PAKISTAN

WATER AND POWER DEVELOPMENT AUTHORITY
POWER DISTRIBUTION WING

GUJRANWALA III DIVISION

LOAD FORECAST STUDY AND PROCEDURES MANUAL

(CADPAD LOADSITE DLF-2)

WAPDA - EBASCO

LAHORE, PAKISTAN
PREPARED : OCTOBER 1992
REVISED : MARCH 1993

EBASCO

WAPDA-USAID Power Distribution Program

INTEROFFICE CORRESPONDENCE

IOM/12/93/042

April 18, 1993

To : M. Shahabuddin
General Manager, PE&S, WAPDA

From : L. A. Rodriguez
General Manager, EBASCO

Subj : **Load Forecast Procedures Manual - Gujranwala III Case Study**

Attached is one copy of the WAPDA/EBASCO final report of the Gujranwala III Division load forecasting study. The report entitled "Gujranwala III Division - Load Forecast Study and Procedures Manual", includes the results of the specific task assigned to a four member WAPDA Planning Engineering Team working under the direction of EBASCO in the development of the 20 year load forecast using the CADPAD DLF-2 program. The report is also to serve as a Load Forecasting Manual to Load Forecast engineers.

The primary objectives of the study were to:

1. provide on-the-job training to WAPDA engineers while working on a real load and energy forecast study.

2. identify type and sources of data, collect, enter and analyze data utilizing the DLF-2 program. Improve collection methodology.

3. develop a twenty years load and energy forecast for Gujranwala III Division.

4. provide the planning engineers with area load maps showing load and/or customer growth locations for specific years of the study period.

5. develop a basic manual showing the miscellaneous steps leading to the successful completion of a load and energy forecast.

6. provide WAPDA with a document that includes a sample load forecasting study case and a manual which is "user friendly" to illustrate the techniques used in developing load forecasts.

The information provided in the report combined with the grid station data and feeder data to be provided by the Mapping Contractors will become the basis for developing long range distribution system studies using SUBSITE and FEEDERSITE modules of the CADPAD program.

The manual (Chapters IV and V of the report) will serve as a guide to all WAPDA users of the DLF-2 program and to a lesser extent to the SLF-2 users to develop load forecasting studies over a given time period. It is expected that as WAPDA engineers increase their expertise, the Manual is to be modified by either adding newer and more efficient techniques or by improving those included in the Manual.

The guidelines given by the Member Power during the EBASCO Load Forecast presentation to WAPDA of February 4, 1993, were also included as applicable during the development of the study.

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I. INTRODUCTION

PROCEDURE FOR DEVELOPMENT OF LOAD FORECASTS FOR TOWNS AND RURAL AREAS

I. INTRODUCTION

A. PURPOSE AND SCOPE

This report presents the procedure used in the development of load forecasts at the time of maximum annual demand of towns and rural areas with less than 200,000 customers based on the use of the Deterministic Load Forecasting (DLF-2) module of Computer Aided Distribution Planning and Design (CADPAD) software. DLF-2 works on the basis of existing and future land use by various customer classes for an area under study. The annual peak load for both the Present Year and the Horizon Year (the final year of study) is provided by the user to establish the saturation levels for each of the small area loads. The program uses the peak load profiles of each customer class, their percentage growth rates and a typical growth S-curve to compute loads for the intermediate years.

In this report, the application of the DLF module of the LOADSITE load forecasting program of CADPAD to the area of Gujranwala III operating Division of WAPDA is described in detail. This area is a rural area with several small towns and villages and DLF module is the suitable program for the area under study. The procedures and methods described in this report can be applied to other Operating Divisions to perform annual load forecasts over a given study period using DLF-2 program.

The program forecasts the distribution of electric load over small areas of the Division's service territory for different years of the study period. The fundamental principle is to identify the location of existing customer classes within a small area. If this area is fully utilized by a given customer class or classes, it is assumed that there would be no additional growth within that area. That is, there is no available land for customer expansion. The results of those analysis are used to evaluate system performance and to determine the distribution system facilities needed to supply the future electric customers demand. In other words, the forecast will be used to design a system capable of serving the areas where the forecast loads are located. Different grid stations and feeder alternatives will be evaluated against the forecast loads. The current capacity of the distribution system serving the area is 48 MVA therefore, expansion of the system will be needed. The planning study will seek to identify the optimal locations and use of added capacity to the system.

Chapters IV and V of this report form essentially a User's Manual. The Manual included therein describes the procedures for using the Loadsite DLF-2 program, development of databases, entering spatial data, development of "load maps" and for entering of global data needed for the development of an annual rural area load forecasts. The User's Manual will be updated from time to time as new techniques are evolved, developed and adopted by WAPDA to make optimum use of the DLF-2 module.

The EBASCO Team acknowledges with thanks the support provided by WAPDA Power Distribution Wing Planning Department engineering team during the Load Forecast Study and in developing the Manual.

B. SUMMARY

1. Load Forecast is the first step towards area planning. Before area planning is undertaken, it is important to ascertain the magnitude and location of load demand in the area. Future load demand is calculated by using the existing loads, consumption pattern of customers, growth potential of different customer classes and the government policies regarding growth of different sectors. Specific information on new industrial zones, routes of existing and proposed highways and railways, status of housing societies and proposals coming up in the area and growth trends of different customer classes are useful in making better load growth projections. A good load forecast is the heart of a practical and feasible area plan.

2. In this study, two different methods were used to develop the load forecasting for the Gujranwala III Division. In the first method, a constant growth rate was used for growth in each class. In the second method, growth rates for each class were varied every five years. The customers for the year 2011 were spatially distributed in existing areas which had space available for growth and in new areas which had no customer density in the starting year.

3. The load forecast maps developed in this study will make it possible to use SUBSITE for grid station optimization and FEEDERSITE for feeders optimization and detailed area planning. Grid station location, capacity and cost data will be used in the SUBSITE program along with the load maps developed in this study to develop area plan for Gujranwala III Division. The distribution record maps for Gujranwala III are under development and as soon as the maps and circuit data are available, comprehensive area planning can be undertaken.

4. The estimated population of the Gujranwala III Division area is 432,274 with about 55,000 electrical customers comprised of residential, commercial, industrial and agricultural classes. Load in the Division is projected to grow at an average annual rate of 6% which means that the load will grow from about 32.4 MW in June 1991 to about 103 MW in 2011. These figures do not include the distribution system losses. Consumption of energy is expected to increase from approximately 150 million kWh in year 1991 to about 567 million kWh in year 2011.

5. Land use data was not easily available for the area (as in all rural areas of the country) so actual customer billing data from the WAPDA Computer Center Gujranwala was used. Customers were classified into ten classes and a forecast of the number and location of new customers of each class was developed. Maps of the Division service territory were used to locate the various customer classes. The customer maps were then converted to spatial loads to be used in the system planning.

6. The growth rate for the number of customers for each class was estimated on the basis of historical data. In a similar manner the actual load growth rate for each customer class, based on the previous years average consumption, was to be determined but it was not possible because of unreliable consumption data available. Instead, percentage increase factors were applied to the 1991 average consumption figures based on the characteristics of each class. The approximate location and year of connection of the new customers was obtained from the Division's field staff and this information was used in spatial distribution of customers in areas which had no customers in the base year 1991.

7. Table I-1 and Figure I-1 show the results of the load forecasting. Figure I-1 shows that load demand will grow from 32.4 MW in 1991 to 102.7 MW in 2011. The load forecast using DLF-2 program is reflected by the curve marked "PROBABLE". The curve marked "UPPER" is the pessimistic projection arrived through linear regression. The last curve marked "LOWER" is the optimistic projection which can be achieved by conservation, time-tariff billing and other measures. Figures I-2 and I-3 show the growth pattern in terms of load density. The load density growth is 16.36 kW/sq.km in 1991 to 51.88 kW/sq.km in the year 2011.

C. RECOMMENDATIONS

Based on the assumptions made, the available data, the procedures used and the results of the study it is recommended that:

1. The annual load forecast developed for a twenty year period be used as the basis for the development of long-range distribution system expansion plans.

2. As the number of customers continues to grow, large changes in customer distribution occur and overall economic conditions change within the Gujranwala III Division, the load forecast be revised annually to meet these changing conditions.

TABLE I-1

YEAR	LOAD IN MW	ENERGY IN GWh (1)	ANNUAL LOAD FACTOR %	
1987	18.1	91.7	57.8%	
1988	19.4	101.1	59.5%	
1989	26.0	116.1	51.0%	
1990	32.6	133.7	46.8%	
1991	32.4	150.5	53.0%	Base Year
1992	35.2	165.0	53.5%	
1993	38.3	181.2	54.0%	
1994	41.7	199.1	54.5%	
1995	45.5	219.2	55.0%	
1996	49.8	242.1	55.5%	
1997	53.0	260.0	56.0%	
1998	56.4	279.1	56.5%	
1999	60.1	300.1	57.0%	
2000	63.9	321.9	57.5%	
2001	67.0	340.4	58.0%	
2002	70.2	359.7	58.5%	
2003	73.6	380.4	59.0%	
2004	77.1	401.9	59.5%	
2005	80.8	424.7	60.0%	
2006	84.1	445.7	60.5%	
2007	87.5	467.6	61.0%	
2008	91.0	490.3	61.5%	
2009	94.7	514.3	62.0%	
2010	98.6	539.8	62.5%	
2011	102.7	566.8	63.0%	Horizon Year

(1) GWh = 1 x 10^6 kWh

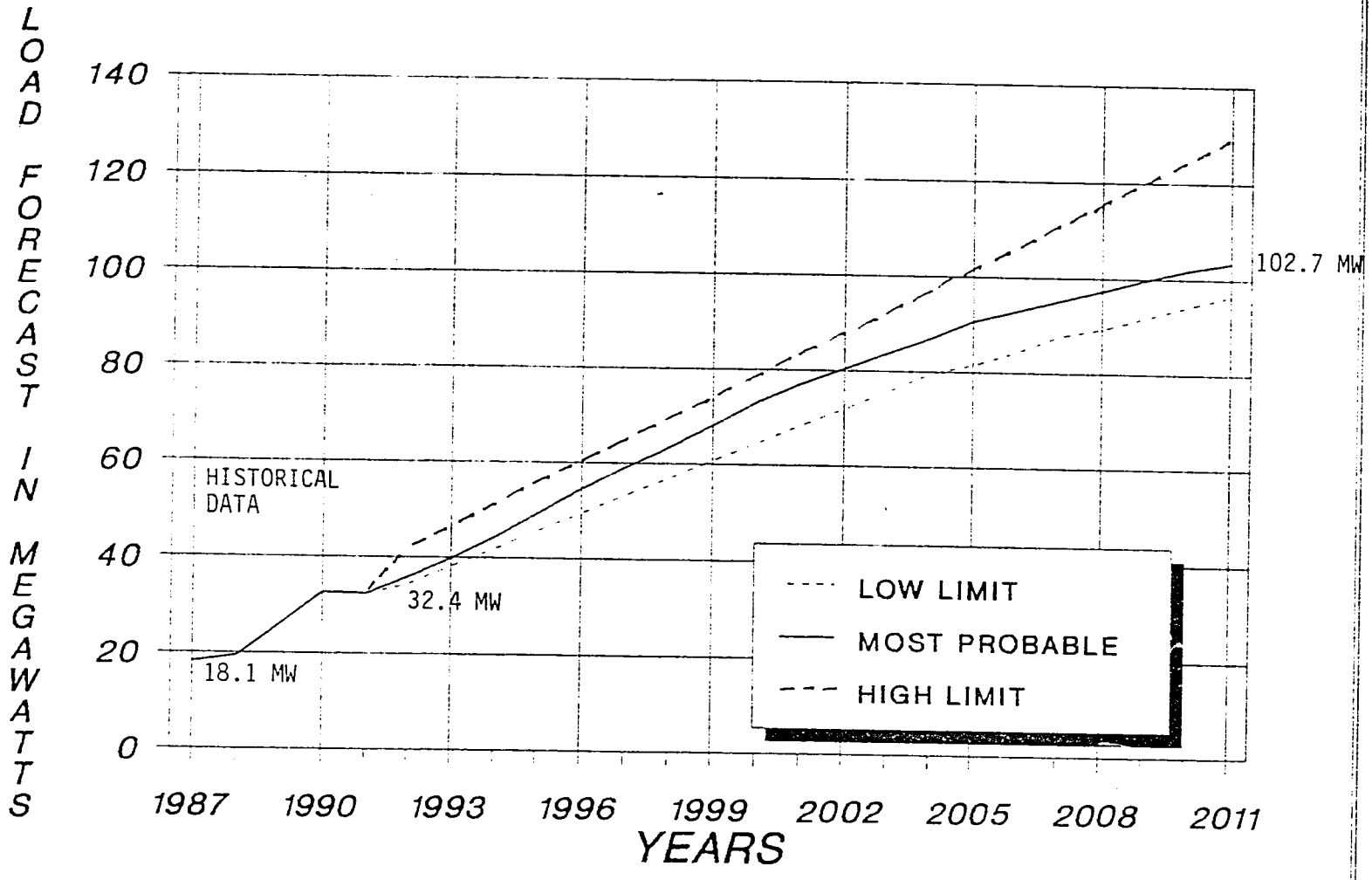

GUJRANWALA III DIVISION
LOW, MOST PROBABLE & HIGH LOAD FORECAST
LOAD FORECAST IN MEGAWATTS
140
120
100
80
60
40
20
0
HISTORICAL DATA
18.1 MW
32.4 MW
102.7 MW
LOW LIMIT
MOST PROBABLE
HIGH LIMIT
1987
1990
1993
1996
1999
2002
2005
2008
2011
YEARS

FIGURE I-1

GUJRANWALA III DIVISION

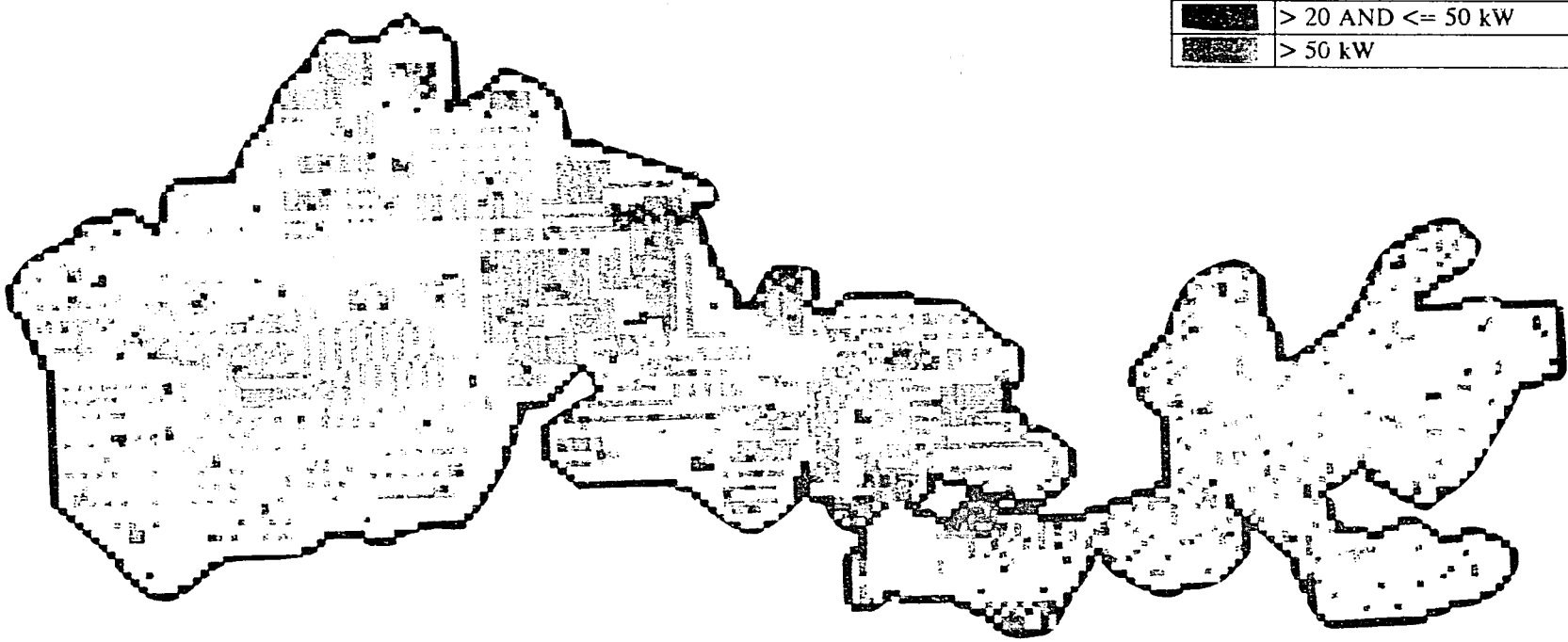
Load Range Map

Base Year 1991

CADPAD (R) LOADSITE (TM) **LOAD FORECASTING MODULE DLF-2** JANUARY 13, 1993

LEGEND

Color Code	*Load Range*
	> 0 AND <= 20 kW
	> 20 AND <= 50 kW
	> 50 kW



Load Density: 16.36 kW/sq.km.

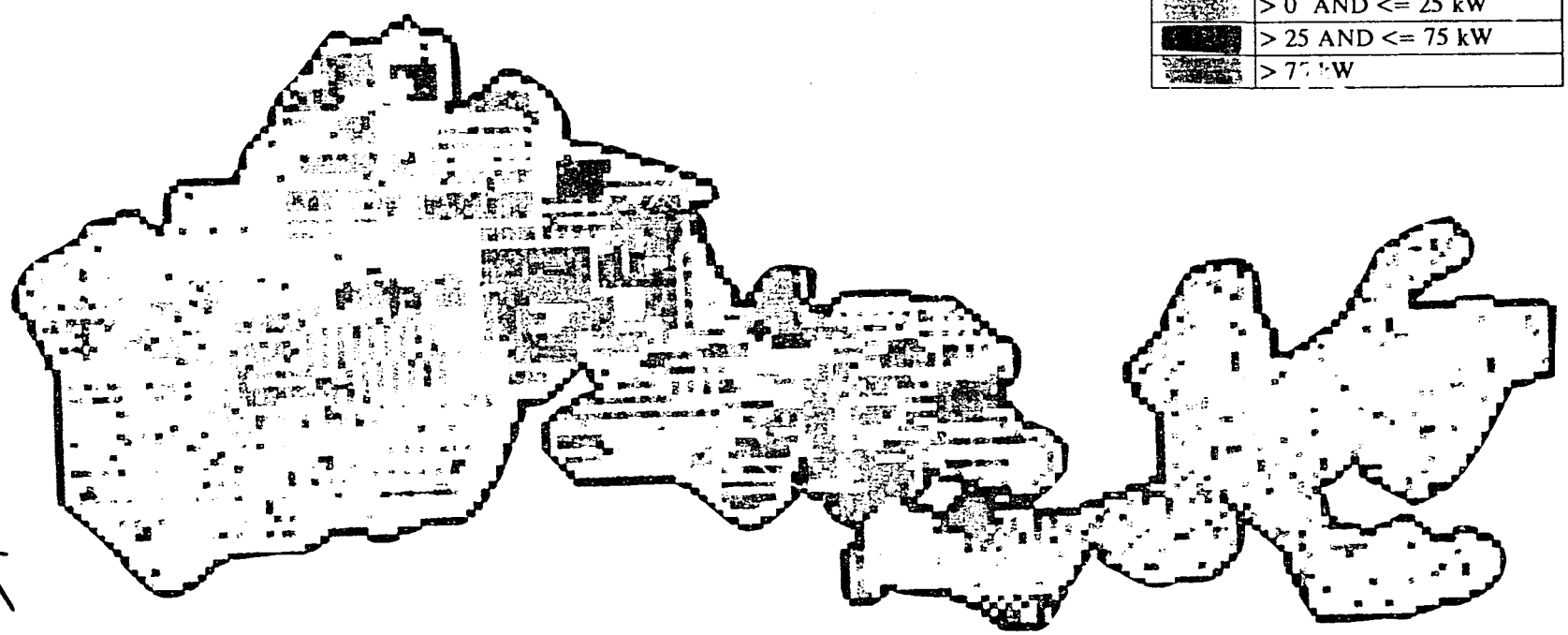
FIGURE 1-5

GUJRANWALA III DIVISION

Load Range Map

Horizon Year 2011

CADPAD (R) LOADSITE (TM) — LOAD FORECASTING MODULE DLF–2 — JANUARY 13, 1993



LEGEND

Color Code	*Load Range*
	> 0 AND <= 25 kW
	> 25 AND <= 75 kW
	> 75 kW

Load Density: 51.88 kW/sq.km.

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II. ANALYSIS

II. ANALYSIS

A. DESCRIPTION OF THE PROJECT AREA

Gujranwala III Operating Division is one of the four Divisions of Circle Gujranwala No. 1 of the Gujranwala Area Electricity Board (AEB). The Division comprises four subdivisions namely Qila Deedar Singh, Ladhyawala, Eminabad and Khiali. The estimated population of the Division is 432,274 with about 55,000 electrical customers including residential (or domestic), commercial, industrial and agricultural classes.

Gujranwala III Operating Division service area begins about five kilometers north of Kamoke when going towards Gujranwala city on the main G.T. Road. Towards the East, it starts from Eminabad Morr, covering Eminabad Town and rural areas stretching to more than twenty five kilometers in this direction. Towards the West, it covers the area on both sides of the Khiali Bypass Road before moving along the Western boundary of Gujranwala city. The Division then extends further West covering area on both sides of the Hafizabad Road for about a twenty five kilometer stretch. Qila Deedar Singh is the main town in this Division. Ladhyawala, Eminabad and Khiali are the other towns included in this Division. Khiali is administratively a part of Gujranwala city. The other three towns have their own town committees. Eminabad Morr locality is also a part of the Division.

Geographically, Gujranwala III is located between longitudes 73 Deg 48 Min. and 74 Deg 30 Min. and, latitudes 32 Deg 0 Min. and 32 Deg 14 Min. The Gujranwala III map of Figure II-1 shows that the Division covers approximately an area of 2,000 square kilometers.

Population of the area as per Census Report of 1981 is 306,743. Applying the annual growth rate of 3.49% for Gujranwala Tehsil, the population in 1991 is calculated to be 432,274. Taking the Gujranwala District average of 7.0 persons per household, this amounts to 61,753 households in the area. In June 1991, there were about 45,500 residential customers i.e. 73.5% of the households were electrified.

GUJRANWALA MAP

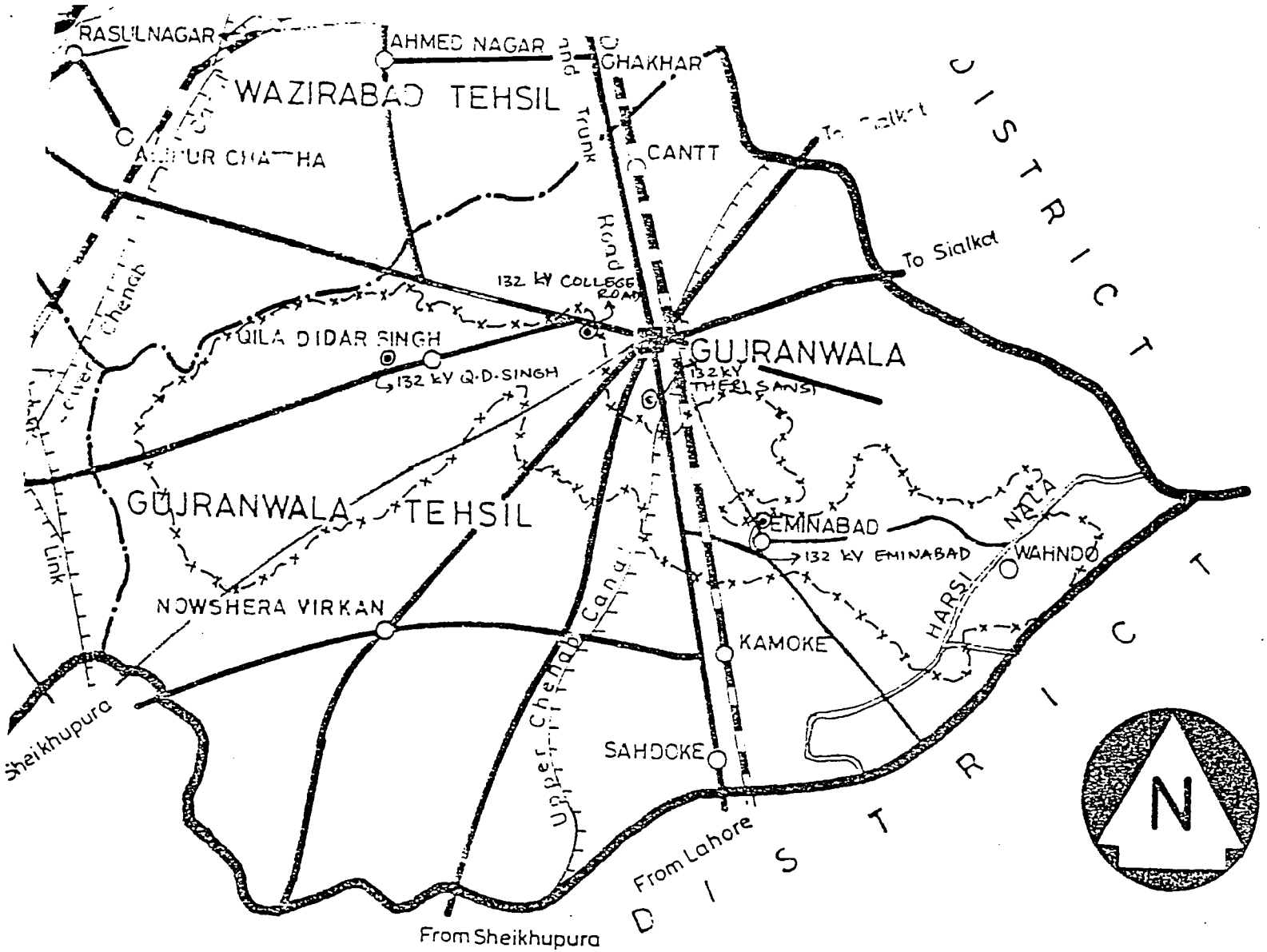

FIGURE II-1

—x—x— Division Boundary

⊙ Grid Station

BEST AVAILABLE COPY

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The economy of the area is a mixture of agriculture and industry; the two sectors together consume almost two thirds of the annual energy. For the purpose of this study, industry was classified as Low, Medium or High based on tariffs B1, B2 and B3 respectively. In June 1991, there were about 1,300 industrial customers including only 6 classified as high consuming industrial customers i.e. with B3 tariff. The total number of tubewells in the Division was well over 3,000. This number of tubewells gives an indication of the contribution of agriculture to the economy of the Division.

Most of the large and medium sized industrial customers are located in the Khiali and Eminabad subdivisions. Ceramics, straw boards, cold storage and ice factories, furnace mills and engineering and metal works mostly make up the medium sized industrial sector. There are a few rice, ghee and flour mills and some dyeing and finishing mills. Among the high consuming industries (Tariff B3), the important industrial customers are a bottling plant, steel furnace and a disposal works in Khiali and a ceramics factory and steel mill in Eminabad. Qila Deedar Singh has one furnace factory classified as a high consuming industrial customer. Most of the medium sized industrial customers run two or three shifts with only a few operating single shift. The high consuming industrial customers run three shifts except for the disposal works in Khiali which is operated to drain out rain water when required.

Gujranwala III Division is served by eighteen (18) 11 kV feeders belonging to four grid stations. These are:

GRID STATION	NO. OF FEEDERS
(1) 132 kV College Road	2
(2) 132 kV Eminabad	4
(3) 132 kV Theri Sansi	4
(4) 132 kV Qila Deedar Singh	8

B. HISTORICAL GROWTH TRENDS

WAPDA Planning Headquarter has developed a Customers Database which is regularly updated to maintain a summary of the number of customers and their consumption by Operating Divisions. The reports of three previous years (1988 to 1990) for Gujranwala AEB were used to obtain the historical data for different customer classes belonging to Gujranwala III Division. The customer data for the year 1987 was taken from the Customer Services Officer Gujranwala. The data for the year 1991 was taken from the billing database obtained from the Gujranwala Computer Center. All figures given below are as of the month of June which was determined to be the month of peak consumption for 1991, taken as the present year.

TABLE II-1
NUMBER OF CUSTOMERS

YEAR	RESI-DENTIAL	COMMERCIAL	TUBEWELLS	INDUSTRY	TOTAL
1987	24,207	3,439	2,743	748	31,137
1988	28,778	4,023	2,914	851	36,566
1989	35,909	4,359	3,133	940	44,341
1990	40,650	4,673	3,181	1,030	49,534
1991	45,408	5,021	3,210	1,264	54,903

TABLE II-2
CUSTOMERS ANNUAL GROWTH RATES

CUSTOMER CLASS	HISTORICAL AVERAGE ANNUAL GROWTH %	LINEAR REGRESSION ANNUAL GROWTH %
Residential	17.03%	6.1%
Commercial	9.92%	4.6%
Tubewells	4.01%	2.8%
Industry	14.01%	5.2%
Total Customers	15.23%	5.8%

By considering the average consumption of each category, residential customers were broken into three classes, commercial customers were divided into two classes and industrial into three. Data for Tubewell-Private and Tubewell-Flat Rate was available by individual classes. A total of ten customer classes were identified for the study. Linear regression was performed on the historical data and growth rates were obtained for each class. The linear growth rates were tapered to allow for saturation and an annual growth rate was computed. This flat annual growth rate was used to compute the number of customers in each class for the horizon year 2011.

It was intended to determine increase in use of electricity by current customers on the basis of average usage over the last four years. The per customer consumption data for the

previous years however did not turn out to be reliable. The variation in average consumption was much too large to be used for regression. Percentage increase factors based on the characteristics of each class were taken and applied to current usage to arrive at the figure for the year 2011. The average consumption figures for base and horizon year were used in developing load profiles.

Historical load data was not available by customer class. The figures below show the total Division system load for successive years during the peak month:

TABLE II-3
HISTORICAL PEAK LOAD & ENERGY CONSUMPTION

YEAR	LOAD (MW)	ENERGY (Million kWh)
1987	18.1	91.7
1988	19.4	101.9
1989	26.0	116.1
1990	32.6	133.7
1991	32.4 (*)	150.5
Historical Annual Growth%	15.67%	13.17%
Linear Regression Growth%	6.30%	5.44%

(*) A figure for 30.7 MW for 1991 was rejected for not being consistent with the historical trend. Feeder loading data was obtained from GSO Circle Office Lahore. The system peak calculated from this data was close to 32 MW. The value for 1991 base year was taken as 32.4 MW as computed by the program from load profiles and customer counts for the base year.

Except for tubewell customers, all other classes have shown considerable growth in the last four to five years. Table II-2 shows that residential customer class has been growing at an average annual rate of 17.0 % followed by the 14% growth in the industrial customers. In the industrial sector, significant growth is indicated in the medium and small size industry. There are no pending applications for B3 industrial tariff at present but the historical trend indicates that in twenty years this class will grow by about three times the present number. Government policies to encourage the industrial sector are bound to cause a rapid increase in customers in the three industrial classes.

Medium and high consuming residential classes are increasing at a slightly faster rate than the low residential class although the increase in low residential class customers is more prominent because of the large numbers involved.

Commercial customers like small stores, shops and restaurants are increasing steadily in numbers. Tubewell growth is much less compared to that in other classes. This may be attributed to the limited funds available with WAPDA for subsidizing agricultural tubewell connections. The high number of existing tubewell connections also indicates that in the Gujranwala III Division, the growth in these customer types is reaching its saturation level and growth will therefore be much slower than what the historical pattern shows.

C. NEW CUSTOMERS AND LOAD GROWTH

By using the historical data and distributing the customers into the selected classes, growth percentages were determined for each customer class. These percentages were arrived at by obtaining a growth rate through regression and then tapering down that number to account for saturation in growth. In this method a uniform growth percentage was applied to each customer class to obtain the number of customers for the horizon year. The number of customers obtained was distributed spatially in the horizon year customer maps. The DLP-2 program was then executed to obtain intermediate year load maps.

An alternative method was used by applying different percentage growth rates for each class for five year time periods and the program was run successively to get load maps for all intermediate years. The second method promised to be more realistic for it used different growth rates for different time periods. The number of customers for the present and the horizon years calculated by both methods are as shown in Tables II-4 and II-5.

TABLE II-4
NUMBER OF CUSTOMERS AND GROWTH RATES IN PERCENT

	<--------- METHOD 1 ---------->		
CLASS	**NUMBER IN 1991**	**% ANNUAL GROWTH**	**NUMBER IN 2011**
Residential	45,408	3.291%	86,774
Commercial	5,021	2.521%	8,261
T/Well	3,210	0.751%	3,728
Industry	1,264	3.174%	2,361

In the second method used for projecting loads, varying growth rates were used for different time periods for the ten customer classes. For the residential classes, the growth rates varied between 6.3 % to 3 %. For the commercial classes, these were between 4.6 % and 1.9 %. Low growth rates were applied for the Tubewell classes because it was anticipated that tubewell growth was close to saturation. The growth rates for Tubewell customers were between 2.6 % to 0.3 %. Growth rates for industrial customers were much higher, the variation being between 6.5 % to 3.8 %. In all cases higher growth rates were maintained in the early years of the study with a gradual decline in growth as the horizon year was approached. The number of customers obtained from the global model of the DLF-2 program after applying these growth rates are shown in Table II-5. Figures II-2 and II-3 show graphically the growth in number of Residential and Industrial Customers as computed by the DLF-2 program by both methods.

TABLE II-5
NUMBER OF CUSTOMERS FORECAST

		<---------- METHOD 2 ---------->			
CLASS	**1991**	**1996**	**2001**	**2006**	**2011**
Residen-tial	45,408	70,074	86,764	102,820	119,201
Commercial	5,021	7,737	10,270	12,870	14,944
T/Well	3,210	3,605	3,877	4,038	4,158
Industry	1,264	2,228	3,153	3,800	4,406

Customer growth is based on several factors. One is the natural growth encountered in existing areas because of increasing population and demand for electrical connections by the residential sector. Where residential customers increase, there will be an increase in commercial activity thus the number of commercial connections is bound to increase. Other than the existing localities, consideration is given to areas where new housing societies are in varying degrees of development. For Gujranwala III Division, the new housing societies are all located in the Khiali subdivision. An industrial estate is also set up in the Khiali area and it has a good development potential. Eminabad area is also showing signs of rapid growth for some time. Information was extracted from the Village Database to obtain data of non electrified villages. A total of fourteen small villages were identified for electrification. Ten of these are located in Qila Deedar Singh subdivision, three in Eminabad and only one in Ladhyawala.

