SYSTEM MANAGEMENT OF CONCENTRATED ELECTRIC LOAD

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ABSTRACT

The paper presents the management of a concentrated electric load which may occur for few days. Diwali is such a festival in India during which the electrical load is increased tremendously. In this paper an actual case of electric network of Jaipur City has been considered and various methods, steps have been suggested to manage such critical load. In order to have distribution automation system for critical load management Supervisory Control and Data Acquisition (SCADA) system is found to be most appropriate which allow the operator to make quick operated decision.

INTRODUCTION

The power needs of various Industrial, Commercial and domestic consumers are met by an extensive 132 KV/33 KV transmission/ distribution network. This network is fed from various power generating stations within the State and from outside state. Beside managing the load of various category consumers catered all over the state, it becomes very critical to manage a very high quantum of load concentrated at small part of the city for few days during any festival or occasion. "Diwali" is such an important function in India which is celebrated all over the country. It falls in October on the last night of lunar month. On this day everybody illuminates his house with rows of lights. Markets and streets are decorated jointly. Every town or village appears gorgeous on this night of mirth and festivity. Lights of all description from the ordinary clay lamp to the costlier chandelier are artistically displayed with splendid effect. High power consuming Halogen lamps are also commonly used. Thus the electrical load in these area increases tremendously which can not be estimated earlier, and it is a challenging job for engineers of electrical utility company to manage this high peak concentrated load during such festivals. During this period uninterrupted electric supply with full capacity is to be managed. Any interruption in electric supply may lead to worst law and order situation. To carry out study for load management of such critical situation, an actual case of Rajasthan State Electricity Board (RSEB) in respect of Jaipur city has been taken into consideration in this paper. During Diwali festival the concentration of the load found increased from 145 MVA to 274 MVA(1998) . An individual distribution transformer loading also found increased tremendously which have been handled by putting additional transformer/ augmentation of transformer and by redistribution of loads. A computerized analysis of last five years load data for Diwali festivals has been carried out and suggested various practical solution for management of such critical load.

EXISTING JAIPUR CITY NETWORK

Jaipur City network with a peak demand of 372 MW(1998) is fed by Heerapura 220/132 KV Grid Sub station which receives supply from Heerapura 400/220 KV sub station and also from Kota Thermal Power Station of RSEB through a double circuit 220 KV line. Heerapura 220/132 KV sub station feeds 8 various 132 KV sub stations surrounding Jaipur City, namely, Chambal, NPH, VKIA, Kunda ki Dhani, Mansarover, Jawahar Nagar, Puranaghat and Sanganer, having total installed capacity of 510 MVA, operating as a closed ring system and feeding power to Jaipur City along with agriculture load of surrounding area. The sub-transmission voltage in the city is 33 KV and the primary distribution voltage is 11 KV. There is a strong 33 KV network existing in the city area, comprising of various 33/11 KV Sub stations. The 33 KV network is normally operate as a open ring system. The 11 KV network is normally operated radially. The primary distribution network is also fed by 132/11 KV transformers. Fig.1 shows the power map of Jaipur city network.

SYSTEM STUDY

Table-1 shows peak load for last five years of various 132 KV GSS, feeding power to Jaipur city during summer, Diwali festivals and winter seasons, which depicts that overall load demand arises during summer season i.e. in June month, which is mainly on account of air conditioning and cooling load of urban area clubbed with the Industrial demand as during summer the temperature of Jaipur city rises upto 45 ø C. During winter season i.e in the month of December, when the temperature of the city falls upto 4 ø C, another peak arises which includes mainly agriculture load demand clubbed with non industrial demand of heating in the

urban area.. The Diwali demand which occurs in evening hours during October/ November month, faces new demand which is comprising of non Industrial demand as well as non Agriculture demand only due to illumination/ decoration load. The year wise increasing trend of connected has been shown in Table-2.

ANALYSIS OF DATA:

Based on Table 1 & Table 2 , Fig.2 is drawn which shows the graphic representation of total Industrial and non Industrial peak load demand during summer, Diwali festival and winter season along with respective connected load for last 5 years. A perusal of the graph would reveal that non industrial peak demand which generally remains around 20% of the total connected load and 40% of the peak demand during summer peak rises up to 40% of the total connected load and 70-80% of the summer peak during Diwali festival. Thus more than 100% rise in non industrial peak from summer is observed during Diwali festival. The graph also represents the industrial peak demand plotted over the Diwali peak to explain the projected peak of Diwali load. This peak not only much more than summer peak but also either equivalent to the total installed capacity of the 220/132 network or crossing the same. It provides a danger of system collapse hence needs effective measures to be taken for maintaining 100% power supply reliability through proper load management using load despatch techniques and by carrying out system maintenance.

