	3,850		3,850	
			BAS	AGN	x			114	114		8,005	8,005	
				BAS	x			74	74		2,758	2,758	
				NLP	x			127	127		14,051	14,051	
			DHA	DHA	x			7	7		58	58	
				GUT	x			77	77		15,863	15,863	
				KUK	x			63	63		14,531	14,531	
			KAR	KAR	x			68	68		4,111	4,111	
				MTK	x			70	70		7,381	7,381	
				OGI	x			101	101		7,840	7,840	
			PED	JAN	x			32	32		2,894	2,894	
				KAN	x			20	20		3,357	3,357	
				KOT	x			85	85		8,828	8,828	
				PED	x			6	6		430	430	
			TUR	BEN	x			12	12		1,865	1,865	
				TAT	x			48	48		6,700	6,700	
				TUR	x			1	1		50	50	
			VIK	ANA	x			52	52		4,451	4,451	
				EKA	x			103	103		7,761	7,761	
				SKA	x			178	178		11,899	11,899	
				VIK	x			165	165		6,034	6,034	
				BAM	x			1	1		110	110	
				BEN	x			151	151		9,797	9,797	
				DEN	x			217	217		30,970	30,970	
				SAN	x			100	100		11,155	11,155	
				VAL	x			2	2		15	15	
				YAL	x			133	133		8,709	8,709	
				YAL +	x			98	98		1,155	1,155	
				****	x			1	1		5	5	
	TTL	16	61	244			6,376	23,522	29,898	611,984	1,760,718	2,372,702	

Chapter 4 SCADA System

Contents

Chapter 4 SCADA System

The study was planned for the purpose of proposing an improvement plan of the existing SCADA to introduce distribution supervisory control and data acquisition functions (distribution SCADA) and achieve the following items.

- Improve electricity supply reliability through reduction of the interruption period and outage duration and improve availability of electric supply.
- Automatically change the transformer taps for maintaining desired voltages and switching on and off of capacitor banks for reducing reactive power, and optimally deliver loads to the feeders by monitoring and analyzing voltage and current on feeder, and in turn, improve the utilization rate of distribution feeder as well as reduce distribution losses.

To be more specific, the existing SCADA is covering as far as the 11kV feeder circuit breakers in the distribution substation, and the distribution SCADA functions should be introduced into the existing SCADA by the manners as shown below:

- Install remote-controlled switches with control device and voltage and current instrument devices on a feeder including voltage booster and capacitor banks.
- Connect the above-mentioned devices with the existing SCADA through a new communication system.

4.1 General

This study includes the following steps:

- Assessment of the existing SCADA System
- Study on introduction of distribution SCADA System
- Proposal of distribution SCADA System

4.1.1 Assessment of the Existing SCADA System

The existing SCADA system is covering up to 11kV feeder circuit breakers in substations. First, the system configuration and its functions were studied. Based on the findings, the additional hardware and software that are required to introduce the distribution SCADA functions were identified. They were reflected in the proposed distribution SCADA system design.

4.1.2 Study of Distribution SCADA Introduction

The system configuration and introduction cost were studied and feasibility of introducing the system was also assessed on the proposal of distribution SCADA.

- Study area
  - Conceptual design: As for the substations covered by the existing SCADA system, collect as many data as possible and summarize them.
  - Detail design study: Survey almost all the substations for study of amount of required distribution SCADA system equipments and information data etc.
- Follow up of the existing SCADA assessment
  The follow up study was conducted with respect to the operation and reliability of equipments duly considering the findings of the 1st site survey.
- Design study
  - Study of total system configuration
    The conceptual design was studied with respect to the installation of remote controlled switches with control device and voltage and current measuring instruments on feeders, computer system configuration and communication method between RTUs (control device) and computer system in distribution control center.
  - Study of additional functions
    The study was conducted with respect to which DMS functions are to be introduced, such as feeder monitoring, control and data recording.
  - Study of communication system
    As for the communication method between feeder devices, substation and DCC, the study of hardware and cost was assessed with respect to radio, wire cable and fiber optic cable.
  - Detail study of system configuration
    The study was conducted with respect to the really installed functions, alteration of DCC computer system, alteration of distribution equipment and system configuration.

- Estimation of cost
  Based on the studied design for typical substations, the cost was estimated with respect to the system alteration, distribution equipment alteration and newly installed equipment.
- Study of introduction of distribution SCADA to feeders
  As for the introduction to the covered area, the priority of introduction to feeders was studied from the viewpoint of reducing the outage period and feeder importance, and the phases of introduction were considered. The cost for each introduction phase was estimated as well.

4.1.3 Proposition of Distribution SCADA System

The plan for improvement of SCADA was proposed with the following contents:

- Existing SCADA and introduction of distribution SCADA functions
  The existing SCADA system configuration and its functions, communication system and the operation status were assessed and the necessity to introduce a distribution SCADA was proposed.
- Design of distribution SCADA system
  Based on the following study results, the optimal system design was proposed.
  - Installation of remote-controlled switches and control devices on the feeders
  - Installation of voltage and current measuring instruments on the feeders
  - Linking n with DMS (including "DMS functions and its adopted functions")
  - Installation of communication system (radio, control wire and optic fiber cable).

  In this case, the optimal design may depend on the location of the corresponding substation and feeders.
- Introduction plan of distribution SCADA to feeders
  Based on the study results and consideration of the reliability and importance of feeders, the introduction plan was proposed.
- Cost
  The cost plan corresponding to the above-mentioned plan was proposed.

4.2 Assessment of Existing SCADA System

The existing SCADA system is covers up to the distribution feeder circuit breakers in the distribution substation. First, the system configuration and its functions will be studied. Based on this result, the additional hardware and software required will be identified in order to introduce the distribution SCADA functions, which will be reflected in the distribution SCADA design.

4.2.1 First Survey of Existing SCADA

At the first survey, the general functioning of the existing SCADA was surveyed mainly based on the explanation document. The results are shown in Table 4.1.

Table 4.1 Functions of existing SCADA

Items	Outline
a. Monitor and control area	The existing SCADA system covers Hyderabad, 10 municipals in Ranga Reddy. Hyderabad is separated into 3 circles, South, North and Central, and SEs (Superintending Engineers) are assigned to these circles including one block of 10 municipalities in Ranga Reddy. In this area, the SCADA is centrally monitoring and controlling 13 EHV substations (220/132kV) and 93 middle voltage substations (33/11kV) from the DCC (Distribution Control Center) at Erragadda.
b. Communication system (Refer to Figure 4.1)	The basic communication system for Hyderabad SCADA system is the state of the art Microwave Communication Network, comprising of two separate Networks. The primary backbone communication network on the Time Division Multi Access (TDMA) principle operating on 2.3 GHz frequency band connects the central station to all the nodal stations – 220/132kV stations. This will carry data of SCADA, voice communication etc. The Secondary Communication Network that is based on the Multiple Address Radio System (MARS) principle interlinks all the 33/11kV substations to the nearest nodal station (TDMA station).
c. Outline of DCC Computer System (Refer to Figure 4.2)	The Master Control Center has ABB's S.P.I.D.E.R. System with three high end servers, namely, a main standby redundant SCADA application server pair and one for the DMS (Distribution Management System) application functions. The programmer's office has one operator's programming workstation. This is an engineering console used for database generation, maintenance and modification of existing pictures and /or addition of new network pictures/data. Additionally, 2 remote communication servers are provided to control and acquire data from 33kV feeders emanating from EHV substations, incoming 33kV circuits and 33/11kV substations, through the substation RTUs. Furthermore, 4 monitoring dual workstations are also provided in the control room. Besides general SCADA functions like Calculation of hourly active and reactive power values, Event & alarm list, Report Generation and Display of status indications etc., this system envisages integration of both Critical Distribution System Control functions such as Emergency Load Shedding, Fault Localization and Restoration of Supply and also application functions such as Automated Meter Reading of the HV customers connected to the city distribution network. Pole-type RTUs (not installed in reality) are envisaged for Feeder SCADA and Automatic Meter Reading functions. It is an integral unit comprising of an

	RTU, Radio Transceiver, equipment power supplies & backup battery supplies.

(Table 4.1 Continue)

Items	Outline
d. DMS Application functions	The following additional DMS function modules have been integrated into the S.P.I.D.E.R. SCADA software. -Emergency load shedding (for HV customer) This facility enables operators to select a group of breakers with a single command and shed blocks of load. However, for protection against operator errors load shedding will be initiated through a two-step procedure. -Load control (for HV customer) Load control of HV loads for single discrete loads or groups of loads brings out effective management of System peak load hours. Synthesis of load peak curves of the feeders to which the HV customers are attached is also done simultaneously for flattening the load curve. -Automatic meter reading (for HV customer) For the various HV bulk consumers that APTRANSCO caters to, such as Railways, heavy industries and others, ABB uses the output of electronic meters installed by APTRANSCO for retrieving and integrating the meter data into the SCADA system through RTUs. This arrangement vastly eases the traditional tasks of the utility company like procurement of billing information, monitoring of customer's load and voltage besides being an effective way of detecting any attempt to temper with meters. -Fault location The operator, through SCADA, can perform identification and isolation of the faulty section through the Fault Localization application function module. -Load balancing Automatic operation of transformer taps from the control center, in the event of actual or likely overloads, distributes the total load on the system. -Automated mapping and facilities management (AM/FM) The latest geographical maps with the electrical network merged on it are a boon for both Troubleshooting and Routine field maintenance of devices such as relaying of under-ground cables etc. -Trouble call management system In APTRANSCO project the information of outage of supply reported by the customers will be collected at fuse-off call centers. By connecting up all the fuse-off call centers to DCC, the operator at DCC can make an analysis and send rectification gangs for supply restoration.

