Load Research
Steps and Procedures at Newfoundland Power

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NEWFOUNDLAND POWER

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Executive Summary

Newfoundland Power has been involved in Load Research since 1977 when it began to collect load data. In 1987 due to deficiencies in this program a new Load Research Program was proposed and accepted. The new program was backed by a significance increase in resources in such areas as computer hardware, pulse meters, and data recorders. This new technological advanced equipment has allowed for Newfoundland Power to make tremendous progress in recent years.

In establishing and maintaining this program there were a number of steps and procedures that had be carried out. The new sample first had to be designed and selected. In creating this sample there were a number of factors taken into consideration. First and foremost, the objectives of the study were defined to identify the user group, their data requirements and the purpose of providing the load research information. Factors such as the desired accuracy and precision the study wished to achieve, and the available resources that could be committed to the study were then investigated. In outlining these components direction was given to the type and size of samples that were to be designed.

Based on these factors, and the characteristics of the rate classes that were to be studied the sample was designed, selected and had to be implemented. Two steps involved in implementing this sample were: gaining customer participation and installing the hardware necessary for recording and retrieving the data. Care was taken in performing these steps, to ensure that customers were fully informed of their role in the study, and that the hardware used was in proper working order. This helped assure overall accurate study results.

The data from these sample customers was retrieved with the use of two methods: 1) remote retrieval with the use of telephone lines; and 2) hand-held retrieval. The telephone retrieval method was largely a carry over from the past, and its use was limited

to isolated situations. For the most part the hand-held method had been adopted as the preferred method of retrieval.

When the data was retrieved, work then began on formulating the data into a useful form. The data that was retrieved was first checked for its validity. Often technical problems with the hardware, or human errors caused unsatisfactory or missing data. In such cases the data was disregarded unless various editing techniques could be utilized to edit the data while maintaining its credibility. Upon determining the accepted sample points they were expanded (totalized) to represent the population. The totalized load data was then stored in summary files, and could be displayed in graphical and tabular form, highlighting trends in the electrical usage of the population of customers.

The data that was after been collected and analyzed from the various samples and groups of customers could then be applied in a number of applications throughout the company. It has been used in Cost of Service studies, in Forecasting, and other applications such as Demand Side Management and Rate Design.

The future will see the program continue its study of the different classes of customers. Due to the ever changing social and economic climate of Newfoundland this information is needed on a continuing and current basis. The typical customer is not what he/she was ten years ago. In order for the many applications that the data is used in, to produce reliable and satisfactory results the load research program will have to change to compensate for the changing environment. New samples will have to be drawn and different factors will have to be included in their design. This will help ensure a viable load research study in the future.

1.0 Introduction

Load Research, as defined by the Association of Edison Illuminating Companies (AEIC), is "an activity embracing the measurement and study of the characteristics of electric loads to provide a thorough and reliable knowledge of trends, and the general behaviour of the load characteristics of more important electrical services rendered by the electrical utility industry" (Load Research Manual,1-1). It basically studies the ways consumers use electricity either by total load or individual end use. In doing so, it utilizes the disciplines of Engineering, Statistics, and Computer Programming. The end result provides electric utilities with information that can be used in a wide range of applications, including rate design, load forecasting, demand-side management, and cost of service studies.

1.1 Background to the Load Research Program

Newfoundland Power became involved in load research in the late 1970's as a result of Order 36 (1976) of the Public Utilities Board. This order required Newfoundland Power "to conduct load research studies of its various classes of services." The program changed very little over the first decade. It was based on a non-probabilistic sample and therefore its accuracy could not be gauged. However,in 1987 a new load research program was proposed and adopted. Additional resources were committed to the program and a new sample was designed and implemented. To date, data is still being processed from this sample and is being applied to various applications throughout the company.

1.2 Purpose of the Load Research Program

The purpose of the Load Research Program is to collect load information from various groups of customers and present this information in a meaningful and useful form for the user groups. Presently, the load research data collected from the study is being used in the Cost of Service study and in the development of a new Forecast

Methodology.

The load research data will also have uses in the design of future rates and in formulating the generating requirements necessary to meet the demand and energy needs of the company's future customers. However, before the data can be applied to these applications it must go through a number of stages of refinement and expansion. Much of this is done with the use of computer hardware and software. Computer applications such as MV90 (a data translation software package), dBase, Symphony, and Freelance are employed in analyzing and moulding the data. One of the underlying objectives of collecting and analyzing the load data is that it must be done in a cost effective manner such that reliable data is produced, satisfying the data requirements of the user group today and tomorrow.

2.0 Sample Design and Selection

A major limitation in the load research study was the high cost of the equipment required for creating, recording, retrieving, storing and processing data. This limited the number of customers that could be included in the study. Consequently, sampling techniques were utilized, allowing for the research to be carried out in a cost effective manner while maintaining the integrity of the data. In order for the study to consistently do so, the samples implemented had to be representative of their populations.

In creating the samples currently being studied at Newfoundland Power there were a number of factors taken into consideration. First and foremost, the objectives of the study were defined to identify the user group, their data requirements and the purpose of providing the load research information. Factors such as the accuracy and precision the study wished to achieve, and the available resources that could be committed to the study were then taken into consideration. In outlining these factors direction was given to the type and size of samples that were to be designed.

2.1 Sampling Techniques and Sizes

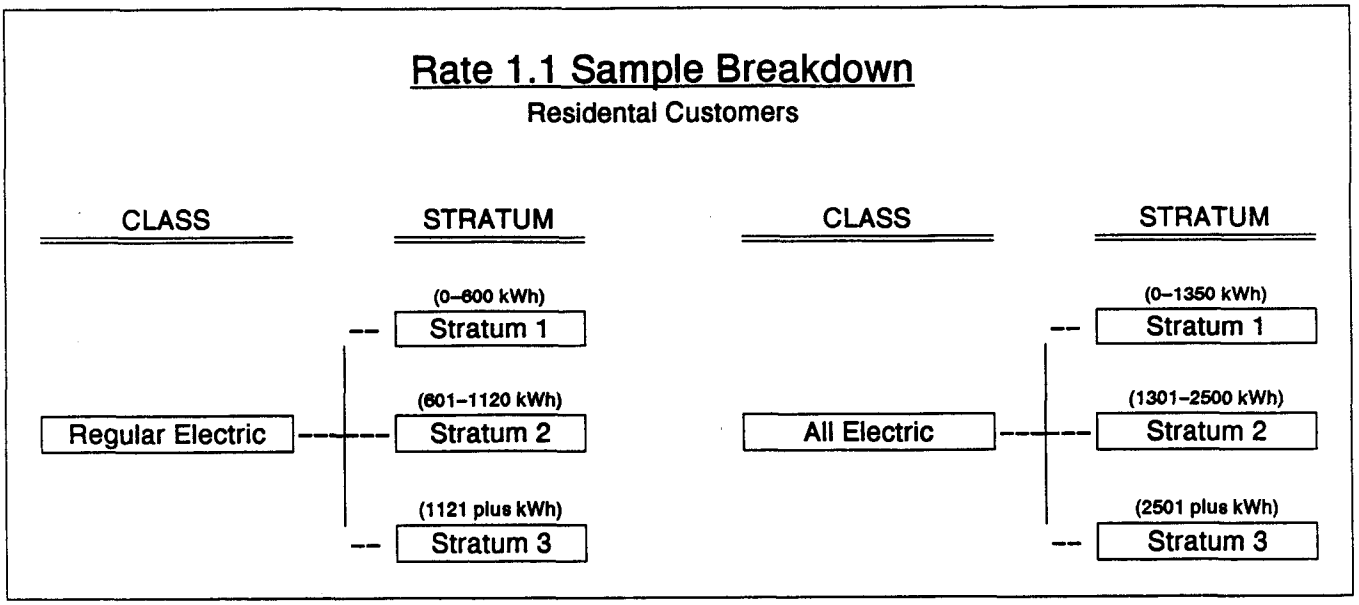
Currently, data is being recorded and analyzed from samples from the Rate 1.1-residential/domestic customers and Rate 2.3-medium sized industrial/commercial customers and from a census from the Rate 2.4-large industrial/commercial customers.

2.1.1 Rate 1.1-Residential/Domestic Customers

There were two distinct groups apparent within the Residential population: the Domestic Regular Electric group which was made up of those customers that do not use electric heat as their primary heating source, and the Domestic All Electric group which was made up of those customers who use electric heat as their primary heating source. There were also obvious distinctions within each of the groups. To account for this, stratified random samples were drawn from each. The groups were divided into mutually exclusive

subpopulations called strata based on their average monthly kWh consumption. By recognizing these groups separately and stratifying each into several small samples that represented smaller more homogeneous groups, the required sample sizes were reduced and the desired precision was maintained. The breakdown of these two groups into the strata can be seen in Illustration 2.1.

Illustration 2.1



2.1.2 Rate 2.3 Medium Industrial/Commercial Customers

Like the Residential customers there were obvious distinctions within the Rate 2.3 population. This class includes all customers with demands between 110 to 1000 kVA. In the past this rate class was broken into two smaller classes. One was made up of customers with demands between 110 to 350kVA, and the other had customers with demands between 350 to 1000kVA. These divisions were apparent at the time of sample design. Consequently, this industrial class was identified as two distinct groups. There were also distinctions within these groups and to account for this, the stratified random sampling technique was utilized again. The groups in this case were stratified based on their type of power supply, either primary voltage supply (electricity that is supplied to a customer at the voltage it is on the main power lines) or secondary voltage supply (electricity that has the voltage stepped downed by a transformer before it is supplied to

a customer). Again this method allowed for a reduced sample size while maintaining the desired precision.

2.1.3 Rate 2.4 Large Industrial/Commercial Customers

In the case of the large industrial/commercial customers, the technique of 100% sampling was used. This class of customers has a small population size and accounts for a large portion of the load. This permitted such a technique to be used. At the time of sample design a census of all the Rate 2.4 customers and potential Rate 2.4 customers was taken, and those customers were selected as participants in the study. Although the entire population was not included every month due to fluctuation of customers between rate classes, those that were missing represent a negligible load that could be incorporated later for applications that require the inclusion of such information.

In the residential and the medium sized industrial customer classes the entire population was not included in the study. In formulating the size of the samples for these classes, a series of calculations was performed which determined the sample sizes and the allocation of the sample to the different strata.

2.2 Sample Selection

Once the sampling technique, the number and type of strata, the sample size, and the target populations were defined, the samples were selected. In the case of the large industrial customers the entire population was included and customers were selected based on inclusion in this rate class.

As for the residential and medium sized industrial class, a random selection procedure was used to select the defined number of sample customers. This gave each customer in the defined populations an equal chance of being selected for inclusion in the study. However, not all of the customers selected for the study participated. For various reasons customers were excluded. In such cases, an alternate was chosen by selecting at random from a group of customers that were similar to the excluded one. This method

of selecting from a similar group of customers was less subject to exclusion bias, because the excluded customer was replaced by one with similar consumption characteristics. Upon completing this step, the desired number of sample points had been acquired, and the samples were ready to be implemented.

3.0 Sample Implementation

Two steps that were involved in implementing the samples were: gaining customer participation, and installing the hardware necessary for recording and retrieving the data. Care was taken in performing these steps, ensuring that customers were fully informed of their role in the study, and that the hardware used was in proper working order. This helped assure overall accurate study results. Customers who were not fully informed often questioned the motives of the company and their role in the study. When such questions were not addressed to the satisfaction of the customer, they became unreceptive to participating in the study. Checks were also made to ensure that all equipment was in working order. Recurring problems with equipment could create uncertainty about the quality of the data.

3.1 Customer Contacts

In implementing the current samples, gaining the customers consent before including him/her in the study, was seen as a vital step in maintaining good customer relations. Instead of forcing customers to participate, customers were made fully aware of the role they would play in the study. Customers who were properly informed were more apt to participate and stay for the duration of the study.

Having 100% participation of the prime sample customers was the desirable outcome. However, some of the selected customers were not in agreement with what they felt was the inconvenience associated with participating in the study such as the temporary power loss associated with installing the recorder, or the physical appearance of the recorder. There were also situations were it was physically impossible to install the recorder due to limited space or other related installation problems. This was a rare occurrence but in these situations, or when a customer was not in agreement with participation in the study they were replaced with an alternate sample point. This activity was avoided whenever possible. The closer the study got to achieving full participation

of all prime sample customers, the less potential bias it created, thus improving the soundness of the study.

In replacing customers who declined to participate in the study, the sample design and selection procedure was revisited. Here as previously stated an alternate customer was chosen by a random selection from a group within that population made up of customers similar to the one that was excluded. The new sample customer was then contacted and the process started over.

Another important step carried out at the time of customer contacts was the collection of demographic data from those customers who agreed to participate in the study. This descriptive customer information was able to enhance the quality of the load research data. Characteristics of the sample could be compared to the population and variations in load characteristics could be analyzed by identifiable demographic variables. These variables differed in the different rate classes. Consequently different information was required from the different classes. From the residential customers, information concerning the family, home size, and number and type of appliances was collected. From the commercial customers on the other hand, information concerning heating and cooling requirements, type of industry, floor space, employment and electric end-use loads was collected. Characteristics like these influence the electric loads of customers. With this information a better understanding of customers use of electricity could be gained.