SYSTEM MANAGEMENT

Measures taken for load management

-In order to restrict the peak demand during Diwali festival 100% cut is imposed on the industrial load during peak load hours. Strict implementation through close monitoring and vigilance checking is ensured.
-Re-orientation of feeding arrangement of 33/11KV feeders based on previous Diwali load data, as indicated in Table-3.
-Augmentation/ new installation of transformers, conductors and cables, considering summer and previous Diwali loads.
-Sectionalisation of existing feeders. Providing of proper protection system at substations etc.
-Load balancing between phases as mostly non industrial loads are of single phase in nature.

Maintenance & other measures taken for improvement in supply reliability

The preventive maintenance work for Diwali purpose starts at least 1 to 2 month ago i.e. just after the monsoon . It includes, tightening of conductors, replacement of broken/ damaged insulators, replacement of rewirable fuses by HRC fuses or MCCBs, distribution pillar boxes maintenance, tightening of consumer's service line/ section jumpers/ cable ends, providing M Seal compound to avoid loose connections as well as oxidation, replacement of the damaged cables/ cable ends, filtration of transformer oil, topping up of transformer/OCB oil etc. Considering loading pattern during previous Diwali and the current loading during peak load hours of pre Diwali days, action for the laying of new circuits, augmentation of conductors/ cables/ transformers/ fuses and for the sectionalization of the existing circuit, is taken. Trimming of tree branches, where trees are in the undesired zone of the line and causing leakage current or short circuiting between overhead conductors, is done. While carrying out the maintenance, care is taken for the minimum interruption to the water supply system, other priority/ essential services like hospital, railway, airport etc. Even shut down for a short period, is planned after coordination with the concerned authority and by making alternate arrangement for supply. Consumers are compelled to obtain temporary connections in advance and illegal connections checked by vigilance squad.

Duty Arrangements

To ensure un-interrupted and stable power supply and to have proper management of loads and change over of supply in emergency on Diwali festival, special duties of various Engineers and staff are assigned for three days period. A central control room at Chambal GSS and divisional control rooms at respective divisions are formed. Adequate vehicles having spare transformers and important materials are provided at various places to attend emergency situation. **VHF facility** is provided to the duty officers and maintenance parties along with substations and control rooms for effective communication as the vehicles are restricted in the city area due to heavy crowd during festival days. Separate parties are deployed for collecting load data of various distribution transformers and circuits for communicating to the control room along with loading of various 33/11 KV substations. This also forms database for next year's analysis.

Distribution Automation System

With a large number of distribution Sub stations feeding to Jaipur city, it becomes very critical to operate these in a coordinated manner so that Grid loading is kept within limits, load transfers are carried with minimum disruption of supply and the various consumers are supplied with regulated, reliable and good quality of power. To achieve this a central remote monitoring and control facility, "Supervisory Control and Data Acquisition (SCADA)" system has been setup to monitor and control the system operations. This system is of great use during Diwali, specially in handling

critical & alarming loading positions when immediate action is taken by auto transfer of loads to the less loaded system.

Acknowledgement

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TABLE-1 : YEARLY PEAK LOAD AND INSTALLED CAPACITY IN MVA OF VARIOUS 132 KV GSS FEEDING TO JAIPUR CITY

