APPENDIX D

7849.0270 PEAK DEMAND AND ANNUAL CONSUMPTION FORECAST.

Subp. 3. Forecast methodology. An applicant may use a forecast methodology of its own choosing, with due consideration given to cost, staffing requirements, and data availability. However, forecast data provided by the applicant is subject to tests of accuracy, reasonableness, and consistency. The applicant shall detail the forecast methodology employed to obtain the forecasts provided under subpart 2, including:

A. the overall methodological framework that is used;

Per the order in Docket E-017/RP-02-1168 issued March 20, 2003, *Item 2.* Implement a different energy and demand forecasting methodology Otter Tail Power Company staff met with staff from the Department of Commerce on April 21, 2003 and discussed the general approach to employ. Otter Tail Power Company has worked with Christensen Associates of Madison, Wisconsin to develop a traditional econometric forecasting model to replace the previous end-use model.

Aggregate econometric models of energy sales were developed for each customer class, using historical data on monthly sales, economic activity, and weather conditions. Monthly sales forecasting models were estimated as a function of these explanatory variables, plus month-specific variables to capture any seasonal patterns that are not related to the other explanatory variables. To forecast system peak demand, an econometric model was developed that explains monthly system peak demands as a function of weather, economic conditions, the number of households in OTP service territory, and month-specific variables.

B. the specific analytical techniques which are used, their purpose, and the components of the forecast to which they have been applied;

Econometric Analysis. Otter Tail Power Company used econometric analysis to develop jurisdictional MWh sales forecasts at the customer meter of the following: Farm, Large Commercial, Malting, Other Public Authority, Pipeline, Residential, Small Commercial, Street Lights, and Unclassified.

Judgment. Judgment is inherent to the development of any forecast. Whenever possible, Otter Tail Power Company tries to use appropriate statistical tests of quantitative models to structure its judgment in the forecasting process.

Loss Factor Methodology. Loss factors were applied to convert the sales forecasts into system energy requirements.

Peak Demand Forecast. Econometric analysis was used to produce a total system MW demand forecast for each month of the forecast period.

The MWh sales forecast was developed for each customer class and jurisdiction. Summing the various jurisdictional class forecasts yields the total system sales forecast. A monthly loss factor is applied to convert MWh sales to MWh native energy requirements.

For the sales forecasting models, we used a SAS regression procedure called AUTOREG. This technique is used when the model error terms are correlated over time, a condition referred to as autocorrelated errors, or simply autocorrelation. That is, ordinary least squares (OLS) regression models assume that the errors (the difference between the actual value and the value predicted by the regression model) are randomly distributed. If instead the errors are correlated over time, then knowledge of the value in period t provides the analyst with information about the value in period t+1 (i.e., the error isn't random). The consequence of autocorrelation is that while the estimated coefficients of the OLS model (e.g., the estimated effect of cooling degree days on usage) are unbiased, they are not efficient (i.e., minimum variance). Using the AUTOREG procedure instead of a standard OLS model is believed to improve the efficiency and increase the accuracy of the forecasting models.

For the system demand forecasting model, we used a standard ordinary least squares (OLS) regression model. The purpose of this model is to estimate the relationship between a dependent variable (in this case monthly system peak demand) and explanatory variables (e.g., heating degree days, or GDP).

C. the manner in which these specific techniques are related in producing the forecast;

The econometric techniques described in Section B are applied to historical data to produce estimated effects of weather, economic factors, and demographic factors on class usage or system demand. Forecast values for the explanatory values (derived either from Woods and Poole forecasts or based on weather normal conditions) are then inserted into the estimated equations to produce forecast values of class-level sales and system demand.

D. where statistical techniques have been used:

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(1) The purpose of the technique;

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(2) Typical computations (e.g., computer printouts, formulas used), specifying variables and data; and

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(3) the results of appropriate statistical tests.

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E. forecast confidence levels or ranges of accuracy for annual peak demand and annual electrical consumption; as well as a description of their derivation;

The estimated effect of each variable in the equations above (e.g., the effect of heating degree days on system peak demand) has a standard error associated with it that is used to generate a confidence interval around the forecasted demand value (e.g., there is some probability that the "true" value of the parameter is actually larger than the estimated value, which would imply that the effect of weather on demand would be larger, leading to a higher peak demand for a given assumed weather condition). In calculating the confidence intervals around the demand forecast, the values of the explanatory variables, such as weather, economic growth, and demographics are all maintained at fixed assumed or expected levels. TABLE 1 (below) shows the results of the confidence levels in 5-year increments.