3.2 Data Recorder Installation

Once consent was received from those customers agreeing to participate in the study, the appropriate equipment was then installed. Presently, solid state recorders are being used to record the load data. Before these recorders were put into the field they were configured with the MV90 software package. This set up the parameters that the recorders would operate within, including the recording interval (presently set at 15 minutes), and the means of retrieval, either remote (use of telephone lines) or with the use

of hand-held units. Once the recorders were configured and tested to verify that they were working properly, they were installed on the selected sample customers.

4.0 Data Retrieval

Currently there are two methods of data retrieval used in the Load Research Program: 1) remote retrieval with the use of telephone lines; and 2) hand-held retrieval. The hand-held meter reading system was not implemented until 1991, and by 1992 it had been modified for use in the Load Research Project. Prior to the implementation and modification of this system, recorder data was limited to being retrieved over phone lines. There were benefits to this method of retrieval, and it is still used in some isolated situations. However, for the most part the use of this method today is largely a carry over from the past. The hand-held method of retrieval has now been adopted as the preferred method of retrieval.

4.1 Telephone Retrieval

With the implementation and adoption of the hand-held retrieval system the remote retrieval method was phased out. The use of telephone retrieval was limited to situations were information from a recorder was required more often then the hand-held method of retrieval would allow. This was the case for some of the large commercial customers who have participated in a load curtailment study. The recorders used in these situations had a modem and phone line installed, and the configuration of the recorders was set up for the telephone retrieval method.

The data from these recorders generally was retrieved once a month. A central PC called the remote recorder (via modem) and requested the data. This typically occurred early in the morning to take advantage of the reduced long distance rates after midnight. When a call was received by the recorder, the requested data would be uploaded to a central PC, were it was ready to be processed.

This method was very convenient in that it allowed for information to be retrieved at almost any time. There were, however, some drawbacks to this method. For one the

telephone lines were expensive and their use was restricted to situations where they were really necessary. As well, there were some problems with some of the hardware used in retrieving the data, resulting in unaccepted data. Phone retrieved data also presented a problem in the validation procedure. Here the recorder data was compared to the meter information. Unlike the hand-held method of retrieval, this method was not complemented with the visual meter read at the time the data was retrieved. As a result the data that was retrieved over telephone line did not match the same time frame as the billing data, consequently, this resulted in a more time consuming validation procedure.

4.2 Hand-Held Retrieval

The most practical method of retrieving the recorder data was with the use of the hand-held retrieval system. It was far less expensive than the telephone method of retrieval. The data was retrieved at the same time as the billing information such that both covered the same time frame, thus making the validating procedure much easier. As well, with the implementation of the hand-held meter reading system, most of the resources necessary were already in place. Under this system, when the meter was read with the hand-held unit the meter reader would download the data from the recorder with the use of an optical probe. This information was then uploaded onto a PC at one of the local offices. From there, the information was transmitted by modem to the Vax (the central Head Office mainframe computer) with the billing information. The recorder information then got routed to an area on the Vax where it was later downloaded to a central PC and imported by the MV90 software.

This method was cheaper and made validating more convenient. It did not, however, offer the versatility of the telephone system. It was also reliant on the hand-held system that has had some problems in the past, resulting in the loss of data. This system relies on someone physically going to a location and reading (downloading) the information. Therefore the hand-held retrieval system was restricted to areas that were read on frequent basis. If the data was not retrieved before the storage capacity of the recorder was exceeded, the recorder would overwrite the oldest data, causing data loss.

This resulted in the loss of that contributor for the month(s) that the missing data spanned. Despite these drawbacks, the hand-held system has come to be the accepted method for retrieving data. When compared to the remote method, it could provide the same quality of data at a reduced cost while meeting the demands of the end-users.

5.0 Data Analysis

Once the data was retrieved into the load research area on the network and imported by the MV90 software, work could begin on formulating the data into a useful form. The data that was retrieved was first checked for its validity. Often technical problems with the hardware, or human errors caused unsatisfactory or missing data. In such cases the data was disregarded unless various editing techniques could be utilized to edit the data while maintaining its credibility. Upon determining the accepted sample points they were expanded to represent the population. This was done with the use of a totalization application in the MV90 software. The totalized load data was stored in summary files, and could be displayed in graphical and tabular form, highlighting trends in the electrical usage of the population of customers.

5.1 Validating the Data

The data was validated to ensure it correctly depicted the load characteristics of the customer(s) in question. In the validating procedure the recorder data was compared to the billing data. This was done with the validation report application. This report was set up with a predefined tolerance level. If the difference between the billing information and the recorder data was greater than the tolerance level then the customer was rejected for that month. It was found that when validating the data it was often helpful and more efficient to validate several months at a time. Trends could then be identified in the data for particular customers. By identifying these trends the analyst could find and edit customers who were rejected because of inconsistent meter readings. In such cases, a difference in the comparison of the two that caused it to be rejected will correct itself the next month having the difference in the opposite direction. Illustration 5.1 depicts an example of this occurrence. In February the meter information was 3989 kWh higher than the recorder data. This was then reversed the next month when the data was 3989 kWh less then the recorder data.

Illustration 5.1

Example of Inconsistent Billing

February/93

Recorder	Meter	% Difference	Difference
66478.0 kWh	62489.0 kWh	6.00%	3989 kWh

March/93

Recorder	Meter	% Difference	Difference
63580.0 kWh	67569.0 kWh	-6.27%	-3989 kWh

Such meter reading errors could be detected by examining the months before and after a rejected sample point. To edit these sample points, the accepted tolerance level was increased to be greater than or equal to the percent difference.

When the data was retrieved with the use of the hand-held units both the meter information and recorder data covered the same time frame. To validate the data a validation report was run on the MV90 software. However, when the data was retrieved with the use of phone lines, it was not for the same time frame. In order to validate this data, an Engineering Units Peak Summary Report had to be processed for the contributors who were retrieved this way. This report could be set up to cover the same time frame as the billing information. It provided the total kWh that the recorder recorded during that defined time frame. The time frame the bill covered was obtained from a meter reading schedule that outlines which days customers have their meters read. Illustration 5.2 is a portion of 1993 schedule. February's bill for a customer who was read on day 3, would cover from the 6th of January to the 4th of February. The Engineering Units Peak Summary Report would then cover the same time frame.

Illustration 5.2

METER READING SCHEDULE
JANUARY - DECEMBER, 1993

LEDGER	JAN/93	FEB/93	MAR/93	APR/93	...	DEC/93
1	4	2	3	2	...	2
2	5	3	4	5	...	3
3	6	4	5	6	...	6
4	7	5	8	7	...	7
.	.	.	.	.	...	.
.	.	.	.	.	...	.
.	.	.	.	.	...	.
19	28	26	29	29	...	30

5.2 Data Editing

Sample points were rejected for more reasons then bad meter readings. There were equipment problems, the memory of the recorders sometimes exceeded their limits, as well as a number of other mechanical and human errors which led to unacceptable data. In severe cases, the data could not be edited and the sample customer(s) in question were rejected for that month. There were however, situations where sophisticated editing procedures were employed to revise the data. Care was taken nevertheless to ensure the integrity of the data was not distorted. This limited the use of editing procedures to circumstances where one could reasonably create credible data. Schedules of operation from customer and other descriptive information were utilized in the editing procedures. Correlations could be made between load profiles and such things as weather, time of year and operations. These relations could then be applied to the time frame during which there was missing or unaccepted data, thus making the data more representative of the customer's actual usage.

Editing data was a time consuming activity. The reasons for a sample point being rejected had be investigated, as well as possible solutions to correct the problem. Better training and having more attention directed to details by employees in the field who were installing the recorders and retrieving the data could have effectively reduced the amount of editing that was required. The resources involved in this procedure could then be employed in a more useful manner.

5.3 Data Totalization

In the totalization procedure, the data from accepted customers within a group was totalled up or expanded for each interval to represent the population of customers they belonged to. There were two forms of totalization used in the Load Research Program. A straight forward totalization was utilized in building the population load curves for the Rate 2.4-large industrial/commercial customers. This rate class is made up of customers with demands over 1000 kVA. It has a small population and makes up a large portion of the load. For this reason, instead of using a sample to study these customers a census was taken of all large industrial customers and potential large industrial customers. Since the entire population was included in this group, their demands were simply summed up across the intervals. The total represented the total Rate 2.4 population.

The other method of totalization used was ratio estimation. This method was utilized when samples rather then populations were being studied. The samples from the residential and medium size industrial customers were expanded to represent their populations using this method. The mechanics of this procedure are explained further in Appendix D.

Before running either of these totalization's on the MV90 software certain parameters were first defined, and information regarding energy used by the sample was calculated. This was carried out in a number of different steps. First, the summary mapping file was set up, for the strata and the class. This file contained information that was used in the totalization procedure, such as the method of totalization, (ratio estimation or a straight forward totalling), and the intervals per hour. When the file was initially set up the UOM codes (codes that define the data type in each channel) were also defined. These codes determine whether such things as interval statistics would be used or how the average kWh used in the ratio of the sample would be calculated. This file also allows for optional data to be entered such as the confidence interval used and the population and sample sizes at time of sample design. The channel status and interval status mask's were specified here as well. These are used by the totalization application to sum the contributors interval data into a summary file based on interval statistics.

The summary mapping file for the strata contained a list of contributors that had accepted data for the month in question. This list was updated for every month that was totalized to reflect those contributors who had good data. The class summary file contained a list of the strata that contributed to the class total. The weighting each strata had in the total was also recorded in this file. These weighting were calculated at time of sample design and remained constant month to month.

This was all the information required for the straightforward totalization. Once the contributors list was updated every month for the large industrial customers the strata within the population could be totalized. When the summary files were built for the strata the class could be totalized.

For the samples which were expanded using the ratio estimation technique, information on the billed energy of the sample had to be calculated first. The energy data for the strata was calculated first, then the billed energy for the accepted contributors for that month was imported. This import file was created in the database containing customer billing information. The billing information was then used to calculate the average billed energy for the class and the stratum.

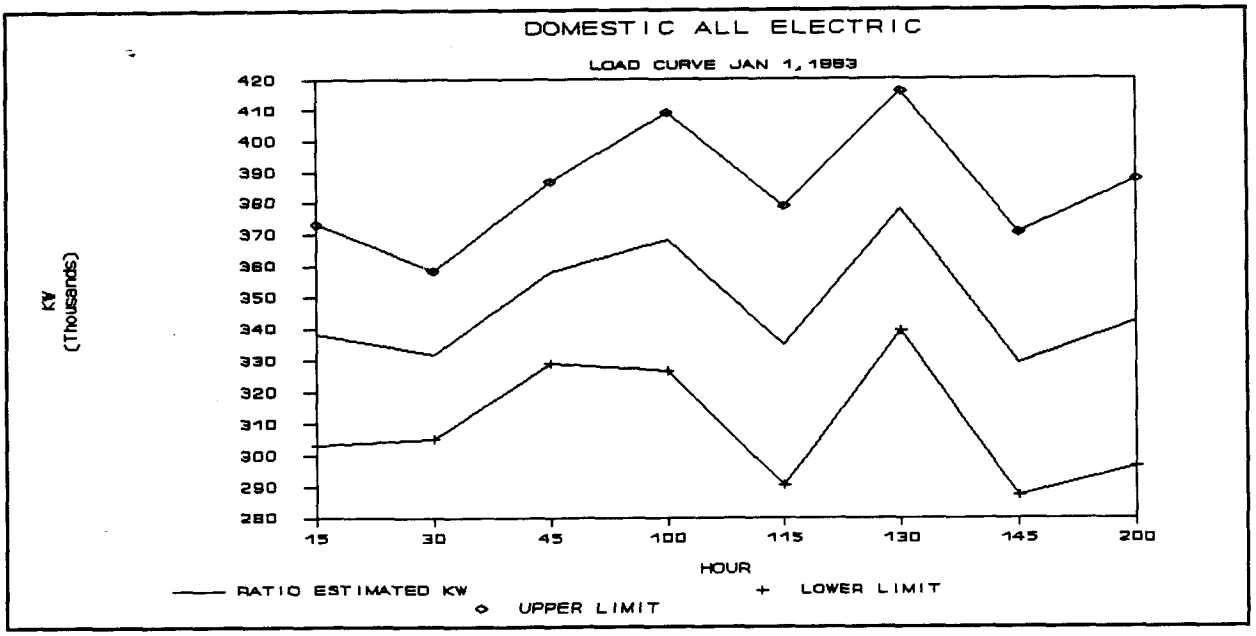
Before the expanded demand and corresponding statistics could be calculated the population billed energy was entered for the class and the strata. The totalization application was then used to build summary files for the strata and then the classes. The statistics corresponding to these summary files were then calculated. Reports and graphical representations of the data could then be produced from the load research and summary statistics files.

5.4 Load Curves

A load curve is "a curve showing the power supplied during a specific period of time plotted against the time of occurrence" (Load Research Manual, G-7). The curve illustrates a profile of a customer or group of customers demand. Accurate load curves are vital to various functions within the company including, rate design, forecasting, and demand-side management. The MV90 software contains several graphical application that allows for colourful and explicit representation of the load data. The information can also be exported to a Lotus format file where it can be manipulated and presented by various other computer applications. A typical load curve looks like the curve depicted in Illustration 5.3. The upper and lower lines represent the upper and lower limit of the ratio estimated demand. The lower the relative error, the closer these get to the ratio estimated kW.