Name of GSS	Installed Capacity		Years	1993	1994	1995	1996	1997	1998
	132/33 kV	132/11 kV	Seasons						
Chambal	2x20/25	2x10/12.5	Summer	73	58	72	69	67	73
		1x31.5	Diwali	67	57	47	35	53	63
			Winter	62	49	54	51	71	54
NPH	2x20/25	2x10/12.5	Summer	40	42	49	51	51	66
			Diwali	19	46	48	43	51	54
			Winter	36	42	45	48	51	51
VKIA	2x20/25	2x10/12.5	Summer	54	65	67	71	73	73
			Diwali	24	20	27	31	38	37
			Winter	71	71	67	67	73	72
K.K. Dhani	2x20/5	1x6	Summer	53	44	44	57	60	65
			Diwali	13	17	17	20	21	21
			Winter	54	40	60	49	63	60
Mansarover	2x10/12.5	-	Summer	-	-	-	-	9	11
			Diwali	-	-	-	9	11	12
			Winter	-	-	-	7	8	11
J. Nagar	2x16/20 1x10/12.5	1x10/12.5	Summer	23	34	42	58	63	66
			Diwali	40	43	36	60	62	66
			Winter	40	36	53	48	50	58
Purana Ghat	1x14/20	1x10/12.5	Summer	7	14	11	14	13	20
			Diwali	8	6	11	13	29	10
			Winter	10	10	15	16	20	20
Sanganer	1x20/25	1x10/12.5	Summer	18	31	38	41	45	39
	2x10/12.5		Diwali	24	28	29	29	16	31
			Winter	37	40	43	37	49	46
Total	510		Summer	268	288	323	361	381	413
			Diwali	195	217	215	240	281	294
			Winter	310	288	337	323	385	372

TABLE-2 YEARLY CATEGORYWISE CONNECTED LOAD (MVA) OF JAIPUR CITY

YEAR	DS	NDS	AG	SL	W/W	M	TOTAL NON-IND.	INDUSTRIAL LOAD	TOTAL JAIPUR LOAD
1993	231	105	2	8	13	14	373	179	552
1994	249	116	2	10	13	14	404	192	596
1995	267	126	2	10	13	18	436	205	641
1996	377	153	32	11	16	17	606	265	871
1997	415	183	32	11	17	16	674	280	954
1998	448	207	32	11	18	21	737	298	1035

DS-Domestic, NDS – Non domestic, AG-Agriculture, SL-Street Light, W/W – Water Works, M- Mixed load

TABLE-3 :SYSTEM ARRANGEMENT TO MEET OUT DIWALI LOAD

S.No.	Name of 132 kV GSS feeding to 33 kV S/S	Installed capacity	Alternate source of supply
1.	**132 kV GSS Chambal**		
	i) 33/11 kV S/S Lalkothi	2x5 MVA	
	ii) 33/11 kV S/S Khasa Kothi	2x5 MVA	NPH-Khasa Kothi line
	iii) 33/11 kV S/S Stadium	2x5 MVA	
	iv) 33/11 kV S/S SMS Hospital	2x5 MVA	33 kV Stadium-SMS Hospital
2.	**132 kV GSS NPH**		
	i) 33 kV S/S Vaishali Nagar	2x5 MVA	33 kV Jhotwara-III from Chambal GSS
	ii) 33 kV S/S Chandpole	2x5 MVA	33 kV Chambal-Khasa Kothi Feeder
	iii) 33 kV S/S Nahri Ka Naka	2x5 MVA,1x3.15	2nd 33 kV Brahampuri feeder from NPH
	iv) 33 kV S/S Brahampuri	3x5 MVA	33 kV Bundhgate-II feeder from K.K.Dhani
	v) 33 kV S/S Old Jhotwara (Amba Badi)	2x5 MVA	33 kV VKIA Old Jhotwara line
3.	**132 kV GSS Jawahar Nagar**		
	i) 33/11 kV S/S Adarsh Nagar (Ram Mandir)	2x5 MVA	33 kV IInd Feeder
	ii) 33/11 kV S/S Ram Niwas Bagh	2x5 MVA	11 kV from SMS Hospital S/S
	iii) 33/11 kV S/S Sri-ji-ki-mori	2x5 MVA	33 kV Chandpole feeder from NPH
	iv) 33/11 kV s/S Agra Road	2x5 MVA	33 kV Bundhgate-I from K.K.Dhani
	v) 33/11 kV S/S Ramganj	2x5 MVA	33 kV J.Nagar feder from Laxman Doongri S/S (K.K.GSS)
	vi) 33/11 kV S/S MREC	2x5 MVA	33 kV MREC feeder from Chambal GSS
	vii) 33/11 kV S/S MIA	1x5 MVA	
4.	**132 kV GSS Kunda Ki Dhani**		
	i) 33/11 kV S/S Laxman Doongri	2x5 MVA	33 kV Brahampuri feeder from NPH GSS
	ii) 33/11 kV S/S Bundhgate	1x3.15 MVA	
5.	**132 kV GSS VKIA**		
	i) 33 kV S/S Vidhydhar Nagar	2x5 MVA	
	ii) 33 kV S/S New Jhotwara	2x5 MVA	
6.	**132 kV GSS Sanganer**		
	i) 33/11 kV S/S Sanganer	2x5 MVA	
	ii) 33/11 kV S/S Mansarovar	2x5 MVA,1x3.15	33 kV second feeder from Sanganer.

