Chapter 321 Methodology Report
Central Maine Power Company

INTRODUCTION

With Chapter 321, the Maine Public Utility Commission (PUC) sets the rules governing load profiling and settlement. The Chapter establishes the requirements for reporting the day-after and month-end electricity loads to the Independent System Operator - New England (ISO-NE) on behalf of competitive electricity providers operating in Maine. It also sets forth the conditions for telemetering as well as the general methods and requirements for load profiling, information access, and data transfer.

With this report, Central Maine Power Company (CMP) submits the first of two reports in accordance with Section 9.A of Chapter 321. As required by Section 9.A.1, this report describes the methods by which CMP will perform sampling and validation to ensure compliance with Section 4 of the Chapter. The report begins with the initial analysis of CMP's existing load research samples.

A second report, which is due by December 1, 1999, will describe in a manner that will allow verification by the PUC the methods used by CMP to ensure compliance with the entire Chapter.

BACKGROUND

The necessity for load profiling and settlement derives from the coordinating procedures performed by ISO-NE for competitive electricity providers serving load in New England. The ISO-NE will compare the hourly demand placed on the system and the resources delivered to it by each provider. The comparison is for purposes of settlement and to keep the system in balance. Thus, accurate load information must be available to the ISO for each hour of a day and for each provider to allocate providers' share of cost to maintain system balance and meet unanticipated demand. Load profiling is necessary because most customers do not have hourly metering, and this should not prohibit them from participating in retail choice.

The purpose of Chapter 321 is "to implement a mechanism within Maine to provide the necessary data to ISO-NE in a manner that ensures timeliness, accuracy, and equity among all competitive electricity providers selling retail electricity in Maine." Order, Docket No. 98-496, Maine PUC (October 13, 1998) at 2. It also establishes the customer profile groups for whom hourly load profiles will be necessary, which are residential, small commercial and industrial, and large commercial and industrial. Samples in each profile group must be designed to achieve a 10% margin of error at a 90% confidence level in hourly load at the time of CMP's summer peak. Customers with load in excess of the large commercial and industrial profile group, which for CMP customers is load greater than 400 kW, will have telemetering.

The following sections summarize the assessment of CMP's existing load-research samples and describe the approach for designing new samples and validating data, including the additional, daily data flow generated by telemetered customers.

ASSESSMENT OF EXISTING SAMPLES

The first step taken by CMP was to examine existing samples, both random and arbitrary, to determine precision levels and the likely need for re-sampling. Table 1 shows a summary of CMP's existing load research by rate and profile class. The breakpoint between small and large commercial & industrial profile classes is 20 kW. Load data comprise 15-minute intervals for all core rate classes. The random samples were designed to meet or exceed a 90% confidence level with 10% margin of error (90/10) for winter peak demand.[1]

Table 1
Summary of Rate Classes and Load Profiling Classes

Profiling Class	Rate Class	No. of Customers	No. of Interval Meters	Annual GWh	Existing Interval Metering
Residential	A	457,053	183	2,551	Random Sample
	A-TOU	16,698	212	264	Random Sample
	LM/Storage Heat	268	82	2	Random Sample
	TOTAL	**474,019**	**477**	**2,817**	
Small Commercial	SGS	40,907	259	407	Random Sample
	SGS-TOU	83	25	2	Arbitrary
	TOTAL	**40,990**	**284**	**409**	
Large Commercial	MGS-S	9,900	111	1,383	Random Sample
	MGS-S-TOU	71	52	19	Arbitrary
	MGS-P	106	80	50	Arbitrary
	MGS-P-TOU	14	8	7	Arbitrary
	TOTAL	**10,091**	**251**	**1,459**	

Note: The number of interval meters shown for each rate class may include some customers' accounts that have migrated to another rate class. The intent of this table is to indicate the relative scope of metering currently in place by rate and profile class and not necessarily absolute values.