Illustration 5.3

Load Curve



6.0 Applications of Load Research

The load research data that was collected and analyzed from the various samples and groups of customers has been, and is being used on a continuing basis in a number of applications throughout the company. It has been used in Cost of Service Studies, in Forecasting, and other applications such as Demand Side Management and Rate Design. Presently, the data is being used in the Cost of Service study and in the development of new Forecasting Methodology. This section will focus on these two applications Illustrating the role load research is playing in each.

6.1 Cost of Service:

The cost of service study functionalizes plant costs and operating expenses to such areas as generation, transmission, distribution, and administration and then classifies each functional amount according to cost causation or parameter of service. That is, it classifies each as either customer related demand related or energy related. Finally it allocates the costs to the different Rate classes. Load research plays an integral part in the allocation of the demand related costs to the customer classes, which in the final analysis accounts for over 50% of all gross costs. The need for cost allocation arises from the common or joint use of facilities to provide electricity to the different rate classes.

Costs can be allocated in several different ways. One method allocates costs based on the relationship of the non-coincident peak of each rate class to the sum of all non-coincident peaks. This method requires load factors for the different rate classes in order to calculate the non-coincident peaks. Presently these load factors are calculated from the load research data.

These calculated load factors are the basis of the cost of service study. As a result, it is critical that reliable load research information is provided. It is important to note that a "Cost of Service study is not an end in itself. Rather, cost analysis is regarded

as a tool for rate design" (Proposed Cost..., 6). Consequently, the role of load research in the cost of service study affects not only the results of the study but the applications it is applied to.

6.2 Forecasting:

One of the primary uses of load research data at Newfoundland Power is in the development of a new forecasting methodology. The data is being used as a direct input into a end-use forecasting system - SHAPES-PC. The energy sector is studied from the "bottom up" by examining the energy requirements of specific end-uses (ie: heating, hot water, etc...). This new forecasting methodology will allow for a detailed causal hourly demand and peak forecast by sector and total system.

Load research data was used to construct load profiles for the various rate classes. Information was available for all of the rate classes except for the Rate 2.1 (General Service customers with demands between 0 and 10 kW) and Rate 2.2 (General Service customers with demands between 10 and 100 kW) customers. Since there was no current load information on these groups, the load profiles had to be constructed by an non-conventional method. Customers in Rate 2.3 and Rate 2.4 classes were categorized together into categories based on Standard Industrial Classification (SIC) codes, and load curves were then constructed for each category. The same SIC categories were evident in the Rate 2.1 and Rate 2.2 customers. By adjusting load factors the curves from the Rate 2.3 and Rate 2.4 were used to construct load curves for the Rate 2.1 and Rate 2.2 classes. As Illustration 6.1 depicts some of the general service customers were isolated and their load curves developed separately. This was the case for very large customers and for those customers with extremely erratic consumption patterns. After constructing these curves a total end-use curve could be constructed by sector. This will later be broken down further into individual end-uses (ie:hot water, heating, etc...) The pieces that feed into the total end-use curve by sector are shown in Illustration 6.1.

Illustration 6.1

System Curve Breakdown by Sector

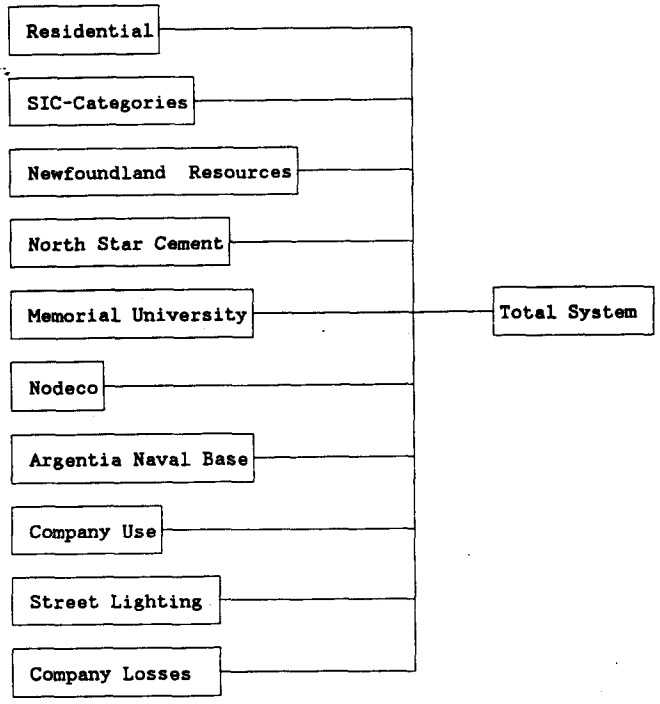
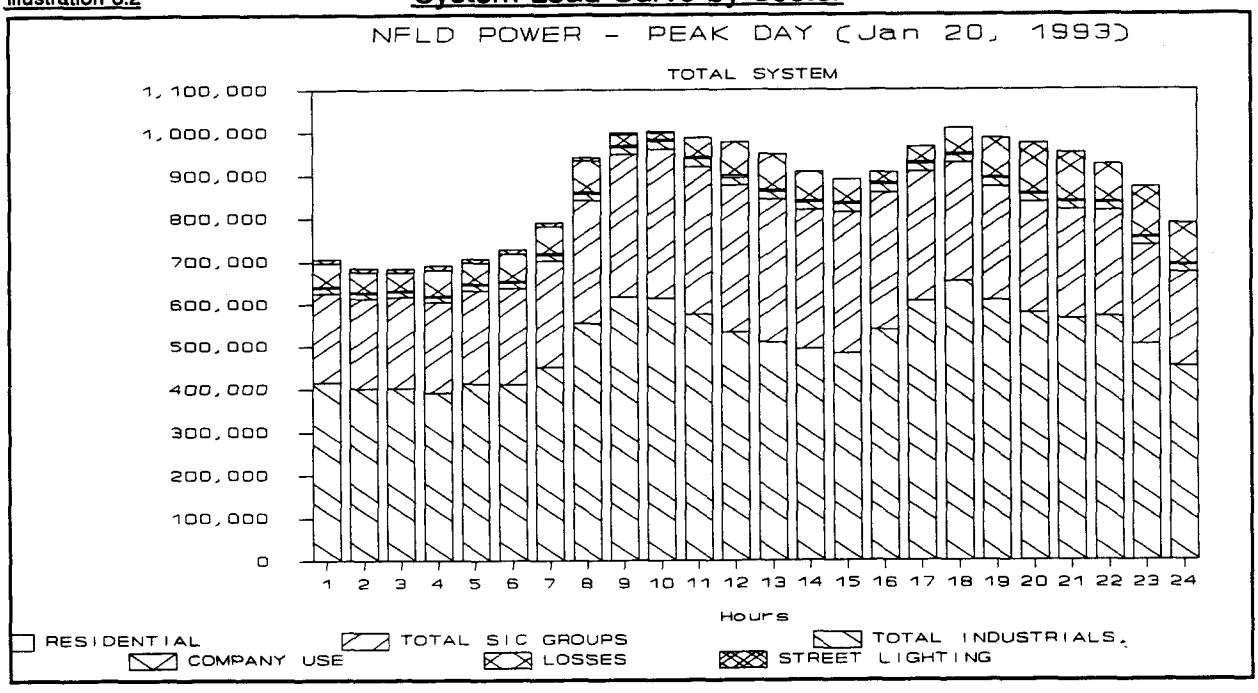


Illustration 6.2 depicts an example of a total end-use by sector curve. The five large industrial customers that were not included in the SIC-Categories are represented in the graph as total industrials.

Illustration 6.2

System Load Curve by Sector



Reliable load data is essential for accurate forecasts. The importance of the role forecasting plays in the planning of the long-term electricity needs of the customers at Newfoundland Power is obvious. "An accurate and detailed demand and energy forecast is essential for regional and head office transmission and distribution planning. Forecasted sales and demand are used directly by the rates group to develop revenue projections and in creating cost of service studies. The forecast is the first step in the development of capital and operating budgets and is used by senior management as a tool in other day-to-day and long-term decision making" (Long-Term Forecasting, 3).

7.0 Conclusion

The Load Research program has come a long way in terms of technological advancement. This has allowed the program to expand and improve the credibility of the data it provides. As the paper illustrated, the steps and procedures involved in processing and analyzing the data are time consuming, and are reliant on human intervention. This has resulted in the need for continuing training for those involved in the program. As well, it has become important to maintain high levels of quality control, accordingly helping to maintain the accountability of the study.

From selecting the sample, to analysis of the final data, it is important that the overall objectives of the study are being met in every step of the process. This has brought rise to periodic accuracy checks. There is also a well developed communication link maintained between the user groups and those involved in the load research study. Maintaining standards like these help keep the study on track to achieving its objectives in the most cost efficient manner.

The future will see the program continue its study of the different classes of customers. Due to the ever changing social and economic climate of Newfoundland this information is needed on a continuing and current basis. The typical customer is not what he/she was ten years ago. In order for the many applications that the data is used in to produce reliable and satisfactory results, the load research program will have to change to compensate for the changing environment. New samples will have to be drawn and different factors will have to be included in their design. This will help ensure a viable load research study in the future.

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Appendix A

Glossary of Terms

Glossary of Terms

Most of these definitions have been taken from the AEIC Load Research Manual. For full bibliographic information please refer to the reference list.

Average Demand: The total energy use over any specific interval of time divided by the units of time in the save interval.

Cost of Service: The total cost of providing utility service or to a customer therein, including operating expenses, depreciation, taxes, and a return on invested capital.

Customer: An individual, firm, or organization that purchases services at one location under one rate classification.

Demand: The rate at which electricity is used in a given instant or averaged over a designated time interval such as 15, 30,45, or 60 minutes.

Demand-Side Management: Programs that attempt to control customer consumption patterns of electricity to match current or projected capabilities of the power supply facilities.

Energy: The kilowatt-hours supplied to or used by and individual customer, group of customers or class or service. Energy use may be determined by calculation or by measurement.

Load Curve: As applied to a customer, class, or system, a load curve shows the power supplied during a specific period of time plotted against the time of occurrence.

Load Forecasting: Projection of customer energy or demand requirements on either a short term or long term bases.

Load Research: An activity embracing the measurement and study of electrical loads so as to provide a through and reliable knowledge of trends and the general behaviour of the load characteristics of the more important electrical services rendered by the electric utility.

Load Study: The various steps and processes generally used in combining and producing load data. It encompasses the selection of loads to be studied, the method of collecting and analyzing the load data, and the presentation of the load characteristics in a useful form.

Rate Class: A group of customers identified as a class based on characteristics of energy use or type of service or activity and subject to a rate that differs in price or structure from those applicable to other groups.

Rate Design: The determination of rate structures based on the costs to serve, social impacts, and conservation.

Recorder: A device, also called a demand recorder, load recorder, or data logger, which is used to capture and store electrical load data on a periodic bases, usually 15, 30, 45 or 60 minutes. The information is stored on magnetic tape (magnetic tape recorder) or electronic memory (solid state recorder) and retrieves either manually or by means of telecommunication means.

Sample : A subset of an entire population, which a researcher surveys in order to obtain information on the entire population.

Stratum: A relatively homogeneous subpopulation that is mutually exclusive of other subpopulations.

Appendix B

Sample Breakdown

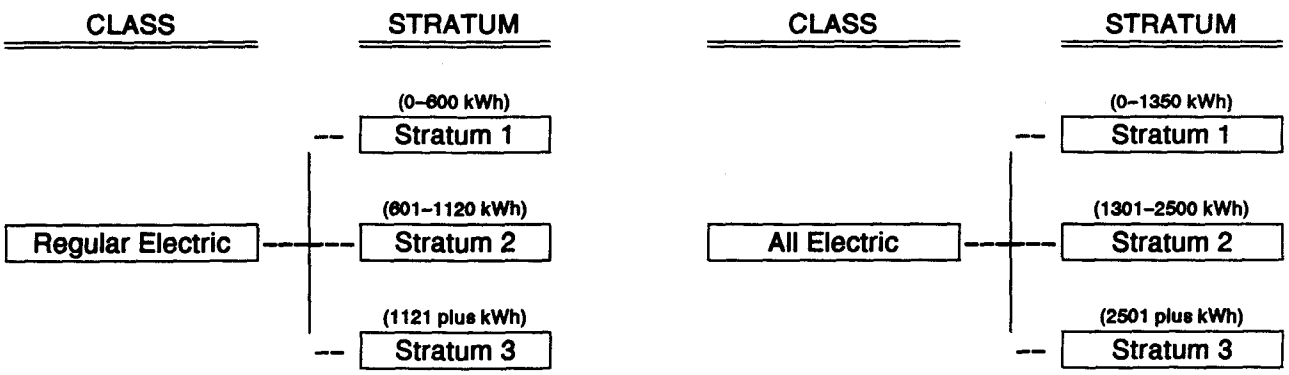
Rate 1.1 Sample Breakdown

The residential customer is defined as a customer whose use of electricity is for the purpose of servicing a "domestic unit or building or facilities which are on the same Serviced Premises as a Domestic Unit and used by the same Customer exclusively for domestic or household purposes, whether such buildings or facilities are included on the same meter as the Domestic Unit or metered separately" (Schedule of Rates...,15). This group of customers represents the majority of the electric load for Newfoundland Power. Analysis of their load was essential because they represent such a large portion of total sales.