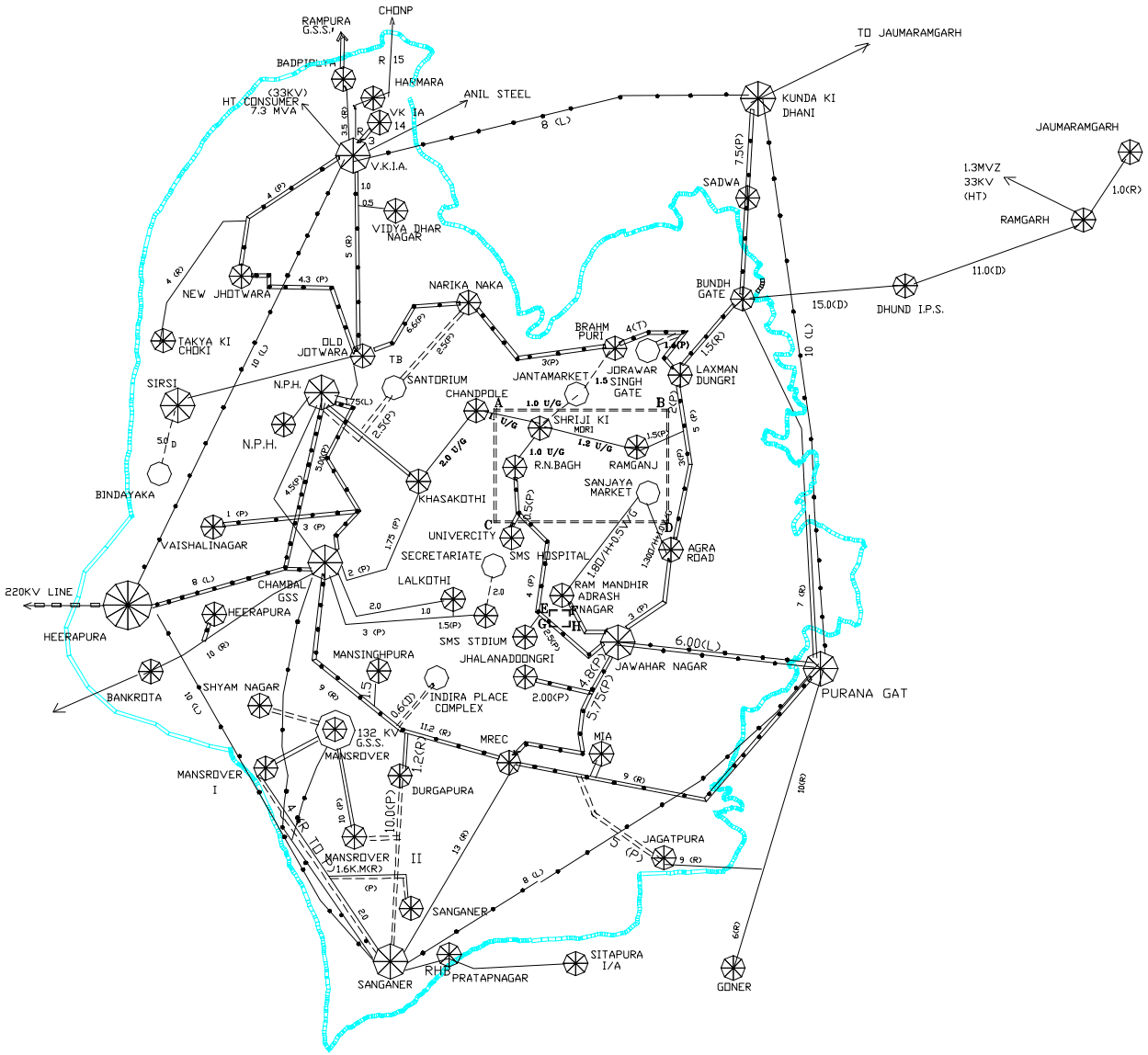

FIG.1 JAIPUR CITY NETWORK

(FN. JPRCITY)