[1] The purpose of a confidence level and error term is to provide a measure of how close the estimate of peak demand is likely to be to the true value. The ±10% error, known as the precision, defines the limits surrounding the estimate of winter peak demand by repeated use of the sampling plan. The 90% confidence level implies that if the sampling plan were used many times in a population, the true value of peak demand would be within ±10% of the estimate for 90% of the samples and would be farther from the estimate for 10% of them.

Additionally, the table shows the data for "arbitrary samples" of certain small general service (SGS) and medium general service (MGS) rate classes. "Arbitrary sampling" refers to meter placement done selectively based on the judgment of customer advisors for load survey purposes. These samples are not considered to be representative of their respective population. Consequently, the ramifications of these arbitrary samples require separate examination from the random samples.

Residential Class

The Residential profiling class includes three rate classes: general (A), time-of-use (A-TOU) and load management (A-LM). Currently, each of these three classes has a load research sample that was designed to provide a minimum of 90/10. Rates A and A-TOU samples were drawn in 1993. However, a large fraction of the customers who were on the A-TOU rate at the time the sample was drawn have since moved off that rate and onto Rate A. As a result, a large fraction of the customers in the original A-TOU load research sample is no longer on that rate. The rate A-LM sample was drawn in 1995. Some customers have also moved off this rate.

There are several ways to handle the customers selected for the A-TOU sample who have since migrated to Rate A. One would be to continue to use these customers to represent the A-TOU population. This treatment is inappropriate, however. Formally, the sample that represents a population must be part of that population. It also is to be expected that the load shape for customers who remain on the A-TOU rate would be different from that of customers who have moved to Rate A.

A second way to handle the migrated customers in the load research sample would be to include them in the load research sample for Rate A. All migrated customers could be assigned to the sampling strata that were used for the Rate A sample, and weights calculated accordingly. Strictly speaking, however, the migrated customers in the sample represent only migrated customers, not other general residential customers. Thus, the cleanest way to handle the migrated customers in the sample is to define this subgroup as a separate stratum, and weight the migrated sample only up to the migrated population. As Table 1 indicates, this approach would result in a relatively large number of meters being used to represent a small portion of the total general population. These meters can be used more efficiently if at least a portion of them is re-deployed in the course of developing the new samples.

The first step in estimating the precision of existing samples is to relocate sample customers among existing strata to account for rate changes and assigning new weights. Once done, we calculate the precision in the average coincident summer and winter demand for each sample. Table 2 presents a summary of this analysis.

Table 2
Precision of Existing, Residential Random Samples
at Time of Winter and Summer Peak (Coincident)
at 90 Percent Confidence

Profiling Class	Rate Class	Winter Precision	Summer Precision	Design Precision
Residential	A	18%	16%	± 10% at 95% C.L.
	A-TOU	19%	26%	± 10% at 95% C.L.
	A-LM	51%	84%	± 10% at 90% C.L.

As the table indicates, none of the samples meets its original precision criterion. Further, it is unlikely that the aggregate of the samples will meet the Chapter 321 requirement. As a result, CMP plans to re-sample the residential rates A and A-TOU classes. Re-sampling will not be done for rate class A-LM; because this class is so small, 90/10 precision for the combined residential sample can be obtained efficiently without improving the precision of the sample for this group.

Small Commercial & Industrial Class

The small commercial profiling class comprises two rate classes: SGS and SGS-TOU. The SGS rate class represents over 99 percent of the customers and the annual consumption for the combined profiling class. This rate class has an existing load research sample that was designed in 1991 to provide 95/5 precision at the time of the winter peak. The SGS-TOU class has about 30 percent of its customers interval metered, in a non-random, arbitrary sample. Table 3 shows the precision estimates for both existing, random and arbitrary samples. In this table, the precision for the SGS-TOU class is calculated as if the "arbitrary" sample had been drawn as a simple random sample from this class.