TABLE 1
Forecast Confidence Levels
2003 Econometric Forecast
% Deviation from Base

	Low Scenario		High Scenario	
Year	Peak	Sales	Peak	Sales
2005	-4.9%	-9.3%	4.7%	10.9%
2010	-4.7%	-9.9%	4.5%	11.7%
2015	-4.6%	-10.6%	4.4%	12.5%
2020	-4.7%	-11.3%	4.5%	13.5%

F. a brief analysis of the methodology used, including:

As discussed in A the change to using an econometric method was in response to the Commission's order in Docket E-017/RP-02-1168 issued March 20, 2003. This method was used as it is a standard methodology in the industry and thus facilitates review. The principle strength of the end-use methodology as applied in the SHAPES-II package was the clarity in which the model can be communicated and understood by the non-technical person. It was reasonable to understand that the components add up and can be disaggregated, but for an analyst to review and understand the end-use method, it took a lot of effort.

(1) its strengths and weaknesses;

As mentioned above, one of the main strengths is the ability of the model to be understood because as mentioned above, the econometric model is more of an industry standard. The model can be reasonably easy to fine tune as it was developed in-house with the assistance of economic consultants (Christensen Associates). One of the weaknesses is that the data it uses is not as detailed as the previous end-use methodology. Another weakness of the econometric methodology for Otter Tail Power Company is the lack of true economists on staff. While we

have staff with "practical" economic training (college and real world), we don't have any economics PhD's on staff. We need to utilize consultants for model design and equation modifications.

(2) its suitability to the system;

The econometric methodology is a very good fit to Otter Tail Power Company's system. Serving three states with distinct economic differences, using the econometric model makes it easy to utilize the different economic data for each state and determine whether particular variables are drivers for each state. With distinct winter and summer season peaks, the demand forecast is easy to test for accuracy.

(3) cost considerations;

As a result of the order in Docket E-017/RP-02-1168 the old end use model was discontinued. Other, more economical techniques were considered and the econometric approach was determined to be the least costly to maintain while being very reliable. Relative to Otter Tail Power Company's previous end-use forecast which was very data intensive and required specialized software to perform, making that model one of the most costly to use, the econometric forecast requires much less support and maintenance.

(4) data requirements;

Data requirements of the econometric forecast are not as extensive as the previous end-use model. The end-use model required that a significant amount of time be devoted to file maintenance. There were at least 59 file types used in one way or another in the database. In contrast the econometric model uses a much smaller number of variables.

(5) past accuracy; and

One of the ways to feel confident about the forecast is to do what is called a 'backcast.' This is where the model is used to predict the historical period. If the model does this well, there is a reasonable confidence that it will predict well in the future. We've looked at the 10-year backcast for the energy and demand forecasts models. The energy model has an error of -0.266% over the 10 years with a -0.195% error for the single year of 2002 (most recent full year backcast). The demand model has an error of 0.30% for the winter peak over the 10 years with a 1.50% error for the single year of 2002. The demand model has an error of -0.09% for the summer peak over the 10 years with a -3.83% error for the single year of 2002.

It is useful to note that the demand forecast is considerably more erratic than the sales forecast when compared to history. There are more undetermined influences affecting demand than energy. Weather characteristics, beyond just temperature, affect peak demand.

(6) other factors considered significant by the applicant.

Not Applicable – see descriptions above.

G. an explanation of discrepancies that appear between the forecasts presented in the application and the forecasts submitted under chapter 7610 or in the applicant's previous certificate of need proceedings;

Not Applicable.

Subp. 4. Database for forecasts. The applicant shall discuss the database used in arriving at the forecast presented in its application, including:

A. a complete list of all data sets used in making the forecast, including a brief description of each data set and an explanation of how each was obtained, (e.g., monthly observations, billing data, consumer survey, etc.) or a citation to the source (e.g., population projection from the statedemographer's office);

Table 2

Data Used in Energy Forecast Models								
	logkwhday	*cddday*	*hddday*	*logcust*	*logques1*	*logques32*	*logques37*	*logrealgdp*
Residential-MN	x	x	x	x				
Residential-ND	x	x	x	x				
Residential-SD	x	x	x	x				
Farm-MN	x	x	x					
Farm-ND	x	x	x			x		
Farm-SD	x	x	x			x		
Small Comm-MN	x	x	x					x
Small Comm-ND	x	x	x					x
Small Comm-SD	x	x	x					x
Large Comm-MN	x	x	x					x
Large Comm-ND	x	x	x					x
Large Comm-SD	x	x	x					x
OPA-MN	x		x					
OPA-ND	x	x	x				x	
OPA-SD	x		x				x	
Streetlight-MN	x				x			
Streetlight-ND	x				x			
Streetlight-SD	x				x			
Pipeline-MN	x		x					x
Pipeline-ND	x							
Malting-ND	x							
Unclassified-MN	x	x	x				x	
Unclassified-ND	x	x	x					
Unclassified-SD	x	x	x					