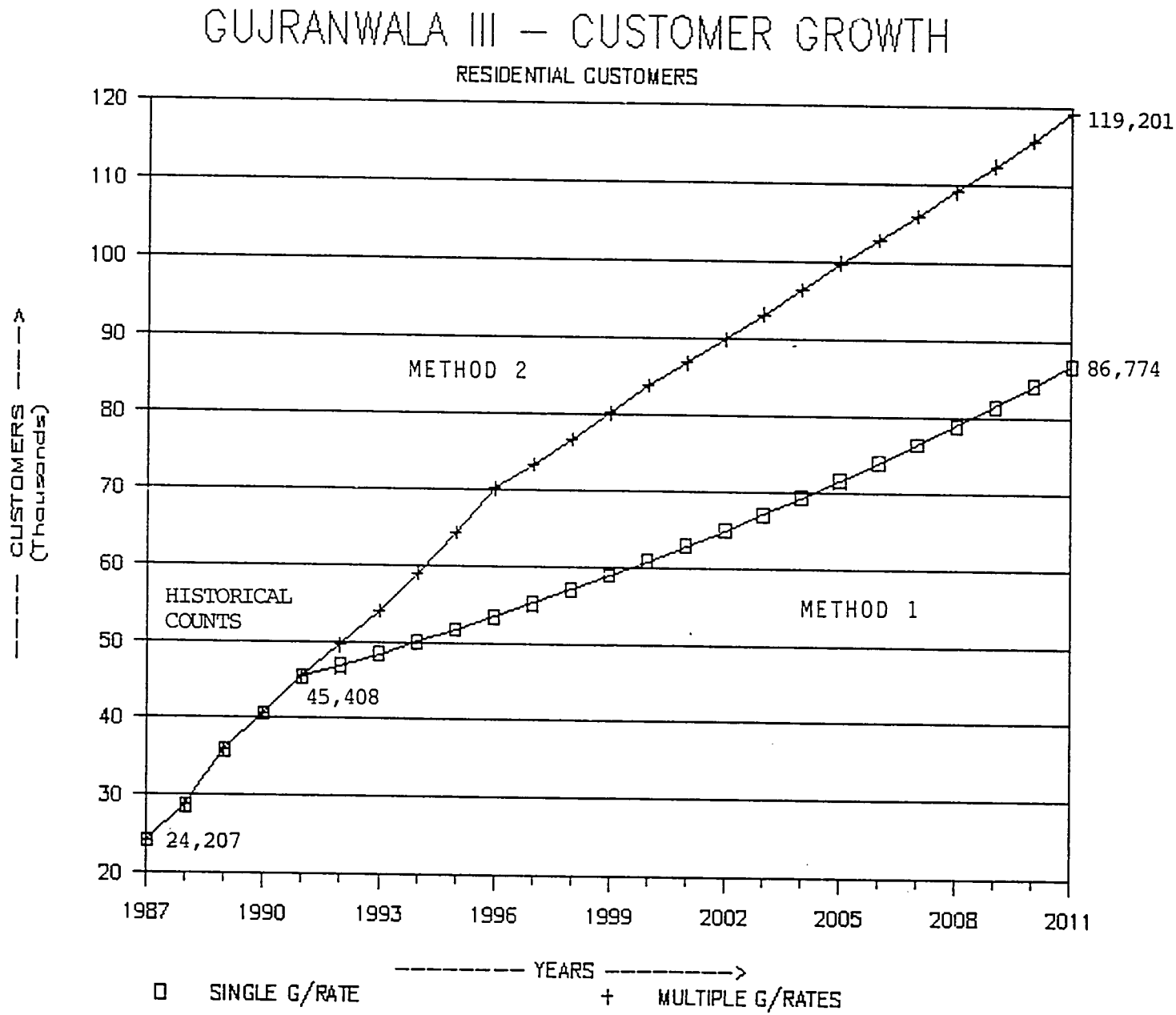

FIGURE II-2

24

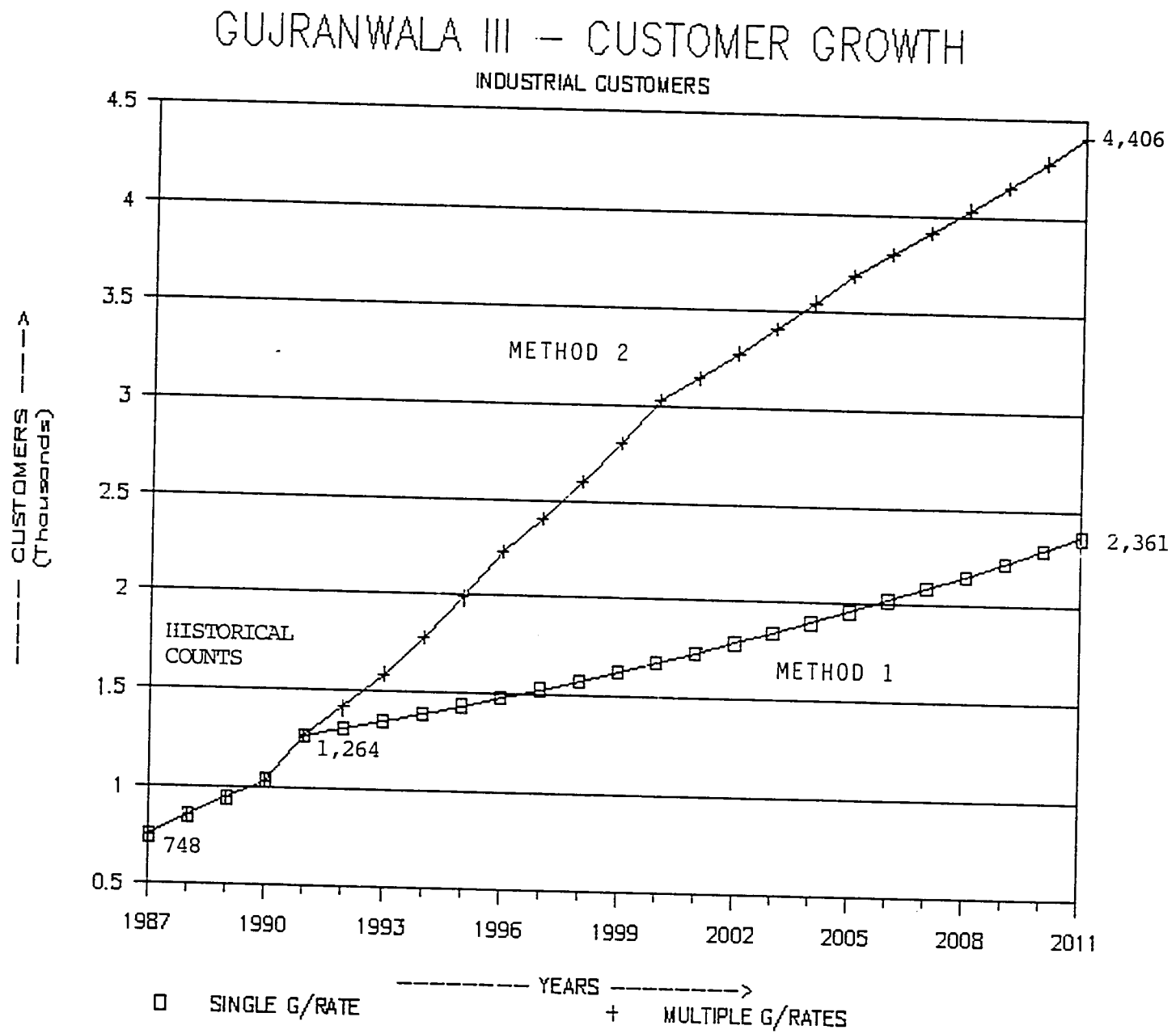
GUJRANWALA III – CUSTOMER GROWTH
INDUSTRIAL CUSTOMERS
4.5
4
3.5
3
2.5
2
1.5
1
0.5
CUSTOMERS (Thousands)
METHOD 2
METHOD 1
HISTORICAL COUNTS
4,406
2,361
1,264
748
1987
1990
1993
1996
1999
2002
2005
2008
2011
YEARS
SINGLE G/RATE
MULTIPLE G/RATES

FIGURE II-3

While applying multiple growth rates in the second method us in the DLF-2 exercise, special attention was given to the fa that the time is ripe for industrial growth. Governme policies including its industrialization drive and investme incentives implies that growth in this sector is going to l rapid for the next five years at least. The trend is expect to continue through the decade tapering down after th because of saturation. This accounts for a high number c industrial customers especially in the low industry class.

As of June 1991, five applications for medium industri connections (Tariff B-2) were pending in Gujranwala I Circl for the area under study. Three of these applications are fc industrial customers based in Eminabad and the remaining tw in the Khiali region. Included in the major customers are ghee mill with connected load of 471 MW and a textile printir and dyeing mill with connected load of 421 MW. Both ar located in Eminabad. Khiali which already has an existin industrial estate and Eminabad which has substantial growt potential promise rapid industrial development in the comin years. Most of the new industrial growth in Gujranwala II Division is anticipated in these two areas.

D. DEVELOPMENT OF LOAD PROFILES

Our basic assumption in making a load profile for any class i that all the customers belonging to this class across th board will have the same pattern of electricity usage. Th difference fundamentally arises because of rural/urban livin style difference as well as type of customers within eac class. Age groups, professions, living habits, type and siz of accommodation can all make differences. A load profil developed purely on the basis of average consumption is no necessarily a true indicator of power usage by an individua user. It does however reflect the average usage pattern o the entire class. The load profiles for all the classes wer developed based on average consumption and anticipation of th number and types of appliances each class has access to.

In developing the profiles for residential customers, th living style of the people of the area was considered. Most customers designated as DOMESTIC-LOW belong either to th rural areas or to the low income group in towns. Peak demanc tends to occur in the early evening hours. Commercial customers consisting of small shops, restaurants and general stores peak in the early evening before tapering down by 9:00 PM. Most commercial customers in this area are closed down by 10:00 PM and the few which are open till late night are either

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the ones located on the main road or small food and video shops and cinema houses in the towns. Some load is accounted for through the night by commercial customers like gas stations and restaurants.

High consuming industrial customers are mostly run in three shifts and at night their demand rises as there is need for lighting. Most industrial customers categorized as INDUSTRY-MEDIUM run either two or three shifts and the load profile for this category was developed accordingly. It accounted for those customers which are shut down at night after running two shifts. A considerable number of customers run three shifts and their load is accounted for in the average load profile for this class.

The program used the present year load profiles and number of customers in each class to compute the system load profile. The shape of the system load profile computed by the program was compared with the actual system load profile shape determined from the grid station data for the feeders serving Gujranwala III Division. The differences were accounted for by modifying individual class profiles and matching the system profile computed by the program with the actual data.

Increase in use of electricity by existing customers in a particular class (as indeed by the new customers in that class) is reflected by the horizon year load profile of that particular class. WAPDA has been organizing a sustained campaign for customers to switch off extra load during the peak hours between 5:00 PM to 8:00 PM. The target of this campaign is the middle and upper classes. It is expected that the campaign will yield positive results in the years to come for these classes which comprise mostly of educated people who are likely to heed the need for conservation of electricity. The horizon year profiles for middle and upper residential customers classes have been developed on the assumption that these two classes will exercise caution in using electricity during the peak hours. The load pattern of Low Domestic and Low Commercial classes remains more or less the same. For the Medium Commercial class, WAPDA will have to take administrative measures to have markets closed down between 7:00 and 7:30 PM to provide relief to the system. The Medium Commercial class load profile for the horizon year is developed on this assumption.

The pattern of load profiles of industrial customers will largely remain the same, the only differences being in magnitude. It is acknowledged that the industrial sector plays a vital role in the economy of the country. Any power

restriction will have a negative impact on the output of this sector and its contribution to the GDP. The continuous process industries may be encouraged to consider self generation alternatives. In the long run this could be the most effective way of combating energy shortages. Increase in use of electricity is expected to be more pronounced in low and medium sized industries rather than the big customers. Normally the power requirements of big customers do not increase substantially unless they go for expansion in capacity. Expansion in low and medium customers is comparatively easier and their average use of electricity is likely to register more increase than the bigger customers. The increase in consumption of tubewell customers is expected to be minimal and is reflected by their load profiles. The assumption in developing horizon year load profiles for tubewell classes is that WAPDA shall be able to exercise control over their usage during peak hours.

Figure II-4 shows the System Peak Day Load Profiles for both the Base Year and the Horizon Year.

E. METHODOLOGY

It was ascertained from the Division map of Gujranwala Division that the area covered by this Division was approximately 65 km by 30 km. DLF-2 program allows the area under study to be divided into a maximum of 264 x 264 square cells. Based on these parameters, Gujranwala III Division was divided into 220 x 100 small areas each measuring 300 x 300 square meters.

Customer data for the last one year i.e. from May 1991 to April 1992 was obtained from the Gujranwala AEB Computer Center. From this data, peak month was found to be June 1991. The data also gave an approximate location of the individual customers by batches in various subdivisions. The data was analyzed by PC based programs to determine customer classes. Final print outs were taken with customers of different classes distributed by batches in each subdivision.

Other than the Division map, following maps were used for data extraction: (1) Ladhyawala, (2) Khiali, (3) Qila Deedar Singh, (4) Eminabad Town and, (5) Eminabad Morr. All batches, low and medium industrial customers and future housing societies were marked on the maps with the help of the field staff. Overlays for all maps were prepared with small areas (300m x 300m) marked on these. Batch wise customers were then re-distributed into small areas of all the maps by allocating percentages based on judgement of the planning engineers. Data files were thus prepared for all the customer class. All data for the present year customer distribution was placed in one file which was then used as input to the DLF-2 program.

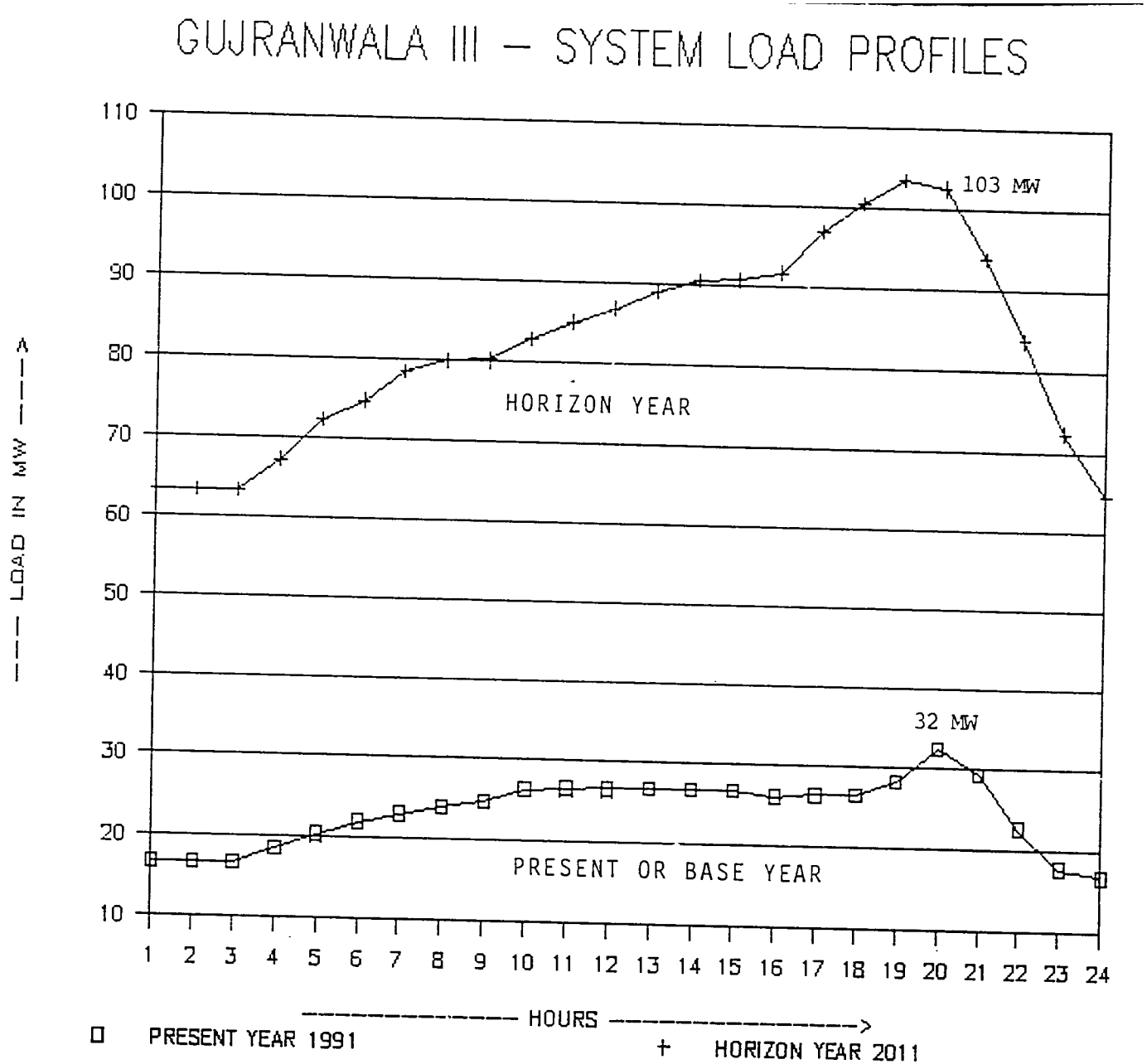

GUJRANWALA III – SYSTEM LOAD PROFILES
110
100
90
80
70
60
50
40
30
20
10
LOAD IN MW
103 MW
HORIZON YEAR
32 MW
PRESENT OR BASE YEAR
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS
PRESENT YEAR 1991
HORIZON YEAR 2011

FIGURE II-4

Growth factors obtained from historical patterns were used to determine the number of customers for the horizon year. The growth factors were applied to copies of present year files to obtain figures for the horizon year. Consideration was given to areas expected to grow at a higher rate from the location, planning of new localities, pending industrial connections and general information. A separate data file was prepared for new cells which had no customers in the present year but were expected to grow in future. Estimated year of development of these cells or small areas and the number of customers expected in the horizon year were entered in this file. These files were used as input to the DLF-2 program for customer distribution for the horizon year.

In an alternative method, it was decided to use different growth rates for each class during four different time periods. Each time period was run as a separate case with the outputs of one being used as the inputs to the next until the horizon year was reached. The number of customers obtained by this method were finally adopted as the horizon year customer counts and there were distributed spatially in the horizon year maps as described earlier. The percentage growth rates applied in both the methods are given below:

TABLE II-6
CUSTOMER CLASSES GROWTH RATES

	METHOD 1	<---------- METHOD 2 ---------->			
	FLAT	VARYING GROWTH RATES			
CLASS	GROWTH	1991-96	1997-00	2001-05	2006-11
Dom-Low	3.3%	9.0%	4.5%	3.5%	3.0%
Dom-Med	3.5%	9.5%	5.0%	4.0%	3.0%
Dom-Hgh	3.5%	10.0%	5.5%	4.5%	3.0%
Com-Low	2.5%	9.0%	6.0%	5.0%	3.0%
Com-Med	2.6%	10.0%	7.0%	5.5%	4.0%
T/W-Pri	0.7%	2.6%	1.4%	0.8%	0.5%
T/W-F.R	1.1%	4.0%	2.5%	1.2%	1.0%
Ind-Low	3.1%	12.0%	8.0%	4.0%	3.0%
Ind-Med	3.9%	12.0%	8.0%	4.0%	3.0%
Ind-Hgh	6.5%	10.0%	7.5%	5.0%	4.0%

Load Profiles were developed for all the classes for the base and horizon as discussed in Section E above. Gujranwala III case was then run using DLF-2 to obtain the system load for five years in one go. The program was run successively to obtain system load for all twenty years. Detailed methodology and procedures for running the program are explained in Sections III and IV.

F. ANALYSIS

In Gujranwala III Division, the region with the greatest development potential is Khiali subdivision. Three new housing societies are coming up in this area namely (1) Judicial Colony, (2) Muhafiz Town (Police Foundation) and, (3) Wapda Colony. New customers have been allocated in these colonies with the expected year of development of these localities. Eminabad town is expected to register expansion in the direction of Eminabad Morr. Eminabad Morr itself should expand along the G.T. Road. Ladhyawala town being close to Gujranwala city is also expected to register expansion. Growth in Qila Deedar Singh town is expected to be gradual.

Industrial customers are concentrated in Khiali and Eminabad areas. In Eminabad most of the industries are along the G.T. Road. Similarly Khiali has the advantage of the bypass road along which most industrial customers are located. The Small Industries Estate #2 is also located in Khiali and it houses several industrial customers. The industries estate has a good growth potential and more industries are expected to come up in this area in future.

As discussed earlier, DLF-2 program was used for Gujranwala III Division by two different methods. In the first method a flat annual growth rate was used for each class through the twenty years of load forecast. In an alternate method, different growth rates were applied to each class for different time periods and the program was run successively for these time periods to obtain the intermediate year load maps.

In this section, the load values for all intermediate years obtained from both methods are listed. The variation in customer counts was described in an earlier section. For comparison the loads calculated by linear regression based on 1987-1991 data are also listed.

TABLE II-7
PEAK LOAD GROWTH

YEAR	METHOD 1 LOAD (MW)	METHOD 2 LOAD (MW)	LINEAR REG. LOAD (MW)
1987	18.1	18.1	18.1
1988	19.4	19.4	19.4
1989	26.0	26.0	26.0
1990	32.6	32.6	32.6
1991	32.4	32.4	32.4
1992	33.3	35.2	38.2
1993	34.3	38.3	42.4
1994	35.3	41.7	46.6
1995	36.3	45.5	50.8
1996	37.4	49.8	55.0
1997	38.5	53.0	59.1
1998	39.7	56.4	63.3
1999	40.9	60.1	67.5
2000	42.2	63.9	71.7
2001	43.6	67.0	75.9
2002	45.0	70.2	80.0
2003	46.5	73.6	84.2
2004	48.0	77.1	88.4
2005	49.6	80.8	92.6
2006	51.3	84.1	96.8
2007	53.1	87.5	100.9
2008	54.9	91.0	105.1
2009	56.9	94.7	109.3
2010	58.9	98.6	113.5
2011	61.0	102.7	117.7

Population of Gujranwala III Division in 1991 was calculated by applying the 3.49% annual growth rate estimated in the Census of 1981. The same growth rate was applied to calculate the estimated population for 2011. This came out to be 858,471 with 122,639 households at an average density of 7.0 persons per household. Residential customers in 2011 were estimated by the DLF-2 program to be 86,774 by the first method and 119,201 by the second method. Since the second method was considered to be more realistic, this amounted to 97% electrified households in 2011. Total energy consumption was calculated to rise from about 150 million kWh in 1991 to approximately 567 million kWh in 2011. Load density is expected to increase from 16.36 kW / sq.km. in 1991 to 51.88 kW / sq.km. in 2011.

A detailed analysis will be possible after SUBSITE and FEEDERSITE programs have been used for Gujranwala III Area Planning Study. The feeder survey and mapping of this area is under progress. When the circuit data for Gujranwala III

Division is available in the mapping database, studies will be conducted and complete area plans developed for this Division. The load forecast maps developed in this study will serve as an input to the area planning study.

III. DETERMINISTIC LOAD FORECASTING (DLF-2)

III. DETERMINISTIC LOAD FORECASTING (DLF-2)

A. INTRODUCTION

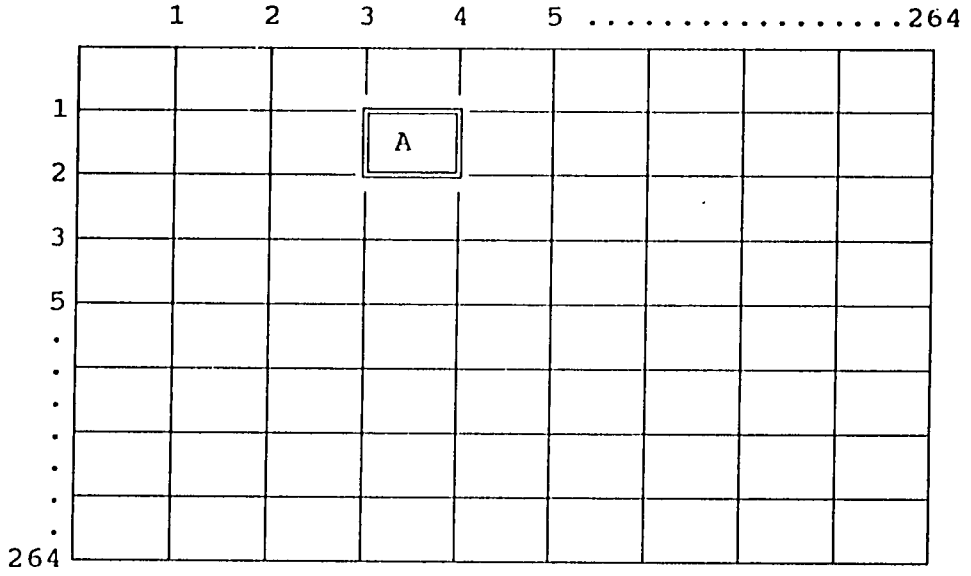
This section of the report sets out to present the advantages and limitations of using CADPAD's load forecasting module DLF-2 (Deterministic Load Forecasting), the data requirements of the program and the methodology to be followed to achieve the end results. While extensive use of PC based packages like Lotus 1-2-3 and dBASE 3+ has been made for data transformation, the human skills and efforts required for obtaining information from the maps cannot be under estimated. It is anticipated that readers and future users of computerized load forecasting techniques described in the manual will be familiar with basic personal computer usage. Programming skill is not required and familiarity with DLF-2 is also not an essential requirement. The methodology has been explained in detail by describing specific steps and should serve as an accurate guideline to the user. Samples of printouts, maps, sketches and diagrams have been inserted wherever required and this will contribute in making the report more comprehensible. While it is desirable to have the data in precise details, some approximations and assumptions are necessary to speed up the pace of work and also to make up for lack of reliable data. All such assumptions have been clearly stated. In the future the use of sophisticated monitoring devices will enable WAPDA to collect data precisely and efficiently. The assumptions given herein will naturally be replaced by actual data which will result in a more accurate forecast. The stress throughout the study has been on location as well as magnitude of forecasted loads to obtain a clear picture of the future. The load forecast results are expected to provide the planners with vital information needed for developing effective planning strategies.

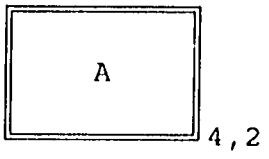
Data is collected in form of maps and tables. Computer spread sheets are developed to transform the raw data into DLF-2 format. The ASCII data files developed are transferred to the mini computer and directly read by the DLF-2 program. This approach bypasses the need for double key entry thus eliminating a potential source of data corruption and operator errors. The load forecasting routine is then executed to obtain loads for five intermediate years. The detailed methodology is explained in Section IV. The precise data requirements and their sources have also been listed with the actual time spent for completing the study. This report should serve as a guide to load forecasting exercise to be undertaken by WAPDA in the coming years at the AEB level.

B. BASIC PARAMETERS OF DLF-2

DLF-2 provides (35) grid maps to the user. Each grid is made up of 264 cells on each axis as shown below:

DLF-2 PROVIDES 35 GRID MAPS
OF
264 X 264 CELLS EACH





Address of Cell "A" is 4,2.

A cell is addressed by its Lower Right Numbers. In the example given above Cell 'A' has the address: 4,2 i.e. Column Number, Row Number.

The size of each square (cell) within the grid is determined by the user. This depends on the area size of the Operation Division under study. The greater side of the length and width of the area under study is divided by 264 and that determines the side of the cell to be used for the load forecasting exercise.

The thirty five grid maps and the information to be filled in these is described below:

Map 1	Domestic Low Customer Dist. Base Year
Map 2	Domestic Medium Customer Dist. Base Year
Map 3	Domestic High Customer Dist. Base Year
Map 4	Commercial Low Customer Dist. Base Year
Map 5	Commercial Medium Customer Dist. Base Year
Map 6	Tubewell Private Customer Dist. Base Year
Map 7	Tubewell Flat Rate Customer Dist. Base Year
Map 8	Industrial Low Customer Dist. Base Year
Map 9	Industrial Medium Customer Dist. Base Year
Map 10	Industrial High Customer Dist. Base Year
Map 11	Domestic Low Customer Dist. Horizon Year
Map 12	Domestic Medium Customer Dist. Horizon Year
Map 13	Domestic High Customer Dist. Horizon Year
Map 14	Commercial Low Customer Dist. Horizon Year
Map 15	Commercial Medium Customer Dist. Horizon Year
Map 16	Tubewell Private Customer Dist. Horizon Year
Map 17	T/Well Flat Rate Customer Dist. Horizon Year
Map 18	Industrial Low Customer Dist. Horizon Year
Map 19	Industrial Med. Customer Dist. Horizon Year
Map 20	Industrial High Customer Dist. Horizon Year
Map 21	Year of Development for Cells with Zero Number of Customers in the Base Year
Map 22	Bus Location NODESIM I/P from existing feeder Maps
Map 23	Base Year Load Map
Map 24-28	Intermediate Five Years Load Maps
Map 29	Horizon Year Load Map
Map 30	NODESIM O/P - Bus Assignments Map for any intermediate year.
Map 31-35	For Map Mathematics.

The grid maps can be thought of as different layers of information. When overlaid upon each other, they make up all the data required by DLF-2. The small cells divide the entire area under study into small squares. These squares have different customer densities and thus each cell has its own unique growth pattern. Based on overall customer class growth and load profiles, the program grows the load in each cell thus giving both magnitude and location of future loads for any five years in one go.

C. CONCEPTS OF LOAD FORECASTING USING DLF-2

DLF-2 allows the user to have ten customer classes. The criteria for choosing customer classes rests with the user. Customer classes, their density, consumption pattern and importance may change drastically from one area to the other.

DLF-2 requires the user to enter customer counts for each small cell for all classes in different grid maps as described above. The customer counts are required for the base year as well as the horizon year.

The reader must keep in mind that DLF-2 is Deterministic Load Forecasting which means that we already know the final counts. It is the direction and magnitude of load growth in intermediate years that is of interest to us.

The user can control the beginning of load growth in vacant cells by putting in the starting year of growth for cells which have a zero customer count in the base year (Map # 21). This grid map is particularly useful for projecting load growth for areas for which we have definite information of future load growth and its approximate time frame. Some sources for this information are (1) List of approved connections for industrial customers, (2) Rural Electrification Plan, (3) Village Database and, (3) Future housing societies under development or planned with their estimated year of electrification. This list is by no means exhaustive and may not be limited to the sources indicated. The program uses this information along with growth rates and load profiles to compute demand for the intermediate years. In a single execution we can get any five years' load maps between the base and horizon years. By repeating the process several times load maps for all twenty years can be obtained.

D. DLF-2 DATA REQUIREMENTS

1. Distribution of all customers into ten or less customer classes.
2. Selection of Base Year, Horizon Year and five intermediate years for which future loads are to be computed.
3. Cell wise customer counts for base year and horizon year for all customer classes.
4. Twenty four hour load profiles for all customer classes for both base and horizon years.
5. For cells which have zero count for base year, the year of initial development may be given.
6. A typical growth curve (S-curve)

E. DATA IDENTIFICATION

It was assessed that the following information would be required to fulfil the mandatory requirements imposed by DLF-2 to conduct the load forecast exercise:

Maps

1. Division map with subdivision boundaries and rural batches of all subdivisions duly marked. Industrial consumers falling under Tariff B2, B3 and B4 to be located on this map. Future housing societies, if planned or under development, also to be located on the map.

2. Town maps of all towns with subdivision and urban batches marked. Industrial consumers (B2, B3 & B4) and future housing societies to be located. Batches are geographical areas in each subdivision for billing purposes. Each subdivision is divided into twenty batches.

The maps shall have a proper scale and preferably should have latitude/longitude shown on all four corners. Using the scale of each map and polar coordinates or other identifiable geographical features, each map can be placed in its proper position on the division map. Lambert coordinate system has been adopted for this study for this has been standardized by WAPDA for the surveying and mapping of its distribution system. CONVERT program available with WAPDA can be used to inter-convert between Polar and Lambert systems.

Other Information

1. Billing Data sorted by Subdivision, Batch and Tariff on Mini Computer tape in ASCII format
2. List of B2 and B3 industrial consumers
3. List of future Housing Societies with location and year of development (i.e. year of electrification)
4. List of current Tariffs with their computer codes
5. Village Database
6. Consumer Database with yearly consumers tariff wise from 1988 to 1991
7. Grid loading data for area under study

F. DATA SOURCES

The above information can be obtained from various sources. A possible list of these sources is given below:

1. Wapda Reproduction Cell, Wapda House Lahore.
2. Assistant Division Managers of all subdivisions in the area under study
3. Town Committees
4. Wapda AEB Computer Center
5. WAPDA Distribution Planning Headquarter, LDA Plaza, Lahore
6. WAPDA Statistics Division, WAPDA House, Lahore

G. CONSUMER CLASSES

The consumer data obtained from WAPDA AEB Computer Center is transferred from mini computer to Personal Computer format. The entire data is read into files created in dBASE 3+ program. A dBASE III + program is run to split the domestic and commercial consumers into different slabs (Exhibit 1 shows these slabs). Based on these slabs, the consumer classes to be used in the study are defined.

All domestic tariffs are lumped together. All the consumers in the area under study can be divided into a maximum of ten customer classes. Classes are determined according to the consumption patterns.

H. LOAD PROFILES

Based on the overall division average for each customer class, its load profile for the base year is developed. DLF-2 allows up to 96 readings per 24 hours for each class. However, for the purpose of this study an hourly load profile for twenty four hours (24 readings) is suggested for each class. In developing the load profile, the consumption pattern and characteristics of all classes are taken into account.

Increase in usage of electricity by existing consumers is taken into account to develop load profiles for the year 2011 (Horizon Year). The increase in usage can be effectively measured by analyzing the average consumption in each class for three or four preceding years. This is used to determine the average consumption for the horizon year. In case the average consumption historical data is unreliable, approximate figures for increase in consumption have to be used. Whatever

the basis, average consumption calculated for each class for the horizon year is used to develop the load profiles for the horizon year. The load profiles for the horizon year are developed based on the assumption that consumers belonging to medium and high domestic classes would have shifted their load to off peak hours in response to WAPDA's extensive campaigns to restrict use of electricity during the peak hours. The industrial users will largely have the same load shape as in the base year although with an increase in usage of power. An overall distribution of load over a wider time period is therefore anticipated.

I. STUDY PERIOD

DLF-2 requires the definition of the Base Year, Horizon Year and intermediate years and the development of load maps for each study. For a study based on Base Year of 1991, these values could be:

Base Year	1991
Horizon Year	2011

Years for which load maps are required:

1994
1997
2000
2004
2007

The load forecast exercise may be run several times to obtain load maps for all the intermediate years between the base year and the horizon year.

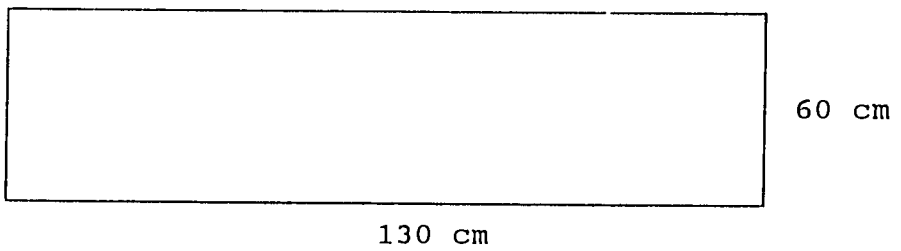
IV. DETAILED FORECASTING METHODOLOGY - GUJRANWALA III

IV. DETAILED FORECASTING METHODOLOGY - GUJRANWALA III

A. DETERMINATION OF SMALL AREA SIZE

The first thing to determine was the size of small areas into which the Gujranwala III Division was to be divided for the purposes of this study. The division map for Gujranwala III was obtained, the division boundaries were marked and the cell size was computed as shown below:

GUJRANWALA III DIVISION MAP



The actual dimensions of Gujranwala III Division shown in the map are 65 km by 30 km represented by a map of 130 cm by 60 cm on a scale of 1:50000.

Length = 130 cm
Width = 60 cm
Scale = 1:50,000

Actual Length = 130 x 50,000 = 6,500,000 cm
= 65,000 m (A)

Actual Width = 60 x 50,000 = 3,000,000
= 30,000 m (B)

Greater value from (A) and (B) determines cell square size:

Computed Cell Size = (A)/264 = 65,000/264 = 247 meters

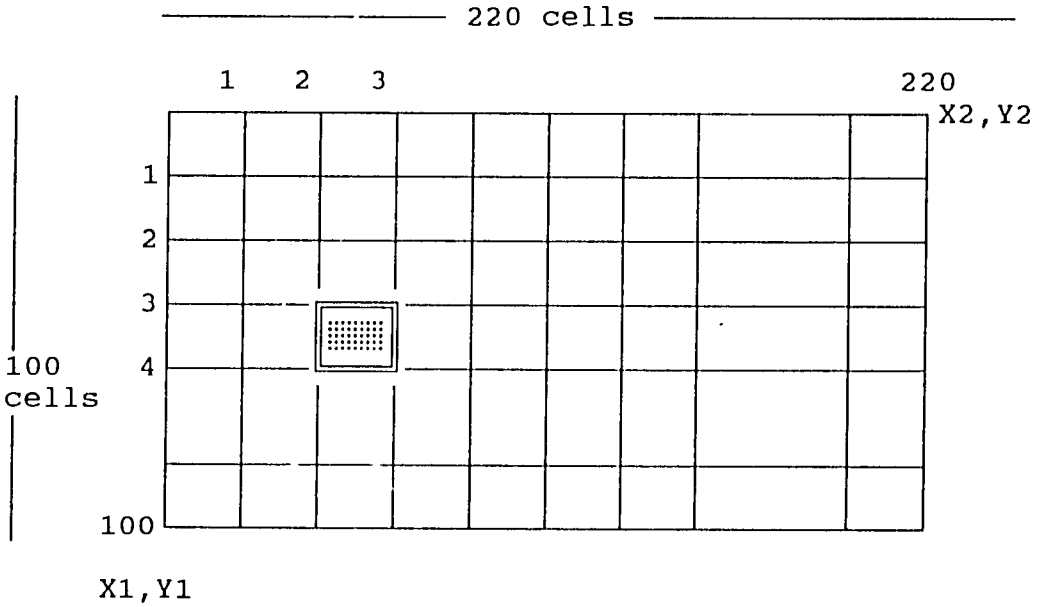
Selected Cell Size = 300 X 300 meters

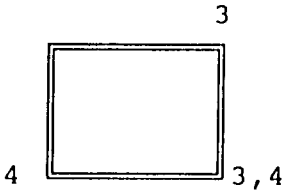
No. of cells on X-Axis = 65,000/300 = 220

No. of cells on Y-Axis = 30,000/300 = 100

For Gujranwala III Division, the grid size selected and used was 220 x 100 cells with each small cell representing 300 x 300 meters.