The SGS sample fails to meet its original precision criterion, and it is unlikely that the aggregate of the two samples will meet the Chapter 321 requirement. As a result, CMP plans to re-sample rates SGS and SGS-TOU so that the overall small commercial & industrial profiling class has 90/10 precision for summer peak consumption

Table 3
Precision of Existing, Small Commercial Samples
at Time of Winter and Summer Peak (Coincident)
at 90 Percent Confidence

Profiling Class	Rate Class	Winter Precision	Summer Precision	Design Precision
Small Commercial	SGS	16%	19%	± 5% at 95% C.L.
	SGS-TOU	34%	39%	None

Large Commercial & Industrial Class

The large commercial profiling class consists of four rate classes: MGS primary and secondary voltage levels (P and S, respectively), each with and without a time-of-use rate (TOU). Only the secondary, non-TOU rate class (MGS-S) currently has a load research sample, which was designed in 1991. The remaining three rate classes have arbitrary metering. Table 4 presents precision estimates for these rate classes. In this table, the precision for each MGS-S-TOU, MGS-P, and MGS-P-TOU class is calculated as if the "arbitrary" sample had been drawn as a simple random sample from this class. The MGS-S sample does not meet its original precision criterion, and it is also unlikely that the aggregate of the samples will meet the Chapter 321 requirement. As a result, CMP plans to re-sample all MGS classes so that the overall large commercial & industrial profiling class has 90/10 precision for summer peak consumption.

Table 4
Precision of Existing, Large Commercial Samples
at Time of Winter and Summer Peak (Coincident)
at 90 Percent Confidence

Profiling Class	Rate Class	Winter Precision	Summer Precision	Design Precision
Large Commercial	MGS-S	17%	14%	± 5% at 95% C.L.
	MGS-S-TOU	24%	26%	None
	MGS-P	10%	11%	None
	MGS-P-TOU	57%	63%	None

METHODOLOGY FOR NEW SAMPLE DESIGN

Residential Profiling Class

For the A and A-TOU rate classes, a new sample will be designed to support 90/10 precision for each rate class at summer peak. The new samples are likely to be a full re-deployment of existing meters. However, we do not rule out that the sample may be developed by filling in weak portions of the existing sample or replacing dropped-out customers. The new sample will be designed for ratio estimation, stratifying on both winter and summer peak months.

Rate A-LM will not be re-sampled. The existing sample comprises customers clustered in a specific geographic region. As Table 1 shows, the rate class represents a very small proportion of total residential sales; less than one tenth of one percent. As a result, its precision will have a negligible impact on the overall precision of the profile class.

Small Commercial & Industrial Profiling Class

The new sample will be designed to provide 90/10 precision for the SGS rate class. In addition, the design will provide 90/10 precision for the small commercial & industrial load profiling class as a whole. However, 90/10 precision will not necessarily be required for the SGS-TOU class. The strategy for this class will be to provide sufficient precision to support internal rate design requirements, and to provide 90/10 precision for the load profiling class as a whole. Since the SGS-TOU rate class is such a small part of the total profiling class, this rate class could have precision much worse than 90/10 and still satisfy the overall profile class requirement.

For the SGS rate class, a new sample will be designed to support 90/10 precision for the rate class at summer peak. The new sample may be a full re-deployment of existing meters, or may be developed by filling in weak portions of the existing sample or replacing dropped-out customers or equipment. The new sample will be designed for ratio estimation, stratifying on both winter and summer peak months.

For the SGS-TOU sample, the target precision level will be set to satisfy two requirements. One is the precision needed for internal rate making. The second requirement is to ensure that, together with 90/10 precision for the SGS sample, the overall small commercial profiling class has 90/10 precision for summer peak consumption. Given this precision target for the TOU sample, the sampling approach will be as follows.