Domestic customers are broken into two classes the Domestic Regular Electric (110) customers who do not use electric heat as their primary source of heat and, the Domestic All Electric (112) customers who do use electric heat as their primary heat source. Each class was broken into three strata based on average monthly energy use. Within each stratum random samples were then drawn. The following illustration outlines the stratum breaks within these two groups as well as the sample and population sizes at time of sample design.

Rate 1.1 Sample Breakdown

Residental Customers



Regular Electric

Sample Size:	Population Size:
Stratum 1 = 27	Stratum 1 = 33091
Stratum 2 = 41	Stratum 2 = 33064
Stratum 3 = 22	Stratum 3 = 12016
Total = 90	Total = 81830

All Electric

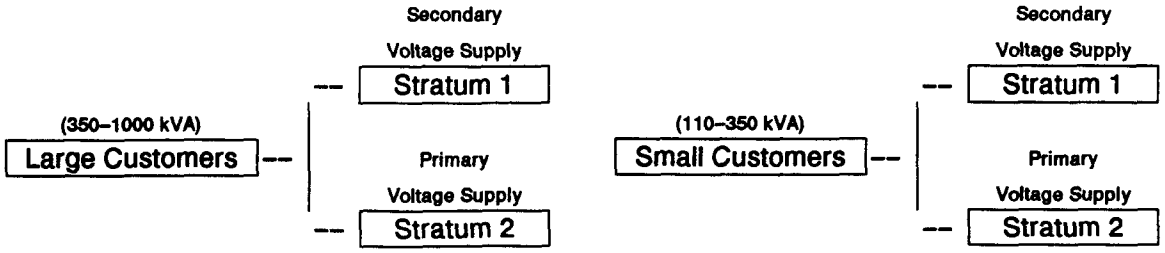
Sample Size:	Population Size:
Stratum 1 = 14	Stratum 1 = 28898
Stratum 2 = 16	Stratum 2 = 37189
Stratum 3 = 16	Stratum 3 = 15743
Total = 46	Total = 78171

Rate 2.3 Sample Breakdown:

This rate class is made up of medium sized industrial/commercial customers that have demands between 110 kVA and 1000 kVA. In the past this rate class was actually two separate rate classes. One contained customers with demands between 110 and 350 kVA and the other was made up of customers with demands between 350 and 1000 kVA. Although now one rate class, these two groups are still coded separately and are still studied/analyzed separately. As a result it was determined that this would be a stratum break. These two strata were then further subdivided based on the supply voltage at which the customer was serviced-either primary or secondary voltage. Random samples were then drawn from each of the four strata.

Rate 2.3 Sample Breakdown

General Service (110–1000 kVA)



Large Customers:

Sample size:	Population Size:
Stratum 1 =30	Stratum 1 =142
Stratum 2 =18	Stratum 2 =49
Total = 48	Total = 191

Small Customers:

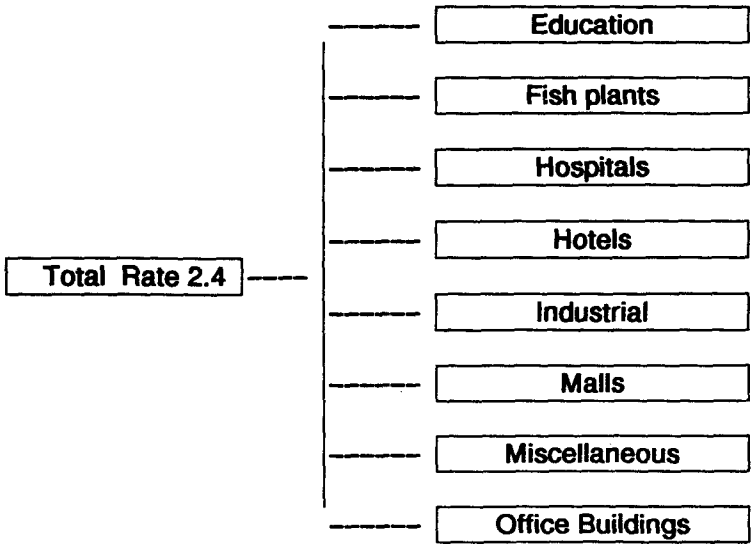
Sample size:	Population Size:
Stratum 1 =60	Stratum 1 =644
Stratum 2 =12	Stratum 2 =35
Total =72	Total =679

Rate 2.4 Sample Breakdown

The entire population of the Rate 2.4 customers were included in the load research study. This rate class was made up of all large industrial/commercial customers. The small population and the large loads of these customers made recording their usage habits essential. At the time of sample design a census was taken of all Rate 2.4 and potential Rate 2.4 customers. This class of customers was then broken down into groups based on industry type. This allows for load curves to be derived for each industry. The effect each industry had on the total Rate 2.4 curve could then be seen. The eight groups and the population sizes are depicted in the following illustration.

Rate 2.4 Sample Breakdown

General Service Customers (1000 kVA and Over)



Population size:

Miscellaneous = 7	Hospitals = 4	Education = 4	Industrial = 7
Office Buildings = 8	Hotels = 3	Fish Plants = 7	Malls = 4

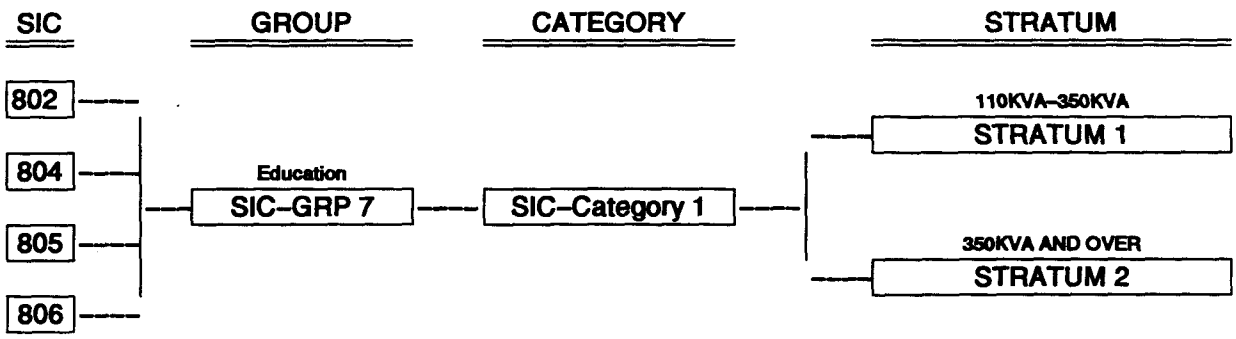
Total = 44

SIC-Categories

The development of the SIC (Standard Industrial Classification)-Categories was primarily for the purpose of aiding in the formulation of load curves for the Rate 2.1 and Rate 2.2 customers. There was no current load data on these two groups of customers. This information was required for the development of a new forecast methodology. The SIC-Categories were a combination of the Rate 2.3 and the Rate 2.4 sample customers. Each of these customers was assigned a SIC code which was dependent on the type of industry they were involved in. Companies or establishments engaged in the same or similar kinds of economic activity were then grouped together making a total of 20 different SIC groups (SIC-GRP ?). These groups were then further combined to create seven SIC-Categories. The seven categories were then stratified based on demand. The following illustrations depict the breakdown of the SIC-Categories and their sample and population sizes. It should be noted that several customers within the Rate 2.4 sample were not able to be included in this classification. This was because the either had a load that was too large or a consumption pattern that was very erratic. Those customers were: Argentia Naval Base, Memorial University, Newfoundland Resources, Lower Cove Mine, North Star Cement, and Nodeco.

SIC–Category Breakdown

SIC–CAT 1 (Education)



SIC Codes Defined:

802 = Elementary and Secondary Schools
804 = Vocational Centers, Trade Schools, and Business Colleges
805 = Post–Secondary Non–University Educational Instititions
806 = Universities and Colleges

Number of sample points:

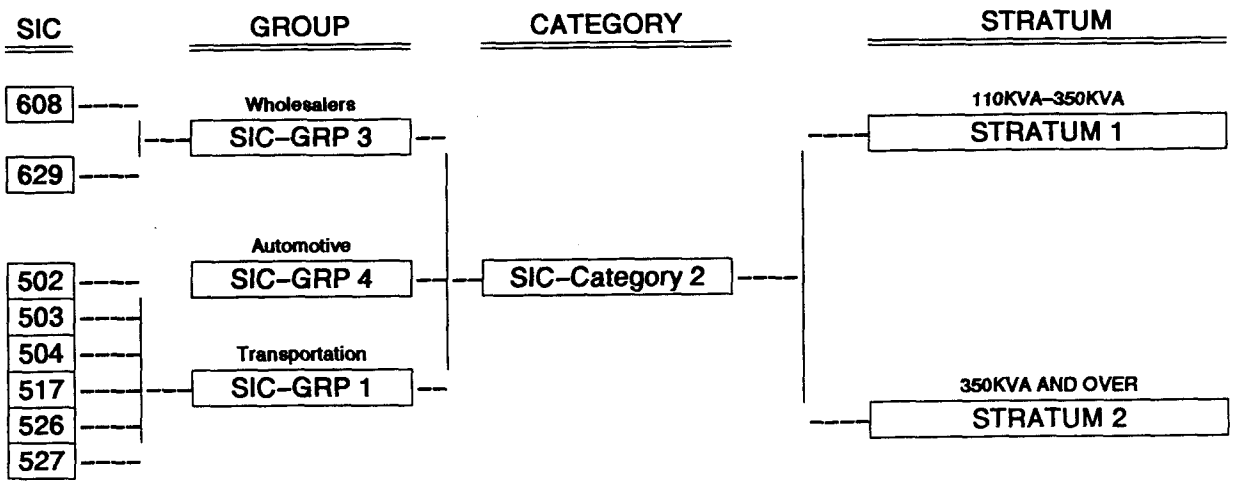
Stratum 1 = 21
Stratum 2 = 8
Total = 29

Population size:

Stratum 1 = 162
Stratum 2 = 23
Total = 185

SIC–Category Breakdown

SIC–CAT 2 (Wholesale, Automotive, and Transportation)



SIC Codes Defined:

608 = Wholesalers of Petroleum Products
629 = Wholesalers – Not Otherwise Reported
502 = Services Incidential to Air Travel
503 = Railway Transportation, Telegraph and Cable Systems
504 = Water Transportation
517 = Miscellaneous Services Incidental to Transport
526 = Miscellaneous
527 = Other Storage and Warehousing

Number of sample points:

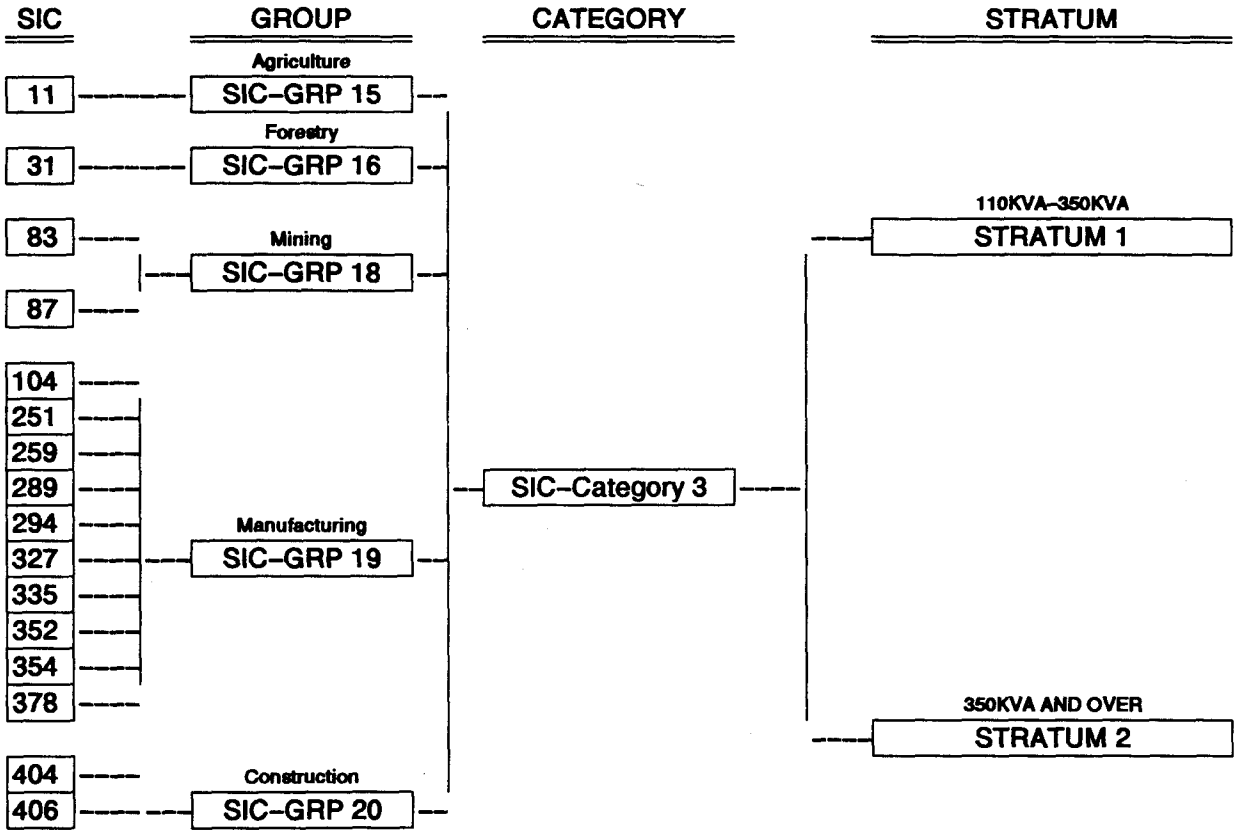
Stratum 1 = 8
Stratum 2 = 8
Total = 16

Population size:

Stratum 1 = 80
Stratum 2 = 21
Total = 101

SIC–Category Breakdown

SIC–CAT 3 (Manfacturing, Construction, Mining, Agriculture, & Forestry)



SIC Codes Defined:

11 = Livestock and Livestock Combination Farms
31 = Logging
83 = Stone Quarries
87 = Sand Pits and Quarries
104 = Dairy Products Industry
251 = Sawmills, Planning Mills, and Shingle Mills
259 = Miscellaneous Wood Industries
289 = Publishing and Printing
294 = Iron Foundries
327 = Shipbuilding and Repair
335 = Communication Equipment Manfacturer
352 = Cement Manfacturers
354 = Concrete Products Manfacturers
378 = Manfacturers of Industrial Chemicals
404 = Building Construction
406 = Highway Bridge and Street Construction

Number of sample points:

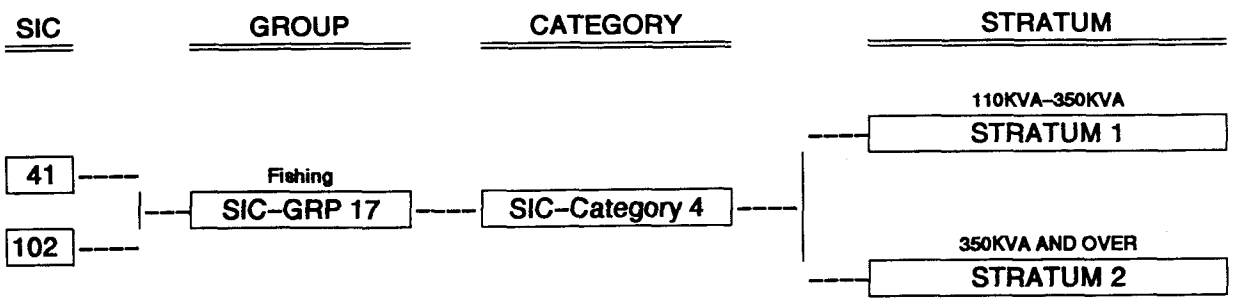
Stratum 1 = 11
Stratum 2 = 9
Total = 20

Population size:

Stratum 1 = 78
Stratum 2 = 31
Total = 109

SIC–Category Breakdown

SIC–CAT 4 (Fishing)



SIC Codes Defined:

41 = Fishing
102 = Fish Products Industry

Number of sample points:

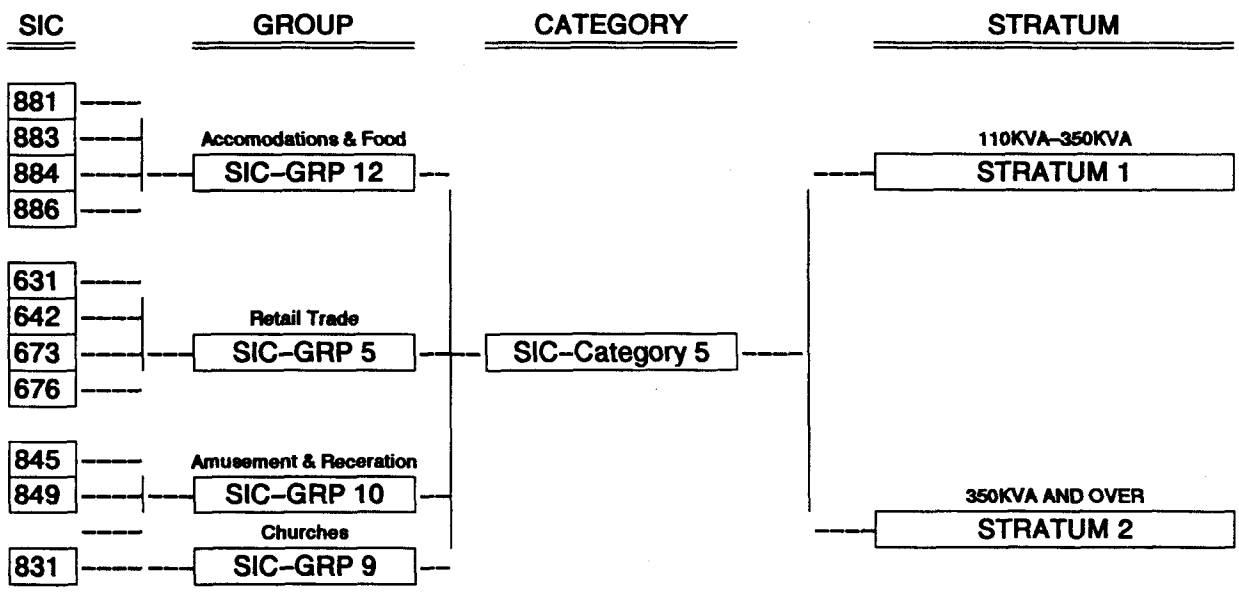
Stratum 1 = 14
Stratum 2 = 5
Total = 19

Population size:

Stratum 1 = 85
Stratum 2 = 5
Total = 90

SIC–Category Breakdown

SIC–CAT 5 (Accom./Food, Retail, Amusement/Receration, Churches)



SIC Codes Defined:

881 = Hotels and Motels
883 = Logging Houses and Residential Clubs
884 = Camping Grounds and Trailer parks
886 = Restaurants, Caterers, and Taverns
631 = Food Stores
642 = General Merchandise Stores
673 = Hardware Stores
676 = Household Furnature and Appliance Stores
845 = Theatrical and Other Stage Entertainment Services
849 = Miscellaneous Ammusement and Recreation Services
831 = Religous Organizations

Number of sample points:

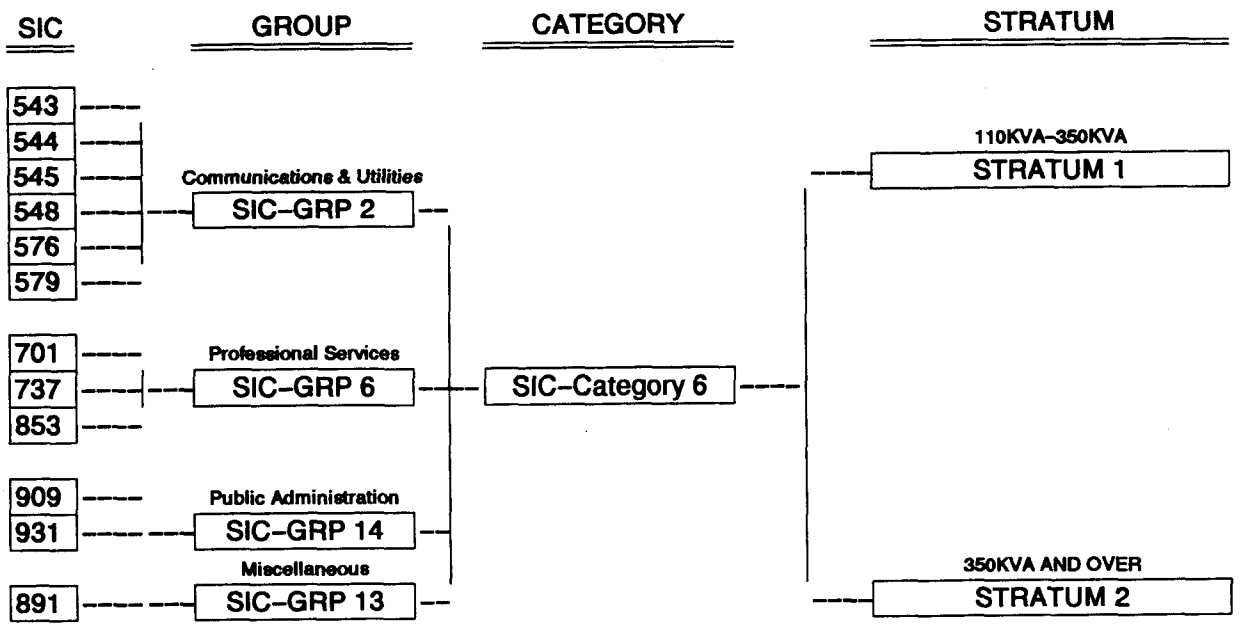
Stratum 1 = 15
Stratum 2 = 13
Total = 28

Population size:

Stratum 1 = 170
Stratum 2 = 50
Total = 220

SIC–Category Breakdown

SIC–CAT 6 (Professional Services, Communications/Utilities, Public Admin.)



SIC Codes Defined:

543 = Radio and Telvision Broadcasting
544 = Telephone Systems
545 = Telegraph and Cable Systems
548 = Post Offices
576 = Water Systems
579 = Other Utilities
701 = Banks and Other Deposit Accepting Establishments
737 = Real Estate Operators
853 = Computer Services
909 = Other Federal Administration
931 = Provincial Administration
891 = Labour Organizations and Trade Organizations

Number of sample points:

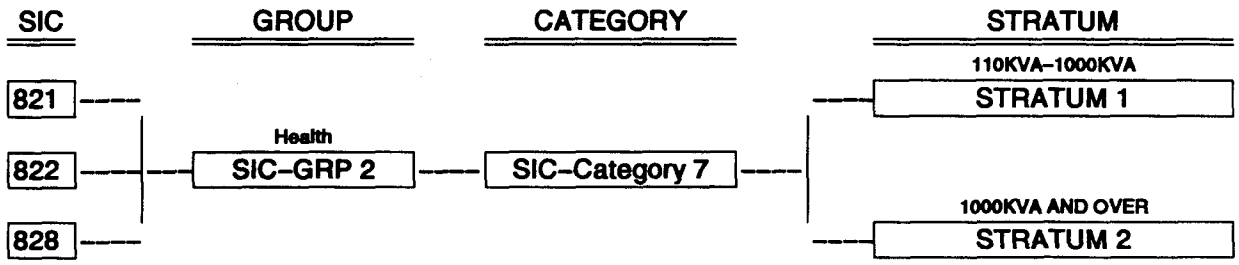
Stratum 1 = 14
Stratum 2 = 25
Total = 39

Population size:

Stratum 1 = 145
Stratum 2 = 71
Total = 216

SIC–Category Breakdown

SIC–CAT 7 (Health)



SIC Codes Defined:

821 = Hospitals
822 = Related Health Care Institutions
828 = Welfare Organizations

Number of sample points:

Stratum 1 = 8
Stratum 2 = 4
Total = 12

Population size:

Stratum 1 = 39
Stratum 2 = 6
Total = 45

Appendix C

MV90 Reports

Reports

There are a number of reports available on the MV90 software. This appendix will discuss some of the main reports used in analyzing the data. A brief description of each follows.

Main Report Menu:

Translation Summary Report: is used to give a brief summary of the translation file. It gives a summary of the meter data and the recorder data. It also gives the status of the contributor in question. This report is effective in detecting inconsistent billing information.

Validation Report: is used to determine the status of a translation file. It compares the meter data to the recorder data, the times found in the translation file to the times expected to be found, and the high and low limits if this function is active.

KVA Analysis Report: will print the KW, KVAR, KVA, and Power Factor either interval by interval, a daily summary form or a peak summary form. The demand or energy usage for a particular time frame can be found on this report.

Engineering Units Report: prints the engineering units quantities along with their corresponding pulse values for all active channels. This report can be printed in detail, daily, peak, or low summary forms. It is often used in calculating some of the relative accuracies of a totalized strata or class.

Engineering Statistics Report: prints out interval by interval statistics for a strata or class. It is often used in conjunction with the engineering units report in investigating and analyzing poor levels of precision.

The following pages contain examples of some of the aforementioned reports in the order they were discussed.