Gujranwala III Division was thus represented by 220 x 100 cell grid as shown below:





Each cell is addressed by its lower right coordinates as shown above.

B. MAPS USED FOR DATA EXTRACTION

Gujranwala III Division is pre-dominantly a rural area with four towns namely (1) Qila Deedar Singh, (2) Eminabad, (3) Ladhyawala and, (4) Khiali. Eminabad Morr is another locality on the main G.T. Road which is shaping into a small town. Qila Deedar Singh, Eminabad and Ladhyawala have their own town committees whereas Khiali is included in the Gujranwala municipality. Separate maps were collected for these towns and the Eminabad Morr locality for accurate data extraction.

The list shown in Table IV-1 gives a description of maps obtained for Gujranwala III Division and used for data extraction:

TABLE IV-1

NO.	DESCRIPTION / SIZE	SCALE	POLAR COORDINATES MARKED	OTHER INFO.
1.	Gujranwala III Division 130 x 60 cm	1:50000	Yes	i) Rural Batches ii) Sub Div. boundaries iii) Industrial Customers
2.	Qila Deedar Singh 68 x 45.5 cm	1:2640	No	i) Batches
3.	Ladhyawala 74 x 45.5 cm	1:5280	No	i) Batches ii) Industrial Customers
4.	Khiali 62.5 X 82.5 cm	1:5280	No	i) Batches ii) Industrial Customers iii) Housing Societies
5.	Eminabad 52.5 x 37.5 cm	1:4000	No	i) Batches ii) Industrial Customers
6.	Eminabad Morr 62.7 x 34.2 cm	1:5280	No	i) Batches

Rural and urban batches' boundaries, subdivision boundaries, industrial customers for B2 and B3 and housing societies were marked on these batches by the load forecasting team with the assistance of WAPDA staff at the subdivisions.

C. BILLING DATA FROM GUJRANWALA COMPUTER CENTER

Wapda Computer Center Gujranwala maintains the billing record for all the customers in Gujranwala Area Board for the last twelve months. Data prior to the last twelve months at any point in time is saved on computer tapes and can be restored if required.

For determining consumer classes and their consumption patterns, Gujranwala Computer Center was requested to provide twelve month data for each and every customer served under Wapda Division Gujranwala III as per the following ASCII(*) file format:

SR. NO.	COLUMN POSITION	WIDTH	DESCRIPTION
1.	1 - 2	2	Batch Number
2.	3 - 6	4	Location Code
3.	7 - 12	6	Reference No.
4.	13 - 14	2	Tariff Computer Code
5.	15 - 21	7	Apr'92 kWh Billed
6.	22 - 28	7	Mar'92 kWh Billed
7.	29 - 35	7	Feb'92 kWh Billed
8.	36 - 42	7	Jan'92 kWh Billed
9	43 - 49	7	Dec'91 kWh Billed
10	50 - 56	7	Nov'91 kWh Billed
11.	57 - 63	7	Oct'91 kWh Billed
12.	64 - 70	7	Sep'91 kWh Billed
13.	71 - 77	7	Aug'91 kWh Billed
14.	78 - 84	7	Jul'91 kWh Billed
15.	85 - 91	7	Jun'91 kWh Billed
16.	92 - 98	7	May'91 kWh Billed

(*)ASCII : This is the standard data interchange format. An ASCII file can be read into almost any computer program.

Batch Number

Each subdivision is divided into clearly recognized geographical areas called batches. There are twenty batches in each subdivision and a meter reader is responsible to collect meter data for each batch. Batches do not necessarily cover same area or have similar customer density.

These batches are formed taking into consideration travelling time and number of consumers. These may be of any shape and size. Also there might be two batches running across each other. Still they indicate specific geographic locations on the maps. Batch Numbers range from 01, 02, 03... to 20. In addition, there is batch number 24 for Industrial consumers with a load of 70 KW or more.

Location Code

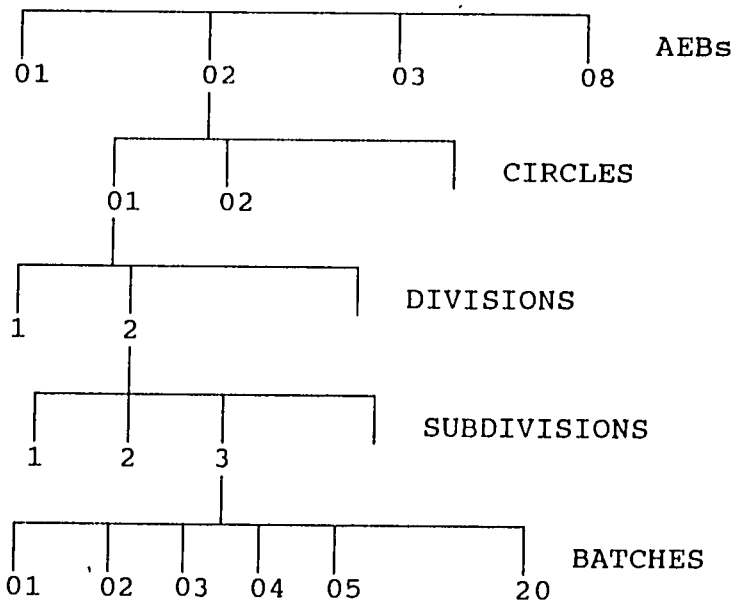
This is a six digit code to identify an area starting from area electricity board and going right down to the subdivision level. Composition of location code is as below:

AA CC D S

AA	--->	Area Board Code	01, 02....08
CC	--->	Circle Code	01, 02....
D	--->	Division Code	1,2,3....
S	--->	Subdivision Code	1,2,3....

e.g. 02 01 2 3

is the code of third subdivision of the second division of the first circle of the second Area Board.



Thus the Location Code plus the Batch Number places the customer within a specific geographic location. The six digit location codes for all locations are defined in the Location Codes Manual.

When billing data was obtained for Gujranwala III Division from the Wapda Computer Center Gujranwala, it was found that the billing database was using a four digit code instead of a six digit code. The preceding zeroes in Area Board and Circle had been removed. Thus all subdivisions in the area under study were being referred by a four digit code as under:

A C D S

A	--->	Area Board Code	1, 2....8
C	--->	Circle Code	1, 2....
D	--->	Division Code	1,2,3....
S	--->	Subdivision Code	1,2,3....

e.g. 2 1 3 4

is the code of fourth subdivision of the third subdivision of the first circle of the second Area Electricity Board.

Reference Number

Each and every consumer is allotted a six digit reference number for billing purposes.

Tariff Computer Code

WAPDA has a number of customer tariffs coded such as A-1, B-1, E1 (1) etc. In the computerized Billing System, two digit numeric codes are used instead of the commonly used tariffs. The tariff indicates the type of the consumer and is the criterion to determine Consumer Class for each customer as shown in Table IV-2.

TABLE IV-2
WAPDA TARIFFS

SR.NO.	WAPDA TARIFF	COMPUTER TARIFF	DESCRIPTION
1.	A-1	01	General Supply-Domestic
2.	A-1 (Tribal)	02	General Supply-Domestic (Tribal areas)
3.	A-2	04	General Supply-Commercial
4.	B-1	07	Industrial - Upto 70kW
5.	B-2	10	Industrial
6.	B-3	13	Industrial
7.	B-4	16	Industrial
8.	C-1 (a)	19	Bulk Supply
9.	C-1 (b)	25	Bulk Supply
10.	C-2 (a)	28	Bulk Supply
11.	C-2 (b)	30	Bulk Supply
12.	C-2 (c)	34	Bulk Supply
13.	C-3	37	Bulk Supply
14.	D (1)	46	
15.	D-1 Punjab	49	Private Tubewells
16.	D (2) Punjab	50	Flat Rate Tubewells
17.	D (2) NWFP	51	
18.	D-1 NWFP	52	
19.	E-1 (1)	55	Temporary General Supply
20.	E-1 (2)	56	Temporary General Supply
21.	E-2 (1)	58	Temporary Indust. Supply
22.	E-2 (2)	59	
23.	E-2 (2)	60	
24.	E-2 (3)	61	
25.	G	72	Public Lighting
26.	H (1)	76	{Residential Industrial
27.	H (2)	79	Colonies}
28.	I	82	Railway Traction
29.	F	99	Seasonal Industrial Supply

Monthly Consumption Data

Fields 5 to 16 in this case show monthly consumption in kWh from April 1992 to May 1991 i.e. for the last twelve months at the time data was obtained. Data for twelve months was obtained to ascertain the Peak Load Month. In case of Gujranwala III, June 1991 was found to be the Peak Load Month. Initially the consumption of July 1991 came out to be the highest but on cross checking, some of the consumption figures were found to be wrong. Doubtful figures were referred to respective subdivisions and were tallied with the Kalamzoo Cards and after making corrections, June 1991 came out to be the peak month. For future studies of Load Forecasting in other areas, the planners need NOT obtain the data for all twelve months. They can simply use for the data of Peak Load month only. This will substantially reduce the strain on hard disk storage and allow the user to perform analysis much more quickly. Another approach is to obtain data for all twelve months but once the peak month is selected, the other eleven months data maybe deleted to conserve disk space and allow quicker data analysis.

D. ANALYSIS OF BILLING DATABASE

a. Downloading and dBASE III File Creation

The billing database was collected on tape in the form of American Standard Code for Information Interchange (ASCII) from the WAPDA Computer Center Gujranwala. The procedure adopted to make this data compatible with the DLF-2 input requirements is as follows.

The billing data file of Gujranwala Division III was loaded in the VAX 3800 computer at L.D.A. Plaza. This data file LFGRW was down loaded from the VAX 3800 to PC through the software Smarterm. This data file was backed up from the PC networked with VAX 3800 and restored to the PC at EBASCO office.

A dBASE III+ file was created according to the structure of the billing data file. This file was appended from the down loaded data already restored. A typical dBASE III+ interactive session would be as follows:

- **CREATE GRW3**

STRUCTURE OF THE dBASE III FILE

NAME	TYPE	LEN	DEC
BATCH	C	002	000
SDIV	C	004	000
CNUMB	C	006	000
TARIFF	C	002	000
NTARIFF	C	002	000
KWH1	C	007	000
KWH2	C	007	000
KWH3	C	007	000
KWH4	C	007	000
KWH5	C	007	000
KWH6	C	007	000
KWH7	C	007	000
KWH8	C	007	000
KWH9	C	007	000
KWH10	C	007	000
KWH11	C	007	000
KWH12	C	007	000

- **APPEND FROM LFGRW.TXT SDF**

On viewing the file appended from the ASCII data file some unwanted characters were found, which rendered all the information useless. So the tape was taken to the WAPDA Computer Center Lahore and got corrected.

After getting the ASCII data file corrected from the WAPDA Computer Center Lahore the procedure of appending outlined above was repeated. But again the appended dBASE III+ file was not in the desired form. As the original data file included end of line markers the appending process treated every line of data as an independent record. A small program was written to amend this file so that it correctly depicted the information.

The tariffs like General Supply Tariff A-1, Bulk Supply Tariff C-1, Temporary General Supply E-1, Public Lighting Tariff G, One Point Residential Colonies Supply Tariff H cater for domestic consumer class, they were lumped into one tariff. Same was done for other tariffs. A new field NTARIFF was added to the file structure for this purpose and a program was written and used to lump the relevant tariffs in this new field. The same program can be used for future studies.

Lumping of tariffs was done by combining tariffs for same type of consumers into a common tariff. A program was developed to check for any unaccounted tariffs but no such tariff was found.

b. Peak Month Selection

A program was written to calculate the consumption for each month for all the consumers to determine the peak month. The preliminary execution of the program yielded July 1991 as the peak month according to the billing data.

Some domestic and commercial consumers were found to have a peak monthly consumption which was well over 10,000 kWh. The data for these consumers was isolated for cross checking with the billing data. On comparing this data with the billing data of the respective subdivision, it was found that the abnormal consumption was due to clerical error in recording. The dBASE III+ file was edited to incorporate the corrections suggested by the subdivisional staff.

After correcting the consumption data, the peak month was recalculated from corrected data. The new Peak Month came out to be June 1991.

c. Consumer Classes

A program was written to calculate the consumer break up into different consumption slabs. The program split the consumer counts for domestic and commercial consumers into different consumption slabs for the Peak Month and printed the results. On the basis of the consumption slab counts the consumers were divided into ten classes as DLF-2 limits the number of consumer classes to ten. The dBASE III+ file GRW3 was split into the ten smaller ones for these classes. Only the required fields i.e. TARIFF, BATCH, SDIV, CNUMB, and KWH of the peak month were copied to these files to make the data handling more convenient.

```
. USE GRW3
. COPY FIELDS TARIFF, BATCH, SDIV, CNUMB, KWH TO DOM_L
FOR KWH > 0 .AND. KWH < 201 .AND. NTARIFF = '01'
```

Similar commands were used for commercial consumers and the class statistics were computed (Exhibit - 3A). Tubewell and industrial consumers were already categorized by their tariffs. The final customer classes are shown in 'Exhibit -3B'

d. Final Analysis Outputs

A program was written to calculate the consumer count for each batch for each subdivision for all the classes. In addition the program also computed the number of consumers with zero consumption. This latter number was distributed in the different classes of the category proportionately. Another program was written to print the results of this distribution. Exhibit - 4 shows these results. Same program can be used for future load forecast studies.

E. DEVELOPMENT OF LOAD PROFILES

For input to DLF-2 program, a load profile has to be prepared for each consumer class. In the present study, ten different load profiles were to be prepared -- one for each of the consumer classes. By multiplying the customer counts and the load profiles, the DLF-2 program determines the system profile. The basic assumption in developing a load profile is that all consumers belonging to that particular class have the same load characteristics. The class load profile therefore may not reflect the true position when compared to individual consumers in that class. However it gives an approximate average load pattern for a particular class.

Domestic consumers were grouped into three classes i.e. Low, Medium and High consumption groups according to their energy consumption in the peak month. Gujranwala III is primarily a rural area. In such an area, the low domestic consumers use electricity primarily for lighting. Most may have an electric fan or two in addition to bulbs. Some of the consumers will occasionally use radio sets. People belonging to this class start the day early and retire sometime in the middle of the evening. The profile for this class is based on their living pattern. The Domestic Medium class consumers will mostly be based in towns with some representation in villages. A number of consumers in this class will have access to television sets with peak viewing hours between 6:00 PM to 10:00 PM. Some consumers in this class might use refrigerators and some other electrical appliances. Quite a few will also have electrical irons. For this class retiring hours will be late evening. Use of lights and fan through the night for this class is much more pronounced compared to Domestic Low users. Domestic High represents the most affluent class in Gujranwala III. This class uses the most electrical appliances including air conditioners. Consumers belonging to this class therefore will have a much heavier load at night as compared to the other two domestic classes.

The Commercial Low class generally consists of food stalls, small shops and general stores where items of every day use are sold. Small bookshops, barber shops and other service sector consumers are also included in this category. Average consumption of this category is very small and almost none of these is expected to operate at night. Some of these, by nature of their work, may start early in the morning but most are expected to have business hours between 9:00 AM in the morning to 9:00 PM in the evening. Some of these may be open till midnight. The Commercial Medium class consists of private business concerns, public offices and educational institutions. Another type of consumer in this class is the video shops whose prime business hours are between 6:00 to 10:00 PM at night. Restaurants are also included in this class and those along the main road are expected to be open till late at night. The few cinema halls in this area are also categorized in medium commercial class.

Tubewells are used for both irrigation purposes and for supplying water for common usage. In summers, irrigation through most tubewells is done either in the early morning or in the late afternoon. The hours in between are generally considered too hot for working. Some tubewells, however, will still be functioning in these hours. Since billing for Flat Rate Tubewells is done at a fixed rate, therefore it is difficult to obtain accurate consumption figures for this class of consumers. Average consumption figure is used for developing load profile for this class just as for other classes. Tubewells which are used to provide tap water are expected to function at all times.

Industrial Low consumers generally comprise of fabrication customers with lathe machines, workshops, small scale flour milling and rice husking customers in villages and small power loom customers. All these customers have sanctioned power of less than 70 KW and are categorized under B-1 tariff. These customers operate during the day time except for power loom customers which may run three shifts. Bulk of the load for this consumer class is in the daytime in normal working hours. Industrial Medium consumers have a sizable population in Gujranwala III Division. These might consist of metal works, foundries, cold storages, ceramic, tile and straw board factories, rice, flour and ghee mills, detergents and dyeing and finishing customers. Most of these operate in two or three shifts with only a few running single shifts. Customers like disposal works are only operated when required to pump out water. Cold storage and ice factories are seasonal customers being operated mostly in the summer months. Almost all the consumers in the Industrial High category run in three shifts. At night the lighting requirements add to the daytime load for these customers as indeed for those Industrial Medium consumers which run night shifts.

Load profiles for all the consumer classes were initially developed on the basis of their average consumption in the peak month. The shape of the system profile computed by the DLF-2 program was compared with that of the actual loading data obtained from the field offices for the feeder network in Gujranwala III Division. The individual class profiles were then modified to make the computed system profile shape similar to that generated by actual data.

An effort was made to reconcile these differences and bring them to a bare minimum by accounting for difference in living styles of various classes. The load profiles were prepared based on average consumption and anticipation of the number and types of appliances each class has access to.

The load profiles of all the ten classes are given in Exhibit '2A' and '2B'. The base figures of per day consumption has been taken from average monthly consumption of that class obtained from the billing database.

The average daily consumption figures used for developing load profiles for both the present and the horizon years are given in Table IV-3. The percent increase applied to the base year figures is also listed. The average daily consumption figures for year 2011 given here are those which were actually used in developing load profiles. These were slightly adjusted to make logical load profiles and therefore may be different from the calculated figures.

TABLE IV-3
AVERAGE DAILY ENERGY CONSUMPTION
BY CUSTOMER CLASS

CLASS	1991 (kWh)	% INCREASE	2011 (kWh)
Domestic-Low	2.37	50%	3.56
Domestic-Med	11.80	60%	18.88
Domestic-Hgh	29.50	80%	53.10
Commercial-Low	1.70	50%	2.55
Commercial-Med	15.20	80%	27.36
Tubewell-Pri	32.77	20%	39.32
Tubewell-F/R	268.50	25%	335.63
Industry-Low	42.10	60%	67.36
Industry-Med	1340.00	50%	2010.00
Industry-Hgh	9250.00	40%	12950.00

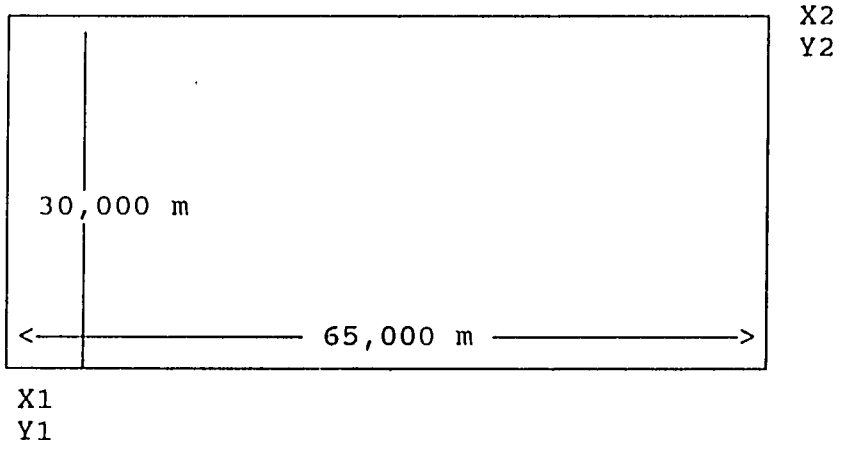
F. DATA EXTRACTION FROM MAPS AND TRANSFORMATION

As mentioned earlier, six maps were used to allocate consumer distribution in the DLF-2 cell wise format. Here we shall take the example of Gujranwala Division III Map No. 1 to illustrate the procedures of data extraction from the maps into tabular format.

a. Geographical/Rectangular Location of Area

Before going into the details of data extraction, we must determine the physical location of each map within the Gujranwala III Division map. The Gujranwala III Division map came out to be 65,000 meters on X-axis and 30,000 meters on Y-axis. The X,Y coordinates for the division were computed from its polar coordinates marked on the SOP division map. WAPDA is using the Lambert rectangular coordinate system therefore all the X,Y coordinate values shown in meters refer to the Lambert system.

Gujranwala III Division limits are reproduced below for convenience:



Distance on X-Axis = 65,000m --- "A"
Distance on Y-Axis = 30,000m --- "B"

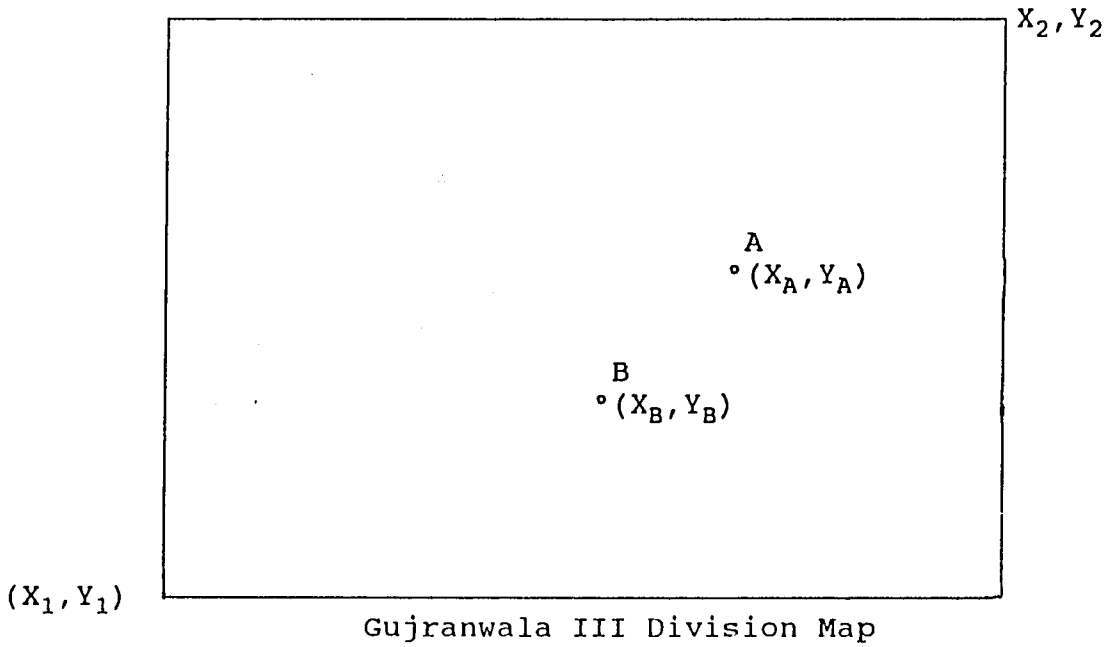
The grid size for Gujranwala III Division was determined to be 220 x 100 cells with each cell measuring 300 m x 300 m.

b. Placement of Maps in the Division Grid

None of the maps had rectangular or polar coordinates marked. However, the Gujranwala III Division SOP Map showed all the main roads, railway line and crossing and several other identifiable geographical features which could be located on other maps. These common features were identified in the division map and their Lambert coordinate calculated. Two sets of the common coordinates were identified on all the other maps and thus their correct position was located vis-a-vis the division map. By this method each map was placed at the right position in the Division Grid Map. The illustration below shows the placement of all maps in the grid.

This calculation is best illustrated with the following example:

We have the Gujranwala III Division map with geographical features 'A' and 'B' as marked.



Gujranwala III Division Map
Scale 1:50,000

The lower left coordinates (X_1, Y_1) and upper right coordinates (X_2, Y_2) of the division map are computed from its polar coordinates (longitude, latitude) given on the SOP map. Computer program CONVERT available with WAPDA is used for this computation. These values are:

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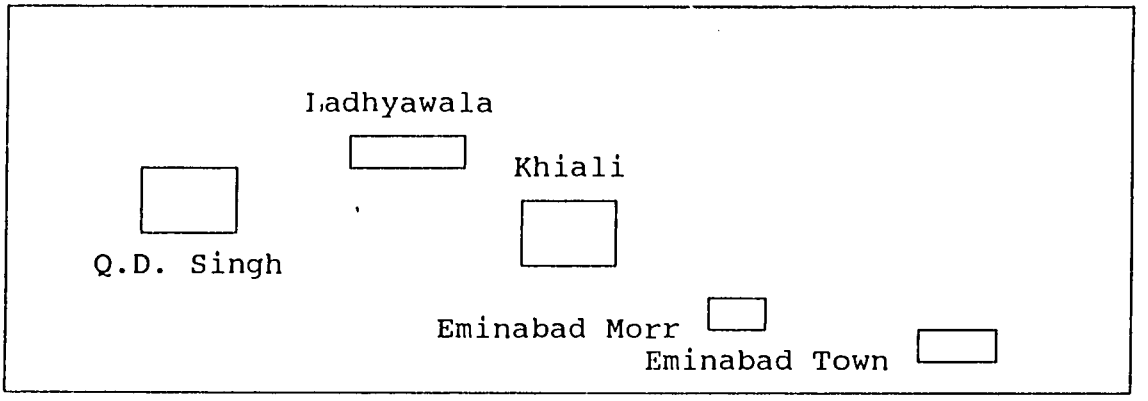
X1 = 3,289,800m Y1 = 873,600m
X2 = 3,354,800m Y2 = 903,600m

The Lambert Co-ordinates of geographical features 'A' and 'B' are calculated. The co-ordinates of feature 'A' are XA, YA and those of feature 'B' are XB, YB.

Feature 'A' is then located in the other map where it is present and the same technique is applied to derive its lower left and upper right Lambert co-ordinates. For example, a main road and railway intersection was used as a reference point for two maps. Using the division map as the main reference, the Lambert co-ordinates of all the maps were ascertained. These maps were then placed in DLF-2 120 x 100 cells grid map as shown below:



The grid layout map identifying the position of each map in the Gujranwala III Division Map is shown above. This map is not drawn according to scale but it gives an approximate picture of the layout. This map was actually drawn on a big sheet with horizontal and vertical grid lines. It was used to derive the cell addresses covered by each map. These cell addresses were fed into Lotus 1-2-3 spreadsheet, to serve as input sheets for extracting data from the maps. Each little square on the grid represented 300 x 300m of the actual area.

c. Data Input Forms

Data Input Forms were prepared for each map in the following format using the Lotus 1-2-3 spreadsheet:

			Sub Division Name						
Sr.No.	X	Y	B1	B2	B3	.....	B20	X	Y

The above illustration shows an input form for all twenty batches of a subdivision. These batches were shown in a single map so a single input sheet consisting of a number of pages has been prepared for them. Sr. No. column shows the serial number of cell. X and Y columns show the corresponding DLF-2 grid cell values of the particular cell. The X,Y values signifying cell address are repeated at the end for clarity. B1, B2, B3 ... B20 are the batch numbers of a particular subdivision for which data input form has been prepared. Exhibit - 5A shows a blank input form while Exhibit - 5B shows a completed one for Ladhay Wala Town Committee Map.

The data input form is handed over to the planner who is assigned to extract data from the maps. Input sheets are prepared separately for the following consumer types:

- Domestic Low, Medium & High
- Commercial Low & Medium
- Tubewells Private & Flat Rate
- Industry B1 (Low)

Data input for medium (B2) and high (B3 & above) consumption industries is done in a different way and is explained in a later section.

d. Data Extraction

The map from which data is to be extracted is placed on the drawing table and stuck on to it firmly with adhesive tape. A transparent sheet with horizontal and vertical grids marked on it is placed on top of the map and stuck firmly in the same way. The grid on the transparent sheet is drawn according to the scale of the actual map. Each cell on the grid corresponds to 300 m x 300 m on the map. For example if the

map is drawn on scale of 1:10000, the grid square on the transparent sheet shall be of side 3 cm.

1 : 10000 scale implies that

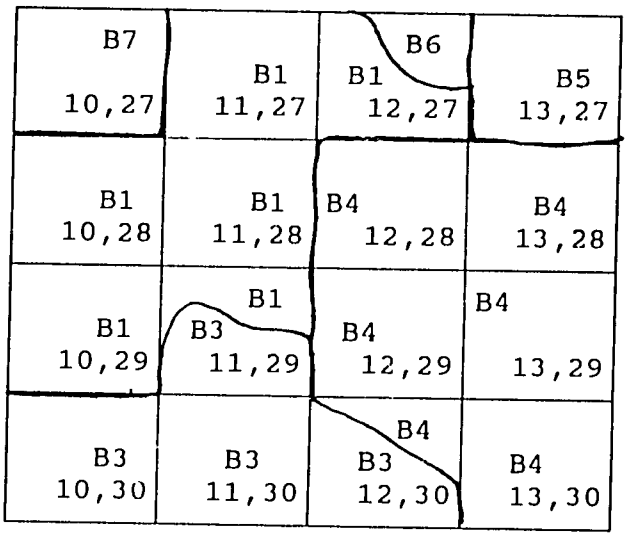
10,000 cm	=	1 cm on scale
1 cm	=	1/10,000 cm on scale
30,000 cm	=	1/10,000 x 30,000 = 3 cm

On one grid the side of a square is thus 3 cm so it is a 3 cm square. An area of 300 x 300m encompassed by a square on the transparent sheet is equivalent to the same area on the map on which it is overlaid.

The squares on the transparent grid are marked by cell addresses as governed by the DLF-2 grid. The cell addresses correspond to the input sheet available with the planner.

The planner begins for example by filling the input sheets for the Domestic Consumer classes. His objective is to re-distribute data from its batch wise division to cell wise division.

Grid Map Overlaid on
Batches of actual map



As we can see in the above illustration, data for Batch B1 is to be re-distributed into not less than six cells on the overlay grid. Addresses of these cells are:

10,28	11,27	11,29
10,29	11,28	12,27

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The first criterion of allocating a percentage weightage to each cell by Batch B1 is the area of the cell covered by the Batch. The second consideration is the location of the cell, whether it is close to urban area, to a railway track, to a main road etc. Based on the geographical information provided by the map and his own knowledge of the area under study, the planner uses his judgement to come to an accurate weightage for each cell. Negative factors could be the presence of a graveyard, a factory premises, a pond, marshy area, forest land, arid land, cultivated land etc. After weighing all the factors shown in the map the planner may have the following figures:

CELL	PERCENT
10,28	20
10,29	10
11,27	25
11,28	30
11,29	5
12,27	10
Total	**100**

Allocation in terms of percentages as shown above is a convenient way to extract data.

e. Data Input and Calculation

Data extracted from maps and entered in Lotus format input sheets (Refer to Exhibit - 5A) is now entered in the computer. Due to extra ordinary number of cells in each area, the data had to be split into several files even for the same subdivision. In case of a single map showing more than one subdivision, the data files contained information on all subdivisions with all the batches which were marked on the map. The data was entered either through Lotus 1-2-3 or a CLIPPER data entry program specially developed for this purpose.

Lotus Format

This format was adopted for the extracted data that showed some order or symmetry so that the Lotus 1-2-3 / Copy command could be used to reduce the manual entries. Exhibit - 5B shows a Lotus spreadsheet in which data has been entered. The data was split basically on the basis of consumer classes. For example, all three domestic classes were lumped together. Similarly both commercial classes appeared together.

Exhibit - 5B shows the distribution of the two commercial consumer classes (Low and Medium) into DLF-2 cell wise format. The two new rows titled COM-LOW and COM-MED contain the number of consumers in each batch. These figures were extracted from the Ladhay Wala Town Committee Map as described earlier. The last two columns give the DLF-2 cell wise distribution of the commercial consumers for each class. The calculation is based on the following example:

A ====> Commercial - Low Cell 101,42 Distribution

B ====> Commercial - Med Cell 101,42 Distribution

A = 50/100 x 52 + 0/100 x 96 + 10/100 x 81 + 5/100 x 125

B = 50/100 x 3 + 0/100 x 1 + 10/100x 4 + 5/100 x 2

Generalized formula is explained as below:

Cell Address (102,42) = A

- Proportions allocated by Planner for the cell from each Batch:

  Batch B3 (50) = P1
  B4 (0) = P2
  B5 (10) = P3
  B6 (5) = P4

- Totals of Proportions for each Batch

  Batch B3 (100) = T1
  B4 (100) = T2
  B5 (100) = T3
  B6 (100) = T4

- Number of Commercial-Low Class Consumers for each Batch

  Batch B3 (52) = CL1
  B4 (96) = CL2
  B5 (81) = CL3
  B6 (125) = CL4

- Commercial-Low Consumers calculated for Cell (101,42)

  A = P1/T1 x CL1 + P2/T2 x CL2 + P3/T3 x CL3 + P4/T4 x CL4
  (Value rounded to integer)

Similarly, the same formula for Commercial-Medium shall be:

$$B = P1/T1 \times CM1 + P2/T2 \times CM2 + P3/T3 \times CM3 + P4/T4 \times CM4$$

Number of Batches in this case was limited to four i.e. from B3 to B6. For any other spreadsheet the general formula shall be:

$$A = P1/T1 * CL1 + P2/T2 * CL2 + \ldots + Pn/Tn * CLn$$

Where:

A is the desired consumers in a cell
P1 is the proportion allocated to that cell
T1 is the total of allocated proportion
CL1 is the actual total of consumers in that batch and,

n is the total number of batches.

The formula is repeated by using the Lotus / Copy command to all the cells and for each consumer class represented by different columns. Similar calculations are made for other classes like Domestic, Tubewells and Industry Low (B1 Tariff). The allocated proportions in all classes will most certainly differ from each other resulting in a cell wise distribution which is distinct for each consumer class.

Data Entry Program

In case the extracted data did not show any symmetry or there were not many cells in it, a data entry program was written and compiled in CLIPPER to accelerate the process. This program was particularly useful for areas where customers were distributed over cells located far from each other. The user has to enter only the cell address and the percentage (or number) of consumers in each cell. The program places the percentage (or number) in the relevant batch number which the user enters only once for all the cells of that batch. The program finally picks up the batch totals from the relevant dBASE III + files already created and calculates the cell totals. The files are converted to Lotus 1-2-3 format using the Lotus Translate Utility. Same program can be used in future studies.

f. Data Transformation to DLF-2 format

The final data obtained by the procedures detailed above consisted of one or more lotus 1-2-3 files for every class for each subdivision. For the Ladhay Wala Subdivision, we had the following Lotus data files for its rural batches.