1. Stratify on winter and summer peak months, and also on whether or not the customer already has an interval meter in place.
2. Allocate meters among the cells defined by the stratification in such a way as to meet the target precision requirement at the least total cost. The allocation formulas will be based on standard allocation formulas for ratio estimation, recognizing a different cost

for including in the sample a customer who does not currently have an interval meter in place.

As an initial step to developing this sample, CMP will compile data on the total kW, total kWh, and variances of kW for each of the cells.

Large Commercial & Industrial Profiling Class

For CMP's internal purposes, the primary and secondary voltage levels can be combined, but the TOU classes need to be distinguished from the non-TOU classes. Thus, two load research samples will be developed, one for the TOU rate classes combined, and one for the non-TOU classes combined. Within each of these samples, the rate class (primary or secondary) will be a stratification variable.

For the non-TOU sample, 90/10 precision will still be required for the MGS-S rate class by itself. The target precision for the MGS-P rate class will be set to satisfy internal ratemaking accuracy requirements, and may be worse than 90/10. This precision level may be set to ensure 90/10 precision for the non-TOU classes combined.

For the TOU sample, the target precision level will be set so that the combined large commercial & industrial load profiling class has 90/10 precision for summer peak consumption. The population will be stratified by rate class (P or S), winter and summer peak demand, and whether the account already is interval metered.

Within each of the rate classes that currently has an arbitrary interval metering sample, the sample allocation will be optimized for ratio estimation, and subject to the specified precision requirements. The allocation will consider the different costs for sampling accounts that currently are interval metered and those that are not.

DATA VALIDITY & MANAGEMENT

Sample Validation

Stratification of rate classes as previously described and optimum allocation with ratio estimation explicitly performs sample validation. Additionally, sample validation will be performed on billed kWh consumption, which is a variable known for the entire population. The validation will compare the sample mean kWh consumption with the population mean kWh consumption.

Customer Notification

The integrity of a load research sample is better maintained if customers do not know they are part of it. Customers who are aware that they are part of the sample may modify their behavior in some way as a result. An extreme example would be collusive behavior, where sampled customers are somehow "paid off" to flatten their load shapes to reduce costs to all customers in the profiling class. Less extreme examples would be customers'

gaining access to even a portion of their own load research data, possibly by observation of their own meters, and modifying their load patterns or shifting to an alternate supplier or rate class as a result.

For the general samples, CMP is considering to not notify customers that they have been selected for the load research sample. We will consult with customer service representatives on the pros and cons of this issue and will make a decision prior to finalizing the sample design. For customers in the current arbitrary samples, notification is more problematic. For many of these customers, the interval meter was installed at the customer's request, or at least with the customer's knowledge.

One option to handle this situation is as follows.

1. All customers in the "arbitrary" classes will be informed that new metering will be put in place. Those who wish to have interval metering (whether or not they currently have such metering) will be required to pay for the full cost of installing a new telemetered interval meter. Those who choose not to pay this cost will not have access to interval metering data from CMP.
2. Those customers who choose telemetered interval meters will have supply costs determined from their own load data, and will be excluded from the load profiling class.
3. The remaining customers will be in the load profiling class. These customers will be included in the sample or not according to the random sampling. If they are included, they will not be informed of this fact and will not have access to their own interval metering data.

Another option could be considered, whereby customers who currently have interval metering could choose to retain this metering, but would not convert it to telemetry. Customers who retain their interval meters by choice rather than as part of the random sampling would be considered as representing only themselves. The random sample would represent only those customers who do not choose to keep interval meters, or who never had them. Those who retain by choice would still be included in the load profiling class; the load profiling rules dictate that without telemetry they cannot be assigned their own load shapes.