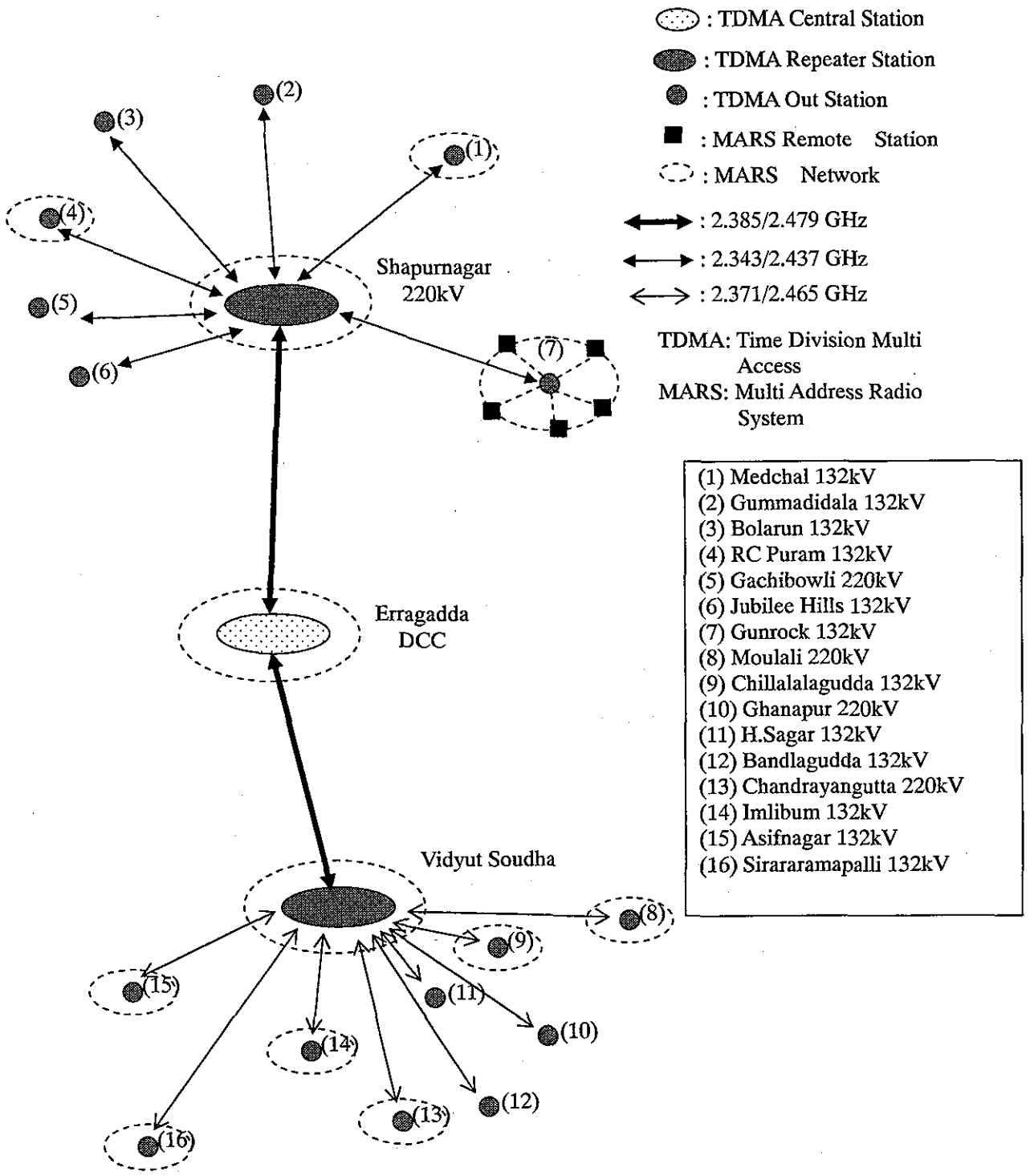


Figure 4.1 Network connection for Hyderabad SCADA system

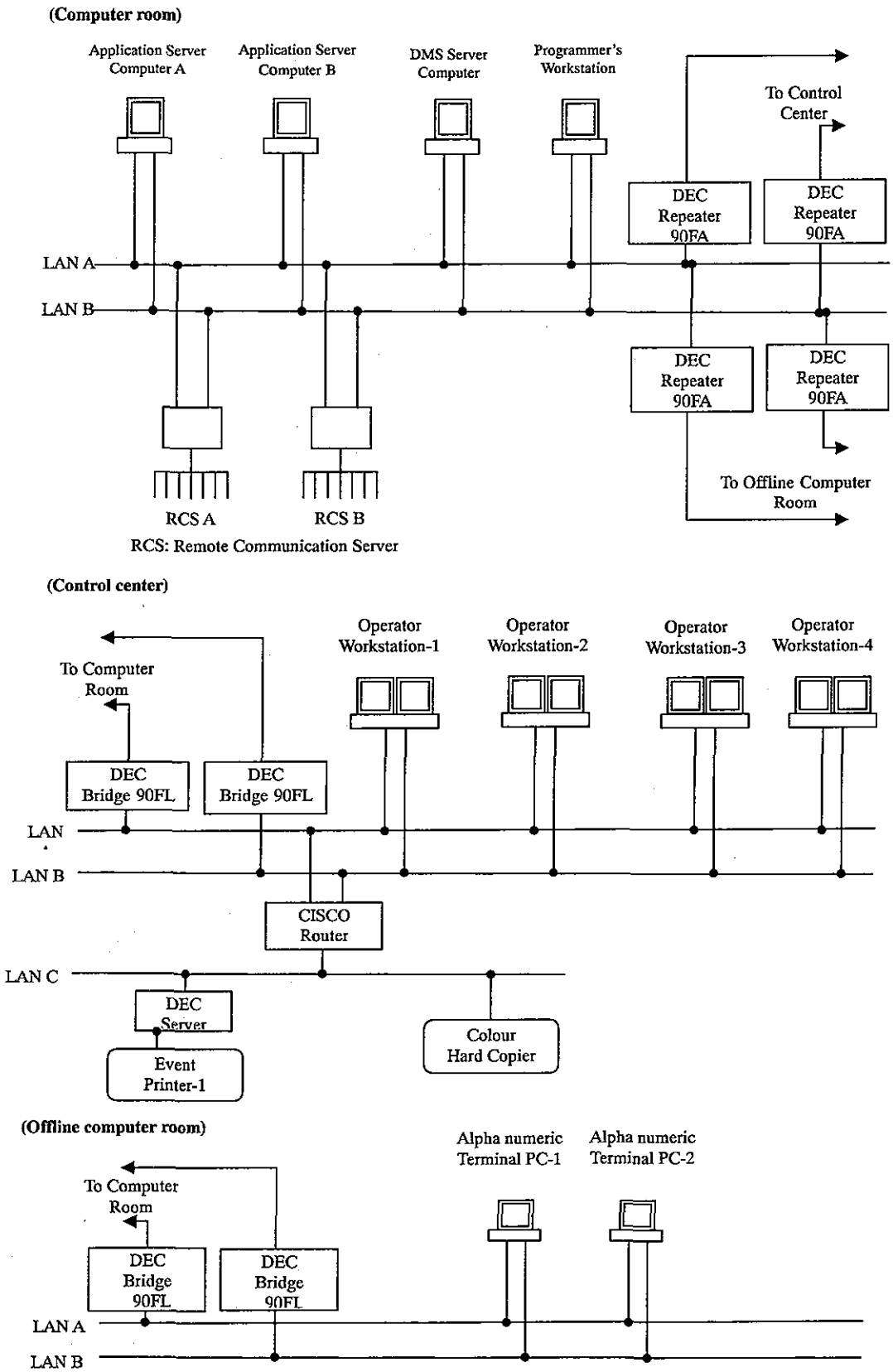


Figure 4.2 DCC computer system

As a conceptual design example, a design such as Figure 4.3 is expected. This design is based on the idea that the existing RF communication route should be most used.

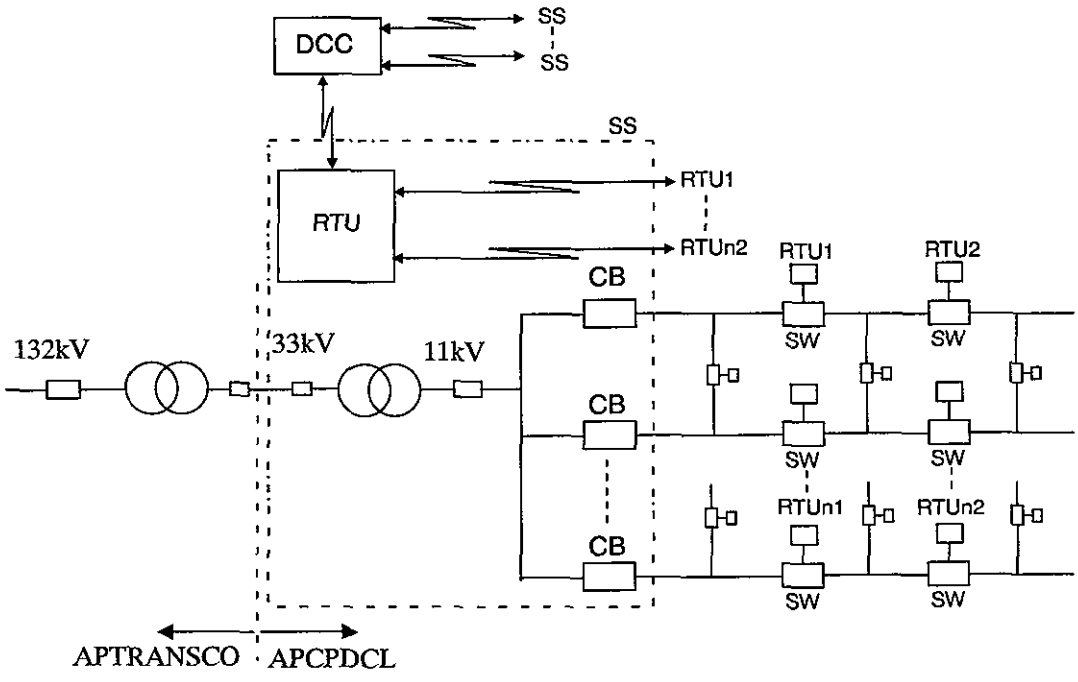


Figure 4.3 Distribution SCADA configuration

4.2.2 Follow-up Survey Regarding SCADA Improvement

For the purpose of SCADA improvement, the following items were also studied through the persons in charge of Indian side.

- Restoration procedure for feeder fault
- Priority of functions for DMS (Distribution Management System)
- Communication system configuration for distribution SCADA
- Feeder fault frequency and feeder specification study
- Substation configuration and monitoring items
- Some review items for existing SCADA

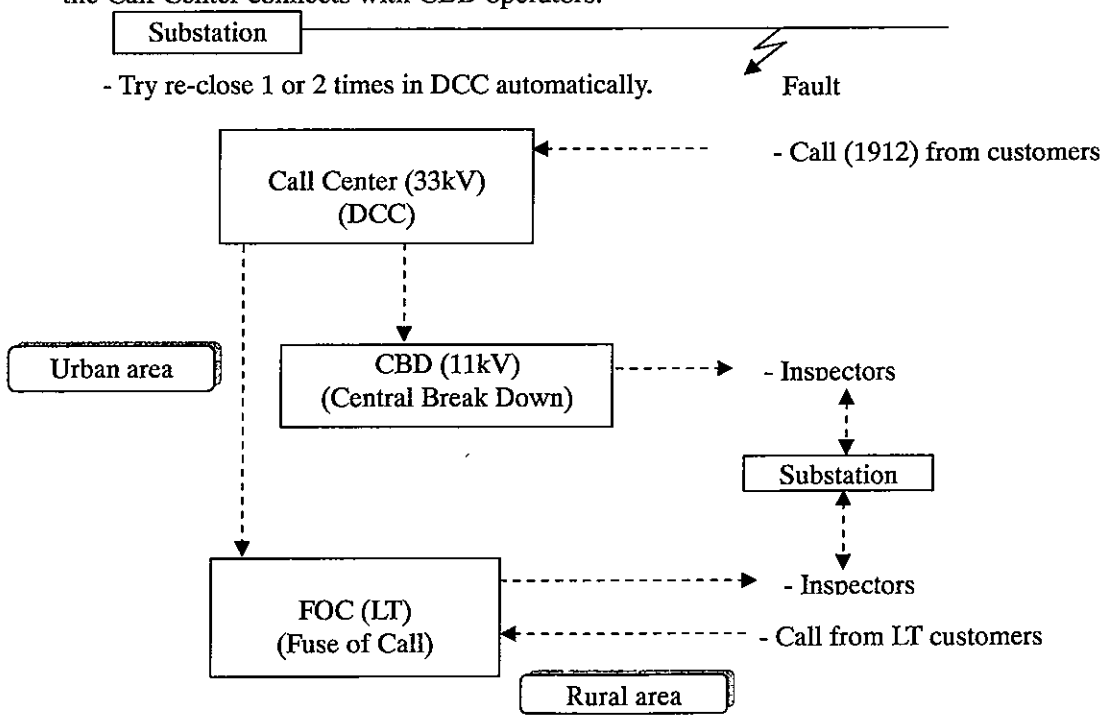
(1) Restoration Procedure for Feeder Fault

With respect to the purpose of a distribution SCADA system, a reduction of outage time is expected through measures such as automatic separation of the fault section and remote restoration operation. Therefore, the possibility of improvement for this reduction was studied.