LWDOMLOW.WK1
LWDOMMED.WK1
LWDOMHGH.WK1
LWCOMLOW.WK1
LWCOMMED.WK1
LWTW49.WK1
LWTW50.WK1
LWINDLOW.WK1

The urban batches were, however, entered through the data entry program. Following are the resulting data base files:

LADOMLOW.DBF
LADOMMED.DBF
LADOMHGH.DBF
LACOMLOW.DBF
LACOMMED.DBF
LATW49.DBF
LATW50.DBF
LAINDLOW.DBF

These files were translated to Lotus 1-2-3 format using the Lotus Translate Utility to get the following files:

LADOMLOW.WK1
LADOMMED.WK1
LADOMHGH.WK1
LACOMLOW.WK1
LACOMMED.WK1
LATW49.WK1
LATW50.WK1
LAINDLOW.WK1

Files of respective classes were combined in Lotus 123 e.g. LWCOMLOW.WK1 and LACOMLOW.WK1 were combined in the file 2137C4.WK1. Same methodology was applied to the rest of the files. This resulted in one Lotus 1-2-3 file for every class for each subdivision. For each customer class there were four such files, one for each subdivision. For example for class 4 (Commercial Low) following files were obtained.

2136C1.WK1	: Q.D. Singh Subdivision Commercial Low
2137C1.WK1	: Ladhay Wala Subdivision Commercial Low
2138C1.WK1	: Khiali Subdivision Commercial Low
2139C1.WK1	: Emin Abad Subdivision Commercial Low

These four files were combined in one file named C1.WK1. This file was sorted and the cells with zero consumer counts were deleted. In cases where same cell address appeared more than once, the consumers were summed up for all these occurrences into one cell and the duplicate entries were deleted. The same procedure was repeated for all the remaining classes except Industrial Medium and High where the cells were too few to cause any duplication problem. The process generated the following files:

C1.WK1	: Domestic Low Lotus File
C2.WK1	: Domestic Medium Lotus File
C3.WK1	: Domestic High Lotus File
C4.WK1	: Commercial Low Lotus File
C5.WK1	: Commercial Medium Lotus File
C6.WK1	: Tubewell (Private) Lotus File
C7.WK1	: Tubewell (Flat Rate) Lotus File
C8.WK1	: Industrial Low Lotus File
C9.WK1	: Industrial Medium Lotus File
C10.WK1	: Industrial High Lotus File

Lotus Translate Utility was used to convert these files into dBASE III format. The program asks for file source directory and file name to convert. The program then asks for the destination directory and file name. The following names were used:

C1.DBF	: Domestic Low dBASE III File
C2.DBF	: Domestic Medium dBASE III File
C3.DBF	: Domestic High dBASE III File
C4.DBF	: Commercial Low dBASE III File
C5.DBF	: Commercial Medium dBASE III File
C6.DBF	: Tubewell (Private) dBASE III File
C7.DBF	: Tubewell (Flat Rate) dBASE III File
C8.DBF	: Industrial Low dBASE III File
C9.DBF	: Industrial Medium dBASE III File
C10.DBF	: Industrial High dBASE III File

At the top of each of the dBASE III+ files a DLF-2 command was added. A typical dBASE III+ interactive session will look like :

```
. USE C1
. COPY TO BASE
. USE
. USE BASE
. GO TOP
```

```
. INSERT
. REPLACE X WITH 40
. REPLACE Y WITH 1
. GO BOTTOM
. APPEND BLANK
. APPEND BLANK
. REPLACE X WITH 40
. REPLACE Y WITH 2
. APPEND FROM C2
```

The last five commands were repeated eight more times to get the integrated dBASE III+ file BASE.DBF. The following command sequence converted this file into the ASCII file BASE.TXT.

```
. APPEND BLANK
. APPEND BLANK
. REPLACE X WITH 90
. COPY TO BASE SDF
```

g. Horizon Year Customer Distribution Files

Using the historical customer counts from the Consumers Database, growth rates were calculated by linear regression for each customer class. The figures for year 1991 taken from the consumers database are slightly different from those obtained from the Billing Database. Linear regression was performed on Consumer Database figures. The linear growth rates obtained were tapered to account for saturation in growth and applied to the number of consumers calculated from the billing database. Historical customer counts for each class are listed in Table IV-4.

TABLE IV-4
CUSTOMER COUNTS FROM CONSUMER DATABASE

CLASS	1988	1989	1990	1991
Domestic-Low	25,328	31,604	35,778	40,057
Domestic-Med	3,212	4,009	4,537	5,082
Domestic-Hgh	238	296	335	375
Commercial-Low	3,902	4,228	4,532	4,922
Commercial-Med	121	131	141	153
T/Well-Private	2,437	2,653	2,662	2,649
T/Well-Flat Rate	477	480	519	561
Industry-Low	818	904	1,030	1,221
Industry-Med	28	30	25	42
Industry-Hgh	5	6	5	8

The growth rates calculated by linear regression were tapered to allow for saturation in growth and then applied to each consumer class figures obtained from the Billing Database. The same numbers were used in spatial distribution. Growth rates used for each class with their counts in base and horizon years are given in Table IV-5.

TABLE IV-5

METHOD 1

CUSTOMER CLASS	BILL.D/B NUMBER IN 1991	REG. PERCENT GROWTH	TAPERED PERCENT GROWTH	NUMBER IN 2011
Domestic-Low	39,962	6.4%	3.3%	75,843
Domestic-Med	5,070	6.4%	3.5%	10,177
Domestic-Hgh	376	6.3%	3.5%	754
Commercial-Low	4,870	4.4%	2.5%	8,009
Commercial-Med	151	4.6%	2.6%	252
T/Well-Private	2,649	1.5%	0.7%	3,023
T/Well-Flat Rate	561	2.5%	1.1%	705
Industry-Low	1,221	6.0%	3.1%	2,260
Industry-Med	37	5.3%	3.9%	80
Industry-Hgh	6	6.5%	6.5%	21

The growth factors were applied to ten dBASE III files containing base year customer counts. This yielded another ten dBASE III files. The above procedure was repeated to combine these ten files into one dBASE III file HORIZ.DBF and ultimately the ASCII file HORIZ.TXT. Cell Saturation limits for consumer growth of each class were decided which are as follows:

CLASS	LIMIT
Domestic Low	450
Domestic Medium	100
Domestic High	11
Commercial Low	200
Commercial Medium	10
Tubewell (Private)	3
Tubewell (Flat Rate)	3
Industrial Low	40
Industrial Medium	4
Industrial High	2

For those cells which exceeded the maximum in base year, no growth is done and these values pass on to the horizon year unchanged e.g.

			BASE	HORIZON
Cell	10,50	DOM-LOW	462	462

For the rest of the cells the growth is applied till the saturation reaches. The excess consumers are distributed in the adjoining cells as well as in the cells with future growth potential. For each class a LOTUS 1-2-3 file was created in the format:

X	Y	A
21	40	90
65	72	23

where x,y and A denote the cell address and the number of consumers in the cell respectively.

These ten files were also converted into the dBASE III files from where they were combined in one file named ZERO DBF and finally the ASCII file ZERO.TXT using the procedure outlined above. (Exhibit - 6) These files contain those cell addresses which had no consumers in the base year but some growth in the horizon year.

In the second method, it was decided to use different growth rates in different time periods for all the classes. The idea was to support accelerated growth rates in the initial years and decrease them progressively as we approached the horizon year. It was felt that this would yield better results since the Gujranwala III Division showed appreciable development potential for the industrial sector. Also the development of industry is bound to improve quality of life and bring greater affluence for the people belonging to this area.

The growth rates used and the number of consumers in the horizon year for each class are given in Table IV-6.

TABLE IV-6

METHOD 2

CLASS	<-------- GROWTH RATES ----------> 1991-96	1997-00	2001-05	2006-11	NUMBER 1991/2011
Dom-Low	9.0%	4.5%	3.5%	3.0%	39,962 103,987
Dom-Med	9.5%	5.0%	4.0%	3.0%	5,070 14,096
Dom-Hgh	10.0%	5.5%	4.5%	3.0%	376 1,118
Com-Low	9.0%	6.0%	5.0%	3.0%	4,870 14,420
Com-Med	10.0%	7.0%	5.5%	4.0%	151 524
T/W-Pri	2.6%	1.4%	0.8%	0.5%	2,649 3,314
T/W-F.R	4.0%	2.5%	1.2%	1.0%	561 844
Ind-Low	12.0%	8.0%	4.0%	3.0%	1,221 4,255
Ind-Med	12.0%	8.0%	4.0%	3.0%	37 130
Ind-Hgh	10.0%	7.5%	5.0%	4.0%	6 21

In this method, the growth rates were applied to the global model in the DLF-2 program and the program was allowed to compute the increase in number of consumers in each class. It was run successively to allow separate growth rates to be applied for different periods. For each class, the growth factor was determined by dividing the horizon year number by the base year number. The base year maps of each class were then multiplied by the corresponding factor to obtain the horizon year map. A new technique is being tested to account for the cells which exceed the maximum permissible values for each customer class. This technique uses a transfer file to take care of all the cells which have already exceeded the maximum limit in the base year and also those cells which exceed the limits in the horizon year after growths have been applied.

The spatial distribution of the horizon year consumers assumes that new consumers will grow in 90% of the exiting cells and 10% new cells. The distribution of consumers in new cells is

done manually according to the information available on areas with growth potential and also in cells adjoining those which are getting saturated. The number of consumers obtained by applying multiple growth factors in the second method are spatially distributed in horizon year maps. Load maps generated by the second method will be used for Subsite and Feedersite studies.

G. DATA INPUT IN DLF-2 ON VAX-3800 MINICOMPUTER SYSTEM

After entering into the DLF-2 program, the user shall undertake the following steps:

1. The data file for area under study is created. It is named by the user to distinguish it from a variety of other files. The data file name in this case is GRW3.

2. Consumer classes are defined. In one case study, we have ten consumer classes as defined in an earlier section.

3. The Base and Horizon Year are defined. In this case 1991 is the Base Year and 2011 the Horizon Year.

4. The Load Maps are available for five intermediate years between the base and horizon years. These five years have also been defined. The program can be run successively to obtain load maps for all the intermediate years as was done in this study.

5. Load Profiles are to be entered for each class for Base and Horizon years. Exhibit '2B' shows the Load Profiles in tabular form for each class for Base and Horizon Years. The Horizon Year Profile data is computed by applying growth factors indicating increase in power consumption of each class.

6. S-Curve is entered to indicate the growth pattern. The S-Curve is developed based on the overall load growth in the area. The values on the curve are on a per unit basis with starting point as zero and the final value at one. The S-Curve shape

determines the division of load between cells and it does not have an effect on the overall load.

7. Data collected for consumer distribution on diskettes in ASCII format is read into the program. This is accomplished in two steps.

   a. At each AEB Planning H/Q site, one personal computer is hooked up to the VAX-3800 mini computer. The PC and the mini computer communicate through a software package like SmarTerm. Physically they are interfaced by a serial cable. SmarTerm is loaded and the PC ASCII file is converted to an equivalent ASCII file in mini computer. All ASCII files on PC format are then converted to the mini format and stored in the hard disk storage of the VAX mini computer.

   b. DLF-2 allows reading of ASCII files into its Spatial Database consisting of all the consumer classes. The ASCII data from all the files is then transferred to appropriate Maps in the DLF-2 format as described earlier.

8. Housing societies data is used to determine the initial growth years of all cells which have a zero value in the Base Year but are marked for development. In this exercise the housing societies are physically marked with an enclosed boundary on the maps. By overlaying the appropriate grid form, all the relevant cells can be given an initial year of growth. For all approved housing societies, the initial year of load growth has already been obtained.

H. PROCEDURE FOR UPLOADING DATA TO VAX

SMARTERM Software is capable of enabling a PC to talk to VAX. It can be used both for uploading and downloading data. The concern here is uploading of data.

Customer Spatial Distribution Data files in ASCII were prepared on PC, and now these files are to be transferred to VAX. These files will be used as Card image files for all consumer classes in DLF-2.

Step 1:

To go to SMARTERM Directory on PC, Type
E:\>CD\ST240 <Enter>

Insert diskette in drive 'A' having ASCII files.
E:\ST240>COPY A:*.* <Enter>

For loading SMARTERM: Type
E:\ST240>ST240 <Enter>

Which configuration? <1> :
Press 1

Step 2:

By doing so, the user will have a blank screen with blinking cursor. Press enter key and PC will work as terminal of VAX and ask for user name and password. User name and password are entered to work in the desired area.

User Name: XXXXX <Enter>
Password : YYYYY <Enter>
(XXXXX and YYYYY represent the User Name and Password for the area in which the user is authorized to work.)

If the correct User Name and Password are entered, the user will have the prompt with a XXX $ sign.

Step 3:

Before data is transferred, a file has to be created which will accept this data on the VAX. Therefore, type:

XXX $ Create FileName.DAT <Enter>

File name will be one of the card image files, for instance

BASE.DAT. For practice SAMPLE.DAT is created.

Press Alt T to have uploading menu.

Step 4:

Type File Name (ASCII) for example BASE.TXT to be transferred to VAX and enter it.

Press Enter key to begin transmitting file.

Step 5:

To return to VAX prompt XXX $, press the following keys together:

a) Alt T
b) Ctrl Z

Step 6:

If the user wants to upload another file, repeat the procedure from Step 3. If the user wants to end uploading of data:

Type LO <Enter>

Press Alt X and you will be back to PC Prompt.

I. INSTRUCTIONS FOR DLF-2 EXERCISE ON VAX-3800

Three databases are setup for Gujranwala III Division. These are 1) Global 2) Spatial and 3) Load. Global and Load data is stored in one file and Spatial Data in another file. Data has to be entered in all three in proper sequence. For Method 1, this sequence of steps is described below :

1. Define base year, five study years and horizon year.
(GLOBAL MODEL)

2. Assign names to grid maps. For example you want to assign new names for customer classes (base and horizon years).
(SPATIAL MODEL)

3. Initialize all grid maps.
(SPATIAL MODEL)

4. By using card image files, fill map from 1 to 10 with base year customer counts and maps 11 to 20 with horizon year customer counts.
(SPATIAL MODEL)

5. Initialize profiles for all customer classes for present (base) and horizon years.
(LOAD MODEL)

6. Enter data for profiles of all customer classes for present and horizon years.
(LOAD MODEL)

7. Compute system profile for present and horizon years.
(LOAD MODEL)

8. Enter annual growth rate for each class. Apply growth rates to year 1991.
(GLOBAL MODEL)

9. Enter S-Curve data.
(GLOBAL MODEL)

10. Execute Deterministic Load Forecast Algorithm.
(SPATIAL MODEL)

For Method 2, a slightly different sequence of steps is followed. This sequence is given below:

1. Define base year, five study years and horizon year.
(GLOBAL MODEL)

2. Assign names to grid maps. For example you want to assign new names for customer classes (base and horizon years).
(SPATIAL MODEL)

3. Initialize all grid maps.
(SPATIAL MODEL)

4. By using card image files, fill map from 1 to 10 with base year customer counts.
(SPATIAL MODEL)

5. Initialize profiles for all customer classes for present (base) and horizon years.
(LOAD MODEL)

6. Enter data for profiles of all customer classes for present and horizon years.
(LOAD MODEL)

7. Compute system profile for present and horizon years.
(LOAD MODEL)

8. Enter S-Curve Data
(GLOBAL MODEL)

9. Enter annual growth rate for each class. Apply growth rates to year 1991.
(GLOBAL MODEL)

10. Execute Deterministic Load Forecast Algorithm and obtain load maps for the intermediate years.
(SPATIAL MODEL)

11. Repeat steps 9. and 10. for applying growth rates to consumer count for years 1996, 2001 and 2006 getting load maps for all the intermediate years.

12. Use the customer counts calculated in the Global Model for each class for the horizon year for spatial distribution of customer maps 11-20. Use Transfer File technique for restricting growth to maximum limits.
(SPATIAL MODEL)

V. USING CADPAD LOADSITE DLF-2 FOR GUJRANWALA III LOAD FORECAST

V. USING CADPAD LOADSITE DLF-2 FOR GUJRANWALA III LOAD FORECAST

Log in to the VAX system by entering user's name and password. The next step is to enter the DLF-2 program by entering:

DLF92 <====

Select the correct terminal which in this case is Tektronix 4205 and enter the output file name. Data Set Up Menu appears and the user is prompted to make a valid choice.

A. CREATION OF DATABASES FOR GUJRANWALA III

Data Set-Up Menu

10 - Global/Load Model Database (GM)
20 - Spatial Model Database (SM)
30 - Open Both Databases (OB)
40 - Change Output File (CO)

Select Database

Creating databases for a Load Forecast Study is a one time effort. Once the databases are created, the user can enter all the data in several sessions spread over a period of time. The databases are to be opened each time of course so that the program knows which study is being carried out. Following the commands and user responses to create database for Gujranwala III Division.

Select "30" or "OB" for Opening (Creating in this case) both Global and Spatial databases. The sequence is listed as under:

1) Please Enter Name of GLOBAL/LOAD Database
GRW3 <====

File does not exist
OK to create (Y or N)? Y <====

Creating new database GRW3

Please enter the following information:

2) Global Data
Title Card 1:
GUJRANWALA III DIVISION <====

3) Title Card 2:
LOAD FORECASTING STUDY BY LFC DIRECTORATE<====

4) Database ID
1 <====

5) Number of load-bearing land-use classes: 10 <====

5a) Name of Class 1:
DOMESTIC LOW <====

5b) Name of Class 2:
DOMESTIC MED <====

5c) Name of Class 3:
DOMESTIC HGH <====

5d) Name of Class 4:
COMMERCIAL LOW <====

5e) Name of Class 5:
COMMERCIAL MED <====

5f) Name of Class 6:
TUBEWELLS - 49 <====

5g) Name of Class 7:
TUBEWELLS - 50 <====

5h) Name of Class 8:
INDUSTRY LOW <====

5i) Name of Class 9:
INDUSTRY MED <====

5j) Name of Class 10:
INDUSTRY HGH <====

6) Load Data
Title Card:
LOAD DATA <====

7) Database ID: 1 <====

8) Base Year (Calendar) of load data: 1991

9) Power Factor (%): 80 <====

10) Number of Load Measurements per Hour: 1 <====

In this study, only one reading per hour has been

used to enter load profile data for different customer classes. The program allows a maximum of four readings per hour for a total of ninety-six (96) readings for a twenty four hour customer class load profile. The number of measurements per hour can thus vary from 1 to 4 in response to this prompt.

The program take some time to physically create the global and load databases on the hard disk and then informs the user before continuing with the creation of spatial database:

```
...Initialization Complete

11)  Please Enter Name of Spatial Database
     GRW3-S <====

10)  Maximum Number of Small Areas EAST-WEST:
     220 <====

11)  Maximum Number of Small Areas NORTH-SOUTH:
     100 <====

     File does not exist.
     OK to create GRW3-S.
     (Y or N)? Y <====

12)  Spatial Data
     Title Card 1:
     GUJRANWALA III DIVISION <====

13)  Title Card 2:
      SMALL AREA LOAD DISTRIBUTION <====

13)  Database ID: 1 <====
     Year: 1991 <====
     Iteration: 0 <====

     Initializing database...
```

After creating the data files for Gujranwala III Division, the user returns to the Primary Menu by entering "/". From here he may leave the program and continue the work in another session. The databases for Gujranwala III have been created. Each time the user wishes to enter data for Gujranwala III, the user has to open the files and start working.

B. OPEN DATABASES FOR GUJRANWALA III

Enter DLF-2 as described in the beginning to reach the Data Set-UP Menu. In this session the user shall learn how to open a database that has previously been created.

```
Data Set-Up Menu

10 - Global/Load Model Database (GM)
20 - Spatial Model Database (SM)
30 - Open Both Databases (OB)
40 - Change Output File (CO)

Select Database
```

Before entering data and finally running the load forecast, the user will need to open the databases every time he enters DLF-2. Select "30" or "OB" for Opening both Global and Spatial Databases. The program prompts and user responses are given below:

1) Please Enter Name of GLOBAL/LOAD Database
   GRW3 <====

   The program looks for the file name entered. If it is found, the program displays the headers and the basic information entered while creating the file.

2) GLOBAL Database Header
   GUJRANWALA III DIVISION
   LOAD FORECASTING STUDY BY LFC DIRECTORATE

3) Database ID
   1

3) Wish to Change Header and ID?
   (Y or N)? N <====

   The user response is "N" if no change in header or ID is required. If the user enters "Y", he is allowed to change the header and the ID.

5) LOAD Database Header
   GUJRANWALA III DIVISION

   The program looks for the file name entered. If it is found, the program displays the headers and the basic information entered while creating the file.

6) Database ID
   1

7) Wish to Change Header and ID?
(Y or N)? N <====

The user response is "N" if no change in header or ID is required. If the user enters "Y", he is allowed to change the header and the ID.

8) Number of Measurements per Hour is 1
Enter New Numbers of Measurements: 1 <====

9) Please Enter Name of Spatial Database
GRW3-S <====

10) Maximum Number of Small Areas EAST-WEST:
220 <====

11) Maximum Number of Small Areas NORTH-SOUTH:
100 <====

12) SPATIAL Database Header
GUJRANWALA III DIVISION
SMALL AREA LOAD DISTRIBUTION

13) Database ID
1 Year: 1991 Iteration: 0

14) Wish to Change Header and ID
(Y or N)? N <====

The user response is "N" if no change in header or ID is required. If the user enters "Y", he is allowed to change the header and the ID.

Data file opened, the user now enters "/" to return to the Primary Menu.

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C. ENTER SPATIAL DATA FOR GUJRANWALA III

Each time the user has to enter data or run the load forecast, he will have to open the database as described.

After opening the data files for Gujranwala III Division, the user returns to the Primary Menu by entering "/".

Primary Menu

10 - Data Set-Up (SU)
20 - Global Model (GM)
30 - Spatial Model (SM)
40 - Load Model (LM)
50 - Substation Siting (SS)
90 - Exit LOADSITE (EX)

Select Primary Operation

User selects "30" or "SM" for entering the Spatial Model.

Spatial Model Menu

10 - Deterministic Forecast Algorithm (DF)
20 - Map Edit (ME)
30 - Map Mathematics* (MM)
40 - Spatial Data Display (SD)

Select Spatial Model Function

The first thing to do in the Spatial Model is to initialize all the customer counts in all the maps to zero. These maps are numbered from 1 to 20. Maps 1 to 10 are for the Base Year and the Maps 11 to 20 are for the Horizon Year. The procedure to initialize the maps is described in the following lines.

Select "20" or "ME" from the Spatial Model Menu. The Map Edit menu appears.

Map Edit Menu

10 - Card Image Data (CI)
15 - COOKBOOK Format Input (CF)
20 - Change Name of a Map (CN)
30 - Initialize a Map (IM)
40 - Set point to a Value (SP)
41 - Set Line to a Value (SL)
42 - Set Block to a Value (SB)
50 - Edit Row of 10 Small Areas (ER)
51 - Edit Column of 10 Small Areas (EC)
88 - Map Mathematics* (MM)
89 - Spatial Data Display (SD)

Select Map Edit Operation

Select "30" or "IM", the Map Initialize command. Program prompts and user responses are listed below:

1) Map Number: 1 <====

2) Enter Initial Value: 0 <====

3) Set All Values of Map 1 to 0.000E+00
(Y or N)? Y <====

The user is returned to Step 1 above and prompted to enter another map number to initialize. By repeating this cycle twenty times, all values in all the maps for Base and Horizon Years for all the customer classes are initialized to zero. To leave the initialization routine, the user enters a "/" when he is prompted to enter a map number.

Map Number: / <====

The program now returns to the Map Edit Menu.

Map Edit Menu

10 - Card Image Data (CI)
15 - COOKBOOK Format Input (CF)
20 - Change Name of a Map (CN)
30 - Initialize a Map (IM)
40 - Set point to a Value (SP)
41 - Set Line to a Value (SL)
42 - Set Block to a Value (SB)
50 - Edit Row of 10 Small Areas (ER)
51 - Edit Column of 10 Small Areas (EC)
88 - Map Mathematics* (MM)
89 - Spatial Data Display (SD)

Select Map Edit Operation

The next step is to read all the data files for all the customer classes. The preparation of these data files on Lotus 1-2-3 on PC and their conversion to ASCII or card image files on the VAX system has been explained in detail earlier. In this section only the procedure for reading these files into DLF-2 will be explained. These data files shall then over-write the customer count maps 1 to 20 which have been initialized to zero as detailed above.

The user selects "10" or "CI" Card Image Data to read the data files for customer counts. The program prompts:

Please enter input file name: BASE <====

The same procedure is repeated for the following two files.

HORIZ : Horizon year customer counts for existing cells

ZERO : Horizon year customer counts for zero cells

The spatial data files in Card Image or ASCII format have now been read into the Gujranwala III Load Forecasting Database. The customer counts are read into the appropriate cells of the first twenty maps and the year of development in the 21st map. Each entry in Spatial Database is now completed. The user returns to the primary menu by entering "/" twice.

D. ENTER LOAD DATA FOR GUJRANWALA III

The user opens the GUJRANWALA III database as described previously and ends up with the Global Model Menu. He enters "/" to reach the Primary Menu.

Primary Menu

10 - Data Set-Up (SU)
20 - Global Model (GM)
30 - Spatial Model (SM)
40 - Load Model (LM)
50 - Substation Siting (SS)
90 - Exit LOADSITE (EX)

Select Primary Operation

User selects "40" or "LM" for Load Model.

Load Model Menu

20 - Compute System Profile (CS)
30 - Edit Load Data (EL)
40 - Display Load Data (DL)
60 - NODESIM (NS)

Select Load Model Function

User selects "30" or "EL" to edit Load Data. This takes him to the Load Data Edit Menu.

Load Data Edit Menu

11 - Add Class Profile (AC)
20 - Copy Class Profile (CC)
30 - Initialize Class Profiles (IC)
40 - Edit Class Profiles (EC)
80 - Display Load Data (DL)

Select Load Data Edit Operation

The first thing to do is to initialize all the customer class load profiles for both Base and Horizon years. Once these are initialized, they can be edited to enter the load measurements on an hourly basis for a twenty four hour load profile.

User selects "30" or "IC" to Initialize Class Profiles. Program prompt and user responses are given below:

1) Class Number: 1 <====

2) Present or Horizon Profile (P or H)? P <====

3) Initialization Value (0 to Delete)? 0 <====

By repeating the above cycle, all the load profile can be initialized to any value. This value may be different for different class profiles. Usually the value which occurs most frequently is used for initialization.

To enter the load profile data, user now elects "40" or "EC" Edit Class Profile. Program prompts and user responses used for Gujranwala III are listed below:

1) Class Number: 1 <====

2) Present or Horizon Profile (P or H)? P <====

3) Current Name
Enter New Name: DOM-LOW (P) <====

4) Enter From, To Hour: 1,24 <====

5) Current Loads are

Hour 1	Hour 2	Hour 3	Hour 4	Hour 24
0.000	0.000	0.000	0.000	0.000

Enter New Values
0.09, 0.09, 0.09, 0.09, 0.095, 0.1, 0.1, 0.095,
0.08, 0.08, 0.08, 0.08, 0.090, 0.094, 0.096, 0.098,
0.1, 0.1, 0.12, 0.15, 0.14, 0.12, 0.1, 0.09

Steps 1 to 5 above are repeated to enter Load Profiles for the ten customer classes for the Present or Base Year. The same sequence is used to enter values for all the classes for the Horizon Year. The user enters "/" to return to the Load Model Menu.

Load Model Menu

20 - Compute System Profile (CS)
30 - Edit Load Data (EL)
40 - Display Load Data (DL)
60 - NODESIM (NS)

Select Load Model Function

After the load profiles have been added, the System Profile is to be computed by the program. User chooses "20" or "CS" from the Load Model Menu to compute the System Profile. The program asks:

Present or Horizon Profile (P or H)? P <====

This leads the user to the Customer Count Input Option Menu.

Customer Count Input Option Menu

10 - Land-Use Maps (LM)
20 - Global Model (GM)
30 - Keyboard Entry (KE)

Enter Input Option:

The user selects "10" or "LM" to opt for Land Use Maps. The program prompts and user responses are given below:

1) 1 2 3 4 5 6 7 8 9 10
Are these your land use maps
(Y or N)? Y <====

2) Store Total Class Counts in Global Database
(Y or N)? Y <====

User enters "/" to return to the Load Model Menu.

Load Model Menu

20 - Compute System Profile (CS)
30 - Edit Load Data (EL)
40 - Display Load Data (DL)
60 - NODESIM (NS)

Select Load Model Function

User chooses "20" or "CS" from the Load Model Menu to compute the System Profile for the Horizon Year. The program asks:

Present or Horizon Profile (P or H)? H <====

This leads the user to the Customer Count Input Option Menu.

Customer Count Input Option Menu

10 - Land-Use Maps (LM)
20 - Global Model (GM)
30 - Keyboard Entry (KE)

Enter Input Option:

The user selects "10" or "LM" to opt for Land Use Maps. The program prompts and user responses are given below:

1) 1 2 3 4 5 6 7 8 9 10
Are these your land use maps
(Y or N)? N <====

2) Enter New Values: 11,12,13,14,15,16,17,18,19,20

3) Store Total Class Counts in Global Database
(Y or N)? Y <====

User enters "/" twice to return to the Primary Menu.

61

E. ENTER GLOBAL DATA FOR GUJRANWALA III

The user opens the Gujranwala III databases as described and ends up with the Primary Menu.

Primary Menu

10 - Data Set-Up (SU)
20 - Global Model (GM)
30 - Spatial Model (SM)
40 - Load Model (LM)
50 - Substation Siting (SS)
90 - Exit LOADSITE (EX)

Select Primary Operation

The user selects "20" or "GM" to go into the Global Model Menu.

Global Model Menu

10 - Edit/Display Global Data (ED)
20 - Simple Growth Model (SG)
40 - Backup Global Data (BG)
50 - Restore Global Data (RG)

Select Global Model Function

User chooses "10" or "ED" for Edit/Display Global Data.

Edit/Display Global Data Menu

10 - Zero All Values (ZA)
11 - Zero Customer Counts Only (ZC)
20 - Modify Customer Count by Year (MC)
21 - Change a Year (CY)
22 - Change Class Name (CC)
23 - Change Number of Classes (CN)
30 - Display All Customer Counts (DA)
31 - Display by Class (DC)
32 - Display by Year (DY)
40 - Update Growth ("S") Curve (UG)

Select Edit/Display Global Data Operation

Choice "21" or "CY" enables the user to set or change the Year, the Five intermediate Load Map Years and the Horizon Year. The prompts and responses are listed below:

1) Iteration: 0 <====
2) Current Year: 1991
3) Enter New Year: 1991 <====

```
4)   Iteration:      1 <====
5)   Current Year:  1994
6)   Enter New Year:      1994<====
7)   Iteration:      2 <====
8)   Current Year:  1997
9)   Enter New Year:      1997 <====
10)  Iteration:      3 <====
11)  Current Year:  2000
12)  Enter New Year:      2000 <====
13)  Iteration:      4 <====
14)  Current Year:  2004
15)  Enter New Year:      2004 <====
16)  Iteration:      5 <====
17)  Current Year:  2007
18)  Enter New Year:      2007 <====
19)  Iteration:      6 <====
20)  Current Year:  2011
21)  Enter New Year:      2011 <====
22)  Iteration :     / <====
```

By executing the program several times, the load maps for all the intermediate years could be obtained as in this study.

The user selects "20" or "MC" to Modify Customer Count by Year. The program prompts and user responses are given below:

```
1)   Year:      1991 <====

2)   From Class, To Class:     1,10 <===

3)   Current Counts are:

     39962, 5070, 376, 4870, 151, 2649, 561, 1221, 37,6

     Enter New Counts:/ <===
```

The user may select "30" or "DA" to Display All Customer Counts. He may then get the display either on the CRT or get the hard copy of customer counts on the printer.

The user then selects "40" or "UG" to upgrade Growth "S" Curve. The prompts and responses are given below:

```
1)   From Point, To Point      1,20
     Current Values are:
     0.000, 0.000, 0.000, 0.0000 .... 0.000

2)   Enter New Values:

     0.10,0.2,0.295,0.39,0.48,0.56,0.64,0.71,0.77,0.82,
     0.86,0.89,0.92,0.94,0.96,0.97,0.98,0.99,1.00,1.00
```

F. DLF-2 RESULTS SUMMARY

As described at the start of this report, DLF-2 input requirements include the following:

a. Spatial Customer Distribution for the Base Year

Present year customer counts for all the classes were combined in one file and the resulting file BASE.DAT was uploaded to VAX 3800 in the format of 'Exhibit - 6'. Maps 1 to 10 of DLF-2 Spatial Model were initialized and the file BASE.DAT was read in using the card image file option. Exhibit - 7 shows the map statistics for the base year customer counts. The map statistics are the same for both Methods 1 and 2 because the base year customer counts were the same in both methods. These statistics correctly reflect the customer counts. If the statistics are not in line with our empirical data the data file BASE.DAT could be corrected and read in after initializing the respective maps.

b. Spatial Customer Distribution for Horizon Year

Just as for the base year, the horizon year customer counts for all the ten classes were also combined in one file HORIZ.DAT. This file comprised only the customer counts for horizon year for the non-zero cells of respective base year maps. The remaining horizon year cells (zero customer count cells of the base year) were taken care of in the file ZERO.DAT. In addition this latter file contained the year of development information for Map 21. Maps 11 to 21 were initialized and the files were read in. Exhibit - 8A reflects horizon year customer counts as per the uniform growth rates used in Method 1. Exhibit - 8B shows the map statistics for horizon year customer counts calculated by applying multiple growth rates in Method 2.

c. Load Profiles for Base and Horizon Years

Load profiles of the ten customer classes for the present and horizon years were also entered as per DLF-2 procedure. Tabular and graphical prints are exhibited in 'Exhibit - 2A' and 'Exhibit - 2B' respectively.

d. S - Curve and Growth Rates

S - Curve and growth rates were entered by using the appropriate options of the DLF-2 program. S-Curve data table is shown in 'Exhibit - 10'. S-Curve shape affects the division of load between cells and it has no effect on the overall yearly load. S-Curve mechanism is being studied for a greater understanding and application.

As discussed earlier, two methods were used to apply growth rates and DLF-2 was run separately to forecast loads. In the first method, a uniform growth rate was applied (different for each class) to each customer class through the twenty years of study. In the second method, growth rates were varied for each class for four different time periods in the twenty years of study. These time periods were, 1) 1991-96, 2) 1997-2000, 3) 2001-05 and, 4) 2006-2010. The growth rates applied and the resulting number of consumers calculated by both methods are given in 'Exhibit 11-A/11-B.'

e. Final Results

Maps 23 through 29 were initialized and the 'Deterministic Load Forecast Algorithm' was run for the peak hour 20:00 Hours. 'Exhibit - 9A/9B' shows the load map statistics obtained by using both the methods. It was decided to use the load maps obtained by the second method for Subsite and Feedersite studies. For a comparison, the system loads calculated by both the methods for each year are given in Table V-1

TABLE V-1

YEAR	METHOD 1 LOAD (MW)	METHOD 2 LOAD (MW)	
1991	32.4	32.4	PRESENT YEAR
1992	33.3	35.2	
1993	34.3	38.3	
1994	35.3	41.7	
1995	36.3	45.5	
1996	37.4	49.8	
1997	38.5	53.0	
1998	39.7	56.4	
1999	40.9	60.1	
2000	42.2	63.9	
2001	43.6	67.0	
2002	45.0	70.2	
2003	46.5	73.6	
2004	48.0	77.1	
2005	49.6	80.8	
2006	51.3	84.1	
2007	53.1	87.5	
2008	54.9	91.0	
2009	56.9	94.7	
2010	58.9	98.6	
2011	61.0	102.7	HORIZON YEAR

'Exhibit - 12' shows load density maps for year 1991, 2001 and 2011 obtained from the DLF-2 program.