There are downsides to both options. Therefore, the decision as to which option to execute will be made prior to finalizing the sample design, and in consultation with customer service. With the first option, there is risk with respect to item three above that customers may become upset by being uninformed of metering and data access changes. With the second option, CMP would be providing free information to certain customers who then could decide whether it was worthwhile to invest in telemetry and seek electricity supply based on their own shapes. Over time, as a result, the customers with flatter load shapes who have access to this information will take themselves out of the load profiling class. The result will be both a more peaked load shape, meaning higher costs, for the remaining customers, and a degradation of the precision of the class average. On the other hand, the customers who would value the load shape information

may already have collected the information they need to make such decisions, from their existing interval data. In addition, it may be awkward from a customer service viewpoint not to allow these customers to keep the interval metering capability if they request it.

Data Retrieval

Load-research data will be read from recorders by meter readers at the same time as the monthly kWh reading. Capturing both kWh consumption and the load-research data at the same time allow for comparison during the data validation process. CMP will upload data from the portable reading devices to a file server and later transfer to MV-90. Pulse information from telemetered recorders at various customer sites will be captured directly by MV-90.

Data Processing

The role of MV-90 will expand to include the capture of increased data for a larger number of customers, and support of new business processes including profiling and settlement. A significant impact within MV-90 will be the installation of telemetered recorders for daily readings at accounts with demand greater than 400 kW.

A goal within the context of Chapter 321 is to improve the capture, processing, and distribution of meter and pulse information through the use of MV-90. Specific objectives include the following:

- handling the increased workload generated by the addition or expansion of pulse data being captured due to deregulation, by reducing or automating the data management steps from capture through analysis; and
- providing validated meter and pulse data to profiling and settlement in a timely fashion.

Validation criteria are broken down into two categories: internal and external. Every "cut" of interval data will carry a flag for each of the two categories indicating whether the data met (or were corrected to meet) all the criteria in that category. Internal validations check the quality of data, such as the number of intervals and the value of pulse data versus meter readings. External validations check the quality of a series of cuts, such as whether the start and stop times leave gaps between cuts or cause the cuts to overlap each other. A cut of data cannot be considered valid until both the internal and external criteria are met. Since the external criteria look at a series of cuts, an individual cut is marked externally invalid until at least one more cut of data has been processed after it. The following list indicates the validation criteria CMP plans to use.

Internal Validations

Number of Intervals

This compares the actual number of intervals in a cut to the expected number, based on the cut start and stop times, and calculates a stop time based on the actual number of intervals. Currently, Load Research accepts the calculated stop time if the difference

between the actual and expected number is not more than 150. If the difference is greater than 150, the cut is archived and not used for load research. For cuts accepted, the difference would be treated as contiguous intervals at the end of the cut, rather than missing or extra intervals throughout the cut.

Energy Discrepancy
This compares a cut's energy usage based on meter readings to its usage based on interval data. The test is performed on every cut, and if the value is incorrect, it is corrected based on the meter reading.

Uncorrected Power Outages
This counts the number of intervals flagged as missing due to outages. If fewer than 10 intervals are missing the cut is accepted as is, otherwise the cut is edited and estimates of the missing intervals are made until less than 10 remain.

Non-Normal Intervals
This counts the number of intervals with non-normal status codes due to interruptions or disturbances. If fewer than 10 intervals are flagged as non-normal the cut is accepted as-is, otherwise the cut is edited and the intervals are corrected until fewer than 10 non-normal intervals remain.

External Validations
Recording Period Match-Up
This compares the stop-time of the current cut of data with the start-time of the following cut to verify that the difference (overlap or gap) falls within the set limit. Cuts with this error are currently accepted; the gap is estimated or any overlap is eliminated.

Merge Attribute Match-Up
This compares three attributes for the current cut of data -- unit of measure, intervals per hour, and pulse multiplier -- to verify that they match the attributes of the following cut. If not, the cut is edited to correct the invalid data.

CONCLUSION

The analysis of CMP's existing load research samples indicates that re-sampling is necessary to meet the requirements of Chapter 321. The new samples will be designed for ratio estimation, stratifying on both winter and summer peak months. CMP's plan is to have new samples drawn by the end of 1998 and re-deployment of load research meters completed by March 1, 1999.