(a) Procedure

Figure 4.4 shows the procedure to be taken when a feeder fault occurs. Operators at substation learn a fault by alarms and customers call to the Call Center or FOC. The CBD does not receive a call but is put in charge of 11 kV feeder affairs.

After fault, re-closing of feeder circuit breaker is tried twice. If the fault remains, the fault section detection is executed with connection to inspectors. For separating the fault section, manual AB switches (Refer to Annex 4.1) are operated on the field side. In urban area, the Call Center connects with CBD operators.



- Restoration period: 10~15 minutes for a small feeder, 30~60 minutes generally

Figure 4.4 Feeder fault and restoration procedure

(b) Outage Time

A period of one outage is from 10 to 15 minutes for a small size feeder and generally, from 30 to 60 minutes. Two categories of interruption and break down exist; the period of the former is less than 30 minutes and that of the latter is more than 30 minutes.

(2) Priority of Introduction of DMS Functions

The existing SCADA has functions of DMS. Some of these functions should be put to use, and the priority of introduction is as shown in Table 4.2 that is based on a SCADA operator's opinion.

Fault location has the first priority and Load balancing the second. These contribute to improvement of reliability and reduction of loss, respectively.

Table 4.2 Priorities of DMS functions

Function	Priority
a. Emergency load shedding (for HV customer)	6
b. Load control (for HV customer)	4
c. Automatic meter reading (for HV customer)	3
d. Fault location	1
e. Load balancing	2
f. Automated mapping and facilities management (AM/FM)	7
g. Trouble call management system	5

(3) One Idea of Communication System Configuration for Distribution SCADA

The communication structure is already shown in Figure 4.1. In this section, one idea of extending the network for distribution SCADA communication is shown in Figure 4.5. In this case a polling master is newly installed at substation where a master MARS is equipped. In another case pole top RTUs can be directly connected with DCC.

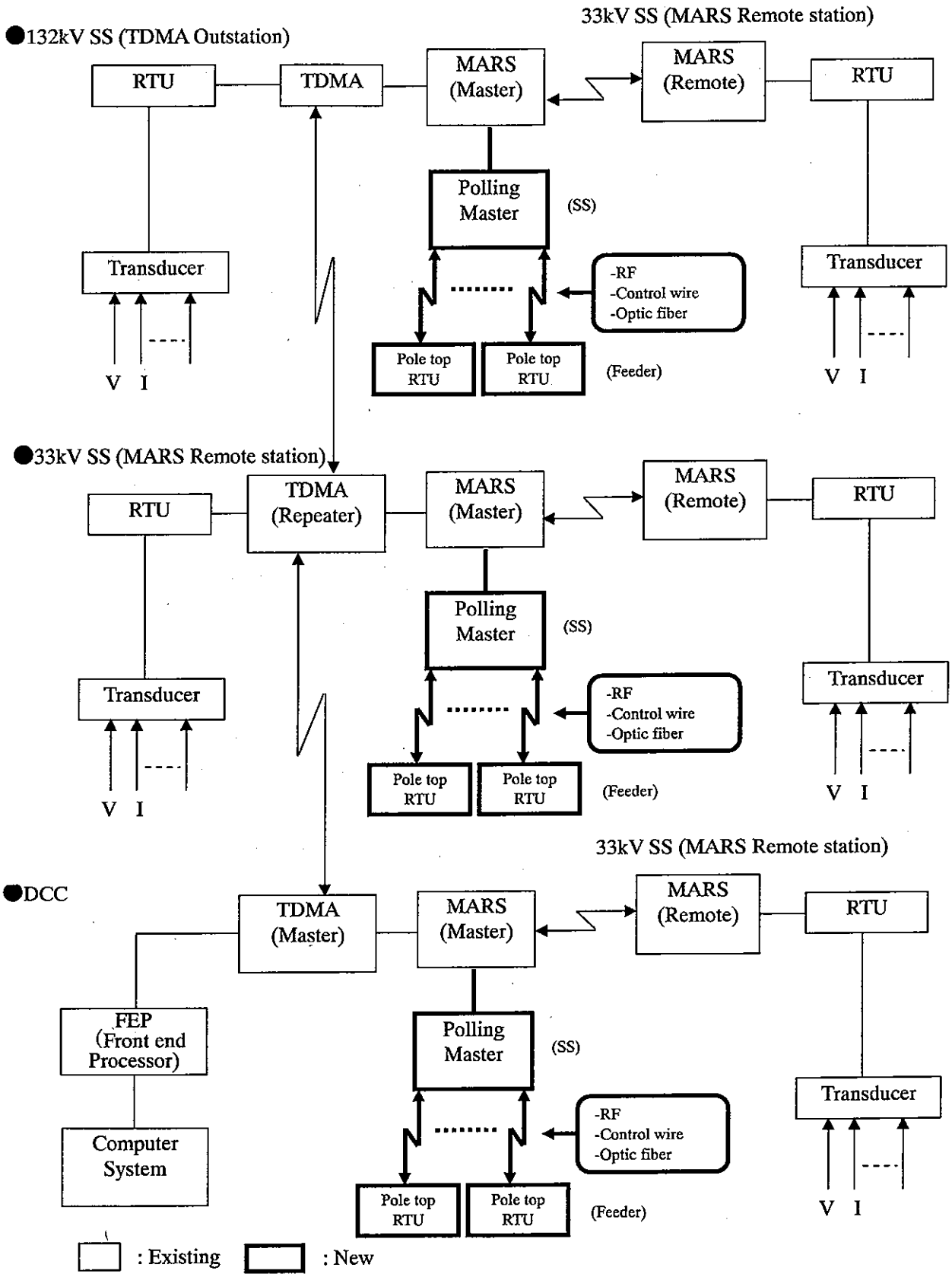


Figure 4.5 Example of telecommunication method

(4) Feeder Fault Frequency and Feeder Specification Study

In order to study the introduction of distribution SCADA, the study was done with respect to feeder specifications such as length, maximum load and expanding form (Refer to Figure 4.6) and the outage period caused by interruption and break down faults. The results are shown in Annex 4.2.

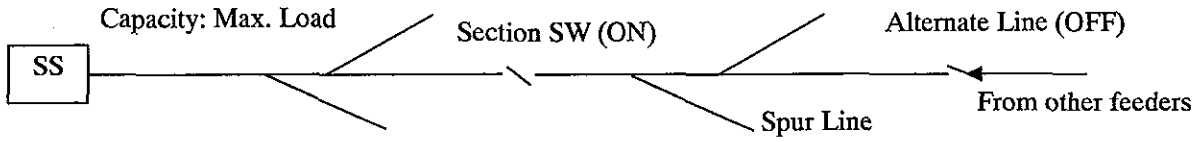


Figure 4.6 Feeder data items

Table 4.3 shows the summary of results. As for the data per one feeder, maximum load is approximately identical in both Ranga Reddy and Hyderabad, but Ranga Reddy is a little longer than Hyderabad in length. The amount of outage in Ranga Reddy is also larger than that in Hyderabad.

Table 4.3 Results of feeder survey

Item	Ranga Reddy			Hyderabad				Total
	North	South	Total	North	Central	South	Total	
Number of substations	22	13	35	30	14	17	61	96
Number of feeders	121	58	179	178	87	102	367	546
Max load (A/F)	111	107	109	100	100	116	104	106
Length (km/F)	9.9	12.3	10.7	4.7	5.0	3.9	4.5	6.5
Sec. SW (Nos./F)	2.0	1.5	1.8	1.6	1.4	1.5	1.5	1.6
Spur line (Nos./F)	4.2	5.5	4.6	4.9	4.7	5.0	4.9	4.8
Alternate line (Nos./F)	0.5	0.9	0.6	1.7	1.3	1.8	1.6	1.3
Outage I+B(Nos./F/M)	5.7	9.1	6.9	4.2	3.7	4.6	4.1	5.0
Outage I+B (minutes/F/M)	56	171	93	78	62	82	75	81

I: interruption, B: breakdown, F: feeder, M: month

4.3 Introduction of Distribution SCADA System

In this section, the possibility for Distribution SCADA introduction is studied with respect to the mainly economical estimate for the substations covered by the existing SCADA. This estimate is conducted on the basis of the average data derived from "4.2.2(4) Feeder Fault Frequency and Feeder Specification Study".

4.3.1 Area to be covered

Among the substations (106) monitored and controlled by the existing system, the study was focused on 96 substations because the data of these 96 substations are available. The details of 106 substations are shown in Table 4.4.

The details of the survey are shown in The Annex 4.2 and summarized in Table 4.5. This table includes some outage energy data regarding the area substations. The amount of energy is nearly equal to the accumulating base value shown in the following section.

Table 4.4 Details of substation number

Total Area							
106							
North				South			
49				57			
Hyderabad City		Ranga Reddy		Hyderabad City		Ranga Reddy	
34		15		33		24	
EHV (132/33kV)	33/11kV	EHV (132/33kV)	33/11kV	EHV (132/33kV)	33/11kV	EHV (132/33kV)	33/11kV
4	30	3	12	2	31	4	20

Table 4.5 Nos. of substations and feeders with some outage energy data

Item				Ranga Redy North	Ranga Redy South	Ranga Redy Gross (1)	Hyderabad North	Hyderabad Central	Hyderabad South	Hyderabad Gross (2)	Hydera.+R.R. (1) + (2)
Maximum load	Current(A/feeder) (a)			110.6	107.0	109.3	100.0	100.4	116.1	104.0	
	Apparent power (kVA/feeder) (1)			2,107.2	2,038.6	2,082.4	1,905.2	1,912.8	2,211.9	1,981.4	
Power factor (b)				0.85	0.85	0.85	0.85	0.85	0.85	0.85	
Load factor (c)				0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Average load(kW) (2)				1,253.8	1,212.9	1,239.0	1,133.6	1,138.1	1,316.1	1,178.9	
Outage period	(m/feeder/M) (d)			55.6	170.7	93.3	78.1	62.2	81.5	74.7	
	(m/feeder/Y) (3)			667.2	2048.4	1119.6	937.2	746.4	978	896.4	
Outage energy (kWh/feeder/Y) (4)				13,942	41,410	23,120	17,707	14,158	21,452	17,613	
Substation Nos				22	13	35	30	14	17	61	96
Feeder Nos(e)				121	58	179	178	87	102	367	546
Outage energy (kWh/Area/Y) (5)				1,686,952	2,401,778	4,138,494	3,151,799	1,231,774	2,188,152	6,464,092	10,602,587
Tariff (f)	(Rs/kWh)	Rs	46.5	4.000	4.000	4.000	4.000	4.000	4.000	4.000	
	(US$/kWh)	US$	1	0.086	0.086	0.086	0.086	0.086	0.086	0.086	
	(Yen/kWh)	Yen	120	10.323	10.323	10.323	10.323	10.323	10.323	10.323	
Tariff incom reduction (6)	(Rs/Y)			6,747,810	9,607,111	16,553,978	12,607,198	4,927,094	8,752,609	25,856,369	42,410,346
	(US$/Y)			145,114	206,605	356,000	271,123	105,959	188,228	556,051	912,050
	(Yen/Y)			17,413,702	24,792,545	42,719,942	32,534,704	12,715,082	22,587,378	66,726,113	109,446,055

(1)=(a)×11kV×$3^{0.5}$
(b):JICA Information booklet
(c):O&M data
(2)=(1)×(b)×(c)
(3)=(d)×12
(4)=(2)×(3)/60
(5)=(4)×(e)
(6)=(5)×(f)

4.3.2 Assessment of the Existing System

(1) Substation Configuration and Monitoring Items

The basic substation structures and the monitoring items are shown in Figure 4.7. Circuit breakers in substations of DISCOM are also monitored and remotely operated from SCADA center as well.