EXHIBITS

EXHIBITS

EXHIBIT - 1	CONSUMER SLABS FOR DOMESTIC AND COMMERCIAL CONSUMERS
EXHIBIT - 2A	LOAD PROFILE CHARTS
EXHIBIT - 2B	PRESENT AND HORIZON YEAR LOAD PROFILES
EXHIBIT - 3A	CLASS STATISTICS FOR DOMESTIC AND COMMERCIAL CONSUMERS
EXHIBIT - 3B	TEN CUSTOMER CLASSES FOR GUJRANWALA III
EXHIBIT - 4	BATCHWISE DISTRIBUTION OF CONSUMERS
EXHIBIT - 5A	BLANK FORM FOR DLF-2 RURAL LOAD FORECASTING
EXHIBIT - 5B	PROCESSED MAP DATA FORM FOR DLF-2 RURAL LOAD FORECASTING
EXHIBIT - 6	ASCII FILE FORMAT FOR DLF-2 INPUT
EXHIBIT - 7	STATISTICS FOR BASE YEAR CUSTOMER COUNTS
EXHIBIT - 8A	STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS (BY METHOD 1)
EXHIBIT - 8B	STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS (BY METHOD 2)
EXHIBIT - 9A	DLF-2 RESULTS BY METHOD 1 - APPLYING FLAT ANNUAL GROWTH RATE
EXHIBIT - 9B	DLF-2 RESULTS BY METHOD 2 - APPLYING MULTIPLE GROWTH RATES
EXHIBIT - 10	S-CURVE VALUES
EXHIBIT - 11A	DLF-2 RESULTS CUSTOMER COUNTS BY METHOD 1 - APPLYING FLAT ANNUAL GROWTH RATE
EXHIBIT - 11B	DLF-2 RESULTS CUSTOMER COUNTS BY METHOD 2 - APPLYING MULTIPLE GROWTH RATES
EXHIBIT - 12	LOAD DENSITY MAPS FOR 1991, 2001 AND 2011

EXHIBIT - 1

CONSUMER SLABS FOR NTARIFF = 01

(DOMESTIC CONSUMERS)

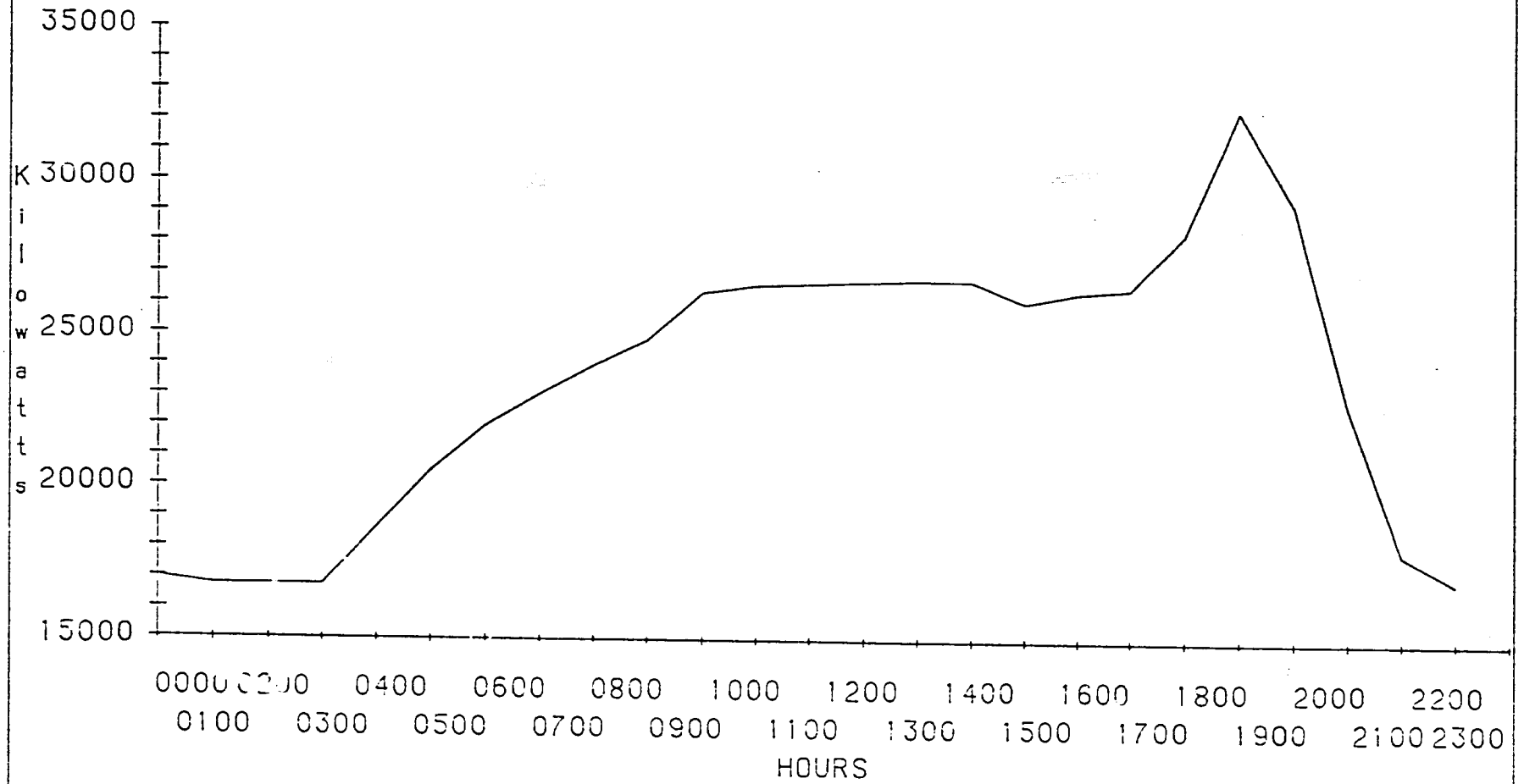
SLABS	NO. OF CONSUMERS	CONSUMPTION	AVERAGE
0	5540	0	0
1 - 100	25290	1300543	51
101 - 200	9840	1372481	139
201 - 300	3151	760861	241
301 - 500	1316	485367	369
501 - 1000	281	181839	647
ABOVE 1000	56	105957	1892

CONSUMER SLABS FOR NTARIFF = 04

(COMMERCIAL CONSUMERS)

SLABS	NO. OF CONSUMERS	CONSUMPTION	AVERAGE
0	1598	0	0
1 - 100	2823	109210	39
101 - 200	504	69353	138
201 - 300	120	28617	238
301 - 500	53	19712	372
501 - 1000	34	22857	672
ABOVE 1000	20	35394	1770

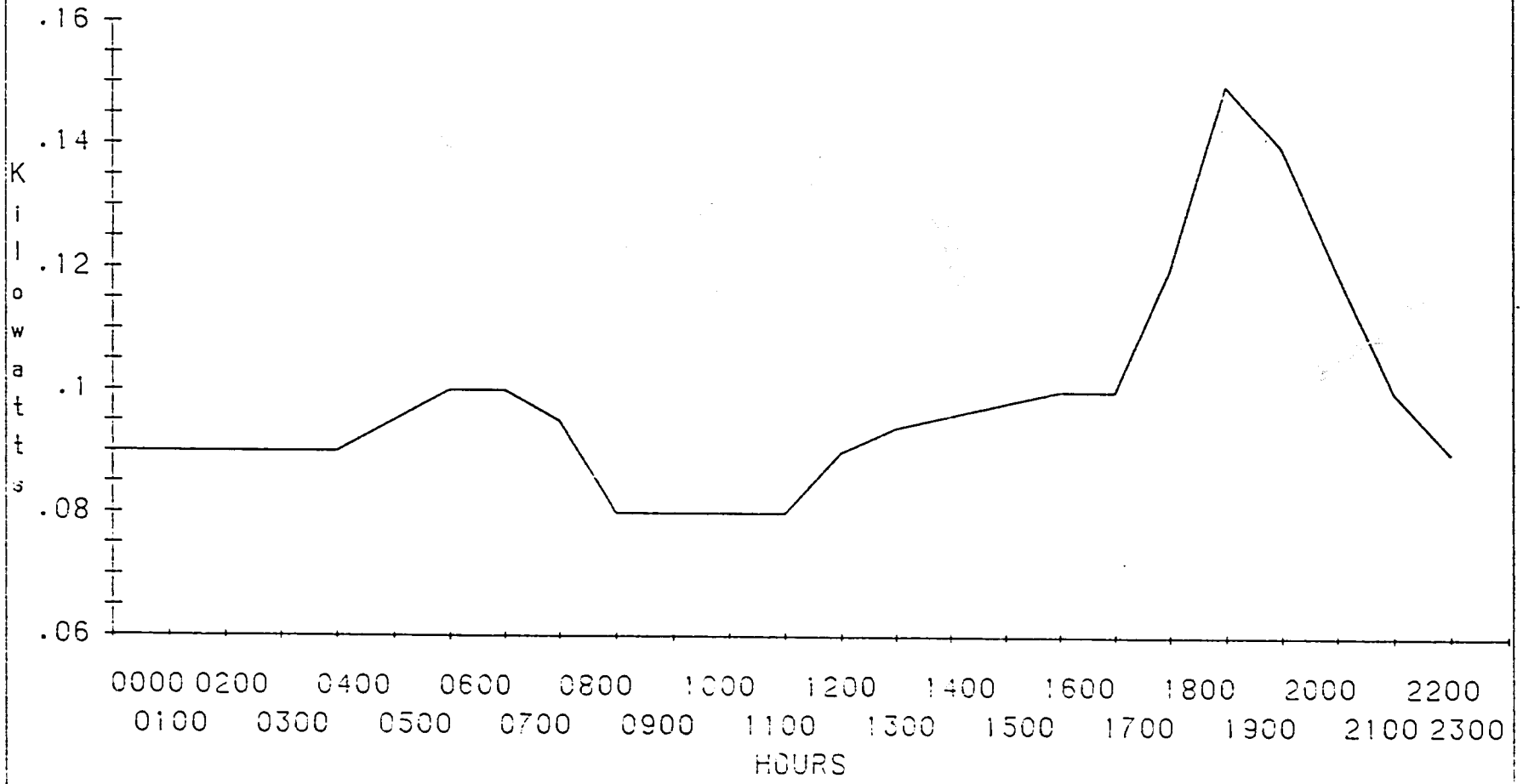
CADPAD(R) LOADSITE (TM) SYSTEM PROFILE (1991) 28-DEC-92 11:28:07



Legend:

Total KWHR Usage: 0.5700E+06

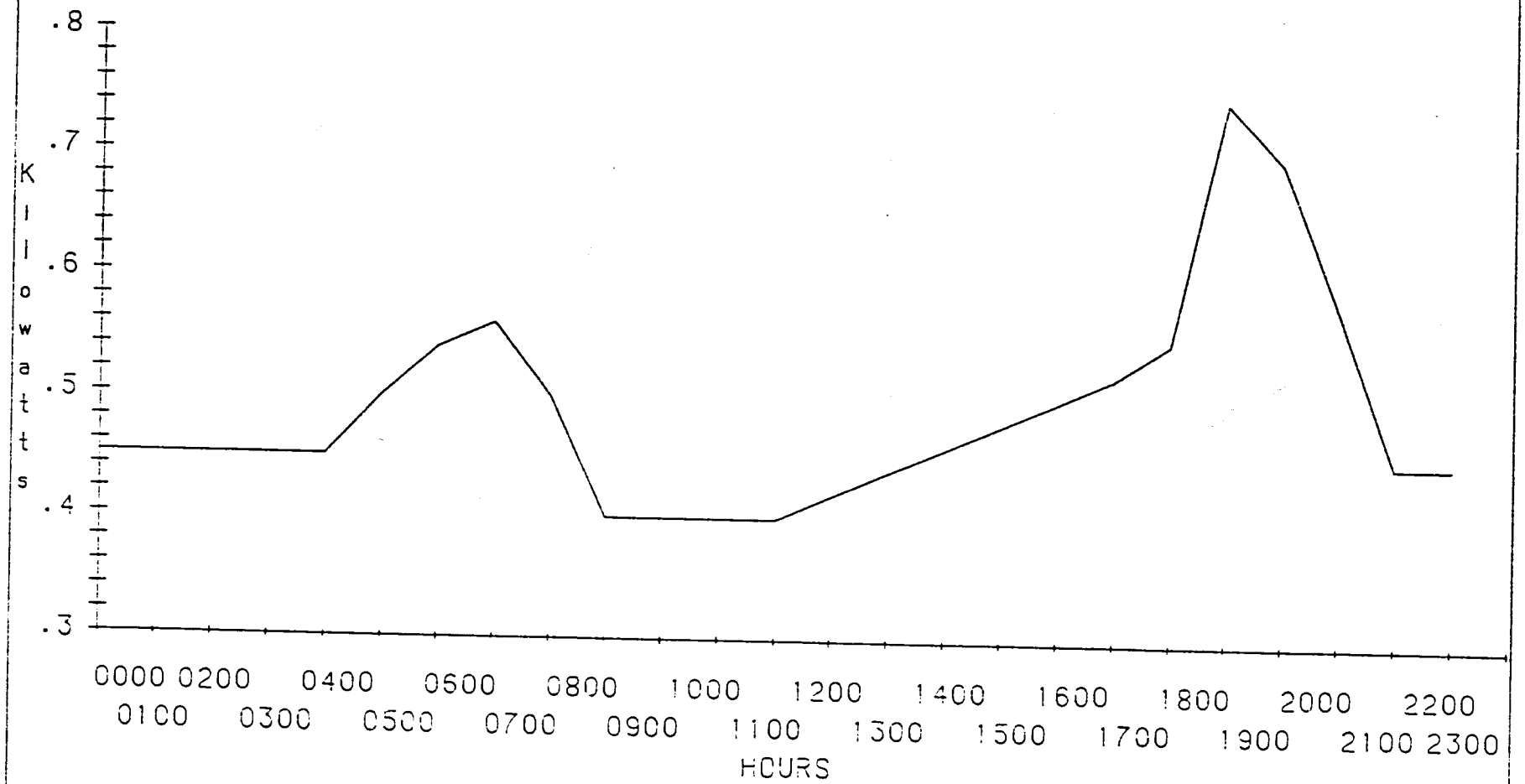
CADPAD(R) LOADSITE (TM) DOM-LOW (1991) 28-DEC-92 11:15:48



Legend:

Total KWHR Usage: [illegible]

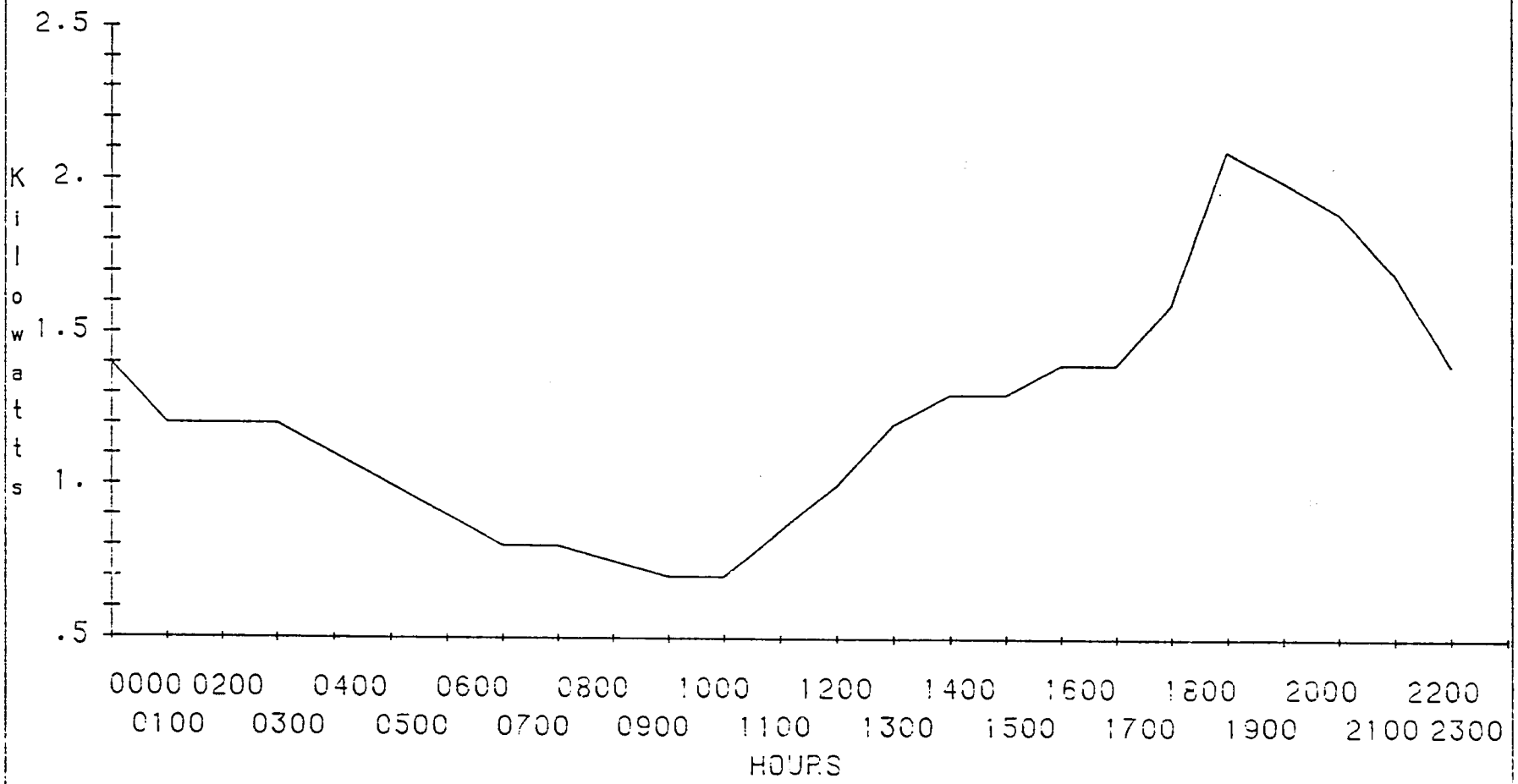
CADPAD(R) LOADSITE (TM) DOM-MED (1991) 28-DEC-92 11:16:16



Legend:

Total kWHR Usage: 11.80

CADPAD(R) LOADSITE (TM) DOM-HGH (1991) 28-DEC-92 11:16:41

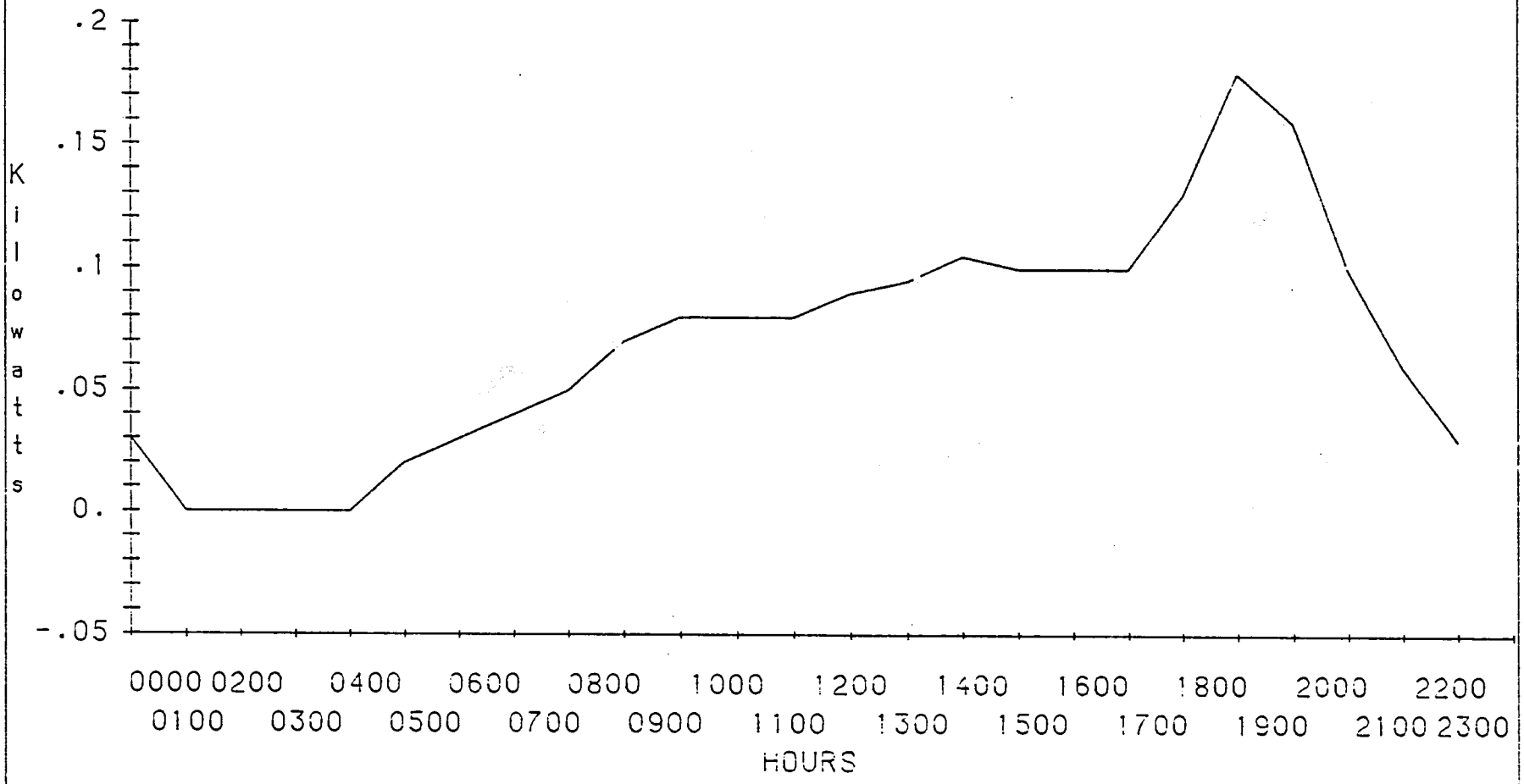


Legend:

Total KWHR Usage: 29.50

EXHIBIT - 2A
Page 4 of 22

CADPAD(R) LOADSITE (TM) COM-LOW (1991) 28-DEC-92 11:17:05

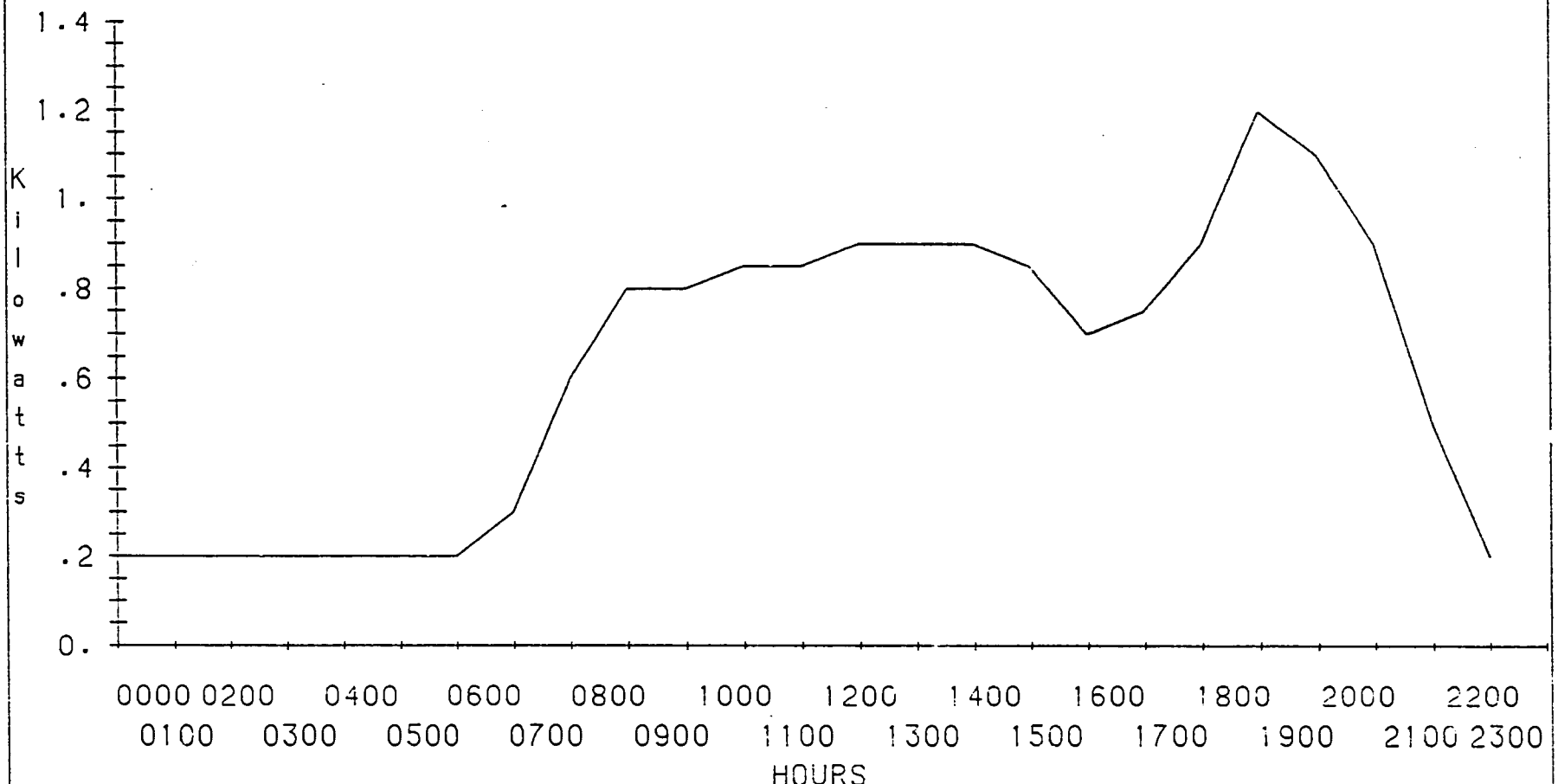


Legend:

Total KWHR Usage: 1.700

100

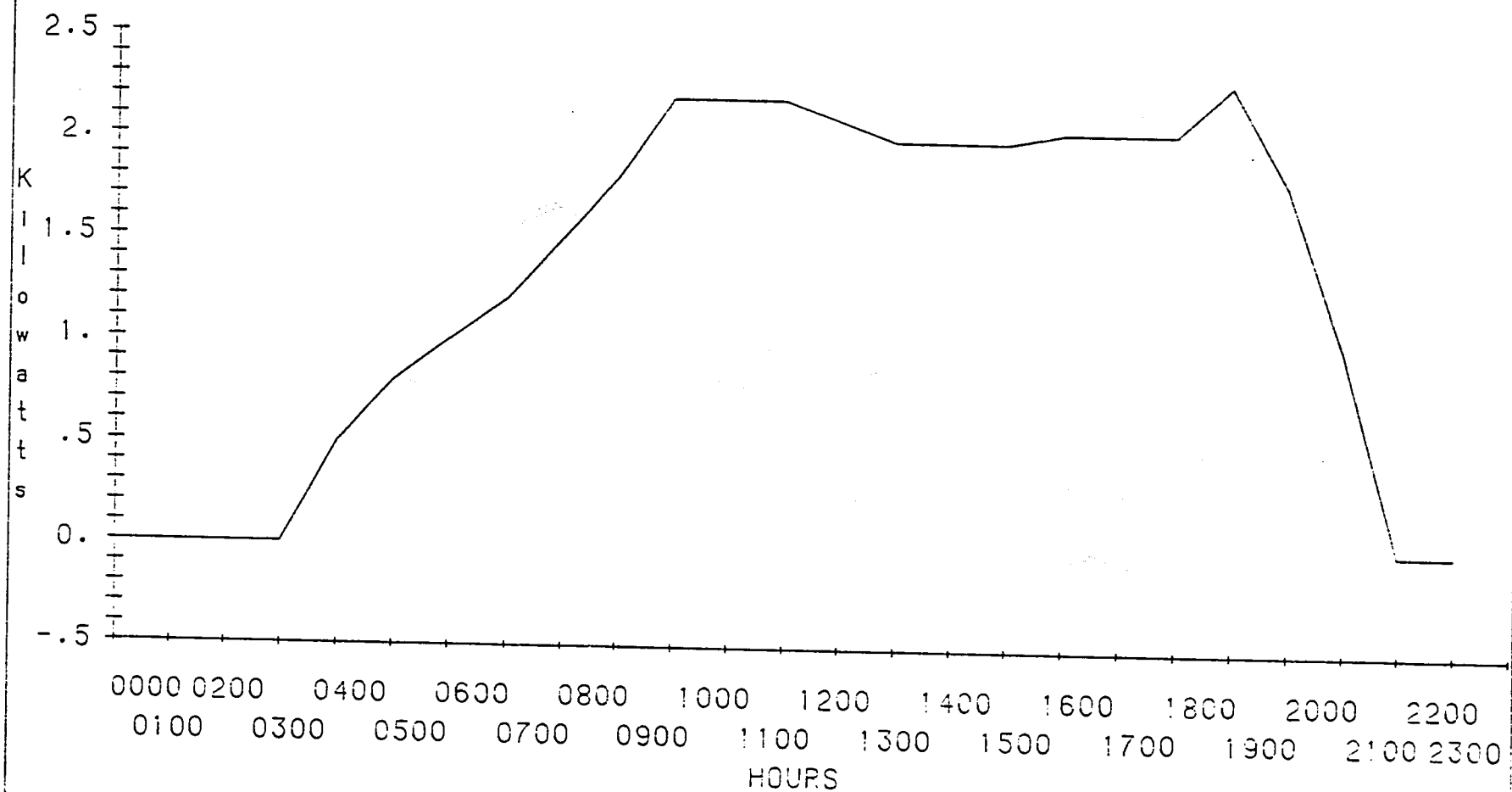
CADPAD(R) LOADSITE (TM) COM-MED (1991) 28-DEC-92 11:17:31



Legend:

Total KWHR Usage: 15.20

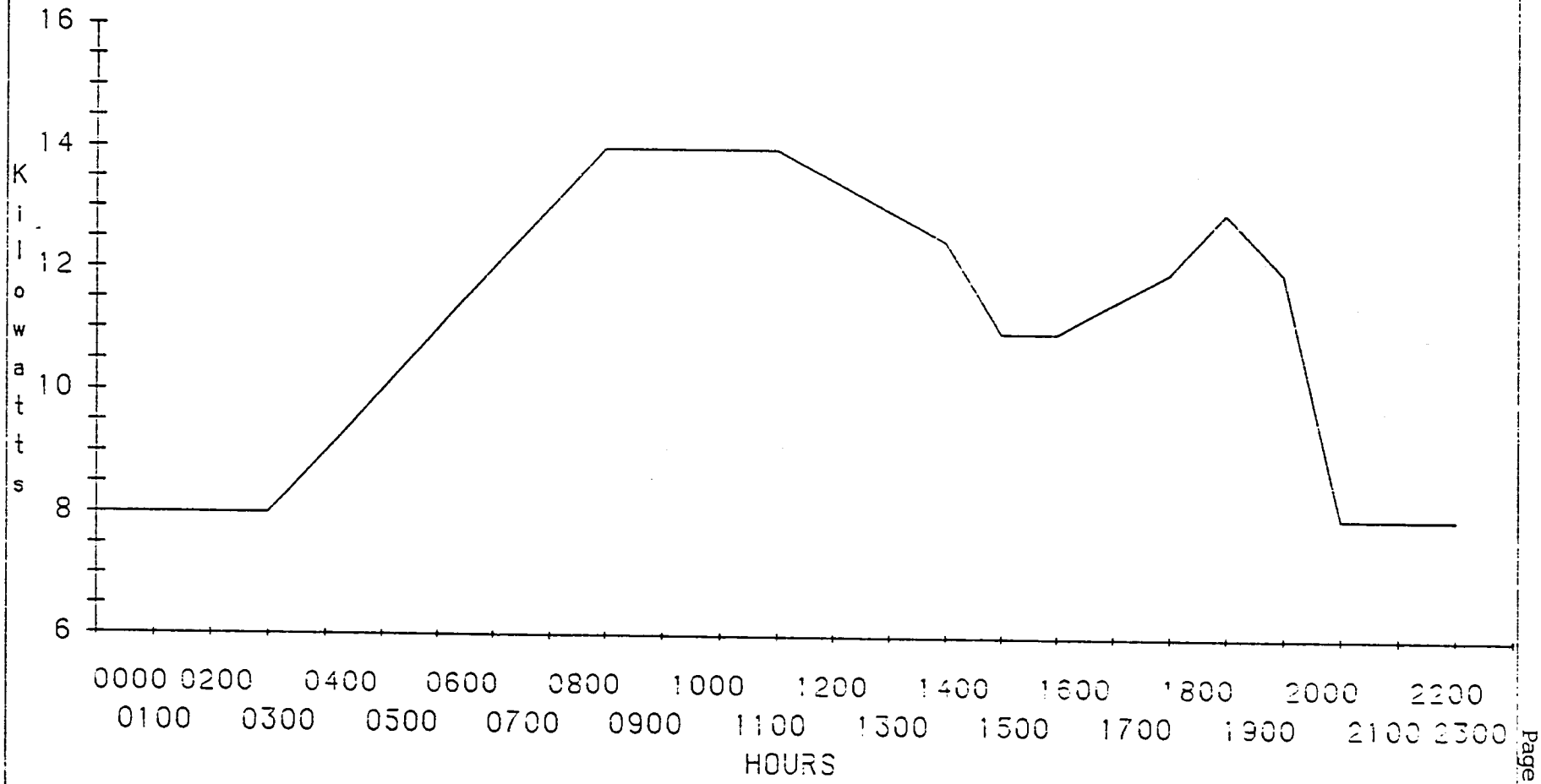
CADPAD(R) LOADSITE (TM) T-WELL (1991) 28-DEC-92 11:18:05



Legend:

Total KWHR Usage: 32.75

CADPAD(R) LOADSITE (TM) FT-WELL (1991) 28-DEC-92 11:18:59

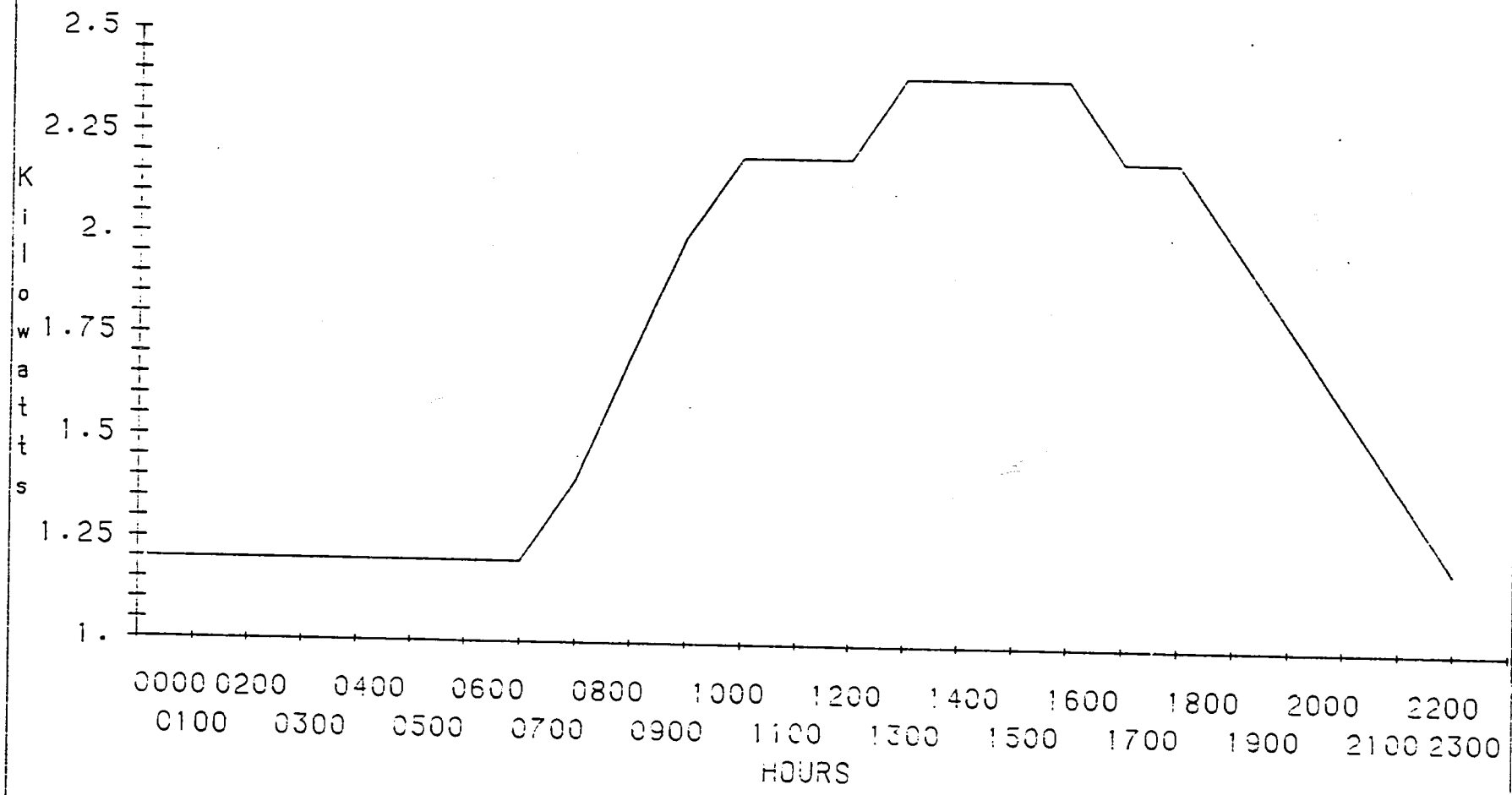


Legend:

Total KWHR Usage: 268.5

103

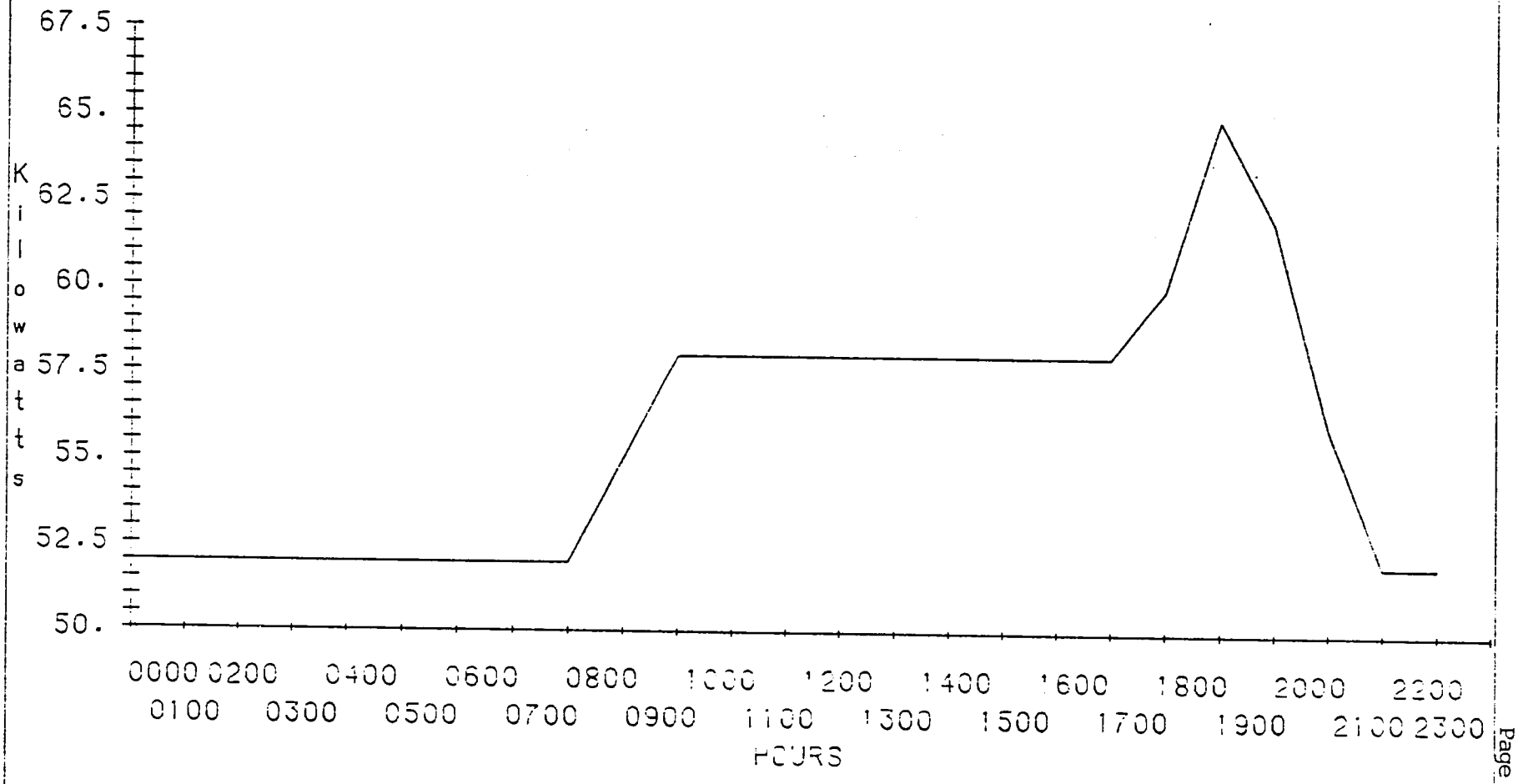
CADPAD (R) LOADSITE (TM) IND-LOW (1991) 28-DEC-92 11:19:33



Legend:

Total KWHR Usage: 42.10

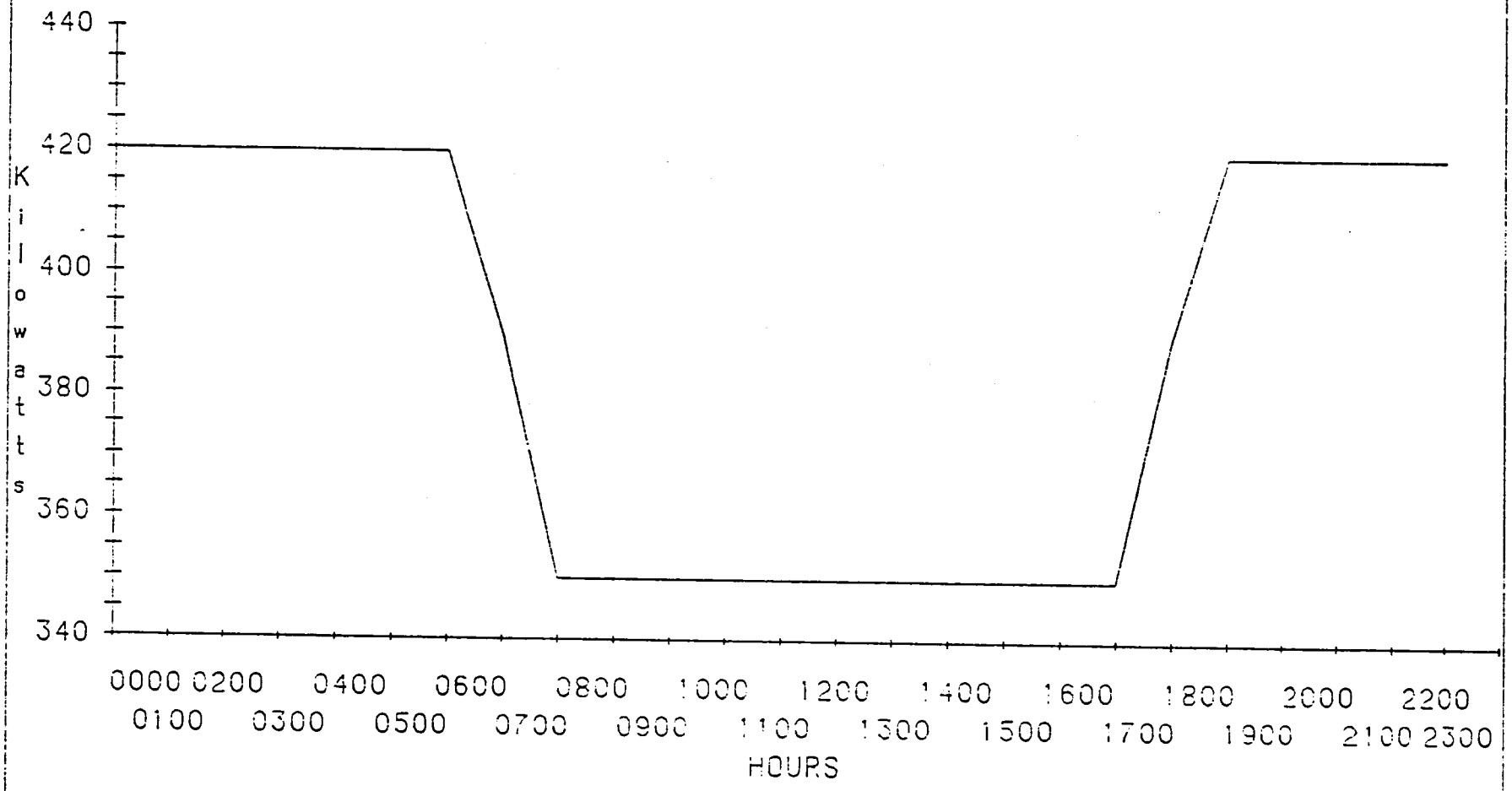
CADPAD(P) LOADSITE (TM) IND-MED (1991) 28-DEC-92 11:20:00



Legend:

Total KWHR Usage: [illegible]

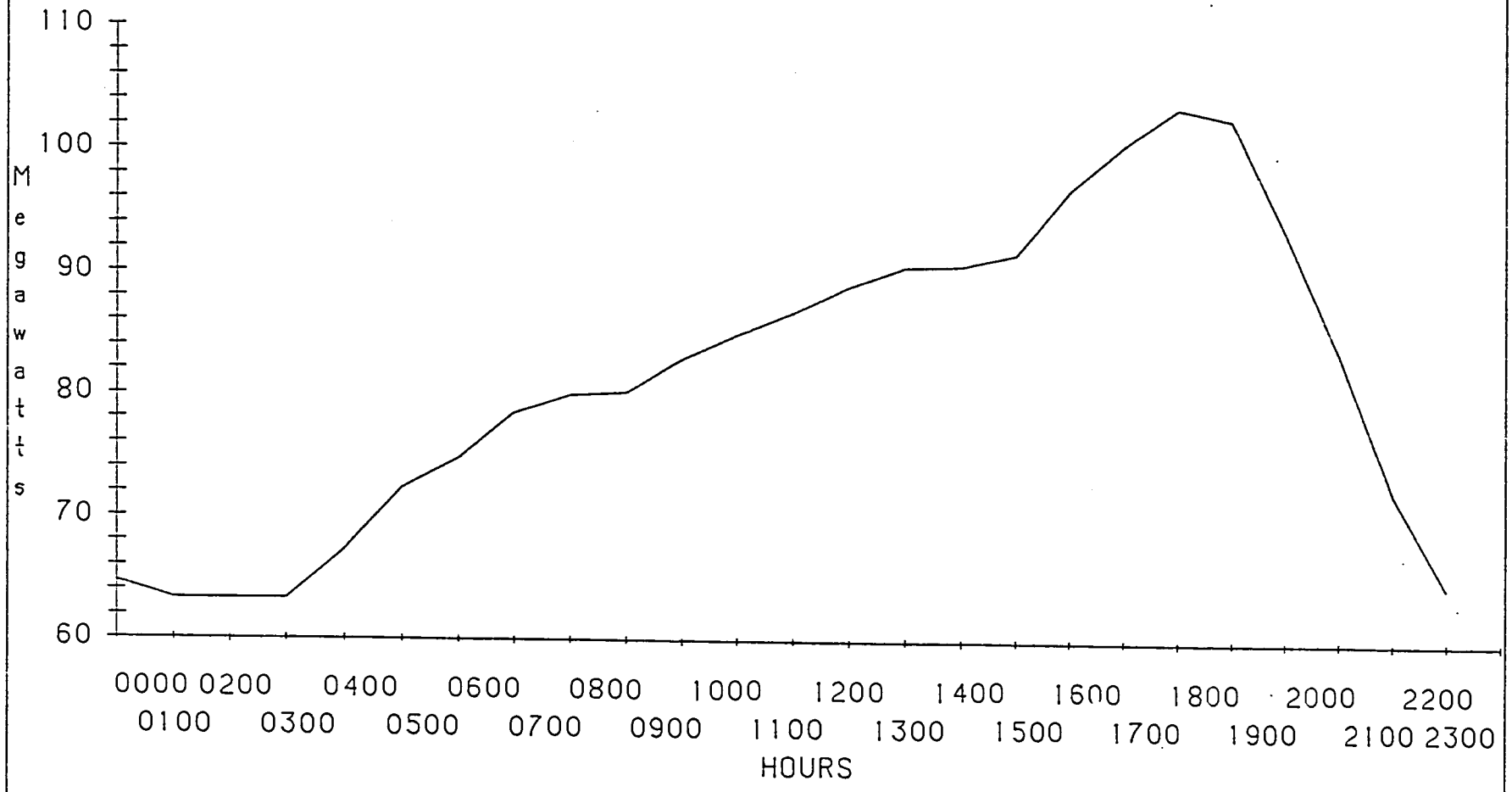
CADPAD(R) LOADSITE (TM) IND-HGH (1991) 28-DEC-92 11:20:29



Legend:

Total KWHR Usage: 9270.

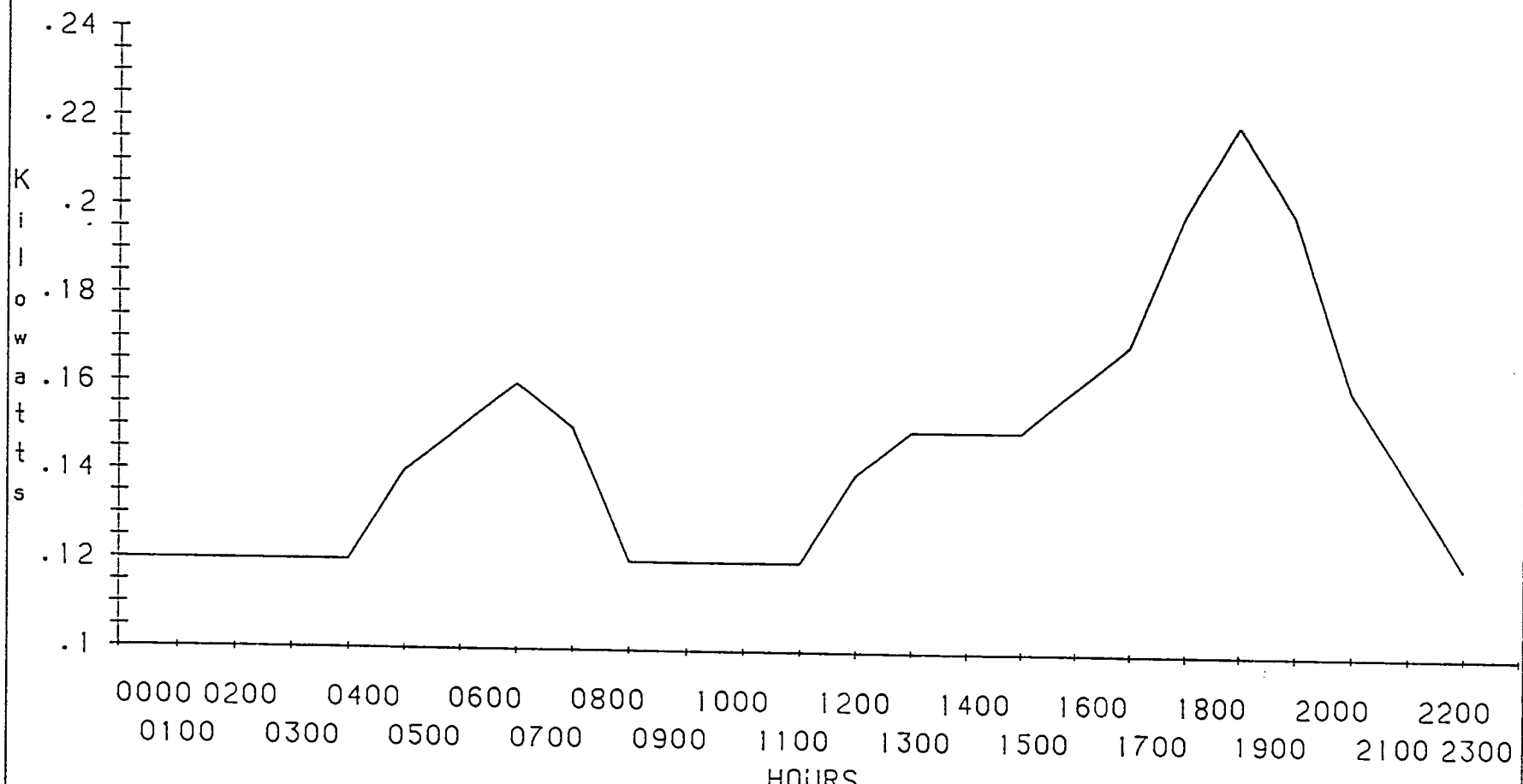
CADPAD(R) LOADSITE (TM) SYSTEM PROFILE (2011) 15-MAR-93 09:43:52



Legend:

Total MWHR Usage: 1978.

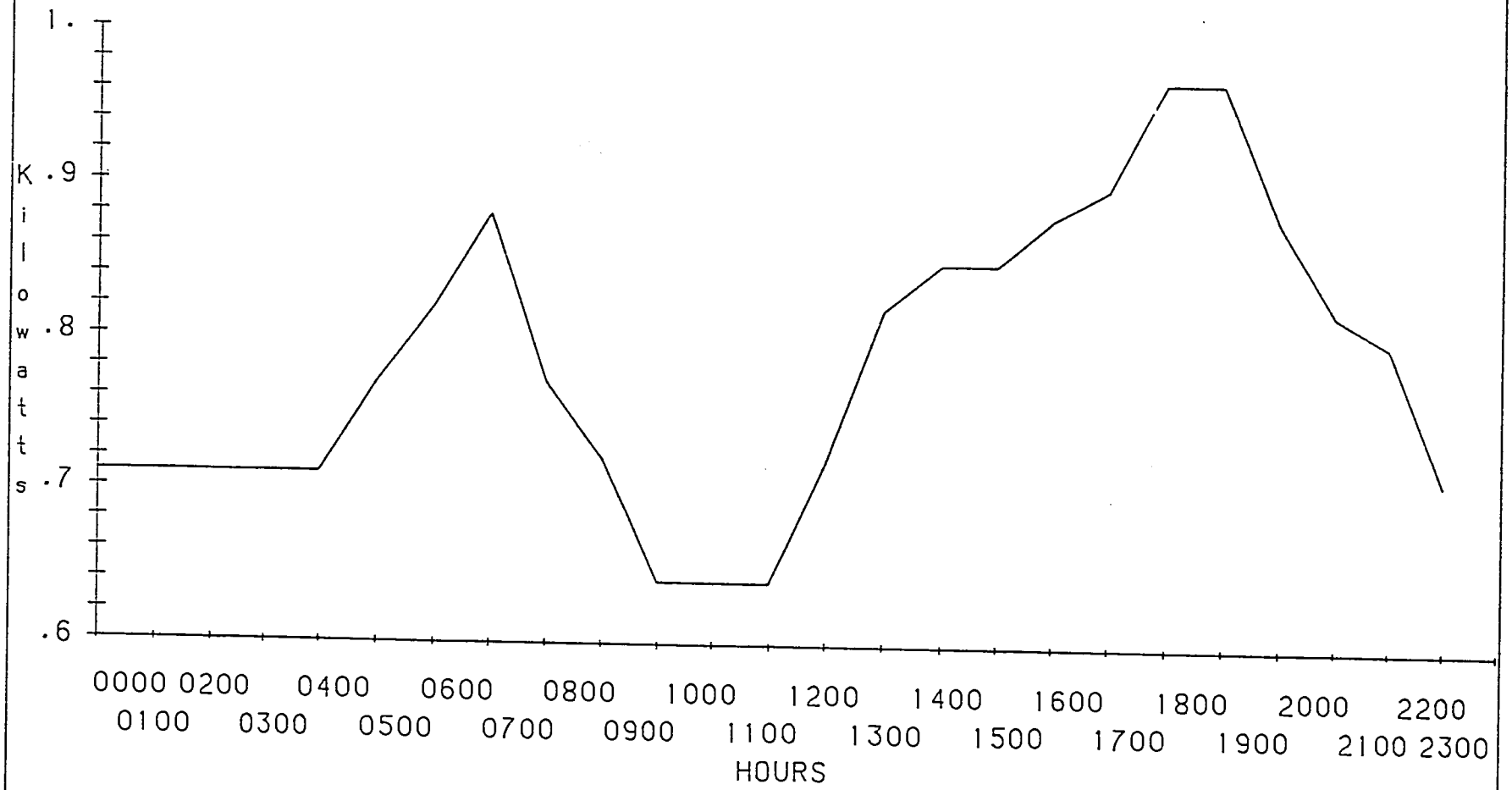
CADPAD (R) LOADSITE (TM) DOM-LOW (2011) 15-MAR-93 09:35:24



Legend:

Total KWHR Usage: 3.520

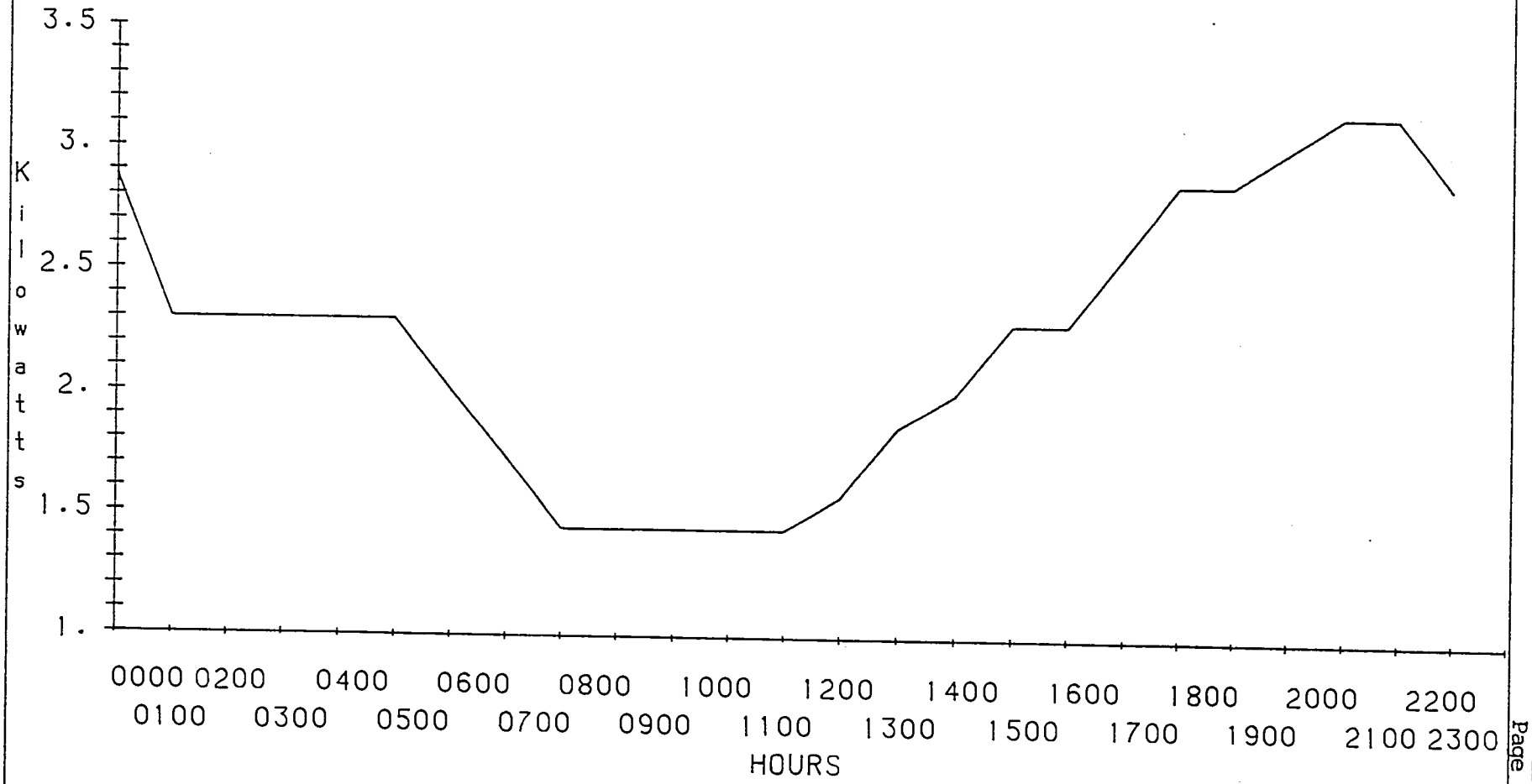
CADPAD(R) LOADSITE (TM) DOM-MED (201:) 15-MAR-93 09:36:08



Legend:

Total KWHR Usage: 18.89

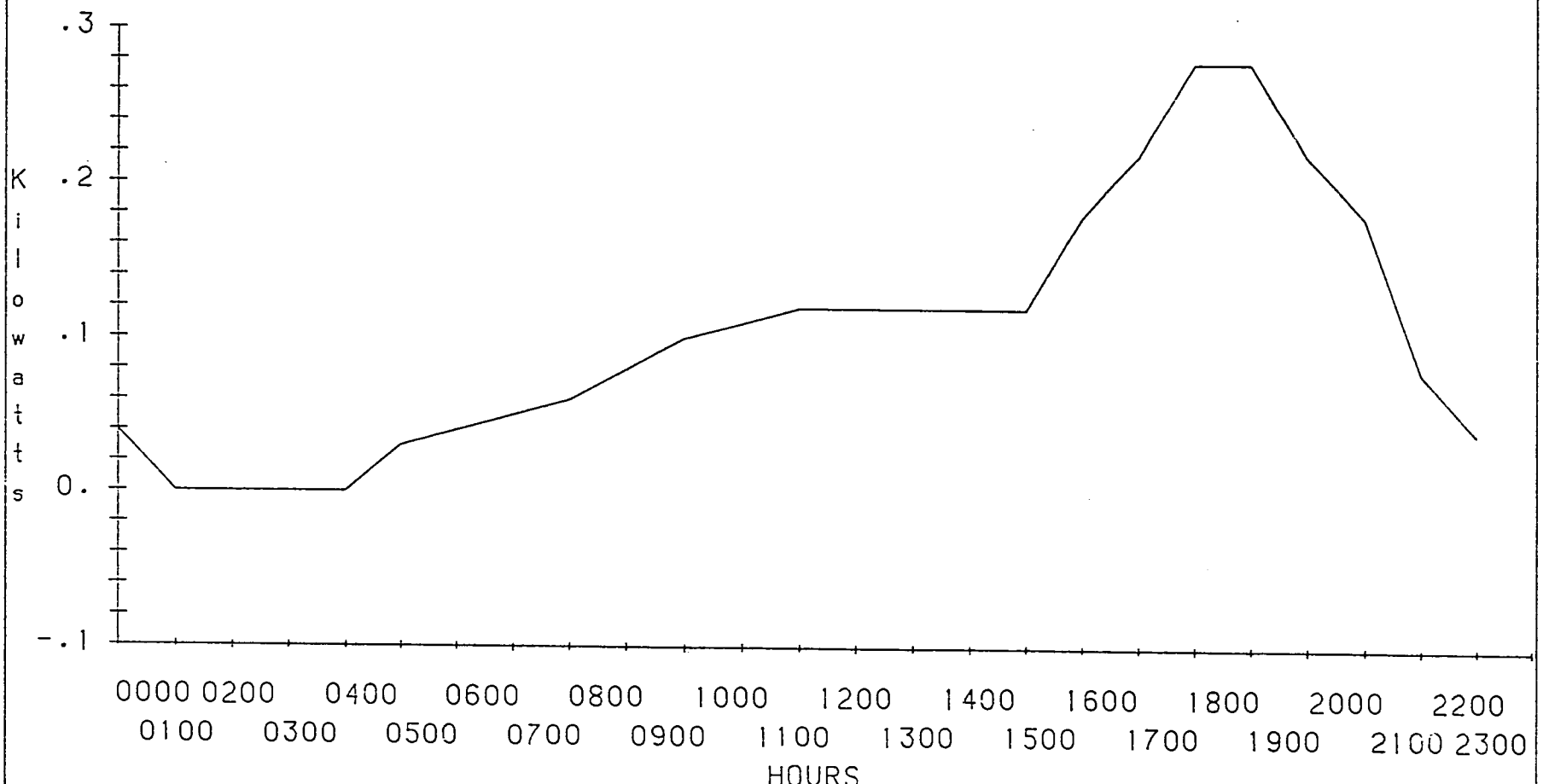
CADPAD(R) LOADSITE (TM) DOM-HGH (2011) 15-MAR-93 09:37:19



Legend:

Total KWHR Usage: 53.09

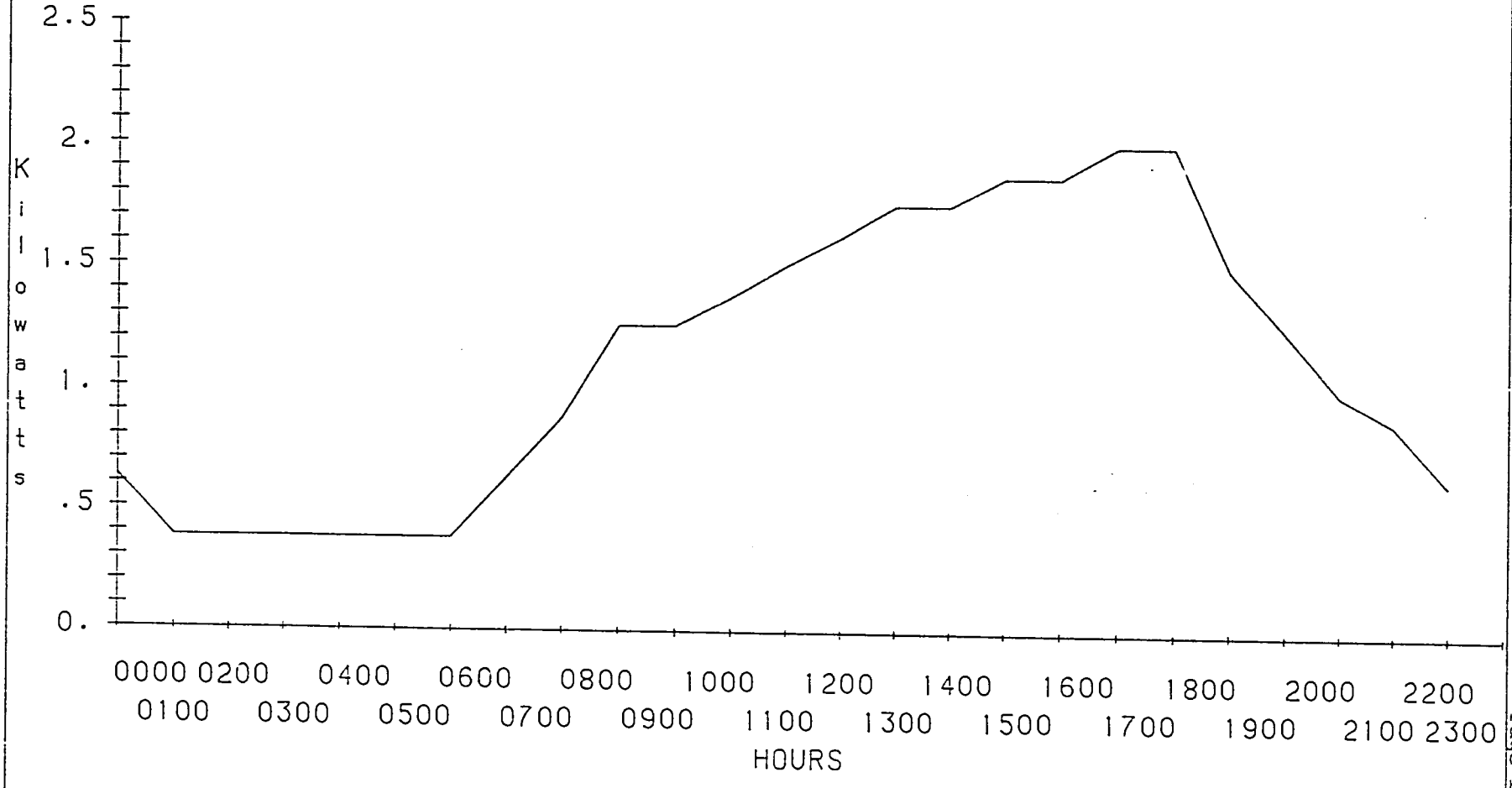
CADPAD(R) LOADSITE (TM) COM-LOW (2011) 15-MAR-93 09:37:50



Legend:

Total KWHR Usage: 2.550

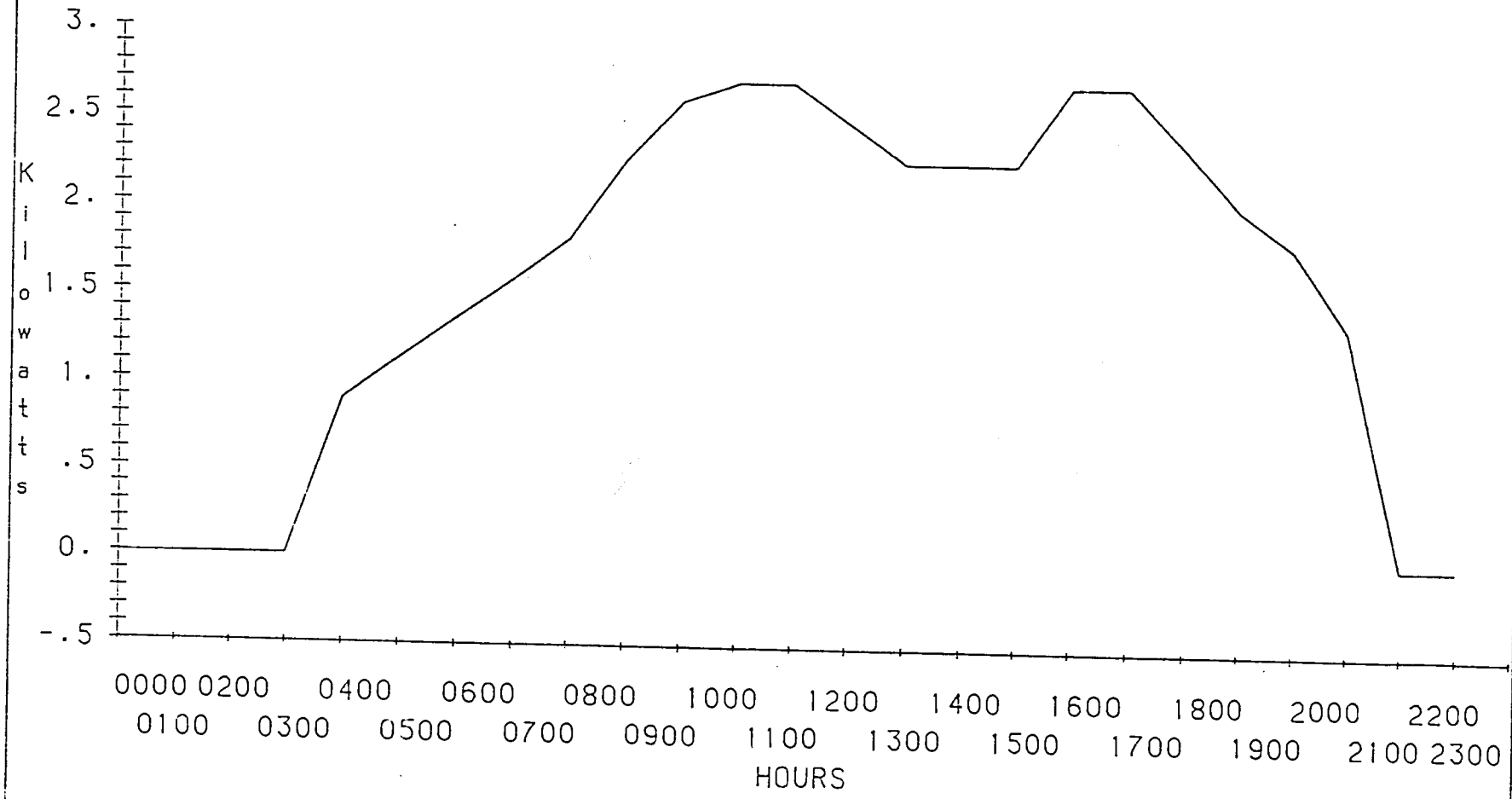
CADPAD(R) LOADSITE (TM) COM-MED (2011) 15-MAR-93 09:38:30



Legend:

Total KWHR Usage: 27.41

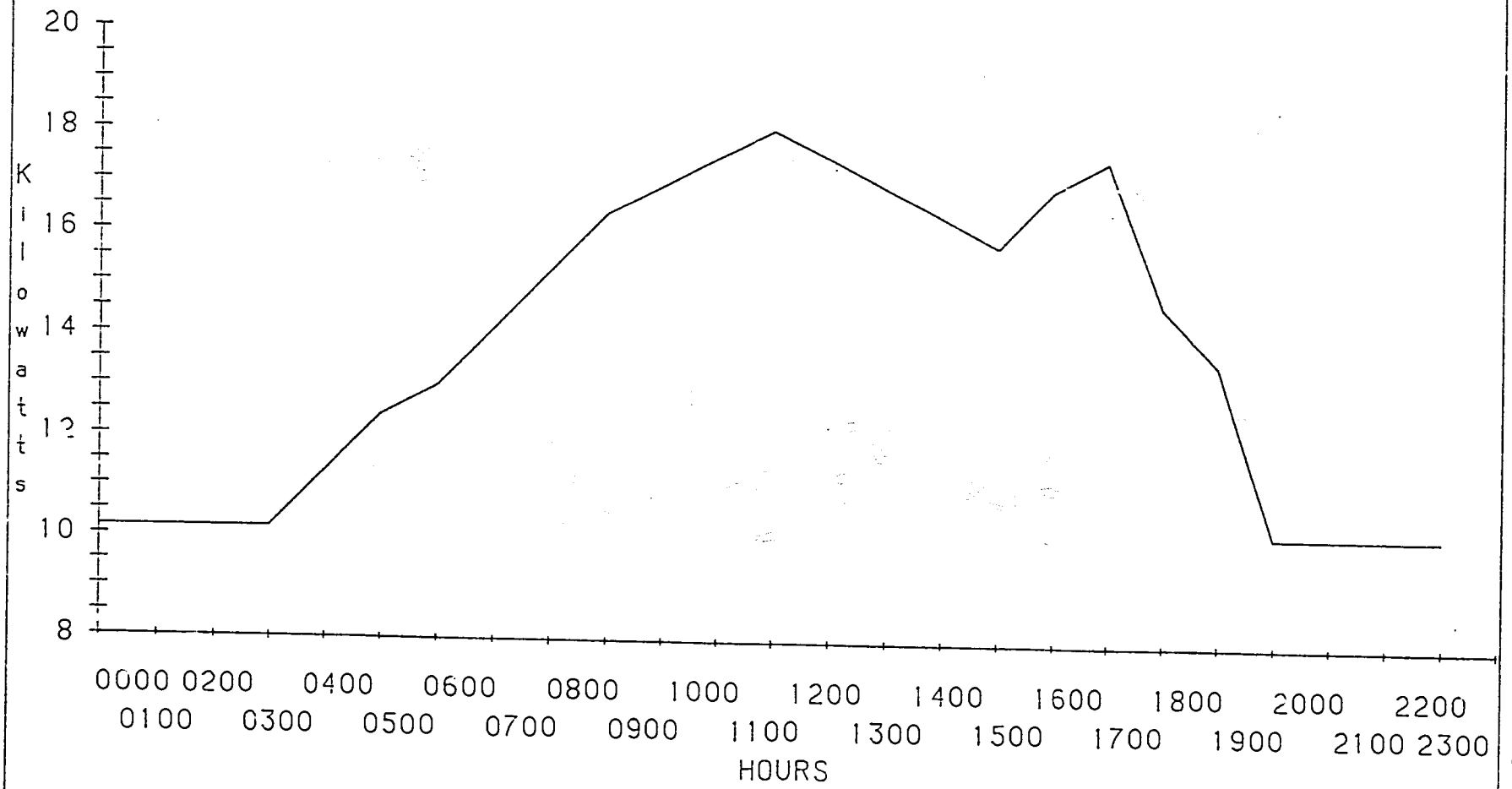
CADPAD(R) LOADSITE (TH) T-WELL (2011) 15-MAR-93 09:39:05



Legend:

Total KWHR Usage: 39.32

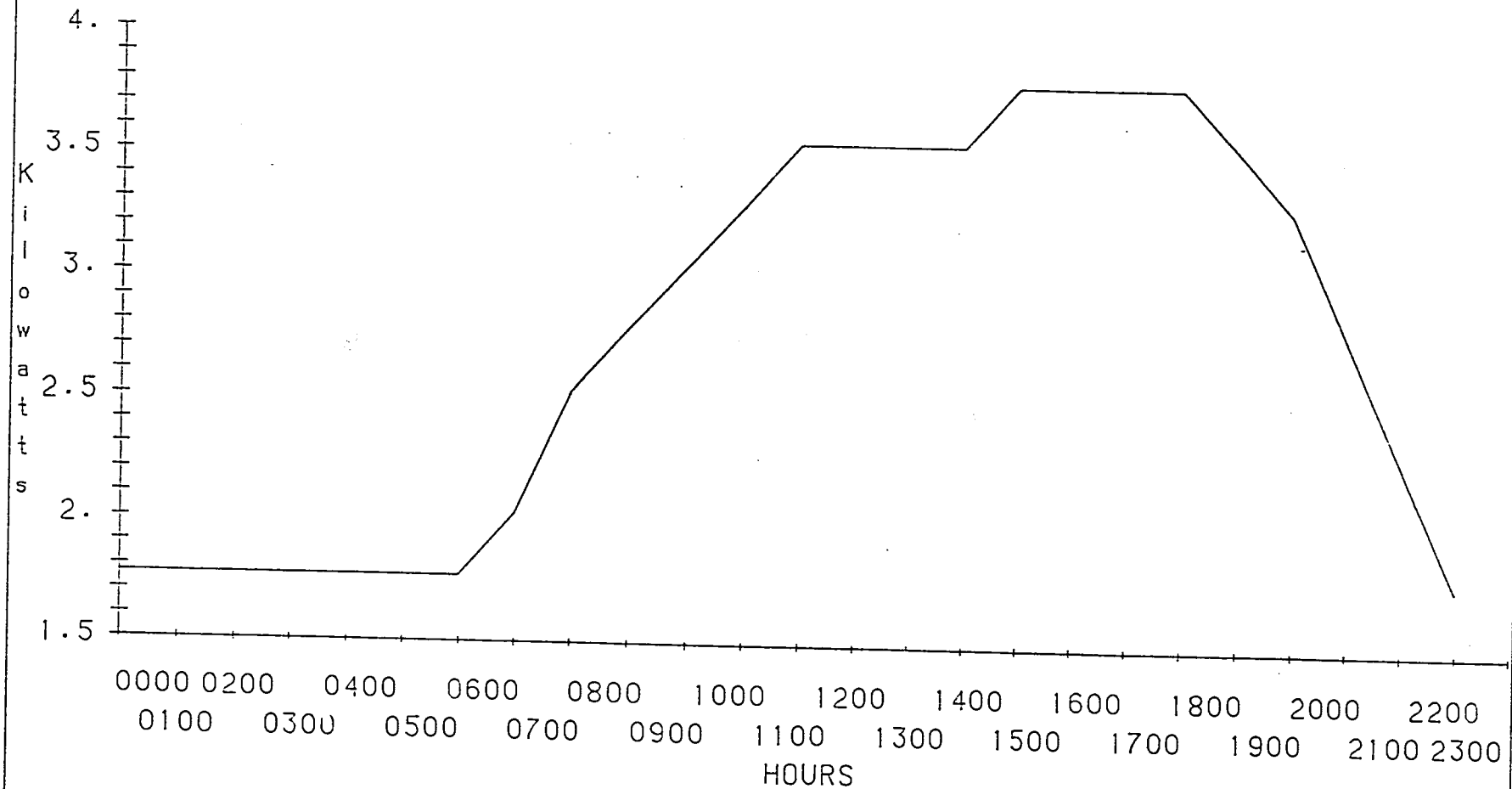
CADPAD(R) LOADSITE (TM) FT-WELL (2011) 15-MAR-93 09:39:44



Legend:

Total KWHR Usage: 335.7

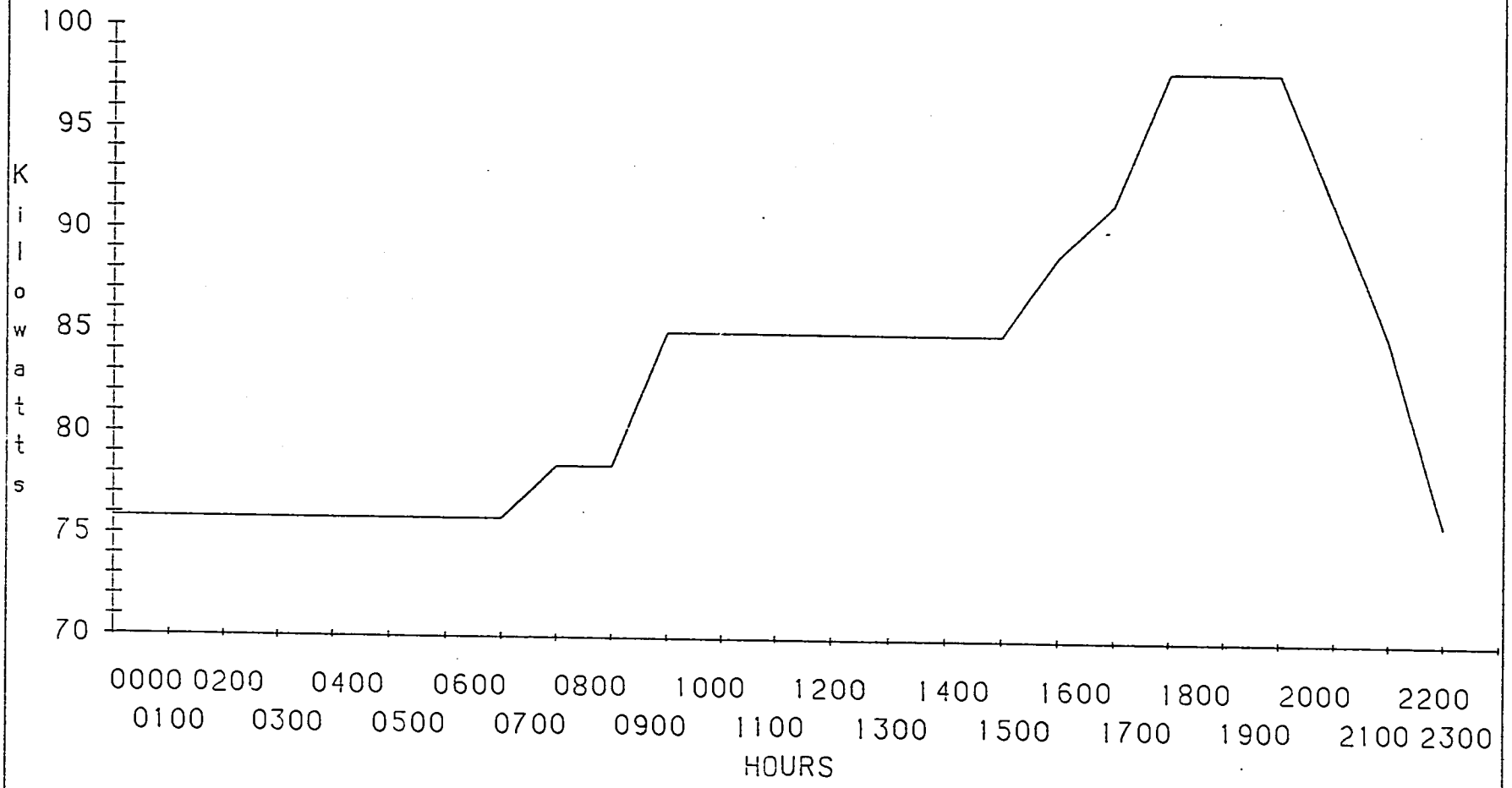
CADPAD(R) LOADSITE (TM) IND-LOW (2011) 15-MAR-93 09:40:14



Legend:

Total KWHR Usage: 67.38

CADPAD(R) LOADSITE (TM) IND-MED (2011) 15-MAR-93 09:41:51



Legend:

Total KWHR Usage: 2010.

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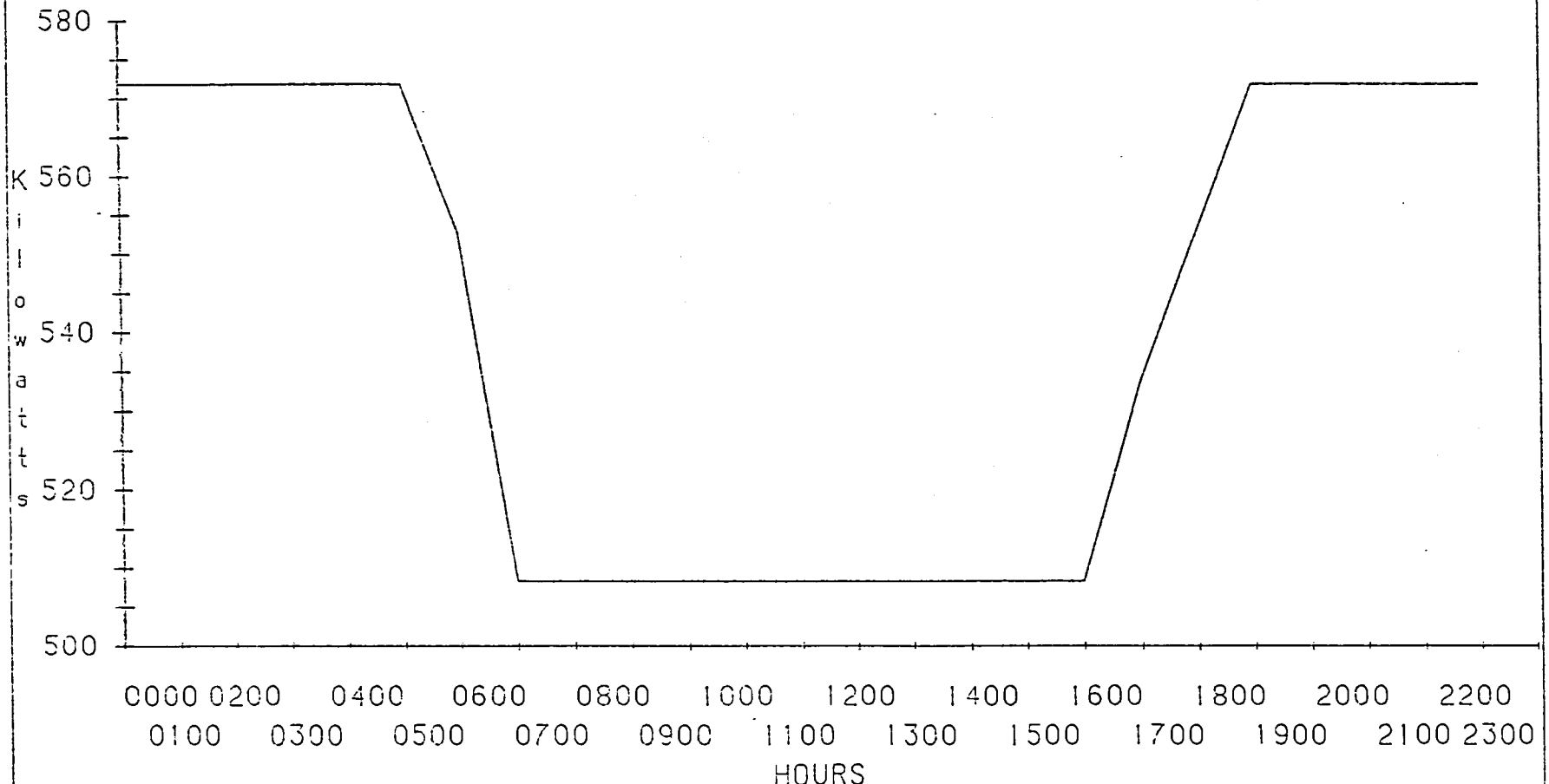
CADPAD(R) LOADSITE (TM) IND-HGH (2011) 15-MAR-93 09:42:16



Legend:

Total KWHR Usage: 0.1295E+05

BEST AVAILABLE COPY

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PRESENT AND HORIZON YEAR LOAD PROFILES
DOMESTIC LOW, MEDIUM AND HIGH CLASSES

(All Values are in kW)

HOUR	DOMESTIC-LOW 1991	DOMESTIC-LOW 2011	DOMESTIC-MED 1991	DOMESTIC-MED 2011	DOMESTIC-HGH 1991	DOMESTIC-HGH 2011
1	0.090	0.120	0.450	0.710	1.200	2.300
2	0.090	0.120	0.450	0.710	1.200	2.300
3	0.090	0.120	0.450	0.710	1.200	2.300
4	0.090	0.120	0.450	0.710	1.100	2.300
5	0.095	0.140	0.500	0.770	1.000	2.300
6	0.100	0.150	0.540	0.820	0.900	2.010
7	0.100	0.160	0.560	0.880	0.800	1.730
8	0.095	0.150	0.500	0.770	0.800	1.440
9	0.080	0.120	0.400	0.720	0.750	1.440
10	0.080	0.120	0.400	0.640	0.700	1.440
11	0.080	0.120	0.400	0.640	0.700	1.440
12	0.080	0.120	0.400	0.640	0.850	1.440
13	0.090	0.140	0.420	0.720	1.000	1.580
14	0.094	0.150	0.440	0.820	1.200	1.870
15	0.096	0.150	0.460	0.850	1.300	2.010
16	0.098	0.150	0.480	0.850	1.300	2.300
17	0.100	0.160	0.500	0.880	1.400	2.300
18	0.100	0.170	0.520	0.900	1.400	2.590
19	0.120	0.200	0.550	0.970	1.600	2.880
20	0.150	0.220	0.750	0.970	2.100	2.880
21	0.140	0.200	0.700	0.880	2.000	3.020
22	0.120	0.160	0.580	0.820	1.900	3.170
23	0.100	0.140	0.450	0.800	1.700	3.170
24	0.090	0.120	0.450	0.710	1.400	2.880

PRESENT AND HORIZON YEAR LOAD PROFILES
COMMERCIAL LOW AND MEDIUM CLASSES

(All Values are in kW)

HOUR	COMMERCIAL-LOW 1991	COMMERCIAL-LOW 2011	COMMERCIAL-MED 1991	COMMERCIAL-MED 2011
1	0.000	0.000	0.200	0.380
2	0.000	0.000	0.200	0.380
3	0.000	0.000	0.200	0.380
4	0.000	0.000	0.200	0.380
5	0.020	0.030	0.200	0.380
6	0.030	0.040	0.200	0.380
7	0.040	0.050	0.300	0.630
8	0.050	0.060	0.600	0.880
9	0.070	0.080	0.800	1.260
10	0.080	0.100	0.800	1.260
11	0.080	0.110	0.850	1.380
12	0.080	0.120	0.850	1.510
13	0.090	0.120	0.900	1.630
14	0.095	0.120	0.900	1.760
15	0.105	0.120	0.900	1.760
16	0.100	0.120	0.850	1.880
17	0.100	0.180	0.700	1.880
18	0.100	0.220	0.750	2.010
19	0.130	0.280	0.900	2.010
20	0.180	0.280	1.200	1.510
21	0.160	0.220	1.100	1.260
22	0.100	0.180	0.900	1.000
23	0.060	0.080	0.500	0.880
24	0.030	0.004	0.200	0.630

PRESENT AND HORIZON YEAR LOAD PROFILES
TUBEWELL PRIVATE AND FLAT RATE CLASSES

(All Values are in kW)

HOUR	TUBEWELL-PRIVATE 1991	TUBEWELL-PRIVATE 2011	TUBEWELL-FLAT RATE 1991	TUBEWELL-FLAT RATE 2011
1	0.000	0.000	8.000	10.170
2	0.000	0.000	8.000	10.170
3	0.000	0.000	8.000	10.170
4	0.500	0.900	9.000	11.300
5	0.800	1.130	10.000	12.430
6	1.000	1.360	11.000	13.000
7	1.200	1.580	12.000	14.130
8	1.500	1.810	13.000	15.260
9	1.800	2.260	14.000	16.390
10	2.200	2.600	14.000	16.950
11	2.200	2.710	14.000	17.520
12	2.200	2.710	14.000	18.080
13	2.100	2.490	13.500	17.520
14	2.000	2.260	13.000	16.950
15	2.000	2.260	12.500	16.390
16	2.000	2.260	11.000	15.820
17	2.050	2.710	11.000	16.950
18	2.050	2.710	11.500	17.520
19	2.050	2.370	12.000	14.690
20	2.300	2.030	13.000	13.560
21	1.800	1.810	12.000	10.170
22	1.000	1.360	8.000	10.170
23	0.000	0.000	8.000	10.170
24	0.000	0.000	8.000	10.170

PRESENT AND HORIZON YEAR LOAD PROFILES
INDUSTRY LOW, MEDIUM AND HIGH CLASSES

(All Values are in kW)

HOUR	INDUSTRY-LOW 1991	INDUSTRY-LOW 2011	INDUSTRY-MED 1991	INDUSTRY-MED 2011	INDUSTRY-HGH 1991	INDUSTRY-HGH 2011
1	1.200	1.770	52	75.850	420	571.880
2	1.200	1.770	52	75.850	420	571.880
3	1.200	1.770	52	75.850	420	571.880
4	1.200	1.770	52	75.850	420	571.880
5	1.200	1.770	52	75.850	420	571.880
6	1.200	1.770	52	75.850	420	552.820
7	1.200	2.030	52	75.850	390	508.340
8	1.400	2.530	52	78.460	350	508.340
9	1.700	2.790	55	78.460	350	508.340
10	2.000	3.040	58	85.000	350	508.340
11	2.200	3.290	58	85.000	350	508.340
12	2.200	3.550	58	85.000	350	508.340
13	2.200	3.550	58	85.000	350	508.340
14	2.400	3.550	58	85.000	350	508.340
15	2.400	3.550	58	85.000	350	508.340
16	2.400	3.800	58	85.000	350	508.340
17	2.400	3.800	58	88.930	350	508.340
18	2.200	3.800	58	91.540	350	533.760
19	2.200	3.800	60	98.080	390	552.820
20	2.000	3.550	65	98.080	420	571.880
21	1.800	3.290	62	98.080	420	571.880
22	1.600	2.790	56	91.540	420	571.880
23	1.400	2.280	52	85.000	420	571.880
24	1.200	1.770	52	75.850	420	571.880

SYSTEM LOAD PROFILES
PRESENT AND HORIZON YEARS

(All Values are in kW)

HOUR	SYSTEM PROFILE 1991	SYSTEM PROFILE 2011
1	16,757	63,242
2	16,757	63,242
3	16,757	63,242
4	18,605	67,178
5	20,473	72,252
6	21,978	74,660
7	23,016	78,363
8	23,966	79,906
9	24,802	80,121
10	26,368	82,795
11	26,620	84,911
12	26,677	86,702
13	26,745	88,927
14	26,804	90,526
15	26,792	90,633
16	26,099	91,602
17	26,428	96,886
18	26,573	100,531
19	28,363	103,562
20	32,397	102,636
21	29,353	93,752
22	22,756	83,732
23	17,926	72,338
24	16,978	64,598

CLASS STATISTICS FOR NTARIFF = 01

(DOMESTIC CONSUMERS)

SLABS	NUMBER OF CONSUMERS	AVG.UNITS PER DAY	CLASS	ADJUSTED CONSUMERS	FINAL CONSUMERS
0	5,540	0.00		0	0
1 - 200	35,130	2.37	DOM-LOW	40,005	39,962
201 - 500	4,467	11.80	DOM-MED	5,077	5,070
500 & ABOVE	337	29.50	DOM-HGH	392	376
TOTAL	45,474			45,474	45,408

CLASS STATISTICS FOR NTARIFF = 04

(COMMERCIAL CONSUMERS)

SLABS	NUMBER OF CONSUMERS	AVG.UNITS PER DAY	CLASS	ADJUSTED CONSUMERS	FINAL CONSUMERS
0	1,598	0.00		0	0
1 - 300	3,447	1.70	COM-LOW	4,997	4,870
301 & ABOVE	107	15.20	COM-HGH	155	151
TOTAL	5,152			5,152	5,021

TEN CUSTOMER CLASSES FOR GUJRANWALA III

S.NO.	CLASS	AV. CONSUMPTION RANGE (JUNE 1990)	TARIFFS
1.	Domestic Low	1 - 200	A-1, E-1 (1) C-1 (b), G, H (1)
2.	Domestic Medium	201 - 500	A-1, E-1 (1) C-1 (b), G, H (1)
3.	Domestic High	> 500	A-1, E-1 (1) C-1 (b), G, H (1)
4.	Commercial Low	1 - 300	A-2
5.	Commercial Medium	> 300	A-2
6.	Tubewells	> 0	D(49)
7.	Tubewells Flat Rate	> 0	D-1 (50)
8.	Industry Low	> 0	B-1, E-1(2), E-2(1)
9.	Industry Medium	> 0	B-2
10.	Industry High	> 0	B-3

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ QILA DEEDAR SINGH
TARIFF ♦ DOMESTIC A-1, E-1 [01]
MAP ♦ 1,2

BATCH	LOW	MEDIUM	HIGH
01	528	79	6
02	453	83	6
03	325	01	13
04	320	158	13
05	514	137	7
06	222	51	2
07	616	141	7
08	376	149	6
09	494	20	0
10	354	9	1
11	715	34	1
12	432	21	1
13	822	44	0
14	660	40	7
15	546	58	3
16	598	48	1
17	571	57	4
18	700	23	2
19	424	30	3
20	926	66	2
24	0	0	1
TOTAL #	10596	1329	86
AVG. CONS	76	279	854
		GRAND TOTAL	12011

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ QILA DEEDAR SINGH
TARIFF ♦ COMMERCIAL A-2 [04]
MAP ♦ 1,2

BATCH	LOW	MEDIUM
01	132	3
02	151	5
03	282	1
04	112	1
05	155	1
06	319	11
07	26	0
08	15	0
09	1	0
10	19	0
11	18	0
12	1	0
13	3	0
14	35	0
15	24	0
16	57	0
17	227	4
18	20	0
19	4	0
20	30	0
24	7	0
TOTAL #	1638	26
AVERAGE CONS	52	452
	GRAND TOTAL	1664

126

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ QILA DEEDAR SINGH
TARIFF ♦ TUBEWELL D-1 [49] &
TUBEWELL D-2 [50]
MAP ♦ 1,2

BATCH	TUBEWELL D-1 CONSUMERS	TUBEWELL D-2 CONSUMERS
01	22	3
02	11	1
05	2	0
06	6	0
09	91	12
10	4	0
11	23	5
12	38	7
13	26	14
14	18	3
15	52	10
16	10	1
17	14	4
18	16	1
19	38	22
20	6	1
TOTAL #	377	84
AVERAGE CONSUMPTION	1123	8021

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ QILA DEEDAR SINGH
TARIFF ♦ INDUSTRY B-1 [07]
MAP ♦ 1,2

BATCH	CONSUMERS
01	21
02	11
03	24
04	6
05	13
06	30
07	4
08	4
10	3
11	4
12	3
13	2
14	3
15	12
16	10
17	17
18	4
19	5
20	4
24	7
TOTAL #	187
AVERAGE CONSUMPTION	1421

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ LADHAY WALA
TARIFF ♦ DOMESTIC A-1, E-1 [01]
MAP ♦ 1,3

BATCH	LOW	MEDIUM	HIGH
01	448	58	2
02	530	43	2
03	339	73	9
04	393	51	2
05	567	76	0
06	595	173	5
07	489	49	6
08	1007	92	3
09	375	17	1
10	438	45	1
11	431	42	2
12	275	12	0
13	422	25	2
14	693	30	6
15	325	35	1
16	385	30	1
17	248	38	0
18	469	57	1
19	543	62	2
20	385	48	0
TOTAL #	9357	1056	46
AVGERAGE CONS	76	279	854
		GRAND TOTAL	10459

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ LADHAY WALA
TARIFF ♦ COMMERCIAL A-2 [04]
MAP ♦ 1,3

BATCH	LOW	MEDIUM
01	24	2
02	40	0
03	52	3
04	96	1
05	81	4
06	125	2
07	50	0
08	48	1
09	19	2
10	8	0
11	53	0
12	4	0
13	27	0
14	17	0
15	6	0
16	4	1
17	4	0
18	21	0
19	31	0
20	10	0
24	0	6
TOTAL #	720	22
AVERAGE CONS	52	452
	GRAND TOTAL	742

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ LADHAY WALA
TARIFF ♦ TUBEWELL D-1 [49] &
TUBEWELL D-2 [50]
MAP ♦ 1,3

BATCH	TUBEWELL D-1 CONSUMERS	TUBEWELL D-2 CONSUMERS
01	48	34
02	16	13
03	4	2
04	2	3
05	12	10
06	91	16
07	26	5
08	109	26
09	106	38
10	46	12
11	62	6
12	53	2
13	88	3
15	102	10
16	45	9
17	30	3
18	107	25
19	76	16
20	67	16
TOTAL #	1090	249
AVERAGE CONSUMPTION	1123	8021

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ LADHAY WALA
TARIFF ♦ INDUSTRY B-1 [07]
MAP ♦ 1,3

BATCH	CONSUMERS
01	13
02	25
03	15
04	84
05	44
06	64
07	6
08	23
09	15
10	5
11	8
12	5
13	4
14	3
15	4
16	2
17	1
18	3
19	7
20	3
24	5
TOTAL #	339
AVERAGE CONSUMPTION	1421

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ KHIALI
TARIFF ♦ DOMESTIC A-1, E-1 [01]
MAP ♦ 1,4

BATCH	LOW	MEDIUM	HIGH
01	761	109	15
02	293	23	0
03	419	66	2
04	408	16	2
05	352	38	4
06	401	62	8
07	315	17	4
08	502	93	13
09	404	105	15
10	375	85	8
11	562	97	15
12	739	156	17
13	680	144	23
14	414	55	5
15	693	57	13
16	406	48	2
17	208	4	1
18	336	24	0
19	518	65	4
20	543	59	5
24	1	0	0
TOTAL #	9330	1323	156
AVG. CONS	76	279	854
		GRAND TOTAL	10809

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ KHIALI
TARIFF ♦ COMMERCIAL A-2 [04]
MAP ♦ 1,4

BATCH	LOW	MEDIUM
01	100	8
02	11	0
03	12	1
04	19	0
05	21	0
06	15	0
07	7	0
08	81	0
09	64	0
10	173	11
11	174	7
12	111	0
13	332	17
14	24	0
15	38	2
16	11	0
17	20	2
18	10	0
19	74	0
20	17	0
24	13	10
TOTAL #	1327	66
AVERAGE CONS	52	452
	GRAND TOTAL	1393

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ KHIALI
TARIFF ♦ TUBEWELL D-1 [49] &
TUBEWELL D-2 [50]
MAP ♦ 1,4

BATCH	TUBEWELL D-1 CONSUMERS	TUBEWELL D-2 CONSUMERS
01	12	0
02	19	3
03	61	16
04	28	2
05	63	8
06	24	5
07	75	22
08	20	0
09	2	0
10	20	1
11	2	0
12	6	0
13	47	3
14	55	5
15	40	24
16	33	4
17	76	22
18	95	18
19	2	0
20	1	0
TOTAL #	681	133
AVERAGE CONSUMPTION	1123	8021

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ KHIALI
TARIFF ♦ INDUSTRY B-1 [07]
MAP ♦ 1,4

BATCH	CONSUMERS
01	39
02	3
03	4
04	12
05	19
06	5
07	2
08	64
09	8
10	85
11	37
12	12
13	96
14	14
15	11
16	5
17	11
18	18
19	1
20	1
24	7
TOTAL #	454
AVERAGE CONSUMPTION	1421

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ EMIN ABAD
TARIFF ♦ DOMESTIC A-1, E-1 [01]
MAP ♦ 1,5,6

BATCH	LOW	MEDIUM	HIGH
01	851	174	26
02	370	133	4
03	227	30	0
04	309	89	2
05	526	91	10
06	207	32	0
07	464	51	2
08	482	120	9
09	228	93	2
10	250	113	8
11	369	85	6
12	570	61	1
13	690	62	1
14	800	86	5
15	334	45	3
16	444	17	1
17	835	14	5
18	590	25	1
19	740	17	0
20	1394	23	1
24	0	1	2
TOTAL #	10680	1362	89
AVG. CONS	76	279	854
		GRAND TOTAL	12131

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ EMIN ABAD
TARIFF ♦ COMMERCIAL A-2 [04]
MAP ♦ 1,5,6

BATCH	LOW	MEDIUM
01	155	20
02	266	14
03	12	2
04	117	0
05	47	5
06	19	0
07	8	0
08	56	3
09	148	4
10	44	0
11	17	0
12	15	0
13	30	1
14	144	3
15	76	2
16	17	0
17	18	0
18	11	0
19	2	0
20	2	0
24	18	0
TOTAL #	1222	54
AVERAGE CONS	52	452
	GRAND TOTAL	1276

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ EMIN ABAD
TARIFF ♦ TUBEWELL D-1 [49] &
TUBEWELL D-2 [50]
MAP ♦ 1,5,6

BATCH	TUBEWELL D-1 CONSUMERS	TUBEWELL D-2 CONSUMERS
01	78	1
02	1	0
03	51	0
04	24	6
05	12	0
06	83	3
07	49	9
08	8	3
09	1	1
11	8	7
12	66	33
13	20	8
14	16	11
15	2	0
16	16	3
17	21	8
18	19	0
19	7	1
20	19	1
TOTAL #	501	95
AVERAGE CONSUMPTION	1123	8021

BATCHWISE DISTRIBUTION OF CONSUMERS

AEB ♦ GUJRANWALA
CIRCLE ♦ FIRST CIRCLE
DIVISION ♦ DIVISION III
SUBDIVISION ♦ EMIN ABAD
TARIFF ♦ INDUSTRY B-1 [07]
MAP ♦ 1,5,6

BATCH	CONSUMERS
01	115
02	35
03	16
04	8
05	14
06	9
07	6
08	8
09	4
10	2
11	8
12	2
13	2
14	12
15	13
16	1
18	3
19	1
20	1
24	7
TOTAL #	267
AVERAGE CONSUMPTION	1421

EXHIBIT - 5A

DLF-2 RURAL LOAD FORECASTING
AREA: GUJRANWALA III - (CONSUMER CLASS NAME)
MAP NO.