RECORDER ID: 3-2-03-0-01 GROUP: CART:
LOCATION: 241 LEMARCHANT ROAD DEVICE TYPE: S200 INTS/HR: 4
DEVICE ID: 266196

CUSTOMER ID: 3-2-03-0-01 APPL CODE:
NAME: S. A. GRACE HOSPITAL RATE CODE: 2.3
ADDRESS: 241 LEMARCHANT ROAD ACCOUNT #: 0-03-8-0-1860-2
ST. JOHN'S BILL CYCLE:

START: 93/05/05 11:01 FOUND : 2879 FILE: P0006744.305
STOP : 93/06/04 10:45 EXPECTED: 2879 PATH:O:\MV90DATA\93DATA\
CALC : 93/06/04 10:45 DIFF. : 0 TRANS. STATUS: AC
EDITED: NO

* * * * * * * * * METER DATA * * * * * * * * *

CHAN	METER #	UOM	START	STOP	NET	MULTIPLIER	TOTAL
1	284744	KWH	6311.	6715.	404.	800.0	323200.0
2	284744	KQH	9338.	9799.	461.	800.0	368800.0

* * * * * * * * * RECORDER DATA * * * * * * * * *

CHAN	DIFF	%DIFF(P)	PULSES	MULTIPLIER	TOTAL
1	-1688.8	.5	406111	.800000	324888.8
2	184.0	.0	460770	.800000	368616.0

* * * * * * * * * * * PEAKS * * * * * * * * * * *

CHAN	TIME OF PEAK	PULSES	PEAK	UOM	SET
1	93/06/03 12:30	191	611.20	KW	1
2	93/06/03 12:30	207	412.01	KVAR	1

RECORDER ID: 3-2-03-0-01 GROUP: CART:
LOCATION: 241 LEMARCHANT ROAD DEVICE TYPE: S200 INTS/HR: 4
DEVICE ID: 266196

CUSTOMER ID: 3-2-03-0-01 APPL CODE:
NAME: S. A. GRACE HOSPITAL RATE CODE: 2.3
ADDRESS: 241 LEMARCHANT ROAD ACCOUNT #: 0-03-8-0-1860-2
ST. JOHN'S BILL CYCLE:

START: 93/05/05 11:01 FOUND : 2879 FILE: P0006744.305
STOP : 93/06/04 10:45 EXPECTED: 2879 PATH: O:\MV90DATA\93DATA\
CALC : 93/06/04 10:45 DIFF. : 0 TRANS. STATUS: AC
EDITED: NO

* * * * * * * * * METER DATA * * * * * * * * *

CHAN	METER #	UOM	START	STOP	NET	MULTIPLIER	TOTAL
1	284744	KWH	6311.	6715.	404.	800.000	323200.0
2	284744	KQH	9338.	9799.	461.	800.000	368800.0

* * * * * * * * * RECORDER DATA * * * * * * * * *

CHAN	DIFF	%DIFF(P)	PULSES	MULTIPLIER	TOTAL
1	-1688.8	.5	406111	.800000	324888.8
2	184.0	.0	460770	.800000	368616.0

TOTAL KVAH(using chans 1 & 2) 402780.0
AVERAGE POWER FACTOR .807
LOAD FACTOR .739

*** PEAK VALUES FOR EACH CHANNEL

CHAN	TIME OF PEAK	PULSES	PEAK	UOM	SET
1	93/06/03 12:30	191	611.20	KW	1
2	93/06/03 12:30	207	412.01	KVAR	1

*** PREVIOUS PEAK VALUES FOR EACH CHANNEL

CHAN	TIME OF PEAK	PEAK	% DIFF
1	93/04/15 09:45	614.40	.52
2	93/04/21 13:00	382.45	7.17

*** PULSE DATA FOR THE FIRST AND LAST FOUR INTERVALS:

CHAN	INT 1	INT 2	INT 3	INT 4	...	INT 2876	INT 2877	INT 2878	INT 2879
1	187	181	175	174	...	176	179	177	180
2	181	178	174	175	...	185	186	183	186

*** ZERO DATA VALUES:

CHAN	TOTAL	MAXIMUM CONSECUTIVE	MINIMUM CONSECUTIVE
1	0	0	0
2	0	0	0

LAST UPLOAD TO MF: 00/00/00 00:00

********** TRANSLATION ACCEPTED **********

MV-90 KVA PEAKS SUMMARY REPORT 1994, MAR 22 6:02 PM PAGE 1

RECORDER ID: 3-2-03-0-01 GROUP: START TIME: 93/01/15 10:45
LOCATION: 241 LEMARCHANT ROAD CLOCK: 15 MINS STOP TIME: 93/01/15 12:45
DEVICE ID: 266196

CUSTOMER ID: 3-2-03-0-01 ADDRESS: 241 LEMARCHANT ROAD
NAME: S. A. GRACE HOSPITAL ST. JOHN'S
ACCOUNT #: 0-03-8-0-1860-2

6 KW PEAKS (CHAN# 1), MTR# 284744 Readings: 4829.90 - 4831.55

	DATE	KW	KVAR	KVA	PF
1	93/01/15 12:15	601.60	362.12	702.18	.8568
2	93/01/15 11:45	595.20	358.43	694.79	.8567
3	93/01/15 12:00	588.80	354.73	687.40	.8566
4	93/01/15 12:30	588.80	365.82	693.19	.8494
5	93/01/15 10:45	582.40	354.73	681.93	.8540
6	93/01/15 12:45	582.40	365.82	687.76	.8468

6 KVAR PEAKS (CHAN# 2), MTR# 284744 Readings: 7673.31 - 7675.01

	DATE	KW	KVAR	KVA	PF
1	93/01/15 12:30	588.80	365.82	693.19	.8494
2	93/01/15 12:45	582.40	365.82	687.76	.8468
3	93/01/15 12:15	601.60	362.12	702.18	.8568
4	93/01/15 11:00	569.60	358.43	672.99	.8464
5	93/01/15 11:45	595.20	358.43	694.79	.8567
6	93/01/15 11:30	579.20	356.58	680.16	.8516

6 KVA PEAKS

	DATE	KW	KVAR	KVA	PF
1	93/01/15 12:15	601.60	362.12	702.18	.8568
2	93/01/15 11:45	595.20	358.43	694.79	.8567
3	93/01/15 12:30	588.80	365.82	693.19	.8494
4	93/01/15 12:45	582.40	365.82	687.76	.8468
5	93/01/15 12:00	588.80	354.73	687.40	.8566
6	93/01/15 10:45	582.40	354.73	681.93	.8540

	KWH	KVARH	KVAH	AVG PF
TOTAL USAGE	1316.00	807.85	1544.18	.8522

* - Interval Status Set # - Channel Status Set @ - Both Statuses Set
INTERVAL STATUS CODES:
PO-Power Outage ,SI-Short(False) ,LI-Long(Missing) ,CR-CRC Chksum Err
RA-RAM Chksum Err ,RO-ROM Chksum Err ,LA-Lapse in Data ,CL-Hdwre Clock Err
BR-Memory Reset ,WT-Watchdog T-out ,TR-Time Reset ,TM-Test Mode
LC-Load Control
CHANNEL STATUS CODES:
AD-Added Interval ,RE-Replaced data ,ES-Estimated data ,OV-Data Overflow
HL-High/Low Limit ,XC-Excluded Data ,PY-Parity Error ,TY-Enrgy Typ Chg
LR-Alarm Error

MV-90 ENGINEERING UNIT LOWS SUMMARY REPORT 1994, MAR 22 6:02 PM PAGE 1

SUMMARY ID: SIC-CAT7 GROUP: START TIME: 93/01/15 10:45
CLOCK: 15 MINS STOP TIME: 93/01/15 12:45

CUSTOMER ID: **** NO MASTER **** ADDRESS:
NAME: *** NO MASTER ***
ACCOUNT #:

6 KW-RE LOWS (CHAN# 2)

	DATE	TIME	KW-RE
* 1 *	93/01/15	11:00	13540.84
* 2 *	93/01/15	12:15	13593.31
* 3 *	93/01/15	10:45	13603.86
* 4 *	93/01/15	12:30	13629.41
* 5 *	93/01/15	11:15	13758.07
* 6 *	93/01/15	12:00	13877.66
TOTAL KW-RE USAGE			124224.74

6 LOLIM LOWS (CHAN# 3)

	DATE	TIME	LOLIM
* 1 *	93/01/15	12:30	10901.87
* 2 *	93/01/15	12:15	10975.76
* 3 *	93/01/15	12:45	11137.96
* 4 *	93/01/15	12:00	11165.75
* 5 *	93/01/15	11:45	11859.87
* 6 *	93/01/15	11:30	12082.04
TOTAL LOLIM USAGE			105644.15

6 UPLIM LOWS (CHAN# 4)

	DATE	TIME	UPLIM
* 1 *	93/01/15	11:00	14520.23
* 2 *	93/01/15	10:45	14531.73
* 3 *	93/01/15	11:15	15232.69
* 4 *	93/01/15	11:30	16158.51
* 5 *	93/01/15	12:15	16210.87
* 6 *	93/01/15	12:30	16356.96
TOTAL UPLIM USAGE			142805.33

6 % ERR LOWS (CHAN# 5)

	DATE	TIME	% ERR
* 1 *	93/01/15	10:45	6.82
* 2 *	93/01/15	11:00	7.23
* 3 *	93/01/15	11:15	10.72
* 4 *	93/01/15	11:30	14.43
* 5 *	93/01/15	11:45	16.29
* 6 *	93/01/15	12:15	19.26
TOTAL % ERR USAGE			134.37

* - Interval Status Set # - Channel Status Set @ - Both Statuses Set
INTERVAL STATUS CODES:
PO-Power Outage ,SI-Short(False) ,LI-Long(Missing) ,CR-CRC Chksum Err
RA-RAM Chksum Err ,RO-ROM Chksum Err ,LA-Lapse in Data ,CL-Hdwre Clock Err
BR-Memory Reset ,WT-Watchdog T-out ,TR-Time Reset ,TM-Test Mode
LC-Load Control
CHANNEL STATUS CODES:
AD-Added Interval ,RE-Replaced data ,ES-Estimated data ,OV-Data Overflow
HL-High/Low Limit ,XC-Excluded Data ,PY-Parity Error ,TY-Enrgy Typ Chg
LR-Alarm Error

MV-90 ENGINEERING STATISTICS CLASS 1994, MAR 22 6:02 PM PAGE 1
SUMMARY ID: SIC-CAT7 NAME: SIC CATEGORY 7 TOTALSTART TIME:93/01/15 10:45
CONF %:90 POP KWH: 7682000 AVG KWH: 312706 INT:15 STOP TIME:93/01/15 12:45

DATE 01/15	WT-MEAN KW	(RE)TOTAL EST. KW	LOWER LIMIT	UPPER LIMIT	WT VARANC	% ERROR	# OF CNTR
10:45	553.764	13604	12676	14532	262213	6.821	11
11:00	551.198	13541	12561	14520	292146	7.233	11
11:15	560.041	13758	12283	15233	662279	10.718	11
11:30	574.785	14120	12082	16159	1265293	14.435	11
11:45	576.746	14168	11860	16477	1623187	16.294	11
12:00	564.909	13878	11166	16590	2239929	19.542	11
12:15	553.335	13593	10976	16211	2086778	19.256	11
12:30	554.804	13629	10902	16357	2265826	20.012	11
12:45	567.156	13933	11138	16728	2379123	20.060	11
HIGH	576.746	14168	12676	16728	2379123	20.060	
AVRG	561.860	13803	11738	15867	1452975	14.930	
LOW	551.198	13541	10902	14520	262213	6.821	
TOTAL KWH		31056					
GRAN TOT KWH		31056					

Appendix D

Mathematical Example of Ratio Estimation

A Mathematical Example of Ratio Estimation

The following appendix explains the mathematical components of ratio estimation, and the statistics corresponding to the ratio estimated total. SIC-category 7 which is made up of health care and related facilities, will be used in this example. The nine intervals surrounding the estimated peak for January 1993 will be worked through. SIC-category 7 peaked in 1993 on January 15th at 11:45 AM.

The MV90 reports at the end of the appendix show the results of MV90's ratio expansion of the sample. "The Engineering Unit Peaks Summary Report" gives the ratio estimated KW peaks, the lower and upper limit peaks as well as the 6 worst levels of precision, during the time period the report covers. "The Engineering Statistics Report" gives an interval by interval breakdown of the mean kW for the contributors, the ratio estimated total, the upper and lower limit of the ratio estimated total, the weighted variance of the population and the relative precision of the ratio estimated total for each interval, over the time frame specified.

MV90 arrives at the ratio estimated totals and statistics by going through a series of calculations, similar to those in the following illustration, which traces the flow of data from the demands of the sample to a ratio estimated total for which a level of precision is calculated. The notation and formulae used in calculating these numbers are defined on the following pages.

How the Expansion Works

At the time of sample design SIC-category 7 had a population of 45, 39 customers in stratum 1 (110-1000 kVA) and 6 in stratum 2 (1000 kVA plus). There were 12 customers in the sample, 8 in stratum one, and 4 in stratum two. For the month in question January, 1993 the number of customers in stratum one's population had dropped to 36, causing the class population to drop to 42. As well the sample size for

January also decreased from 8 to 7. The population and sample sizes for the second stratum remained the same as at time of design.

The two strata are expanded (totalized) first. A ratio estimator is calculated for each interval. In the strata the ratio estimator is the ratio of the average demand of the sample customers for the interval in question to the average monthly billed energy. For the peak interval 11:45 AM of stratum 2 it would be:

$$\text{Average demand}(\bar{Y}) = \frac{1094.4 + 835.2 + 1516.8 + 57.6}{4} = 876.0 \text{ kW}$$

$$\text{Average billed energy}(\bar{X}) = \frac{588000+381600+955200+41100}{4} = 491475 \text{ kWh}$$

$$\text{Ratio estimator}(\hat{R}) = \frac{867.0}{491475} = 0.00178239$$

The product of this ratio and the total monthly billed kWh for the stratum equals the ratio estimated total demand, for the interval in question.