(2) Some Review Items for Existing SCADA

Officers in charge pointed out some items to be improved as follows. Among these items, there are some points that will improve the existing SCADA and need the distribution SCADA functions.

(a) All outdoor substations

Problem:

Only one GC breaker on 33 kV is available; Transformer protection relays (Buchholz + Temperature) for all 3 phases transformers are connected to one GC breaker. If any fault happens on any transformer at an outdoor substation, the GC breaker will trip. In this case, 2 transformers cannot be charged from SCADA, since no independent breaker is available for each transformer.

Improvement:

Propose to install an independent 33 kV breaker for each transformer.

(b) All the isolators

Problem: All the isolators (AB switches) are now of manual operation type.

Improvement: They may be motorized.

(c) Transducer supply power

Problem: AC power is supplied. Even when the incoming supply fails, total remote operation will be lost.

Improvement: Change all transducers to DC power supply type.

(d) Bus Coupler Breaker

Provide instead of isolator (AB switch) for all outdoor substations.

(e) Operation of transformer and breaker

All transformers and breakers should be loaded up to 50 % of capacity, so that an alternate supply can be arranged from SCADA.

(f) Operation of 11 kV feeder

All 11 kV feeders should be loaded up to 100 amperes, since CT ratio of almost all 11 kV feeders is 200/5 amperes. In case of emergency, one feeder should be able to take alternate feeder load by choosing sectionalizer.

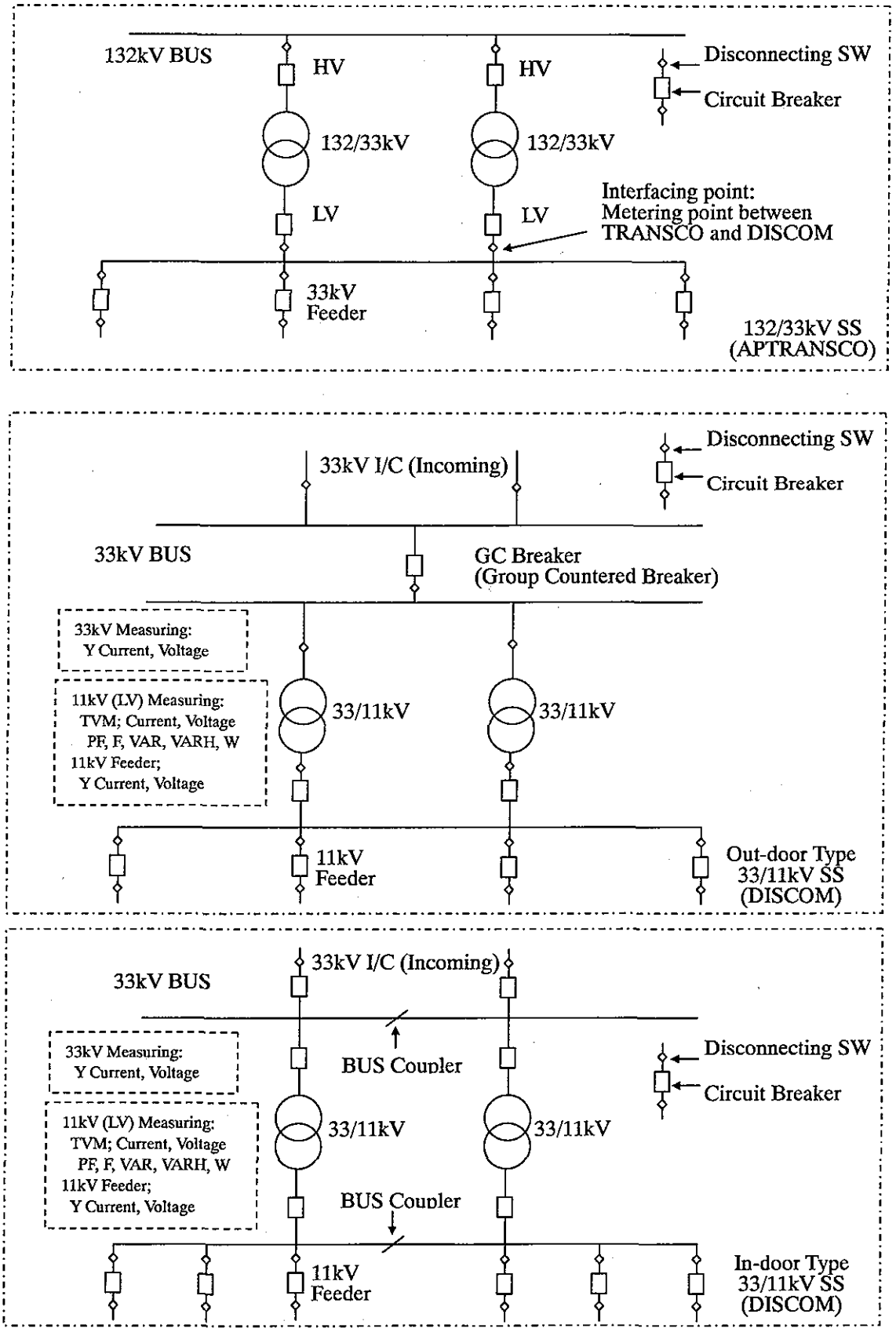


Figure 4.7 Substation configuration and monitoring items

(3) Effectiveness of Distribution SCADA

As mentioned above, the existing SCADA seems to monitor the system and control up to the distribution substations. The functions such as monitoring and controlling feeder current or transformer load, however, are expected to be present in the SCADA system. These functions indirectly realize load leveling of feeders in a substation and reduce feeder ohm loss.

In addition to these functions, the faulty zone sectionalization seems to be needed because the outage period is very long as shown in Annex 4.2.

Therefore, loss recovery energy by balancing of feeder load and lost energy by outage are estimated as follows.

(a) Outage Energy Estimate

Lost energy (kWh) by outage is calculated for every feeder based on its fault data. The equation is as follows.

$$E\ (kWh/year) = MA \times V \times 3^{1/2} \times PF \times LF \times OPM/60 \times 12(months)$$

MA : Maximum ampere for a month, V : 11 kV, PF: Power factor 0.85,

LF : Load factor 0.7, OPM : Outage period for a month (minutes)

The result is shown in Annex 4.3.

(b) Recovery Energy by Load Balancing of Feeders in a Substation

Loss energies at maximum amperes and at leveled amperes are calculated as follows and recovery energy is derived as the difference between the two calculated energy values.

$$Em\ (kWh/year) = 3 \times MA^2 \times Ru \times L \times 24(h) \times 365(days) \times LF \times DLF$$

MA: Maximum ampere, Ru: Ohm/km, L: Feeder length(km), LF: Loss factor=$aF+(1-a)F^2$ =0.553 at a=0.3 F(load factor)=0.7, DLF(Dispersal loss factor): 0.33 at flat load on feeder

$$El\ (kWh/year) = 3 \times LA \times Ru \times L \times 24(h) \times 365(days) \times LF \times DLF$$

LA: Leveled ampere, others are same as above.

The result is shown in Annex 4.4.

4.3.3 Design

(1) Communication Method

The communication methods between pole top RTUs and DCC (Distribution control center) are shown in Table 4.6. Every method has merits and demerits, respectively. In this survey, Radio and Fiber Optic Cable methods seem to be available from the view point of cost as studied in the following section and because a lot of fiber optic cables have been laid in Hyderabad. The Power Line Carrier (PLC) method is not available here because the distribution network is directly earthed and PLC cannot be used.

Table 4.6 Comparison of communication methods

Method	Merit	Demerit
Radio Communication	- No selection for cable route and it's number. - Freedom for places, where RTUs are installed. - Easy for increase of facility.	- Depending on transmission path. - Low reliability of transmission.
Control Cable	- Proper for the case where the number (par km) of switches is large. - Easy construction of cable.	- Not proper for the case where the distance between switches is large because of expensive cost - Need an amplifier, in some case.
Power Line Carrier (V0 Signal)	- Can be adopted everywhere the distribution lines exist.	- Low reliability of transmission. - Some influence because of using distribution line. - Unusable for direct earth network.
Fiber Optic Cable	- High speed and large capacity for signal transmission. -Few number of cables because of large capacity par one cable.	- Need the special technique for cable connecting etc. - Impossible to make a small radial curve. - Low efficiency for small scale transmission signals.

(2) Faulty Zone Sectionalization

Figure 4.8 shows a mechanism for detecting a faulty zone. This function is expected to be equipped first while introducing distribution SCADA.

- Step 1 : CB opens because of a fault on the section 2.
- Step 2 : CB closes and charges the section 1.
- Step 3 : The first SW tries to close.
- Step 4 : CB opens again because the fault remains in the section2. The first SW is locked not to close next.
- Step 5 : CB closes again and the first section is charged. The first SW, however, is not able to close because of lock mode.
- Step 6 : The SW tied to a neighboring feeder closes to charge a no-fault section.

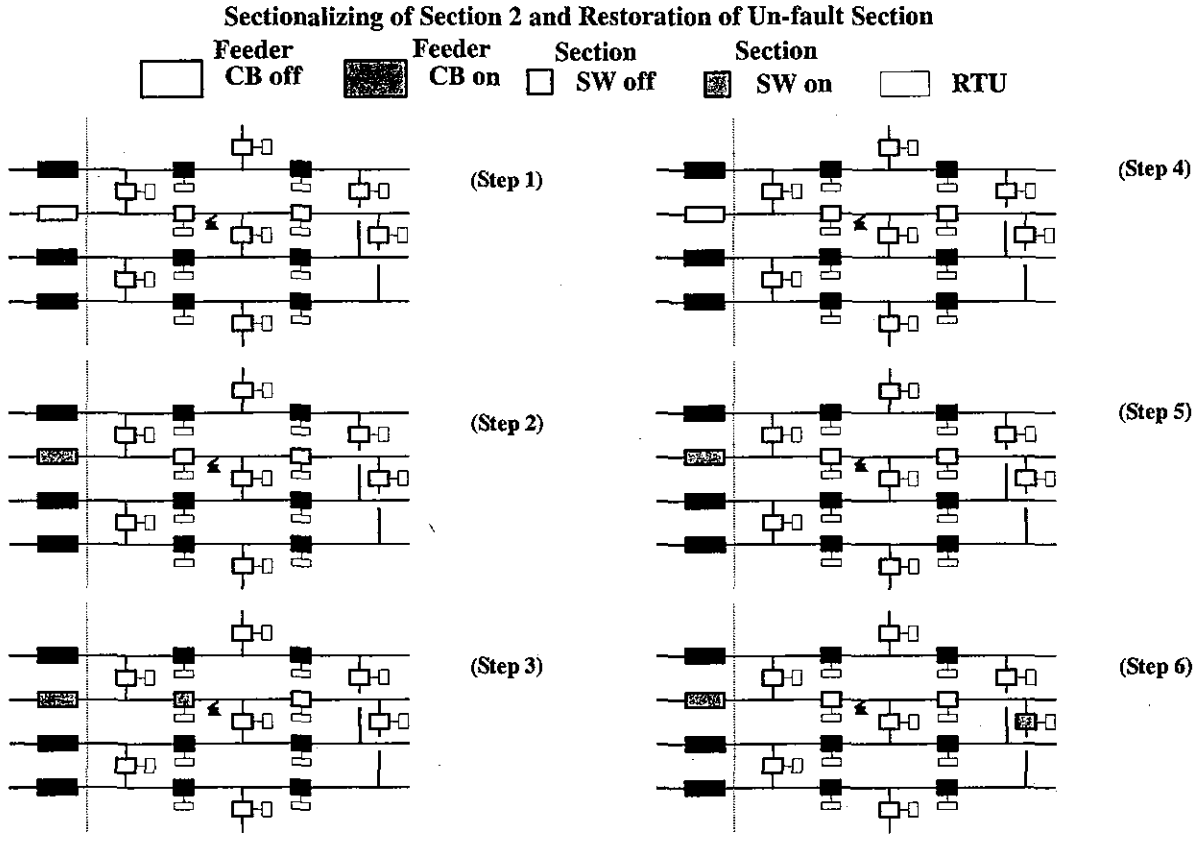


Figure 4.8 Faulty zone sectionalization method

(3) Load Balancing by Back Up from a Neighboring Feeder

Figure 4.9 shows an example of network connection for load balancing. Every section on a feeder can be also supplied with electric power from another feeder. Tie-line switches are usually open and they will be closed depending on feeder load conditions, namely, if a back up supply is available.