S.NO.	NAME OF S/S	VOLTAGE RATIO	T.R. CAPACITY IN MVA	PROP.T.R.F. CAP. IN MVA
1	HEERAPURA	220/132KV	3X100.0	
2	CHAMBAL	132/33 132/11	2X2.0 1x31.5+2x12.5	1X20/25 Addl
3	JAWAHAR NAGAR	132/33KV 132/11KV	2X16/20.0 1x10/12.5	1X20/25Addl.
4	KUNDA KI DANI	132/33KV	1X20.0	1X20/25Addl.
5	N. P. H.	132/11KV 132/33KV	1X6.0 1X14/20.0	1X20/25Addl
6	PURANA GHAT	132/11KV 132/33KV 132/11KV	1X10/12.5 1X12.5 1X6.0	
7	SANGANER	132/33KV 132/11KV	2X12.5 1X12.5	1X12.5Addl.
8	V. K. I. A.	132/33KV 132/11KV	2X20/25.0 2X6.0	2X12.5-2X6.0
9	J. RAMGARH	132/33KV	1X12.5	

S.NO.	NAME OF S/S	VOLTAGE RATIO	T.R. CAPACITY IN MVA	PROP.T.R.F. CAP. IN MVA
1	AGRA ROAD	33/11KV	2.50	
2	BRAHMPURI	33/11KV	2X5.0+1X3.15	
3	BUDH GATE	33/11KV	1X3.15+2X1.0	
4	BADPIPILYA	33/11KV	1X1.5+1X3.15	
5	BHANKROTA	33/11KV	1X5.0+1X2.5	1X5.0-1X2.5
6	MANSINGHPURA	33/11KV	1X5.0	
7	CHANDPOL	33/11KV	2X5.0	
8	DHUND I.P.S.	33/11KV	1X1.6	1X1.6 Addl.
9	DURGAPURA	33/11KV	2x5.0	
10	HARMARA	33/11KV	3.15	1x2.5 Addl.
11	JAGATPURA	33/11KV	2x1.6	
12	JHALANADUNGRI I.A.	33/11KV	1x5.0	1X5.0 Addl.
13	KHASAKOTHI	33/11KV	2x5.0	
14	LALKOTHI	33/11KV	2x5.0	
15	LAXMANDUNGRI	33/11KV	2x5.0	
16	MANSEROVAR	33/11KV	1x5.0+1x1.6	1x5-1x1.6
17	M.R.E.C.	33/11KV	2x5.0	
18	NAHARIKANAKA	33/11KV	2x5.0	
19	NEW JOTWARA	33/11KV	2x5.0	2x8.0-2x5
20	N.P.H.	33/11KV	1x5.0	
21	OLD JOTWARA	33/11KV	2x5.0	
22	RAMGANJ	33/11KV	2x5.0	
23	RAMGARH	33/11KV	2x1.0	1x1.6 Addl.
24	RAM MANDIR(ADRASH NG)	33/11KV	2x5.0	
25	SANGANER	33/11KV	2x5.0	
26	S.M.S.STADUM	33/11KV	2x5.0	
27	S.M.S.HOSPITAL	33/11KV	2x5.0	
28	SHRI JI KI MDRI	33/11KV	2x5.0	
29	TAKIA KI CHOKI	33/11KV	1x3.15	
30	VAISHALI NAGAR	33/11KV	2x5.0	
31	VIDYA DHAR NAGAR	33/11KV	2x5.0	
32	V.K.I.A. = 14	33/11KV	2x5.0	
33	NEW JOTWARA - II	33/11KV	-	2x5.0
34	MANSOROVAR II	33/11KV	2x5.0	
35	RAMNIWASBAG	33/11KV	2x5.0	
36	JORAWARSINGH GATE	33/11KV	-	1X5.0
37	UNIVERSICTY	33/11KV	1X5.0	
38	SIRSI	33/11KV	5-3.15	
39	SECRETAIRIAT	33/11KV	2X5.0	
40	HEERAPURA	33/11KV	1X5.0	
41	RIICO I.A. BINDAYAKA	33/11KV	2X5.0	
42	INDRA PALCE COMPLEX	33/11KV	2X5.0	
43	SADWA	33/11KV	1X3.15 MVA	
44	SHYAM NAGAR	33/11KV	1X5.0	
45	JANTA MARKET	33/11KV	1X5.0	
46	SANJAY MARKET	33/11KV	1X5.0	
47	M.I.A. MALYANAGAR	33/11KV	1X5.0	
48	R. H. B. PRATAPNAGAR	33/11KV	1X5.0	
49	SITAPURA I.A.	33/11KV	1X5.0	