Total monthly billed kWh for the stratum = 1024000 kWh

Ratio estimated total = 0.00178239 x 1024000 = 1825.17 kW

Note: Numbers were taken from illustration that follows.

This calculation is repeated for each interval in each stratum. The formulae used to calculate the statistical components corresponding to this ratio estimated total are depicted on the formula sheet that follows.

Once the strata have been calculated a ratio estimated total can be formulated for the class. The ratio used here is the summation of the weighted average demands of the strata for an interval divided by the summation of the weighted average monthly billed energy of the strata for the interval in question. The product of this ratio and the total

monthly billed energy of the class equals the ratio estimated total for the class for the interval. In the following illustration peak Interval of 11:45 AM for the class is used to show how these calculations are preformed.

Summation Average Weighted Demand = Weighted Average Demand St.1 + Weighted Average Demand St.2
= (0.8667) x (530.7) + (0.1333) x (876) = 576

Summation Average Weighted Monthly Billed kWh = Weighted Monthly Billed Energy St.1 + Weighted Monthly Billed Energy St.2
= (0.8667) x (285211.43) + (0.1333) x (491475) = 312713

$$\text{Ratio Estimator Class} = \frac{\text{Summation Average Weighted Demand}}{\text{Summation Average Weighted Monthly Billed kWh}} = \frac{576}{312713} = 0.00184$$

Ratio Estimated Total = Total Class Population Monthly Billed kWh x Class Ratio Estimator = (7682000) x (0.00184) = 14168 kW

Note: St. = Stratum

The mathematical notation and formulae used in this estimation technique are illustrated in the following pages. The example involving SIC category 7 follows, and can be compared to the MV90 reports that cover the same time frame as the example.

Mathematical Notation

X_{hi}	Monthly billed energy of customer i in stratum h.
Y_{ith}	Demand for customer i in interval t of stratum h.
$\bar{X}_h$	Mean billed energy of the sample in stratum h.
$\bar{Y}_{ht}$	Mean demand for stratum h in interval t.
n_{ht}	Sample size of stratum h of the t^{th} interval.
N_h	Stratum population for month in question.
N	Class population for month in question.
$\acute{n}_h$	Sample size of stratum h at time of design.
$\acute{N}_h$	Population size of stratum h at time of sample design.
$\acute{N}$	Population size of class at time of design.
W_h	The weight of stratum h, the ratio $\acute{N}_h$ to $\acute{N}$.
$\hat{R}_t$	Estimated ratio of Y to X for interval t.
$d(y)_{ith}$	The residual of customer i's demand in interval t of stratum h.
$s^2(d)_{ht}$	The variance of the residuals (d(y)) in interval t of stratum h.
$\hat{T}(y)_{ht}$	The ratio estimated total demand for stratum h interval t.
$\hat{B}(T(y))$	The bound of the ratio estimated demand.
$\hat{V}_t$	The variance of the ratio estimated total for interval t.
LL, UL	Lower limit(LL) or Upper limit(UL) of ratio estimated demand.
% Error	The relative precision within a predefined confidence interval.
T_h	Total billed kWh for the population of stratum h.
T	Total billed kWh for the population of the class.
$Z_{\alpha/2}$	The number of standard errors corresponding to the desired confidence (Note: For sample size less then 30 the t-value is used.)

Formulas

Ratio Estimation - Stratum:

$$\bar{X} = \Sigma X_{hi} \div n_{ht} \qquad \bar{Y} = \Sigma Y_{tih} \div n_{ht}$$

$$\hat{R}_{ht} = \frac{\bar{Y}_{tih}}{\bar{X}_{ht}} \qquad \hat{T}(y)_{ht} = \hat{R}_t \times T_h$$

Statistical Components - Stratum:

$$d_{tih} = Y_{tih} - (X_{hi} \times \hat{R}_{ht}) \qquad S^2(d)_{ht} = \frac{\Sigma(d_{tih}^2) - ((\Sigma d_{tih})^2 \div n_{ht})}{n_{ht}-1}$$

$$\hat{V}_{ht} = (1-(\acute{n}_h \div \acute{N}_h) \times \left[\frac{(N \times (N_h \div N))}{n_{ht}} \right] \times S^2(d)_{ht}$$

$$B(\hat{T}(y)_{ht}) = t_{\alpha/2} \times \sqrt{\hat{V}_{ht}} \qquad LL = \hat{T}(y)_{ht} - B(\hat{T}(y)_{ht})$$

$$UL = \hat{T}(y)_{ht} - B(\hat{T}(y)_{ht}) \qquad \% \text{ Error} = \frac{B(\hat{T}(y)_{ht})}{\hat{T}(y)_{ht}}$$

Ratio Estimation - Class:

$$\hat{R}_t = \frac{\Sigma(W_h \times \bar{Y}_{ht})}{\Sigma(W_h \times \bar{X}_{ht})} \qquad W_h = \acute{N}_h \div \acute{N} \qquad \hat{T}(y)_t = \hat{R}_t \times T$$

Statistical Components - Class:

$$\hat{V} = \Sigma \hat{V}_{ht} \qquad B(\hat{T}(y)_{ht}) = t_{\alpha/2} \times \sqrt{\hat{V}}$$

$$\% \text{ Error} = \frac{B(\hat{T}(y))}{\hat{T}(y)}$$

Note: $t_{\alpha/2}$ is used for sample sizes less than 30. When the sample size is greater than 30, $Z_{\alpha/2}$ is used.

RATIO ESTIMATION
SIC-CATEGORY 7 STRATUM 1

RELEVEANT INFORMATION

Total customers in category 7's population for month in question = 42
Total customers in stratum population for month in question = 36

Total customers in category 7's population at time of sample design = 45
Total customers in stratum population at time of sample design = 39
Number of sample customers = 7
Number of sample customers at time of sample design = 7

Confidence level 90% with relative accuracies + or - 10%
(corresponding t value from the t distribution table = 1.943
Total billed kWh for stratum 1 = 6658000
Weighting St. 1 [W(h)] = .8666667

MONTHLY BILLED kWh (X)

1	2	3	4	5	6	7
348800.00	226440.00	214080.00	114200.00	503520.00	284640.00	304800.00

$\bar{X}$
285211.43

SAMPLE POINT KW DEMANDS (Y)
15 MINUTE INTERVALS

DATE	HOUR	Sample Pt. 1	Sample Pt. 2	Sample Pt. 3	Sample Pt. 4	Sample Pt. 5
93-01-15	1045	582.4000	394.5600	408.9600	208.8000	854.4000
93-01-15	1100	569.6000	401.7600	403.2000	188.0000	842.8800
93-01-15	1115	576.0000	383.0400	393.6000	212.0000	846.7200
93-01-15	1130	579.2000	411.8400	401.2800	202.4000	846.7200
93-01-15	1145	595.2000	436.3200	384.0000	195.2000	846.7200
93-01-15	1200	588.8000	381.6000	382.0800	189.6000	829.4400
93-01-15	1215	601.6000	352.8000	366.7200	183.2000	833.2800
93-01-15	1230	588.8000	348.4800	385.9200	192.8000	819.8400
93-01-15	1245	582.4000	368.6400	403.2000	210.4000	816.0000

DATE	HOUR	Sample Pt. 6	Sample Pt. 7	$\bar{Y}$
93-01-15	1045	470.4000	542.4000	494.5600
93-01-15	1100	468.4800	576.0000	492.8457
93-01-15	1115	468.4800	669.6000	507.0629
93-01-15	1130	476.1600	746.4000	523.4286
93-01-15	1145	470.4000	787.2000	530.7200
93-01-15	1200	460.8000	830.4000	523.2457
93-01-15	1215	455.0400	816.0000	515.5200
93-01-15	1230	443.5200	820.8000	514.3086
93-01-15	1245	447.3600	828.0000	522.2857

RATIO ESTIMATED TOTAL - STRATUM

DATE	HOUR	$\bar{W}(h)*Y(h)$	$\bar{W}(h)*X(h)$	$\hat{R}$	Total Billed kWh	$\hat{T}(Y)$ Total kW
93-01-15	1045	428.6187	247183.2381	0.00173401	6658000.00	11545.0510
93-01-15	1100	427.1330	247183.2381	0.00172800	6658000.00	11505.0325
93-01-15	1115	439.4545	247183.2381	0.00177785	6658000.00	11836.9187
93-01-15	1130	453.6381	247183.2381	0.00183523	6658000.00	12218.9614
93-01-15	1145	459.9573	247183.2381	0.00186079	6658000.00	12389.1731
93-01-15	1200	453.4796	247183.2381	0.00183459	6658000.00	12214.6927
93-01-15	1215	446.7840	247183.2381	0.00180750	6658000.00	12034.3430
93-01-15	1230	445.7341	247183.2381	0.00180325	6658000.00	12006.0633
93-01-15	1245	452.6476	247183.2381	0.00183122	6658000.00	12192.2824

STATISTICAL COMPONENTS - STRATUM

RESIDUALS [d(h(i))]

DATE	HOUR	Sample Pt. 1	Sample Pt. 2	Sample Pt. 3	Sample Pt. 4	Sample Pt. 5
93-01-15	1045	-22.42334	1.91035	37.74274	10.77585	-18.70965
93-01-15	1100	-33.12685	10.47139	33.26949	-9.33775	-27.20321
93-01-15	1115	-44.11374	-19.53613	12.99808	8.96964	-48.46254
93-01-15	1130	-60.92823	-3.72948	8.39396	-7.18327	-77.35501
93-01-15	1145	-53.84530	14.96158	-14.35899	-17.30279	-90.22750
93-01-15	1200	-51.10460	-33.82431	-10.66879	-19.91005	-94.31219
93-01-15	1215	-28.85642	-56.49057	-20.22986	-23.21664	-76.83301
93-01-15	1230	-40.17490	-59.84877	-0.12056	-13.13158	-88.13432
93-01-15	1245	-56.33057	-46.02213	11.17179	1.27434	-106.05738

HOUR	Sample Pt. 6	Sample Pt. 7	$\bar{d}(h)$	d(h) Sum of Squares	s^2(d)	$\hat{V}$
1045	-23.16914	13.87318	-5.709718E-16	3126.41404	521.069006	76683.0344
1100	-23.37828	49.30521	-3.425831E-14	6118.65244	1019.775407	150075.0796
1115	-37.56694	127.71162	-5.075305E-16	22647.23738	3774.539563	555479.4925
1130	-46.21987	187.02189	-4.453580E-14	46945.47879	7824.246464	1151453.9412
1145	-59.25669	220.02968	-6.674026E-14	63694.15044	10615.691740	1562256.5251
1200	-61.39738	271.21731	-7.612958E-15	90489.25374	15081.542289	2219472.6851
1215	-59.44714	265.07363	8.1204884E-15	84673.44170	14112.240283	2076825.5151
1230	-69.75814	271.16826	-4.932562E-15	91534.43452	15255.739087	2245108.3280
1245	-73.87930	269.84324	-9.053076E-14	94939.29710	15823.216183	2328621.0014

DATE	HOUR	^ ^ B(T(Y))	L.L of Total	U.L of Total	% ERROR
93-01-15	1045	538.10515	11006.9458	12083.1561	4.66%
93-01-15	1100	752.78645	10752.2461	12257.8190	6.54%
93-01-15	1115	1448.27661	10388.6421	13285.1953	12.24%
93-01-15	1130	2085.16673	10133.7946	14304.1281	17.07%
93-01-15	1145	2428.81074	9960.3624	14817.9838	19.60%
93-01-15	1200	2894.95891	9319.7338	15109.6517	23.70%
93-01-15	1215	2800.38348	9233.9595	14834.7265	23.27%
93-01-15	1230	2911.62978	9094.4335	14917.6931	24.25%
93-01-15	1245	2965.28818	9226.9942	15157.5706	24.32%

RATIO ESTIMATION
SIC-CATEGORY 7 STRATUM 2

RELEVEANT INFORMATION

Total customers in category 7's population for month in question = 42

Total customers in stratum population for month in question = 6

Total customers in category 7's population at time of sample design = 45

Total customers in stratum population at time of sample design = 6

Number of sample customers for month in question = 4

Number of sample customers at time of sample design = 4

Confidence level 90% with relative accuracies + or − 10%

(corresponding t value from the t distribution table = 2.353

Total billed KWH for stratum 2 = 1024000

Weighting St. 2 [W(h)] = .13333333

MONTHLY BILLED kWh (X)

1	2	3	4	$\bar{X}$
588000.00	381600.00	955200.00	41100.00	491475.00

SAMPLE POINT KW DEMANDS (Y)

15 MINUTE INTERVALS

DATE	HOUR	Sample Pt. 1	Sample Pt. 2	Sample Pt. 3	Sample Pt. 4	$\bar{Y}$
93-01-15	1045	1392.0000	806.4000	1497.6000	58.8000	938.7000
93-01-15	1100	1353.6000	787.2000	1526.4000	55.2000	930.6000
93-01-15	1115	1276.8000	777.6000	1507.2000	56.4000	904.5000
93-01-15	1130	1248.0000	830.4000	1497.6000	58.8000	908.7000
93-01-15	1145	1094.4000	835.2000	1516.8000	57.6000	876.0000
93-01-15	1200	1036.8000	734.4000	1516.8000	55.2000	835.8000
93-01-15	1215	979.2000	681.6000	1478.4000	57.6000	799.2000
93-01-15	1230	1056.0000	681.6000	1478.4000	56.4000	818.1000
93-01-15	1245	1161.6000	720.0000	1497.6000	56.4000	858.9000