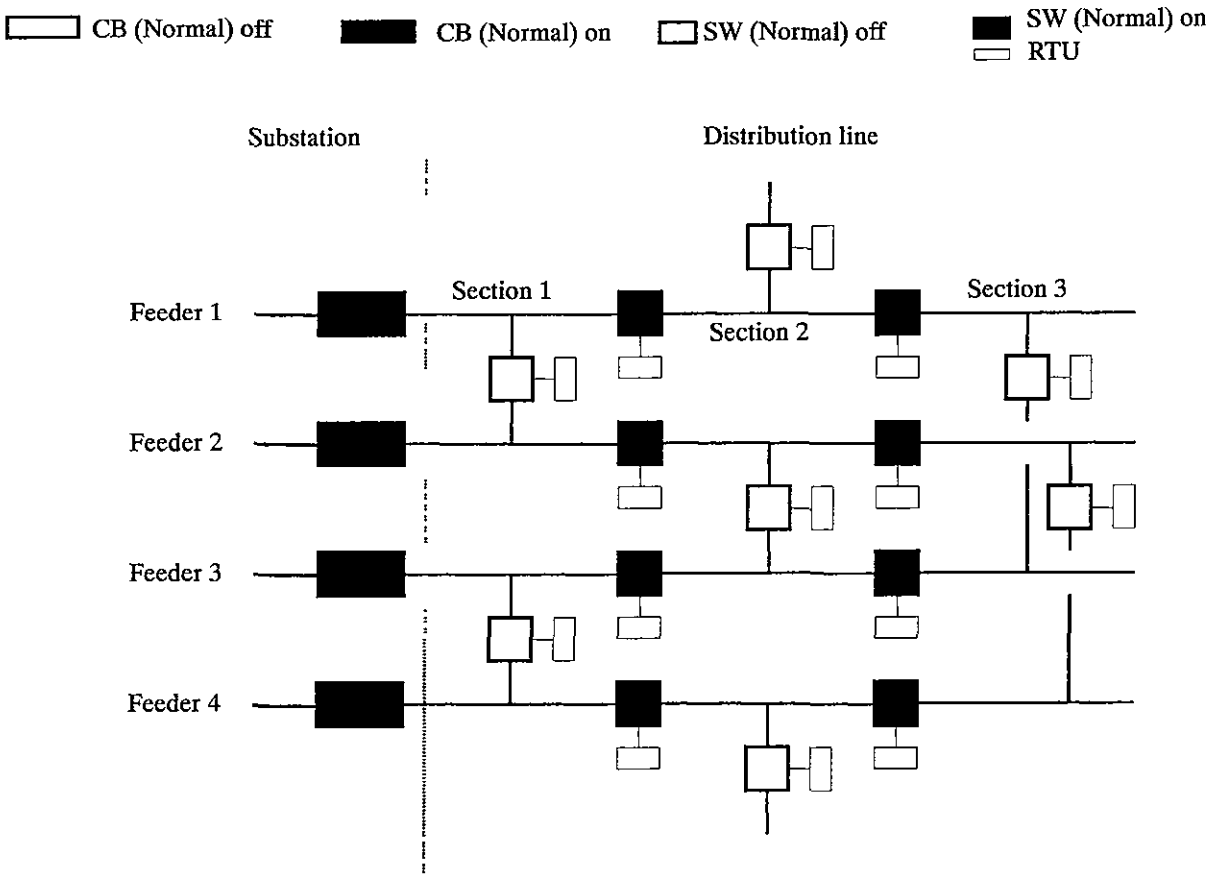


Figure 4.9 Example of distribution connection for load balancing

4.3.4 Cost Estimate

The NPV (Net Present Value) method is adopted in this cost estimation. This method is considered practical or theoretical when a social discount is difficult to decide.

(1) Costs of Components

At first, the costs of components used in distribution SCADA system were surveyed in India and Japan. The results are shown in Table 4.7. Based on this table, every component cost is decided for economical estimate of system introduction.

(2) Benefits of System Introduction

As for benefits of the distribution SCADA, three advantages are considered in this estimate as follows.

(a) Reduced outage period and recovery of supply energy and tariff income

The amount of outage energy is described in "4.3.2 (3) (a)". But the amount of energy recovered depends on the number of sections on a feeder that are made by automatic switches. For example, if a feeder is separated into two sections by one automatic switch, the amount of power (kW) during outage period decreases by half and the outage period also decreases by half because the inspection zone is reduced by half. As a result, the outage energy (kWh) is reduced by quarter. This means that the energy is recovered by 3/4 by means of faulty zone sectionalization.

- ✓ Section Nos. = 2 : Recovered energy 3/4 (1-1/4) (mentioned above)
- ✓ Section Nos. = 3 : Recovered energy 8/9 (1-1/9)
- ✓ Section Nos. = 4 : Recovered energy 15/16 (1-1/16)

(b) Loss energy recovery by load balancing of distribution feeders

The amount of loss recovery energy is described in "4.3.2 (3) (a)". The procedure for load balancing seems to be difficult but the calculated amount is applied to the estimate.

(c) Reduced personnel expense

Distribution SCADA enables reduction of the service crew because the fault section can be isolated by remote- control facilities installed at a distribution control center. The crew can be reduced by about one person in every substation.

(3) Conditions for Estimate

Conditions for approximate estimate are shown in Table 4.8 considering above (1) and (2). This table includes other values than cost and benefit such as social discount rate and price index increasing rate etc.

Table 4.7 Costs of components

Exchange Rate

US$	Rs	Yen	Yen/Rs
1	46.5	120	2.58

■ Pole mounted device — Bold font: original value

Item		unit	Rs		Yen		Remark
			Materials	Construction	Materials	Construction	
(Example in Japan)							
Controle cable method (metallic,optic fiber)	Automatic SW	device	142,360	26,956	**367,380**	**69,564**	
	Power supply transformer		41,543	8,982	**107,208**	**23,180**	
	Pole mounted RTU		209,360	36,659	**540,284**	**94,604**	
	Sub total	set	393,263	72,597	**1,014,872**	**187,348**	
Distribution PLC method	Automatic SW	device	142,360	26,956	**367,380**	**69,564**	
	Power supply transformer		144,658	12,717	**373,312**	**32,819**	
	Pole mounted RTU		193,860	30,661	**500,284**	**79,124**	
	Sub total	set	480,878	70,334	**1,240,976**	**181,507**	
Current sensor		device	24,800	11,548	**64,000**	**29,800**	
(Example in India)							
Radio Frequency method	Automatic SW (with pole top RTUs cum tranceiver and 3 phase PTs)	set	**362,500**		935,484		1.25×below
			290,000		748,387		Value in 1996
	Pole mounted RTU cum tranceiver at DTR	device	**221,250**		570,968		1.25×below
			177,000		456,774		Value in 1996
(Old)	Remote metering HV service with Pole mounted and 11kV breaker, metering sets.	set	**412,500**		1,064,516		1.25×below
			330,000		851,613		Value in 1996
(Latest)	Remote metering HV service GSM Modem(12500Rs) SIM Card(1000),Labour(1500)	set	**13,500**	**1,500**	34,839	3,871	
(Read DTR or LV)	LV,CT TVM with box(10000) Modem(12500),SIM Card(1000) Labour inc. wire cost(1500)	set	**23,500**	**1,500**	60,645	3,871	

Data : Development of 'Distribution Automation' Project at 33/11 kV Gachibowli SS jointly with M/s CMC Limited.

■ Communication device

Item		unit	Rs		Yen		Remark
			Materials	Construction	Materials	Construction	
(Example in Japan)							
Controle cable method(metallic)	Master RTU (DCC)	device	9,687,500	116,250	**25,000,000**	**300,000**	
Distribution PLC method	Master RTU (DCC)	device	7,750,000	116,250	**20,000,000**	**300,000**	
	Repeat RTU(SS)		3,875,000	38,750	**10,000,000**	**100,000**	
	Sub total	set	11,625,000	155,000	**30,000,000**	**400,000**	
Metallic cable(20c(10p))		km	212,738	400,094	**549,000**	**1,032,500**	
Fiber optic cable(16c(16p))		km	116,250	581,250	**300,000**	**1,500,000**	
Radio communication tanceiver		device	27,125		**70,000**		
(Example in India)							
Radio Frequency method	Communication equipment(SS) (MARS Master,radio Tower,Anntennas, Cables Communication I/F and Testing equipment)	set	**5,775,000**		14,903,226		1.25×below
			4,620,000		11,922,581		Value in 1996
	Substation RTU with tranceiver, transducer/TVM, Tele signal and tele comand, charger etc.	device	**955,000**		2,464,516		1.25×below
			764,000		1,971,613		Value in 1996

Data : Development of 'Distribution Automation' Project at 33/11 kV Gachibowli SS jointly with M/s CMC Limited.