S.NO.	PARTICULAR	EXISTING	SANCTIONED
1	220/132KV S/S		
2	132/33KV S/S		
3	33/11KV S/S		
4	220KV LINE		
5	132KV LINE		
6	33KV S/C LINE		
7	33KV D/C LINE		
8	CONCENTRATED LOAD CENTRE	A B E F C D G H	

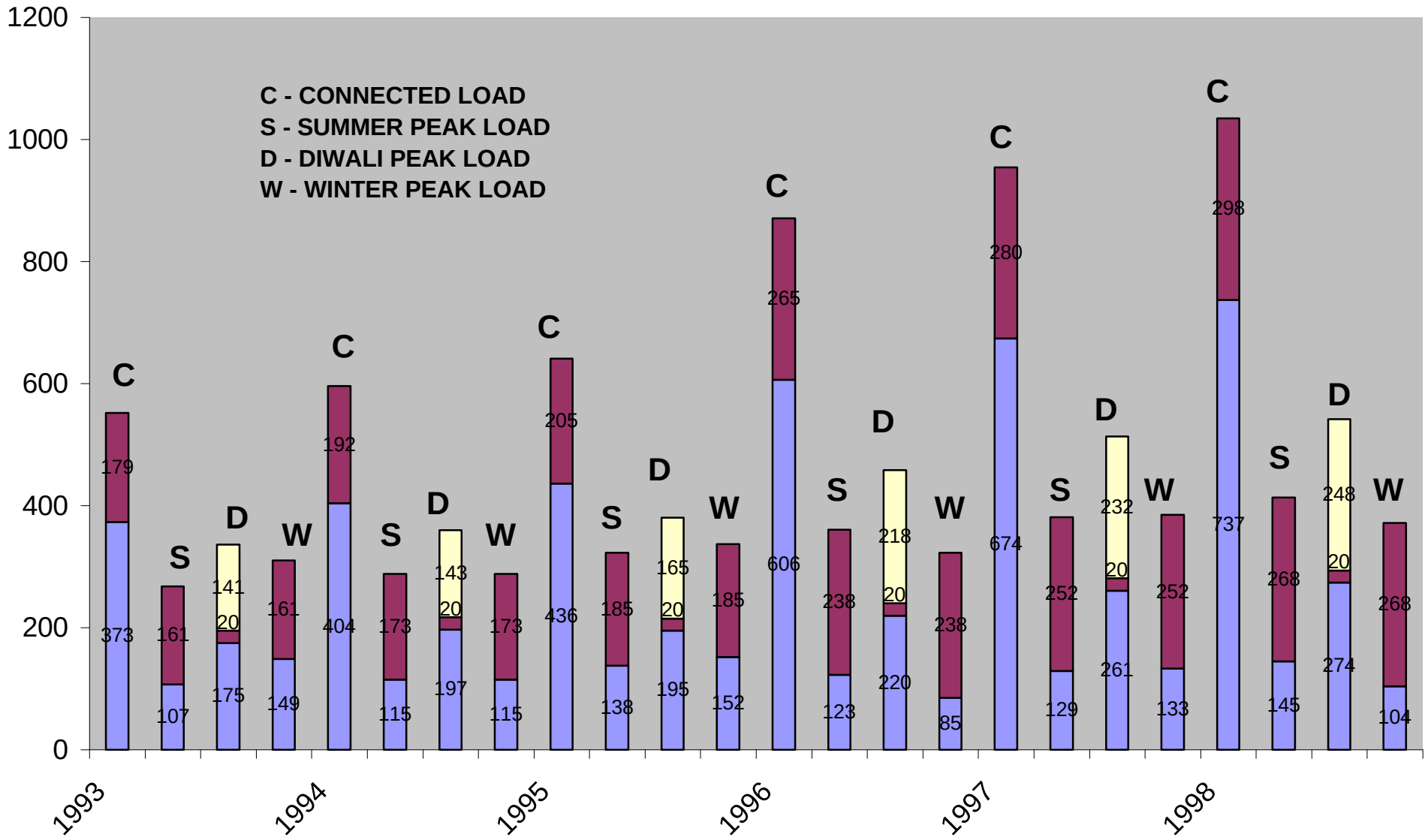

FIG.2 : GRAPHICAL REPRESENTATION OF CONNECTED LOAD, PEAK DEMAND OF SUMMER AND WINTER SEASON AND DIWALI