RATIO ESTIMATED TOTAL - STRATUM

DATE	HOUR	$\bar{W(h)*Y(h)}$	$\bar{W(h)*X(h)}$	$\hat{R}$	Total Billed kWh	$\hat{T(Y)}$ Total kW
93-01-15	1045	125.160000	65530.0000	0.00190996	1024000.00	1955.8041
93-01-15	1100	124.080000	65530.0000	0.00189348	1024000.00	1938.9275
93-01-15	1115	120.600000	65530.0000	0.00184038	1024000.00	1884.5475
93-01-15	1130	121.160000	65530.0000	0.00184892	1024000.00	1893.2983
93-01-15	1145	116.800000	65530.0000	0.00178239	1024000.00	1825.1671
93-01-15	1200	111.440000	65530.0000	0.00170060	1024000.00	1741.4094
93-01-15	1215	106.560000	65530.0000	0.00162613	1024000.00	1665.1524
93-01-15	1230	109.080000	65530.0000	0.00166458	1024000.00	1704.5311
93-01-15	1245	114.520000	65530.0000	0.00174760	1024000.00	1789.5388

STATISTICAL COMPONENTS - STRATUM

RESIDUALS [d(h(i))]

DATE	HOUR	Sample Pt. 1	Sample Pt. 2	Sample Pt. 3	Sample Pt. 4	$\bar{d(h)}$
93-01-15	1045	268.940638	77.557394	-326.798474	-19.699557	1.2789769E-13
93-01-15	1100	240.231467	64.646544	-282.255822	-22.622188	6.3948846E-14
93-01-15	1115	194.657470	75.311582	-250.729498	-19.239554	2.4868996E-14
93-01-15	1130	160.832596	124.850542	-268.492355	-17.190783	1.2168044E-13
93-01-15	1145	46.354830	155.040073	-185.738685	-15.656219	6.3504757E-14
93-01-15	1200	36.850053	85.452892	-107.608485	-14.694461	1.4210855E-14
93-01-15	1215	23.038242	61.070533	-74.875019	-9.233756	7.9936058E-15
93-01-15	1230	77.226309	46.395849	-111.607874	-12.014284	7.4162898E-14
93-01-15	1245	134.013246	53.117168	-171.704197	-15.426217	-1.731948E-14

HOUR	d(h) Sum of Squares	s^2(d)	$\hat{V}$	$\hat{B(T(Y))}$	L.L of Total	U.L of Total
1045	185529.5312	61843.1771	185529.53116	1013.68325548	942.1208	2969.4873
1100	142070.4454	47356.8151	142070.44542	887.04901942	1051.8785	2825.9765
1115	106798.8066	35599.6022	106798.80662	769.09316021	1115.4544	2653.6407
1130	113838.4491	37946.1497	113838.44915	794.03607589	1099.2623	2687.3344
1145	60930.1707	20310.0569	60930.17069	580.91413833	1244.2530	2406.0812
1200	20455.6363	6818.5454	20455.63630	336.59080348	1404.8186	2078.0002
1215	9951.9013	3317.3004	9951.90127	234.77334001	1430.3791	1899.9258
1230	20717.1382	6905.7127	20717.13816	338.73543492	1365.7956	2043.2665
1245	50501.2829	16833.7610	50501.28285	528.86759103	1260.6712	2318.4064

DATE	HOUR	% ERROR
93-01-15	1045	51.83%
93-01-15	1100	45.75%
93-01-15	1115	40.81%
93-01-15	1130	41.94%
93-01-15	1145	31.83%
93-01-15	1200	19.33%
93-01-15	1215	14.10%
93-01-15	1230	19.87%
93-01-15	1245	29.55%

RATIO ESTIMATION
THE CLASS SIC-CATEGORY 7

RELEVEANT INFORMATION

Total customers in category 7's population at time of design = 45

Total customers in category 7's population for month in question = 42

Number of stratum = 2

Confidence level 90% with relative accuracies + or - 10%

(corresponding t value from the t distribution table = 1.799

Total billed kWh for class = 7682000

RATIO ESTIMATED TOTAL - CLASS

DATE	HOUR	Sum of W(h)*Y(h)	Sum of W(h)*X(h)	$\hat{R}$	$\hat{V}$	$\hat{T(Y)}$ Total KW
93-01-15	1045	553.7787	312713.2381	0.001770883	262212.56558	13603.92589
93-01-15	1100	551.2130	312713.2381	0.001762679	292145.52505	13540.89749
93-01-15	1115	560.0545	312713.2381	0.001790952	662278.29916	13758.09516
93-01-15	1130	574.7981	312713.2381	0.001838100	1265292.3903	14120.28155
93-01-15	1145	576.7573	312713.2381	0.001844365	1623186.6957	14168.41149
93-01-15	1200	564.9196	312713.2381	0.001806510	2239928.3213	13877.61049
93-01-15	1215	553.3440	312713.2381	0.001769493	2086777.4164	13593.24803
93-01-15	1230	554.8141	312713.2381	0.001774194	2265825.4662	13629.36186
93-01-15	1245	567.1676	312713.2381	0.001813699	2379122.2842	13932.83404

STATISTICAL COMPONENTS - CLASS

DATE	HOUR	$\hat{\hat{B}}(T(Y))$	L.L of Total	U.L of Total	% ERROR
93-01-15	1045	927.9677344	12675.95816	14531.89363	6.82%
93-01-15	1100	979.50294312	12561.39454	14520.40043	7.23%
93-01-15	1115	1474.7771105	12283.31804	15232.87227	10.72%
93-01-15	1130	2038.4570912	12081.82446	16158.73865	14.44%
93-01-15	1145	2308.8215282	11859.58996	16477.23301	16.30%
93-01-15	1200	2712.209211	11165.40128	16589.81970	19.54%
93-01-15	1215	2617.8465748	10975.40146	16211.09461	19.26%
93-01-15	1230	2727.842886	10901.51897	16357.20474	20.01%
93-01-15	1245	2795.2104322	11137.62361	16728.04448	20.06%

MV-90 ENGINEERING STATISTICS STRATUM 1994, MAR 19 1:24 PM PAGE 1
SUMMARY ID: SIC-CAT7-1 NAME: SIC CATEGORY 7 STR 1START TIME:93/01/15 10:45
CONF %:90 POP KWH: 6658000 AVG KWH: 285211 INT:15 STOP TIME :93/01/15 12:45

DATE 01/15	MEAN KW	(RE)TOTAL EST. KW	LOWER LIMIT	UPPER LIMIT	WT VARANC	% ERROR	# OF CNTR
10:45	494.560	11545	11007	12083	76683	4.660	7
11:00	492.846	11505	10752	12258	150075	6.542	7
11:15	507.063	11837	10389	13285	555480	12.234	7
11:30	523.429	12219	10134	14304	1151454	17.063	7
11:45	530.720	12389	9961	14818	1562257	19.602	7
12:00	523.246	12215	9320	15109	2219473	23.698	7
12:15	515.520	12034	9234	14834	2076826	23.268	7
12:30	514.309	12006	9095	14917	2245109	24.249	7
12:45	522.286	12192	9227	15157	2328621	24.319	7
HIGH	530.720	12389	11007	15157	2328621	24.319	
AVRG	513.775	11994	9902	14085	1373998	17.293	
LOW	492.846	11505	9095	12083	76683	4.660	
TOTAL KWH		26986					
GRAN TOT KWH		26986					

SUMMARY ID: SIC-CAT7-2 NAME: SIC CATEGORY 7 STR 2START TIME:93/01/15 10:45
CONF %:90 POP KWH: 1024000 AVG KWH: 491475 INT:15 STOP TIME :93/01/15 12:45

DATE 01/15	MEAN KW	(RE)TOTAL EST. KW	LOWER LIMIT	UPPER LIMIT	WT VARANC	% ERROR	# OF CNTR
10:45	938.700	1956	942	2969	185530	51.821	4
11:00	930.600	1939	1052	2826	142070	45.742	4
11:15	904.500	1885	1116	2654	106799	40.804	4
11:30	908.700	1893	1099	2687	113838	41.932	4
11:45	876.000	1825	1244	2406	60930	31.823	4
12:00	835.800	1741	1405	2078	20456	19.325	4
12:15	799.200	1665	1430	1900	9952	14.097	4
12:30	818.100	1705	1366	2043	20717	19.869	4
12:45	858.900	1790	1261	2318	50501	29.548	4
HIGH	938.700	1956	1430	2969	185530	51.821	
AVRG	874.500	1822	1213	2431	78977	32.773	
LOW	799.200	1665	942	1900	9952	14.097	
TOTAL KWH		4100					
GRAN TOT KWH		4100					

SUMMARY ID: SIC-CAT7 NAME: SIC CATEGORY 7 TOTALSTART TIME:93/01/15 10:45
CONF %:90 POP KWH: 7682000 AVG KWH: 312706 INT:15 STOP TIME:93/01/15 12:45

DATE 01/15	WT-MEAN KW	(RE)TOTAL EST. KW	LOWER LIMIT	UPPER LIMIT	WT VARANC	% ERROR	# OF CNTR
10:45	553.764	13604	12676	14532	262213	6.821	11
11:00	551.198	13541	12561	14520	292146	7.233	11
11:15	560.041	13758	12283	15233	662279	10.718	11
11:30	574.785	14120	12082	16159	1265293	14.435	11
11:45	576.746	14168	11860	16477	1623187	16.294	11
12:00	564.909	13878	11166	16590	2239929	19.542	11
12:15	553.335	13593	10976	16211	2086778	19.256	11
12:30	554.804	13629	10902	16357	2265826	20.012	11
12:45	567.156	13933	11138	16728	2379123	20.060	11
HIGH	576.746	14168	12676	16728	2379123	20.060	
AVRG	561.860	13803	11738	15867	1452975	14.930	
LOW	551.198	13541	10902	14520	262213	6.821	
TOTAL KWH		31056					
GRAN TOT KWH		31056					

MV-90 ENGINEERING UNIT PEAKS SUMMARY REPORT 1994, MAR 19 1:25 PM PAGE 1

SUMMARY ID: SIC-CAT7 GROUP: START TIME: 93/01/15 10:45
CLOCK: 15 MINS STOP TIME: 93/01/15 12:45

CUSTOMER ID: **** NO MASTER **** ADDRESS:
NAME: *** NO MASTER ***
ACCOUNT #:

6 KW-RE PEAKS (CHAN# 2)

	DATE	TIME	KW-RE
* 1 *	93/01/15	11:45	14168.44
* 2 *	93/01/15	11:30	14120.28
* 3 *	93/01/15	12:45	13932.86
* 4 *	93/01/15	12:00	13877.66
* 5 *	93/01/15	11:15	13758.07
* 6 *	93/01/15	12:30	13629.41
TOTAL KW-RE USAGE			124224.74

6 LOLIM PEAKS (CHAN# 3)

	DATE	TIME	LOLIM
* 1 *	93/01/15	10:45	12676.00
* 2 *	93/01/15	11:00	12561.44
* 3 *	93/01/15	11:15	12283.46
* 4 *	93/01/15	11:30	12082.04
* 5 *	93/01/15	11:45	11859.87
* 6 *	93/01/15	12:00	11165.75
TOTAL LOLIM USAGE			105644.15

6 UPLIM PEAKS (CHAN# 4)

	DATE	TIME	UPLIM
* 1 *	93/01/15	12:45	16727.77
* 2 *	93/01/15	12:00	16589.57
* 3 *	93/01/15	11:45	16477.01
* 4 *	93/01/15	12:30	16356.96
* 5 *	93/01/15	12:15	16210.87
* 6 *	93/01/15	11:30	16158.51
TOTAL UPLIM USAGE			142805.33

6 % ERR PEAKS (CHAN# 5)

	DATE	TIME	% ERR
* 1 *	93/01/15	12:45	20.06
* 2 *	93/01/15	12:30	20.01
* 3 *	93/01/15	12:00	19.54
* 4 *	93/01/15	12:15	19.26
* 5 *	93/01/15	11:45	16.29
* 6 *	93/01/15	11:30	14.43
TOTAL % ERR USAGE			134.37

* - Interval Status Set # - Channel Status Set @ - Both Statuses Set
INTERVAL STATUS CODES:
PO-Power Outage ,SI-Short(False) ,LI-Long(Missing) ,CR-CRC Chksum Err
RA-RAM Chksum Err ,RO-ROM Chksum Err ,LA-Lapse in Data ,CL-Hdwre Clock Err
BR-Memory Reset ,WT-Watchdog T-out ,TR-Time Reset ,TM-Test Mode
LC-Load Control
CHANNEL STATUS CODES:
AD-Added Interval ,RE-Replaced data ,ES-Estimated data ,OV-Data Overflow
HL-High/Low Limit ,XC-Excluded Data ,PY-Parity Error ,TY-Enrgy Typ Chg
LR-Alarm Error