Radio Frequency method	MAR System (Master or Repeater Station)		**300,390**		775,200		1.2×below
			250,325		646,000		Value in 1998
	MAR System (Remote Station at 33/11kV SS)		**61,572**		158,895		1.2×below
			51,310		132,413		Value in 1998
	RTU(96staus inputs, 72 Analog inputs, 48 control outputs for 33/11kV SS)		**490,987**		1,267,064		1.2×below
			409,156		1,055,886		Value in 1998
	RTU(96staus inputs, 72 Analog inputs, 48 control outputs for 33/11kV SS)		**855,360**		2,207,381		1.2×below
			712,800		1,839,484		Value in 1998

Data : Contract Agreement of SCADA System (April 1998)

Fiber optic cable(12 to 20 c)		km	**25,000**		64,516		minimum
			50,000		129,032		maxmum

(Remarks) Fiber optic cable has already been laid by M/S Reliance in Hyderabad city (65,000km in India) and can be leased for commun

■ DAS(Distribution Automation System) Master System

(Example in India)

Radio Frequency method	Remote Communication Server (Reddundant RCS 300)	set	**2,859,912**		7,380,418		1.2×below
			2,383,260		6,150,348		Value in 1998

Data : Contract Agreement of SCADA System (April 1998)

Table 4.8 Conditions for estimate

Item				Value	Remark
Social Discount				0.05	
Price Index Increasing				0.01	
Exchange Rate		Yen/US$		120	
		Rupee/US$		46.5	
		Yen/Rupee		2.58	
Facilities					
Feeder Number	Nos/SS (RR and Hyderabad)			6.00	
Feeder Length	km/Feeder(RR and Hyderabad)			6.50	
Construction Cost(Rs)					
Pole Mounted Device (per unit)	SW,RTU etc.	Materials(India)	362,500	435,097	
		Construction(Japan)	72,597		
	SW,RTU etc. (for PLC)	Materials(Japan)	480,878	551,212	
		Construction(Japan)	70,334		
	Radio Communication Device (GSM Mobile)	Materials(India)	13,500	15,000	
		Construction(India)	1,500		
Communication Line (per km)	Metaric Cable	Materials(Japan)	212,738	612,832	
		Construction(Japan)	400,094		
	Fiber Optic cable	Materials(India)	50,000	631,250	
		Construction(Japan)	581,250		
RTU etc. at SS, DCC per unit)	For RF at SS (RTU)	Materials(India)	490,987	540,086	
		Construction(Japan)	49,099		
	For PLC at SS	Materials(Japan)	3,875,000	3,913,750	
		Construction(Japan)	38,750		
	MAR for RF at SS (MAR Master)	Materials(India)	300,390	330,429	
		Construction(Japan)	30,039		
	MAR for RF at SS (MAR Remote)	Materials(India)	61,572	67,729	
		Construction(Japan)	6,157		
	For Metallic Cable, Fiber at DCC	Materials(Japan)	9,687,500	9,803,750	
		Construction(Japan)	116,250		
	For PLC at DCC	Materials(India)	7,750,000	7,866,250	
		Construction(Japan)	116,250		
	RCS for RF at DCC	Materials(India)	2,859,912	2,976,162	
		Construction(Japan)	116,250		
Maintenannce(%)				3	
Benefit Estimate					
Tarrif(Rs/kWh)				5	
Outage Energy Reduction	kWh/Feeder/Y(RR and Hyderabad)			19,729	(*1)
Loss Energy Recovery	kWh/SS/Y(RR and Hyderabad)			97,096	(*1)
Woerkers' Number Reduction	Rs/SS/Y			120,000	One person

(*1): Refer to Annex 4.4

	Outage Energy (kWh/Y)	Loss Energy Recovery (kWh/Y)	Feder NO	SS NO
RR	4,772,941	6,287,610	179	35
Hyderabad	5,999,138	3,033,577	367	61
Total	10,772,079	9,321,187	546	96
Average	19,729 (kWh/Feeder/Y)	97,096 (kWh/SS/Y)		

4.3.5 Plan of Introduction

(1) Section Number and Number of Pole-mounted Automatic Switches (SWs)

At first, the relation of section number and SW number is considered as Figure 4.10. For example, in case of 2 sections per one feeder needs 1 SW for separation and 0.5+0.5 SW for 2 sections to be connected with neighboring feeders. Here, 0.5 SW means that 1 SW is connected with 2 feeders. As a result, isolation of 2 sections needs 2 SWs per one feeder. The relation is concluded on the basis of Table 4.9 as follows. The relation between section number and recovery energy is also shown in Figure 4.11 and Table 4.9.

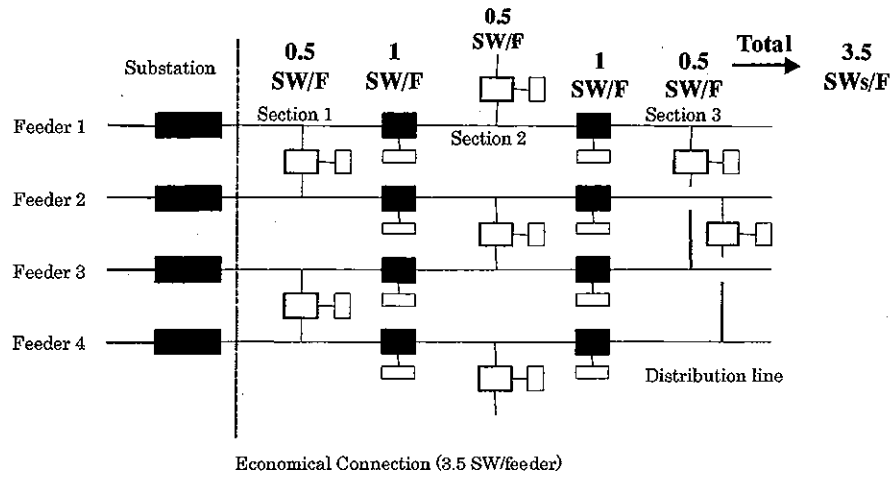
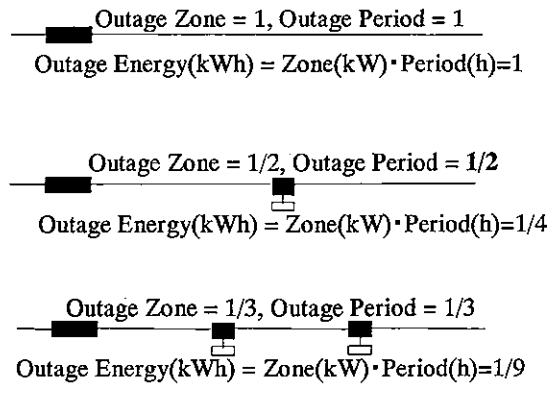


Figure 4.10 Section number and SW number



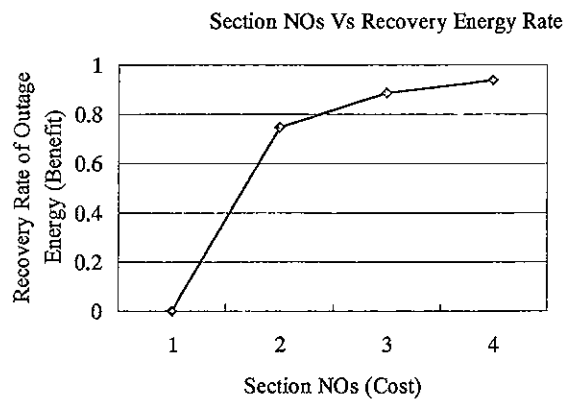


Figure 4.11 Section number and energy recovery rate

Table 4.9 Relation between section number ,and SW number and energy recovery rate

Section Number/feeder	SW Number/Feeder	Energy Recovery Rate
2	2	3/4
3	3.5	8/9
4	5	15/16

(2) Number of SWs and Economical Estimate

Based on Tables 4.8 and 4.9, cost and benefit were estimated by changing the number of SWs. Table 4.11 shows the result of a case of 2 to 5 per feeder SWs.

The estimate conditions are as follows:

- Cost only includes pole-mounted automated switches and its attached devices.
- Substation Nos and Feeder Nos are 96 and 546, respectively.
- Construction period is 5 years.

From this result shown in Table 4.10, feeders of 2 or 3 sections seem to be available with Fiber Optic Cable or RF method of communication.

Table 4.10 Number of section switch and economical estimate

(Million Rs)

Number of sections	No. of switches /feeder	Equipment Cost	NPV (20 Year)	Recovery Period
2	2	511	528	8 years
3	3.5	894	137	16 years
4	5	1,277	▲313	Over 20 years

(3) Policy for Introducing Distribution SCADA

(a) Section number

2 or 3 (Number of switches is 2 or 3.5 per feeder) .

(b) Communication method

Fiber Optic Cable or RF depending on the site condition.

(c) Priority for introduction

Economical aspects are considerably different from substation to substation. Hence priority should be given to introducing the system to substations.

Table 4.11 Example of estimate

Section SW No.: 2/Feeder

Cash Flow Analysis (Money unit:10^6 Rs)

Relative Year					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Total Equip.
Calender Year(n)					2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
Discount=1/(1+i)^n		rate i= 0.05			1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614	0.585	0.557	0.530	0.505	0.481	0.458	0.436	0.416	0.396	0.377		
Price=(1+i)^n		rate r= 0.01			1.000	1.010	1.020	1.030	1.041	1.051	1.062	1.072	1.083	1.094	1.105	1.116	1.127	1.138	1.149	1.161	1.173	1.184	1.196	1.208	1.220		
Amount of Construction Facilities																											
Substation Number					20	20	20	20	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	
Feeder Number		6	(Nos/SS)		120	120	120	120	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	576	
Feeder Length(km)		6.5	(km/Feeder)		780	780	780	780	624	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,744	
Cost																											
Pole Mounted Device	a.SW,RTU	0.4351	(10^6 Rs/Unit)	Acquisition Cost	104.42	105.47	106.52	107.59	86.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	511	
	etc.	2	(Nos/Feeder)	Maintenance	3.13	6.30	9.49	12.72	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	292	
	Maintenance Factor	3	(%)																								
Total Cost				Current Value	107.6	111.8	116.0	120.3	102.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	803.1	511
				Present Value	107.6	106.4	105.2	103.9	84.1	12.0	11.4	10.9	10.4	9.9	9.4	9.0	8.5	8.1	7.7	7.4	7.0	6.7	6.4	6.1	5.8	292.2	
Benefit																											
Outage	19,729	(kWh/Feeder/Y)		Current Value	8.9	17.8	26.6	35.5	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6	813	
Loss	97,096	(kWh/SS/Y)		Current Value	9.7	19.4	29.1	38.8	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	889	
Worker	0.12	(10^6 Rs/SS/Y)		Current Value	2.4	4.8	7.2	9.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	220	
Tariff Rate	5	(Rs/kWh)																									
Outage Reduction Rate	0.75																										
Total Benefit			Current Value		21.0	42.0	63.0	84.0	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	100.7	1,922	
			Present Value		21.0	40.0	57.1	72.5	82.9	78.9	75.2	71.6	68.2	64.9	61.8	58.9	56.1	53.4	50.9	48.5	46.2	44.0	41.9	39.9	38.0	1,172	
Return																											
Benefit - Total Cost				Current Value	-86.6	-69.8	-53.1	-36.4	-1.5	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	85.4	1,119	
				Present Value	-86.6	-66.5	-48.1	-31.4	-1.2	66.9	63.7	60.7	57.8	55.1	52.4	49.9	47.6	45.3	43.1	41.1	39.1	37.3	35.5	33.8	32.2	528	
Return Accumulation																											
Benefit - Total Cost				Current Value	-86.6	-156.4	-209.4	-245.8	-247.3	-161.9	-76.5	9.0	94.4	179.8	265.2	350.6	436.0	521.4	606.8	692.3	777.7	863.1	948.5	1033.9	1119.3		
				Present Value	-86.6	-153.0	-201.2	-232.6	-233.8	-166.9	-103.1	-42.4	15.4	70.4	122.9	172.8	220.4	265.7	308.8	349.9	389.0	426.3	461.8	495.6	527.8		

(Table 4.11 Continue)
Section SW No.: 3.5/Feeder

Cash Flow Analysis (Money unit:10^6 Rs)