			SUBDIVISION NAME						
SR.NO.	X	Y	B1	B2	B3	B4	.....B20	X	Y

DLF-2 RURAL LOAD FORECASTING
AREA: GUJRANWALA III - COMMERCIAL CONSUMERS
MAP NO. 3 - LADHAY WALA TOWN COMMITTEE MAP

SR. NO.	COM-LOW X	COM-MED Y	LADHAY WALA S/DIV 52 3 B3	96 1 B4	81 4 B5	125 2 B6	354 10 X	Y	COM-LOW	COM-MED
1	99	40	0	0	0	0	99	40	0	0
2	100	40	0	0	0	0	100	40	0	0
3	101	40	0	0	0	0	101	40	0	0
4	102	40	0	0	0	0	102	40	0	0
5	103	40	0	0	0	0	103	40	0	0
6	104	40	0	0	0	0	104	40	0	0
7	105	40	0	0	0	0	105	40	0	0
8	106	40	0	0	0	0	106	40	0	0
9	107	40	0	0	0	0	107	40	0	0
10	108	40	0	0	0	0	108	40	0	0
11	109	40	0	0	0	0	109	40	0	0
12	110	40	0	0	0	0	110	40	0	0
13	111	40	0	0	0	0	111	40	0	0
14	99	41	0	0	0	0	99	41	0	0
15	100	41	0	0	5	0	100	41	4	0
16	101	41	0	0	5	5	101	41	10	0
17	102	41	0	0	0	1	102	41	1	0
18	103	41	0	0	0	2	103	41	3	0
19	104	41	0	0	0	2	104	41	3	0
20	105	41	0	0	0	1	105	41	1	0
21	106	41	0	0	0	0	106	41	0	0
22	107	41	0	0	0	1	107	41	1	0
23	108	41	0	0	0	15	108	41	19	0

DLF-2 RURAL LOAD FORECASTING
AREA: GUJRANWALA III - COMMERCIAL CONSUMERS
MAP NO. 3 - LADHAY WALA TOWN COMMITTEE MAP

SR. NO.	COM-LOW COM-MED X	Y	LADHAY WALA S/DIV 52 3 B3	96 1 B4	81 4 B5	125 2 B6	354 10 X	Y	COM-LOW	COM-MED
24	109	41	0	0	0	2	109	41	3	0
25	110	41	0	0	0	0	110	41	0	0
26	111	41	0	0	0	0	111	41	0	0
27	99	42	0	0	0	0	99	42	0	0
28	100	42	25	0	10	0	100	42	21	1
29	101	42	50	0	10	5	101	42	40	1
30	102	42	10	15	0	5	102	42	26	1
31	103	42	0	15	10	7	103	42	31	1
32	104	42	0	0	15	5	104	42	18	1
33	105	42	0	0	15	2	105	42	15	1
34	106	42	0	0	0	1	106	42	1	0
35	107	42	0	0	0	4	107	42	5	0
36	108	42	0	0	0	10	108	42	13	0
37	109	42	0	0	0	11	109	42	14	0
38	110	42	0	0	5	10	110	42	13	0
39	111	42	0	0	5	2	111	42	3	0
40	99	43	0	0	0	0	99	43	0	0
41	100	43	2	0	0	0	100	43	1	0
42	101	43	12	20	0	0	101	43	24	1
43	102	43	1	50	0	0	102	43	48	1
44	103	43	0	0	2	0	103	43	2	0
45	104	43	0	0	13	0	104	43	11	1
46	105	43	0	0	15	0	105	43	12	1

DLF-2 RURAL LOAD FORECASTING
AREA: GUJRANWALA III - COMMERCIAL CONSUMERS
MAP NO. 3 - LADHAY WALA TOWN COMMITTEE MAP

SR. NO.	COM-LOW COM-MED X	Y	LADHAY WALA S/DIV 52 3 B3	96 1 B4	81 4 B5	125 2 B6	354 10 X	Y	COM-LOW	COM-MED
47	106	43	0	0	0	0	106	43	0	0
48	107	43	0	0	0	0	107	43	0	0
49	108	43	0	0	0	0	108	43	0	0
50	109	43	0	0	0	0	109	43	0	0
51	110	43	0	0	0	5	110	43	6	0
52	111	43	0	0	0	3	111	43	4	0
53	99	44	0	0	0	0	99	44	0	0
54	100	44	0	0	0	0	100	44	0	0
55	101	44	0	0	0	0	101	44	0	0
56	102	44	0	0	0	0	102	44	0	0
57	103	44	0	0	0	0	103	44	0	0
58	104	44	0	0	0	0	104	44	0	0
59	105	44	0	0	0	0	105	44	0	0
60	106	44	0	0	0	0	106	44	0	0
61	107	44	0	0	0	0	107	44	0	0
62	108	44	0	0	0	0	108	44	0	0
63	109	44	0	0	0	0	109	44	0	0
64	110	44	0	0	0	1	110	44	1	0
65	111	44	0	0	0	0	111	44	0	0
66	99	45	0	0	0	0	99	45	0	0
67	100	45	0	0	0	0	100	45	0	0
68	101	45	0	0	0	0	101	45	0	0
69	102	45	0	0	0	0	102	45	0	0
			100	100	100	100			354	10

ASCII FILE FORMAT FOR DLF-2 INPUT

```
 40     11
121     58 170.00
123     58 185.00
.................
.................
.................
131     84 109.00
129     84 109.00
129     85 109.00

 40     12
121     58  33.00
123     58  33.00
.................
.................
.................
131     84  18.00
129     84  18.00
129     85  18.00

 40     13
121     58   6.00
123     58   6.00
.................
.................
.................

108     43   1.00
100     40   1.00
139     85   1.00

 40     14
121     58  21.00
123     58  14.00
.................
.................
.................
131     84  10.00
129     84  10.00
129     85  10.00
```

(40) DLF-2 Command, (11) Map No
(121 58) Map Cell Coordiantes
(185.00) Consumer Count

```
 40     15
121     58    1.00
123     58    1.00
.................
.................
.................
143     87    1.00
128     80    1.00
131     84    1.00

 40     16
 29     52    1.00
 30     75    1.00
.................
.................
.................
169     62    1.00
170     90    1.00
171     63    1.00

 40     17
 35     63    1.00
 51     79    1.00
.................
.................
.................
 70     35    1.00
 80     50    1.00
100     70    1.00

 40     18
 66     50    7.00
 70     50    7.00
.................
.................
.................
131     84    7.00
129     84    7.00
129     85    7.00

 40     19
109     40    1.00
123     57    2.00
.................
.................
.................
128     75    1.00
130     85    1.00
130     91    1.00
```

```
 40     20
110     41    1.00
121     58    2.00
.................
.................
.................

128     74    1.00
128     76    1.00
130     87    1.00

 40     21
121     581997.00
122     581995.00
.................
.................
.................
122     601997.00
123     601997.00
124     601997.00
```

90 ——————————> **(90)** DLF-2 Command

STATISTICS FOR BASE YEAR CUSTOMER COUNTS

STATISTICS FOR MAP 1 - DOM-LOW (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	543.0000
TOTAL =	39962.0000	AVERAGE=	107.1367
-SIGMA =	12.6423	+SIGMA =	201.6311
NON-ZERO CELLS =	373.	NEGATIVE CELLS =	0.
X COORD= 107 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 2 - DOM-MED (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	197.0000
TOTAL =	5070.0000	AVERAGE=	13.9286
-SIGMA =	-7.0694	+SIGMA =	34.9265
NON-ZERO CELLS =	364.	NEGATIVE CELLS =	0.
X COORD= 106 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 3 - DOM-HGH (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	14.0000
TOTAL =	376.0000	AVERAGE=	2.3797
-SIGMA =	0.0208	+SIGMA =	4.7387
NON-ZERO CELLS =	158.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 4 - COM-LOW (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	276.0000
TOTAL =	4870.0000	AVERAGE=	18.1041
-SIGMA =	-17.1849	+SIGMA =	53.3931
NON-ZERO CELLS =	269.	NEGATIVE CELLS =	0.
X COORD= 104 ----- LOAD CENTER ----		Y COORD=	60

STATISTICS FOR BASE YEAR CUSTOMER COUNTS

STATISTICS FOR MAP 5 - COM-MED (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	12.0000
TOTAL =	151.0000	AVERAGE=	2.4355
-SIGMA =	-0.0181	+SIGMA =	4.8891
NON-ZERO CELLS =	62.	NEGATIVE CELLS =	0.
X COORD= 115 ----- LOAD CENTER ----		Y COORD=	62

STATISTICS FOR MAP 6 - TUBEWELL (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	17.0000
TOTAL =	2649.0000	AVERAGE=	1.5268
-SIGMA =	0.4260	+SIGMA =	2.6276
NON-ZERO CELLS =	1735.	NEGATIVE CELLS =	0.
X COORD= 102 ----- LOAD CENTER ----		Y COORD=	57

STATISTICS FOR MAP 7 - F-TWELL (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	3.0000
TOTAL =	561.0000	AVERAGE=	1.0768
-SIGMA =	0.7965	+SIGMA =	1.3571
NON-ZERO CELLS =	521.	NEGATIVE CELLS =	0.
X COORD= 103 ----- LOAD CENTER ----		Y COORD=	58

STATISTICS FOR MAP 8 - IND-LOW (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	80.0000
TOTAL =	1221.0000	AVERAGE=	5.9561
-SIGMA =	-4.0874	+SIGMA =	15.9996
NON-ZERO CELLS =	205.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	57

STATISTICS FOR BASE YEAR CUSTOMER COUNTS

STATISTICS FOR MAP 9 - IND-MED (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	6.0000
TOTAL =	37.0000	AVERAGE=	1.6087
-SIGMA =	0.4388	+SIGMA =	2.7786
NON-ZERO CELLS =	23.	NEGATIVE CELLS =	0.

X COORD= 125 ----- LOAD CENTER ---- Y COORD= 64

STATISTICS FOR MAP 10 - IND-HGH (BASE YEAR)

MINIMUM=	0.0000	MAXIMUM=	1.0000
TOTAL =	6.0000	AVERAGE=	1.0000
-SIGMA =	1.0000	+SIGMA =	1.0000
NON-ZERO CELLS =	6.	NEGATIVE CELLS =	0.

X COORD= 113 ----- LOAD CENTER ---- Y COORD= 59

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 1

STATISTICS FOR MAP 11 - DOM-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	543.0000
TOTAL =	75843.0000	AVERAGE=	176.3791
-SIGMA =	54.5249	+SIGMA =	298.2332
NON-ZERO CELLS =	430.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 12 - DOM-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	197.0000
TOTAL =	10177.0000	AVERAGE=	24.1734
-SIGMA =	-2.7188	+SIGMA =	51.0656
NON-ZERO CELLS =	421.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 13 - DOM-HGH (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	15.0000
TOTAL =	754.0000	AVERAGE=	4.2360
-SIGMA =	1.0400	+SIGMA =	7.4319
NON-ZERO CELLS =	178.	NEGATIVE CELLS =	0.
X COORD= 111 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 14 - COM-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	276.0000
TOTAL =	8009.0000	AVERAGE=	24.7191
-SIGMA =	-18.1951	+SIGMA =	67.6334
NON-ZERO CELLS =	324.	NEGATIVE CELLS =	0.
X COORD= 107 ----- LOAD CENTER ----		Y COORD=	60

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 1

STATISTICS FOR MAP 15 - COM-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	12.0000
TOTAL =	252.0000	AVERAGE=	3.1111
-SIGMA =	0.4260	+SIGMA =	5.7962
NON-ZERO CELLS =	81.	NEGATIVE CELLS =	0.
X COORD= 113 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 16 - T-WELL49 (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	17.0000
TOTAL =	3023.0000	AVERAGE=	1.4703
-SIGMA =	0.3597	+SIGMA =	2.5810
NON-ZERO CELLS =	2056.	NEGATIVE CELLS =	0.
X COORD= 104 ----- LOAD CENTER ----		Y COORD=	58

STATISTICS FOR MAP 17 - T-WELL50 (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	3.0000
TOTAL =	705.0000	AVERAGE=	1.2795
-SIGMA =	0.7424	+SIGMA =	1.8166
NON-ZERO CELLS =	551.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	62

STATISTICS FOR MAP 18 - IND-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	80.0000
TOTAL =	2260.0000	AVERAGE=	9.1498
-SIGMA =	-2.1082	+SIGMA =	20.4078
NON-ZERO CELLS =	247.	NEGATIVE CELLS =	0.
X COORD= 108 ----- LOAD CENTER ----		Y COORD=	58

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 1

STATISTICS FOR MAP 19 - IND-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	6.0000
TOTAL =	80.0000	AVERAGE=	2.1622
-SIGMA =	0.9426	+SIGMA =	3.3817
NON-ZERO CELLS =	37.	NEGATIVE CELLS =	0.
X COORD= 125 ----- LOAD CENTER ----		Y COORD=	65

STATISTICS FOR MAP 20 - IND-HGH (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	2.0000
TOTAL =	21.0000	AVERAGE=	1.1053
-SIGMA =	0.7984	+SIGMA =	1.4122
NON-ZERO CELLS =	19.	NEGATIVE CELLS =	0.
X COORD= 121 ----- LOAD CENTER ----		Y COORD=	62

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 2

STATISTICS FOR MAP 11 - DOM-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	543.0000
TOTAL =	103987.3203	AVERAGE=	195.8330
-SIGMA =	70.1085	+SIGMA =	321.5575
NON-ZERO CELLS =	531.	NEGATIVE CELLS =	0.
X COORD= 110 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 12 - DOM-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	197.0000
TOTAL =	14096.2051	AVERAGE=	27.5855
-SIGMA =	0.5092	+SIGMA =	54.6618
NON-ZERO CELLS =	511.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 13 - DOM-HGH (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	14.0000
TOTAL =	1118.0116	AVERAGE=	4.6584
-SIGMA =	1.7416	+SIGMA =	7.5751
NON-ZERO CELLS =	240.	NEGATIVE CELLS =	0.
X COORD= 111 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR MAP 14 - COM-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	276.0000
TOTAL =	14419.6084	AVERAGE=	34.9991
-SIGMA =	-10.2216	+SIGMA =	80.2197
NON-ZERO CELLS =	412.	NEGATIVE CELLS =	0.
X COORD= 110 ----- LOAD CENTER ----		Y COORD=	61

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 2

STATISTICS FOR MAP 15 - COM-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	12.0000
TOTAL =	524.1824	AVERAGE=	4.2616
-SIGMA =	1.5031	+SIGMA =	7.0202
NON-ZERO CELLS =	123.	NEGATIVE CELLS =	0.
X COORD= 113 ----- LOAD CENTER ----		Y COORD=	62

STATISTICS FOR MAP 16 - T-WELL49 (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	17.0000
TOTAL =	3313.5083	AVERAGE=	1.8429
-SIGMA =	0.6966	+SIGMA =	2.9892
NON-ZERO CELLS =	1798.	NEGATIVE CELLS =	0.
X COORD= 102 ----- LOAD CENTER ----		Y COORD=	57

STATISTICS FOR MAP 17 - T-WELL50 (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	4.4036
TOTAL =	843.9790	AVERAGE=	1.5543
-SIGMA =	1.0986	+SIGMA =	2.0100
NON-ZERO CELLS =	543.	NEGATIVE CELLS =	0.
X COORD= 102 ----- LOAD CENTER ----		Y COORD=	58

STATISTICS FOR MAP 18 - IND-LOW (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	80.0000
TOTAL =	4255.5933	AVERAGE=	12.8957
-SIGMA =	0.8782	+SIGMA =	24.9133
NON-ZERO CELLS =	330.	NEGATIVE CELLS =	0.
X COORD= 109 ----- LOAD CENTER ----		Y COORD=	59

STATISTICS FOR HORIZON YEAR CUSTOMER COUNTS
METHOD 2

STATISTICS FOR MAP 19 - IND-MED (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	6.0000
TOTAL =	130.8857	AVERAGE=	3.0439
-SIGMA =	2.1526	+SIGMA =	3.9351
NON-ZERO CELLS =	43.	NEGATIVE CELLS =	0.
X COORD= 125 ----- LOAD CENTER ----		Y COORD=	68

STATISTICS FOR MAP 20 - IND-HGH (HOR. YEAR)

MINIMUM=	0.0000	MAXIMUM=	2.0000
TOTAL =	21.0000	AVERAGE=	1.6154
-SIGMA =	1.1289	+SIGMA =	2.1019
NON-ZERO CELLS =	13.	NEGATIVE CELLS =	0.
X COORD= 116 ----- LOAD CENTER ----		Y COORD=	60

DLF-2 RESULTS

BY METHOD 1 - APPLYING FLAT ANNUAL GROWTH RATE

STATISTICS FOR PRESENT YEAR 1991 LOADS

MINIMUM =	0.0000	MAXIMUM =	887.1500
TOTAL =	32397.1973	AVERAGE =	15.1389
NON-ZERO CELLS =	2140	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1992)

MINIMUM =	0.0000	MAXIMUM =	892.5392
TOTAL =	33309.7773	AVERAGE =	13.3882
NON-ZERO CELLS =	2488	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1993)

MINIMUM =	0.0000	MAXIMUM =	897.7427
TOTAL =	34261.4414	AVERAGE =	13.7707
NON-ZERO CELLS =	2488	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1994)

MINIMUM =	0.0000	MAXIMUM =	902.9818
TOTAL =	35255.7852	AVERAGE =	14.1703
NON-ZERO CELLS =	2488	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1995)

MINIMUM =	0.0000	MAXIMUM =	908.4353
TOTAL =	36295.0039	AVERAGE =	14.5880
NON-ZERO CELLS =	2488	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1996)

MINIMUM =	0.0000	MAXIMUM =	913.4353
TOTAL =	37380.7695	AVERAGE =	15.0063
NON-ZERO CELLS =	2491	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1997)

MINIMUM =	0.0000	MAXIMUM =	918.6548
TOTAL =	38514.4180	AVERAGE =	15.4614
NON-ZERO CELLS =	2491	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1998)

MINIMUM =	0.0000	MAXIMUM =	923.8943
TOTAL =	39696.2969	AVERAGE =	15.8722
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1999)

MINIMUM =	0.0000	MAXIMUM =	929.1699
TOTAL =	40933.5430	AVERAGE =	16.3669
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2000)

MINIMUM =	0.0000	MAXIMUM =	934.3146
TOTAL =	42226.2813	AVERAGE =	16.8838
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2001)

MINIMUM =	0.0000	MAXIMUM =	938.8959
TOTAL =	43578.5781	AVERAGE =	17.4245
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2002)

MINIMUM =	0.0000	MAXIMUM =	944.0242
TOTAL =	44993.9648	AVERAGE =	17.9904
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2003)

MINIMUM =	0.0000	MAXIMUM =	949.1857
TOTAL =	46470.6758	AVERAGE =	18.5808
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2004)

MINIMUM =	0.0000	MAXIMUM =	954.3514
TOTAL =	48015.6055	AVERAGE =	19.1986
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2005)

MINIMUM =	0.0000	MAXIMUM =	959.5405
TOTAL =	49629.4102	AVERAGE =	19.8438
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2006)

MINIMUM =	0.0000	MAXIMUM =	964.7531
TOTAL =	51321.0547	AVERAGE =	20.5202
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2007)

MINIMUM =	0.0000	MAXIMUM =	969.0460
TOTAL =	53093.4766	AVERAGE =	21.2289
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2008)

MINIMUM =	0.0000	MAXIMUM =	974.2172
TOTAL =	54941.6328	AVERAGE =	21.9679
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2009)

MINIMUM =	0.0000	MAXIMUM =	979.4063
TOTAL =	56878.3438	AVERAGE =	22.7422
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2010)

MINIMUM =	0.0000	MAXIMUM =	984.6192
TOTAL =	58906.8242	AVERAGE =	23.5533
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

STATISTICS FOR HORIZON YEAR 2011 LOADS

MINIMUM =	0.0000	MAXIMUM =	1095.1000
TOTAL =	61017.7500	AVERAGE =	24.3973
NON-ZERO CELLS =	2501	NEGATIVE CELLS =	0

DLF-2 RESULTS

BY METHOD 2 - APPLYING MULTIPLE GROWTH RATES

STATISTICS FOR PRESENT YEAR 1991 LOADS

MINIMUM =	0.0000	MAXIMUM =	904.4600
TOTAL =	32397.1953	AVERAGE =	15.3323
NON-ZERO CELLS =	2113	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1992)

MINIMUM =	0.0000	MAXIMUM =	925.9435
TOTAL =	35184.4023	AVERAGE =	16.6514
NON-ZERO CELLS =	2113	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1993)

MINIMUM =	0.0000	MAXIMUM =	947.9165
TOTAL =	38278.9336	AVERAGE =	18.1159
NON-ZERO CELLS =	2113	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1994)

MINIMUM =	0.0000	MAXIMUM =	970.9165
TOTAL =	41720.8125	AVERAGE =	19.7355
NON-ZERO CELLS =	2114	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1995)

MINIMUM =	0.0000	MAXIMUM =	993.2172
TOTAL =	45541.4883	AVERAGE =	21.4616
NON-ZERO CELLS =	2122	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1996)

MINIMUM =	0.0000	MAXIMUM =	1016.1539
TOTAL =	49797.5938	AVERAGE =	23.3353
NON-ZERO CELLS =	2134	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1997)

MINIMUM =	0.0000	MAXIMUM =	1037.0703
TOTAL =	52959.0664	AVERAGE =	24.6207
NON-ZERO CELLS =	2151	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1998)

MINIMUM =	0.0000	MAXIMUM =	1058.9279
TOTAL =	56370.9531	AVERAGE =	26.1704
NON-ZERO CELLS =	2154	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (1999)

MINIMUM =	0.0000	MAXIMUM =	1078.7234
TOTAL =	60050.5859	AVERAGE =	27.6349
NON-ZERO CELLS =	2173	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2000)

MINIMUM =	0.0000	MAXIMUM =	1100.9688
TOTAL =	63940.9414	AVERAGE =	29.4252
NON-ZERO CELLS =	2173	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2001)

MINIMUM =	0.0000	MAXIMUM =	1122.0928
TOTAL =	67001.0703	AVERAGE =	30.4136
NON-ZERO CELLS =	2203	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2002)

MINIMUM =	0.0000	MAXIMUM =	1142.0654
TOTAL =	70192.7500	AVERAGE =	31.8623
NON-ZERO CELLS =	2203	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2003)

MINIMUM =	0.0000	MAXIMUM =	1163.7219
TOTAL =	73596.4375	AVERAGE =	33.3619
NON-ZERO CELLS =	2206	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2004)

MINIMUM =	0.0000	MAXIMUM =	1185.5353
TOTAL =	77102.0000	AVERAGE =	34.9510
NON-ZERO CELLS =	2206	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2005)

MINIMUM =	0.0000	MAXIMUM =	1206.8314
TOTAL =	80821.2500	AVERAGE =	36.6038
NON-ZERO CELLS =	2208	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2006)

MINIMUM =	0.0000	MAXIMUM =	1227.7428
TOTAL =	84103.5859	AVERAGE =	37.5966
NON-ZERO CELLS =	2237	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2007)

MINIMUM =	0.0000	MAXIMUM =	1242.9225
TOTAL =	87517.9609	AVERAGE =	39.0357
NON-ZERO CELLS =	2242	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2008)

MINIMUM =	0.0000	MAXIMUM =	1263.8175
TOTAL =	91048.7500	AVERAGE =	40.5382
NON-ZERO CELLS =	2246	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2009)

MINIMUM =	0.0000	MAXIMUM =	1282.9417
TOTAL =	94715.6172	AVERAGE =	41.9839
NON-ZERO CELLS =	2256	NEGATIVE CELLS =	0

STATISTICS FOR LOAD FORECAST (2010)

MINIMUM =	0.0000	MAXIMUM =	1303.8981
TOTAL =	98580.4844	AVERAGE =	43.6390
NON-ZERO CELLS =	2259	NEGATIVE CELLS =	0

STATISTICS FOR HORIZON YEAR 2011 LOADS

MINIMUM =	0.0000	MAXIMUM =	2009.4371
TOTAL =	102724.9219	AVERAGE =	45.4535
NON-ZERO CELLS =	2260	NEGATIVE CELLS =	0

S CURVE VALUES

VALUE 1	0.100
VALUE 2	0.200
VALUE 3	0.295
VALUE 4	0.390
VALUE 5	0.480
VALUE 6	0.560
VALUE 7	0.640
VALUE 8	0.710
VALUE 9	0.770
VALUE 10	0.820
VALUE 11	0.860
VALUE 12	0.890
VALUE 13	0.920
VALUE 14	0.940
VALUE 15	0.960
VALUE 16	0.970
VALUE 17	0.980
VALUE 18	0.990
VALUE 19	1.000
VALUE 20	1.000

DLF-2 RESULTS
CUSTOMER COUNTS
BY METHOD 1 - APPLYING FLAT ANNUAL GROWTH RATE

GROWTH % YEAR	3.3% DOM-LOW	3.5% DOM-MED	3.5% DOM-HGH	2.5% COM-LOW	2.6% COM-MED
1991	39,962	5,070	376	4,870	151
1992	41,265	5,250	389	4,993	155
1993	42,610	5,436	403	5,119	159
1994	43,999	5,629	417	5,248	163
1995	45,433	5,829	432	5,380	167
1996	46,915	6,036	447	5,515	172
1997	48,444	6,250	463	5,654	176
1998	50,023	6,472	480	5,797	181
1999	51,654	6,702	497	5,943	185
2000	53,338	6,940	514	6,093	190
2001	55,077	7,186	532	6,246	195
2002	56,872	7,442	551	6,404	200
2003	58,726	7,706	571	6,565	205
2004	60,641	7,979	591	6,730	211
2005	62,618	8,263	612	6,900	216
2006	64,659	8,556	634	7,074	222
2007	66,767	8,860	656	7,252	227
2008	68,944	9,174	679	7,435	233
2009	71,191	9,500	703	7,622	239
2010	73,512	9,837	728	7,814	246
2011	75,843	10,177	754	8,009	252

GROWTH % YEAR	0.7% T/W-PRI	1.1% T/W-F.R	3.1% IND-LOW	3.9% IND-MED	6.5% IND-HGH
1991	2,649	561	1,221	37	6
1992	2,667	568	1,259	39	6
1993	2,684	574	1,299	40	7
1994	2,702	581	1,339	42	7
1995	2,720	587	1,381	43	8
1996	2,738	594	1,424	45	8
1997	2,756	601	1,469	47	9
1998	2,774	608	1,515	49	9
1999	2,792	615	1,562	50	10
2000	2,811	622	1,611	52	11
2001	2,829	629	1,662	54	11
2002	2,848	636	1,714	57	12
2003	2,867	644	1,767	59	13
2004	2,886	651	1,823	61	14
2005	2,905	658	1,880	64	14
2006	2,924	666	1,939	66	15
2007	2,943	674	1,999	69	16
2008	2,962	681	2,062	71	17
2009	2,982	689	2,126	74	18
2010	3,002	697	2,193	77	20
2011	3,023	705	2,260	80	21

DLF-2 RESULTS
CUSTOMER COUNTS
BY METHOD 2 - APPLYING MULTIPLE GROWTH RATES

YEAR	DOMESTIC-LOW GROWTH	DOMESTIC-LOW NUMBER	DOMESTIC-MED GROWTH	DOMESTIC-MED NUMBER	DOMESTIC-HGH GROWTH	DOMESTIC-HGH NUMBER
1991	9.0%	39,962	9.5%	5,070	10.0%	376
1992	9.0%	43,559	9.5%	5,552	10.0%	414
1993	9.0%	47,479	9.5%	6,079	10.0%	455
1994	9.0%	51,752	9.5%	6,657	10.0%	501
1995	9.0%	56,410	9.5%	7,289	10.0%	551
1996	9.0%	61,487	9.5%	7,981	10.0%	606
1997	4.5%	64,253	5.0%	8,381	5.5%	639
1998	4.5%	67,145	5.0%	8,800	5.5%	674
1999	4.5%	70,166	5.0%	9,240	5.5%	711
2000	4.5%	73,324	5.0%	9,701	5.5%	750
2001	3.5%	75,890	4.0%	10,090	4.5%	784
2002	3.5%	78,546	4.0%	10,493	4.5%	819
2003	3.5%	81,295	4.0%	10,913	4.5%	856
2004	3.5%	84,141	4.0%	11,349	4.5%	895
2005	3.5%	87,086	4.0%	11,803	4.5%	935
2006	3.0%	89,698	3.0%	12,157	3.0%	963
2007	3.0%	92,389	3.0%	12,522	3.0%	992
2008	3.0%	95,161	3.0%	12,898	3.0%	1,022
2009	3.0%	98,016	3.0%	13,285	3.0%	1,052
2010	3.0%	100,956	3.0%	13,683	3.0%	1,084
2011	-	103,987	-	14,096	-	1,118

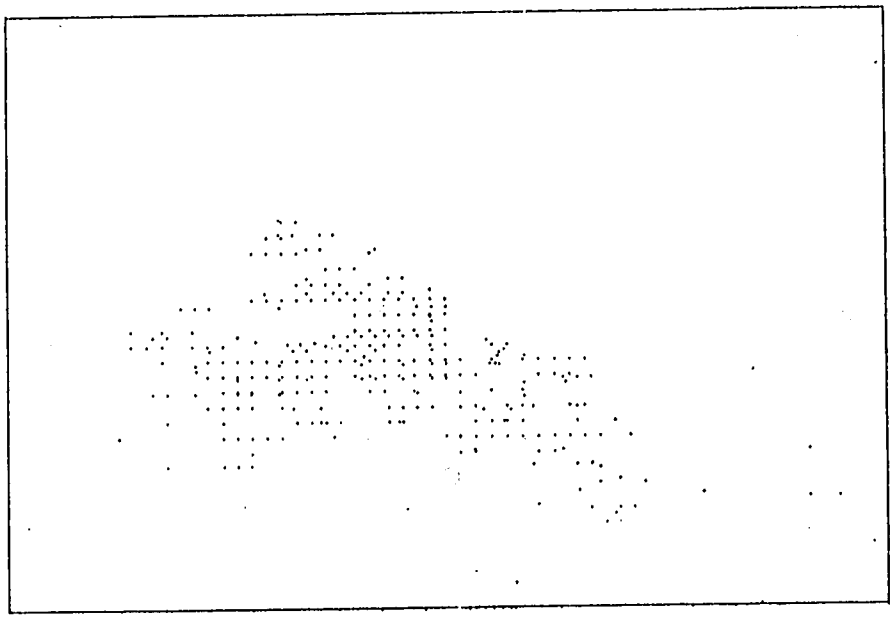
YEAR	COMMERCIAL-LOW GROWTH	COMMERCIAL-LOW NUMBER	COMMERCIAL-MED GROWTH	COMMERCIAL-MED NUMBER
1991	9.0%	4,870	10.0%	151
1992	9.0%	5,308	10.0%	166
1993	9.0%	5,786	10.0%	183
1994	9.0%	6,307	10.0%	201
1995	9.0%	6,874	10.0%	221
1996	9.0%	7,493	10.0%	243
1997	6.0%	7,943	7.0%	260
1998	6.0%	8,419	7.0%	278
1999	6.0%	8,924	7.0%	298
2000	6.0%	9,460	7.0%	319
2001	5.0%	9,933	5.5%	336
2002	5.0%	10,430	5.5%	355
2003	5.0%	10,951	5.5%	374
2004	5.0%	11,499	5.5%	395
2005	5.0%	12,074	5.5%	416
2006	3.0%	12,436	4.0%	433
2007	3.0%	12,809	4.0%	451
2008	3.0%	13,193	4.0%	469
2009	3.0%	13,589	4.0%	489
2010	3.0%	13,997	4.0%	507
2011	-	14,420	-	524

YEAR	T/WELL-PRIVATE GROWTH	T/WELL-PRIVATE NUMBER	T/WELL-F.RATE GROWTH	T/WELL-F.RATE NUMBER
1991	2.0%	2,649	4.0%	561
1992	2.0%	2,702	4.0%	583
1993	2.0%	2,756	4.0%	607
1994	2.0%	2,811	4.0%	631
1995	2.0%	2,867	4.0%	656
1996	2.0%	2,925	4.0%	683
1997	1.4%	2,966	2.5%	700
1998	1.4%	3,007	2.5%	717
1999	1.4%	3,049	2.5%	735
2000	1.4%	3,092	2.5%	753
2001	0.8%	3,117	1.2%	762
2002	0.8%	3,142	1.2%	772
2003	0.8%	3,167	1.2%	781
2004	0.8%	3,192	1.2%	790
2005	0.8%	3,218	1.2%	800
2006	0.5%	3,234	1.0%	808
2007	0.5%	3,250	1.0%	816
2008	0.5%	3,266	1.0%	824
2009	0.5%	3,283	1.0%	832
2010	0.5%	3,299	1.0%	841
2011	-	3,314	-	844

YEAR	INDUSTRY-LOW GROWTH	INDUSTRY-LOW NUMBER	INDUSTRY-MED GROWTH	INDUSTRY-MED NUMBER	INDUSTRY-HGH GROWTH	INDUSTRY-HGH NUMBER
1991	12.0%	1,221	12.0%	37	10.0%	6
1992	12.0%	1,368	12.0%	41	10.0%	7
1993	12.0%	1,532	12.0%	46	10.0%	7
1994	12.0%	1,715	12.0%	52	10.0%	8
1995	12.0%	1,921	12.0%	58	10.0%	9
1996	12.0%	2,152	12.0%	65	10.0%	10
1997	8.0%	2,324	8.0%	70	7.5%	10
1998	8.0%	2,510	8.0%	76	7.5%	11
1999	8.0%	2,711	8.0%	82	7.5%	12
2000	8.0%	2,928	8.0%	89	7.5%	13
2001	4.0%	3,045	4.0%	92	5.0%	14
2002	4.0%	3,166	4.0%	96	5.0%	14
2003	4.0%	3,293	4.0%	100	5.0%	15
2004	4.0%	3,425	4.0%	104	5.0%	16
2005	4.0%	3,562	4.0%	108	5.0%	17
2006	4.0%	3,669	4.0%	111	5.0%	17
2007	3.0%	3,779	3.0%	115	4.0%	18
2008	3.0%	3,892	3.0%	118	4.0%	19
2009	3.0%	4,009	3.0%	121	4.0%	19
2010	3.0%	4,129	3.0%	125	4.0%	20
2011	-	4,255	-	130	-	21

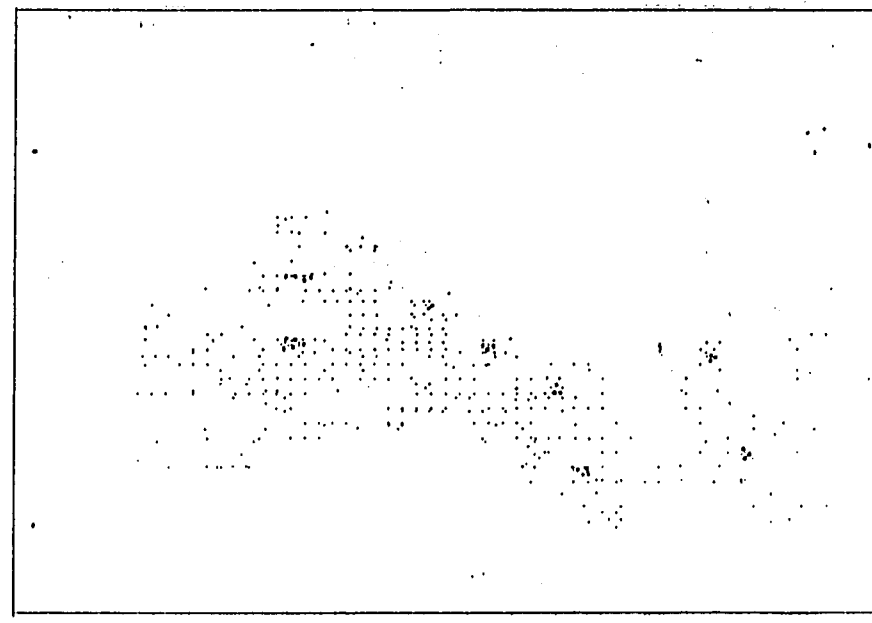
EXHIBIT - 12

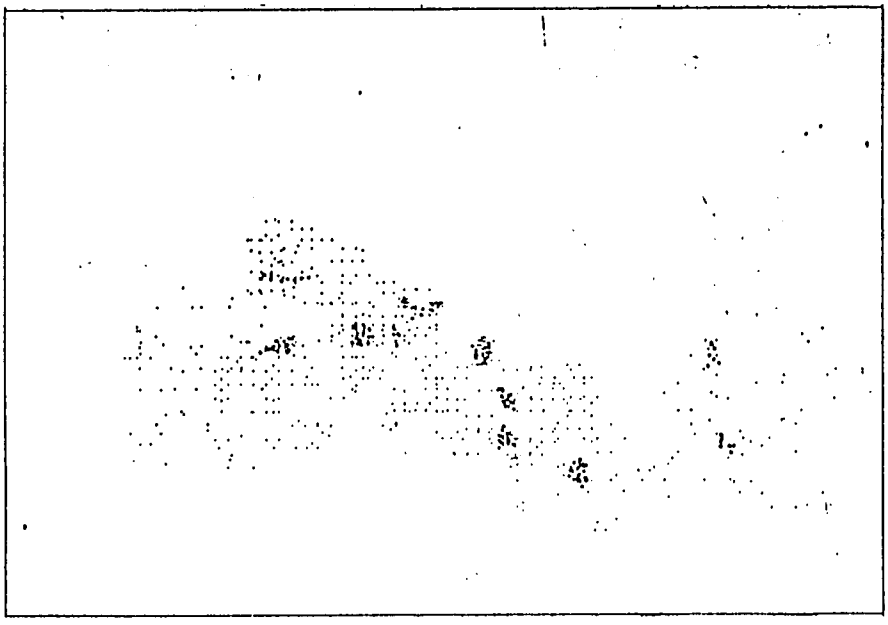
GUJRANWALA III



LOAD DENSITY MAP
1991
(BASE YEAR)

LOAD DENSITY MAP
2001





LOAD DENSITY MAP
2011
(HORIZON YEAR)

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