Relative Year				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Total Equip.
Calender Year(n)				2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
Discount=1/(1+i)^n		rate i= 0.05		1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614	0.585	0.557	0.530	0.505	0.481	0.458	0.436	0.416	0.396	0.377		
Price=(1+i)^n		rate r= 0.01		1.000	1.010	1.020	1.030	1.041	1.051	1.062	1.072	1.083	1.094	1.105	1.116	1.127	1.138	1.149	1.161	1.173	1.184	1.196	1.208	1.220		
Amount of Construction Facilities																										
Substation Number				20	20	20	20	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	
Feeder Number	6	(Nos/SS)		120	120	120	120	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	576	
Feeder Length(km)	6.5	(km/Feeder)		780	780	780	780	624	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,744	
Cost																										
Pole Mounted Device	a.SW,RTU etc.	0.4351 (10^6 Rs/Unit)	Acquisition Cost	182.74	184.57	186.41	188.28	152.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	894	
		3.5 (Nos/Feeder)	Maintenance	5.48	11.02	16.61	22.26	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	26.82	511	
	Maintenance Factor	3 (%)																								
Total Cost			Current Value	188.2	195.6	203.0	210.5	179.0	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	1,405.5	894
			Present Value	188.2	186.3	184.2	181.9	147.2	21.0	20.0	19.1	18.2	17.3	16.5	15.7	14.9	14.2	13.5	12.9	12.3	11.7	11.1	10.6	10.1	511.4	
Benefit																										
Outage	19,729	(kWh/Feeder/Y)	Current Value	10.5	21.1	31.6	42.1	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	50.6	965	
Loss	97,096	(kWh/SS/Y)	Current Value	9.7	19.4	29.1	38.8	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	889	
Worker	0.12	(10^6 Rs/SS/Y)	Current Value	2.4	4.8	7.2	9.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	220	
Tariff Rate	5	(Rs/kWh)																								
Outage Reduction Rate	0.89																									
Total Benefit			Current Value	22.6	45.3	67.9	90.6	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	108.7	2,074	
			Present Value	22.6	43.1	61.6	78.2	89.4	85.2	81.1	77.2	73.6	70.1	66.7	63.6	60.5	57.6	54.9	52.3	49.8	47.4	45.2	43.0	41.0	1,264	
Return																										
Benefit - Total Cost			Current Value	-165.6	-150.3	-135.1	-120.0	-70.3	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	81.9	669	
			Present Value	-165.6	-143.1	-122.5	-103.6	-57.8	64.1	61.1	58.2	55.4	52.8	50.3	47.9	45.6	43.4	41.4	39.4	37.5	35.7	34.0	32.4	30.9	137	
Return Accumulation																										
Benefit - Total Cost			Current Value	-165.6	-315.9	-451.0	-570.9	-641.2	-559.3	-477.4	-395.6	-313.7	-231.8	-150.0	-68.1	13.8	95.7	177.5	259.4	341.3	423.1	505.0	586.9	668.8		
			Present Value	-165.6	-308.7	-431.3	-534.9	-592.7	-528.5	-467.4	-409.2	-353.8	-301.1	-250.8	-202.9	-157.3	-113.9	-72.6	-33.2	4.3	40.0	74.1	106.5	137.3		

(Table 4.11 Continue)
Section SW No.: 5/Feeder

Cash Flow Analysis (Money unit:10^6 Rs)

Relative Year					0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Total Equip.
Calender Year(n)					2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024		
Discount=1/(1+i)^n		rate i= 0.05			1.000	0.952	0.907	0.864	0.823	0.784	0.746	0.711	0.677	0.645	0.614	0.585	0.557	0.530	0.505	0.481	0.458	0.436	0.416	0.396	0.377		
Price=(1+i)^n		rate r= 0.01			1.000	1.010	1.020	1.030	1.041	1.051	1.062	1.072	1.083	1.094	1.105	1.116	1.127	1.138	1.149	1.161	1.173	1.184	1.196	1.208	1.220		
Amount of Construction Facilities																											
Substation Number					20	20	20	20	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	
Feeder Number		6 (Nos/SS)			120	120	120	120	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	576	
Feeder Length(km)		6.5 (km/Feeder)			780	780	780	780	624	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,744	
Cost																											
Pole Mounted Device	a.SW,RTU etc.	0.4351 (10^6 Rs/Unit)	Acquisition Cost		261.06	263.67	266.31	268.97	217.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,277	
		5 (Nos/Feeder)	Maintenance		7.83	15.74	23.73	31.80	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	38.32	731	
	Maintenance Factor	3 (%)																									
Total Cost			Current Value		268.9	279.4	290.0	300.8	255.6	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	38.3	2,007.9	1,277
			Present Value		268.9	266.1	263.1	259.8	210.3	30.0	28.6	27.2	25.9	24.7	23.5	22.4	21.3	20.3	19.4	18.4	17.6	16.7	15.9	15.2	14.4	730.5	
Benefit																											
Outage	19,729	(kWh/Feeder/Y)	Current Value		11.1	22.3	33.4	44.5	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	1,019	
Loss	97,096	(kWh/SS/Y)	Current Value		9.7	19.4	29.1	38.8	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	46.6	889	
Worker	0.12	(10^6 Rs/SS/Y)	Current Value		2.4	4.8	7.2	9.6	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	220	
Tariff Rate	5	(Rs/kWh)																									
Outage Reduction Rate	0.94																										
Total Benefit			Current Value		23.2	46.5	69.7	92.9	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	111.5	2,128	
			Present Vallue		23.2	44.3	63.2	80.3	91.8	87.4	83.2	79.3	75.5	71.9	68.5	65.2	62.1	59.2	56.3	53.7	51.1	48.7	46.3	44.1	42.0	1,297	
Return																											
Benefit - Total Cost			Current Value		-245.7	-232.9	-220.3	-207.8	-144.1	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	121	
			Present Vallue		-245.7	-221.8	-199.8	-179.5	-118.6	57.4	54.6	52.0	49.6	47.2	44.9	42.8	40.8	38.8	37.0	35.2	33.5	31.9	30.4	29.0	27.6	-313	
Return Accumulation																											
Benefit - Total Cost			Current Value		-245.7	-478.6	-698.9	-906.7	-1050.8	-977.6	-904.4	-831.2	-758.0	-684.8	-611.5	-538.3	-465.1	-391.9	-318.7	-245.5	-172.2	-99.0	-25.8	47.4	120.6		
			Present Value		-245.7	-467.5	-667.3	-846.9	-965.4	-908.1	-853.4	-801.4	-751.8	-704.6	-659.7	-616.9	-576.1	-537.3	-500.3	-465.1	-431.5	-399.6	-369.2	-340.2	-312.6		

4.4 Recommendation on Distribution SCADA System

In this section, the more concrete ideas for distribution SCADA are studied. The previous section treated average data of substations and feeders in Ranga Reddy district and Hyderabad. This section treats more specific data of individual substations.

4.4.1 Functions of Existing SCADA and of Distribution SCADA

The existing SCADA mainly monitors and controls the facilities inside the distribution substations. But the existing SCADA software includes the distribution SCADA functions such as DMS (Distribution Management System). This indicates an intention to introduce the concrete hardware for distribution SCADA in the future.

In addition to these software functions, the communication facility of RF also has some marginal capacity to add distribution SCADA function, and fiber optic cables have been already laid in urban area of Hyderabad. This also means that some infrastructure is already available for introducing distribution SCADA functions.

Table 4.12 shows DMS software functions and recommendable addressing policy.

Table 4.12 DMS functions and priority

Function	Priority	Situation and Recommendable Policy for Addressing
a. Emergency load shedding (for HV customer)	6	Priority is low, so consider introduction after the primary functions.
b. Load control (for HV customer)	4	This is concerning load leveling, so also consider introduction after the primary functions.
c. Automatic meter reading (for HV customer)	3	Priority is middle and if distribution SCADA is introduced, this function is easy to introduce. Hence consider introduction in the middle future.
d. Fault location	1	Priority is the highest and this is the most basic function, so consider introduction from the start.
e. Load balancing	2	Priority is the second highest and this is an important function, so consider introduction from the start.
f. Automated mapping and facilities management (AM/FM)	7	Priority is low but GIS is prevailing and is studied in this project, so better consider connecting GIS with distribution SCADA system.
g. Trouble call management system	5	This function is already installed independent of the existing SCADA as the following Call Center, so better consider interconnecting them with each other.

(1) Call Center at SCADA Center

- Telephone no: 1912, 24 independent lines connected to this Call Center
- 16 only incoming, 4 only outgoing
- Headed by ADE+AE + system engineers, Operators are outsourced, 24 hours basis.
- LAN network, Data is available for 1,040,624 (Hyderabad), to be added for Ranga Reddy circle 797,732.
- Data: Address, Telephone No, Customer ID, Name of the feeding substation, feeder, fuse off call office, electric and revenue office
- The customer can call 1912 for registering a complaint. A call can be registered, either by customer No or telephone No or by house No.

- Software : ORACLE data base
- This Center is proposed to be linked to SCADA DCC. Upon any feeder trip, the save will appear on every screen in Call Center

(2) Load Monitoring System at SCADA Center

- Districts
  6 Districts of Ranga Redy, Medak, Nalgonda, Mahaboob Nagar, Kurnool, Anatzapur.
- Numbers of substations and feeders
  363 substations and 667 feeders (urban;800, rural;1,700) among 827 substations and 2,500 feeders.
- Monitoring items
  V, I, P, kVA, PF at feeder outlet and 2nd side of 4 DTRs for sample.
- Communication method
  Public telephone network, and GSM mobile network recently.
- Point
  Monitoring for change 3F supply (9 hours) and 1F supply (15 hours) on agricultural feeder.
- Operator
  2 shifts (6 persons per 1 shift).
- Meter specification
  Meter protocol: SEM by SECURE,
  36 days data available
  Optional port: use for remote metering
  SECURE meter;RS-232C in Hyderabad SCADA project
- Finance
  World Bank: APL-1 (Adaptable Program of Lending 1)
  Meter Number: 1000 (for 4 DISCOMs)
  Material and erection: M/S SECURE
  Loan amount: US$ 1 billion (Rs 4,000 crore)

4.4.2 System Design

(1) Communication System

Figure 4.12, Figure 4.13 and Figure 4.14 show the ideas of communication system configuration.

- Idea 1 (Figure 4.12): DCC directly communicates with the field device (pole top SW, RTU).
- Idea 2 (Figure 4.13): DCC communicates through TDMA Repeater Station and /or TDMA Out Station.
- Idea 3 (Figure 4.14): DCC communicates through TDMA Repeater Station, TDMA Out Station and MARS Remote Station.

Table 4.13 shows the devices to be considered for every idea.

RF MARS has a security problem and is not able to be used for non line of sight communication.

Fiber optic cables are already laid to total length of 200 km in Hyderabad and its surrounding area.

As for cost, the following section treats. If that result is also considered here, the

following methods are expected to be promising ones.

- Fiber Optic Cable (Case 1)
- RF Mobile System

(2) Equipped System Specification

As for the field equipment and the software functions, the following items are recommended.

- Isolated section number on a feeder should be 2 or 3.
- The software functions to be introduced in the first stage should be for, at least, Fault location and Load balancing.

Table 4.13 Communication methods and system configuration

Method		Pole-top Device	Installation of Com. Line	RTU etc. at SS, DCC
Idea1				
Fiber Optic Cable	Case 1 (Much infrastructure of fiber optic cable)	- Automated switch with RTU	- 1% of feeder length	- 10% improvement of RCS(Remote communication System) at DCC
	Case 2 (A little infrastructure)		- 10% of feeder length	
	Case 3 (Little infrastructure)		- 50% of feeder length	
Metallic Wire		- Same as above	- 100% of feeder length	
RF Mobile System		- Automated switch with RTU and RF communication device	(Not need)	- 50% of improvement of RCS at DCC
Idea2				
RF MARS		- Automated switch with RTU and RF communication device	(Not need)	- 50% of new MARS Master at SS and improvement of RCS at DCC
Idea3				
PLC (Vo Carrier)		- Automated switch with RTU	(Not need)	- New RTU at SS and DCC

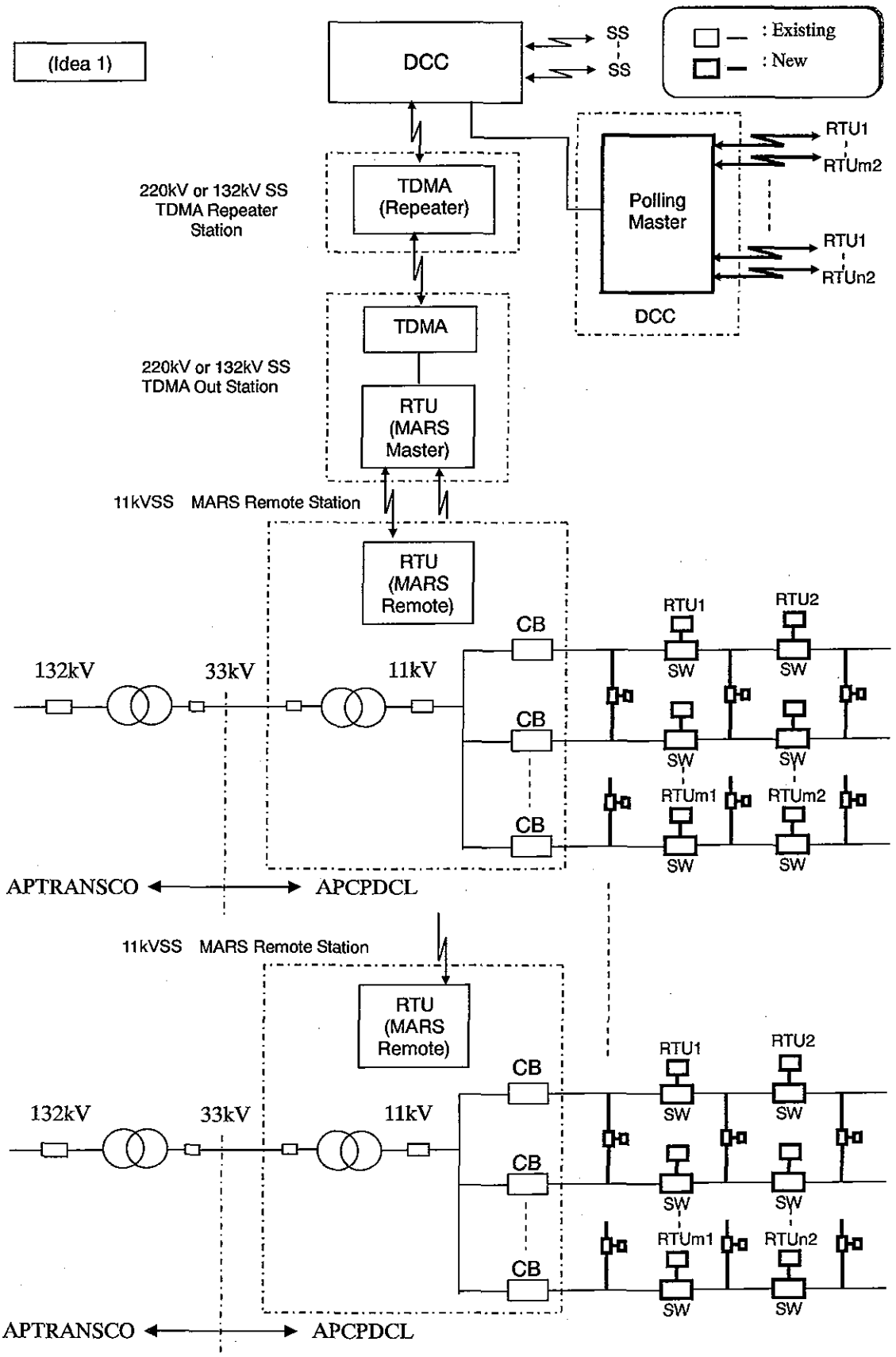


Figure 4.12 Communication configuration (Idea 1)

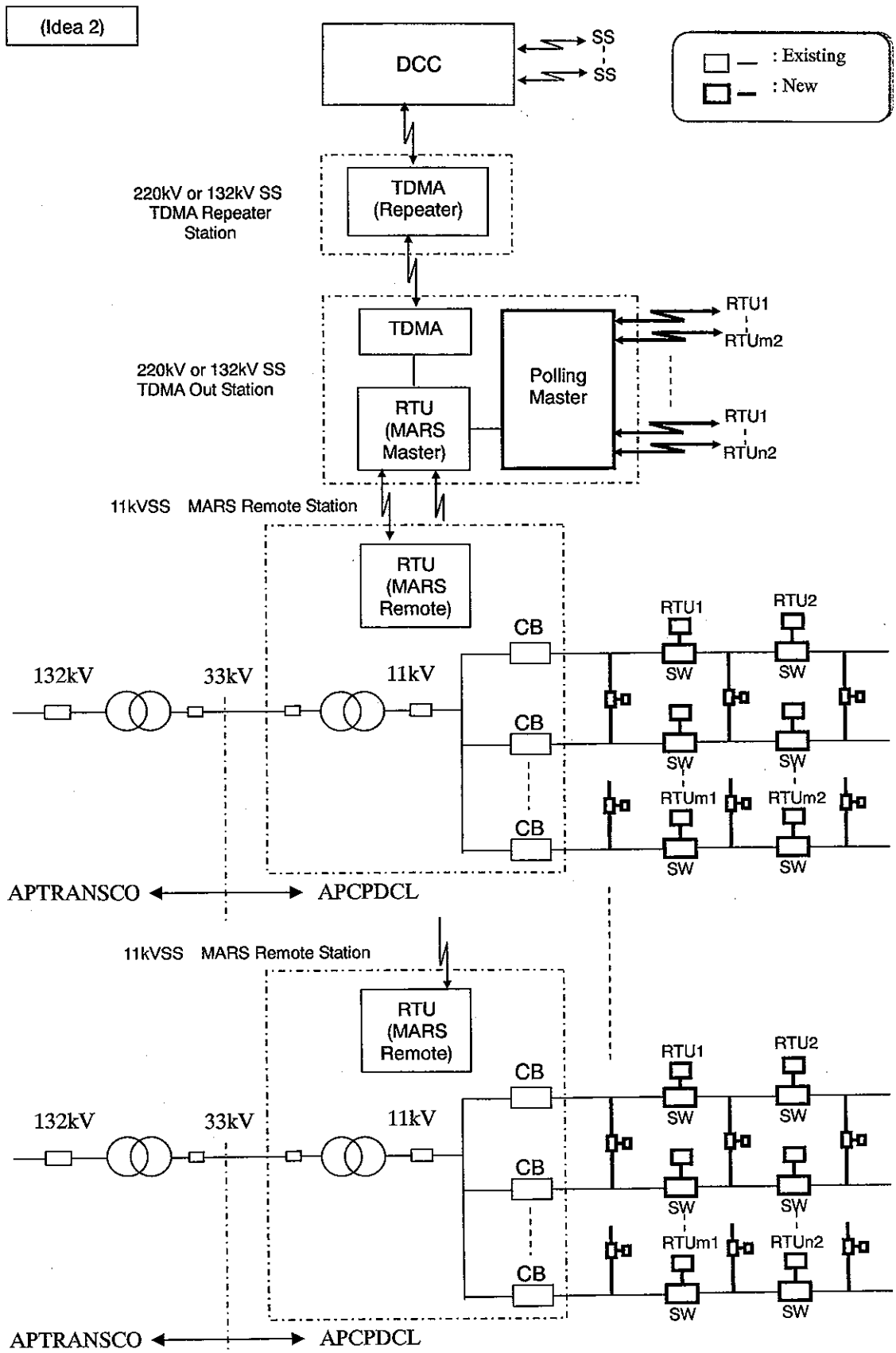


Figure 4.13 Communication configuration (Idea 2)

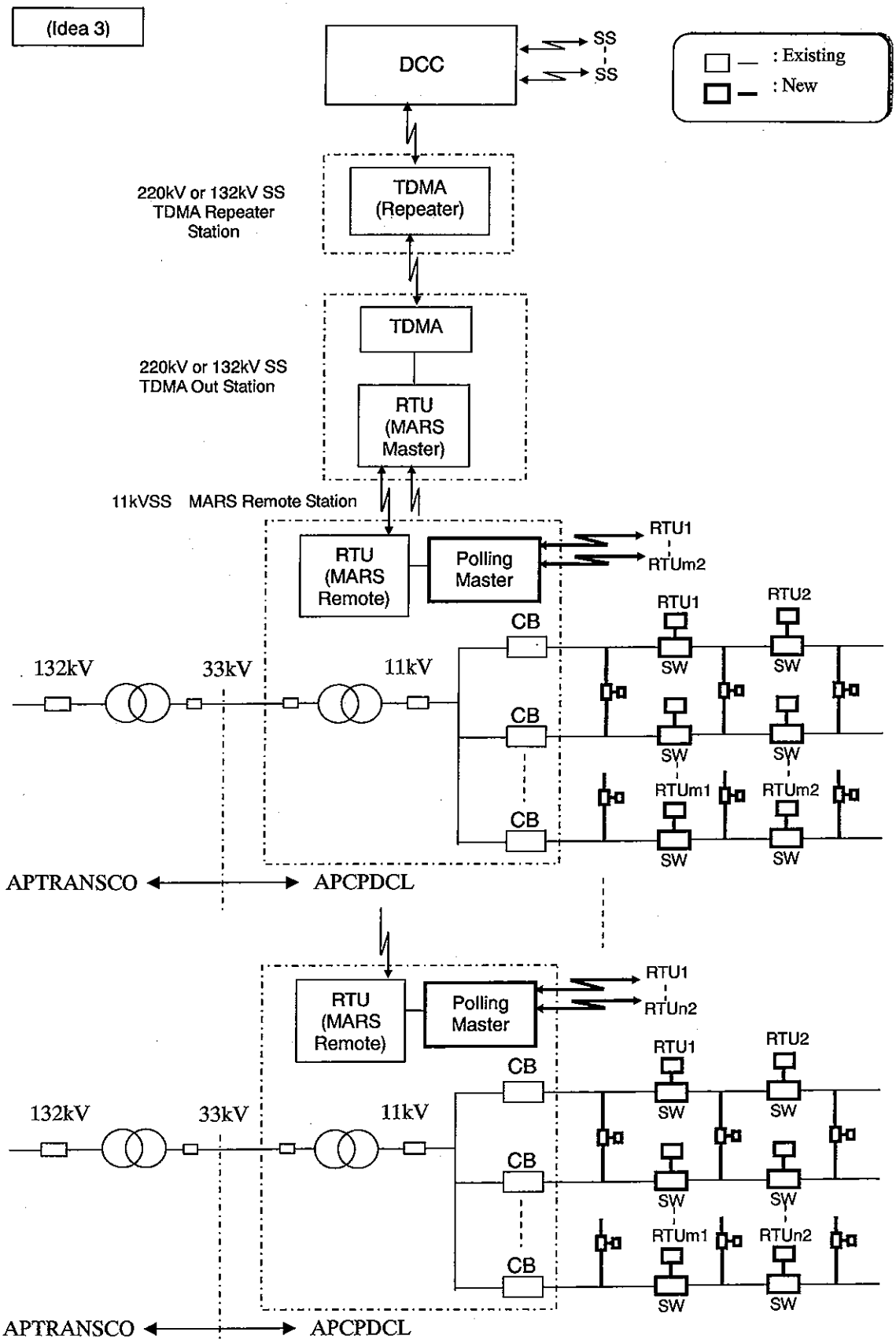


Figure 4.14 Communication configuration (Idea 3)