- *logkWh day*: the log of average daily energy use for each class for each month
- *cddday*: average daily cooling degree days for each month
- *hddday*: average daily heating degree days for each month
- *logcust*: the log of the customer count for the residential class
- *logques1*: the log of total population – Woods & Poole
- *logques32*: the log of farm total employment – Woods & Poole
- *logques37*: the log of transportation, communications and public utilities total employment – Woods & Poole
- *Logrealgdp*: the log of real gross domestic product Quarterly Real Gross Domestic Product (GDP) data was downloaded from www.bea.doc.gov/bea/dn/gdplev.xls Real GDP was based on 1996 dollars.

B. a clear identification of any adjustments made to raw data to adapt them for use in forecasts, including;

(1) the nature of the adjustment;

(2) the reason for the adjustment; and

(3) the magnitude of the adjustment.

The applicant shall provide to the commission or the administrative law judge on demand copies of the data sets used in making the forecasts, including both raw and adjusted data, input and output data.

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Subp. 5. Assumptions and special information. The applicant shall discuss each essential assumption made in preparing the forecast, including the need for the assumption, the nature of the assumption, and the sensitivity of forecast results to variations in the essential assumptions.

The underlying assumptions used to prepare Otter Tail Power Company's forecast are as follows:

1. No load management:

Need: Load management is used at Otter Tail Power during peak conditions, summer, and winter. The use of the control is not always predictable. To build a forecast to match a load subject to load management is not practical.

Assumption: The forecast is made to match uncontrolled load. Therefore, to match forecast to load, the observed load must have the estimated load management added. This simplifies the process of reconciling the forecast.

Sensitivity: There is nothing to test.

2. Woods and Poole Economics, Inc.

Need: Economic forecasts are needed to provide projections of population and employment. The forecasts must be consistent among county, state, and national projections, so the forecasts need to be from similar sources or be based on similar assumptions. For this reason, these elements of the forecast are taken from a single source.

Assumption: Woods and Poole data provides a consistent scenario of the future that connects national, state and county projections. Population and employment follow this story of the future economy.

Sensitivity: No consistent alternatives are provided.

See also the above discussions and the discussion below regarding subject of assumption.

The applicant shall discuss the assumptions made regarding:

A. the availability of alternative sources of energy;

Otter Tail Power Company's forecast assumes availability of alternative sources of energy will continue in similar patterns as have been historically. While there have been increases in natural gas prices in recent years, according to EIA Appendix A Reference Case Forecast (2001-2025) Table 14 (http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_14.xls), consumer natural gas prices are forecast to decline 9% between 2003 and 2025. There is some volatility forecast with prices rising and falling through the time period forecast.

Otter Tail Power Company did not assume any changes in the availability of alternative sources of energy.

B. the expected conversion from other fuels to electricity or vice versa;

Otter Tail Power Company did not assume any changes in the expected conversions from other fuels to electricity or vice versa

C. future prices of electricity for customers in the utility's system and the effect that such price changes will likely have on the utility's system demand;

After testing equations with price variables, Otter Tail Power Company did not assume any changes in future prices of electricity for customers in the utility's system and the effect that such price changes will have on the utility's system demand. The price variables did not affect the

sales forecast. (We believe that this is because there have not been any large price changes during our analysis period, so that our models don't have enough price variation on which to estimate the effect of such price changes on usage.) The current forecast by default assumes any prices changes would be in small increments that demand is not noticeably impacted. While price changes due to rate cases are not necessarily smooth in the short-term (reality), for the purposes of the long-term forecast any price changes smooth out over time. The reality is due to the long-term planning process. The utility itself and regulatory bodies are involved in the IRP process in part to avoid situations that create large price increases. While it is always possible some legislation will cause investment in plant that will necessitate a large price increase, we aren't aware of such a situation on the current horizon.

D. the assumptions made in arriving at any data requested in data subpart 2 that is not available historically or not generated by the utility in preparing its own internal forecast;

See the description of the databases in subpart 2. Otter Tail Power used data from Woods and Poole, weather data from the High Plains Regional Climatic Center and the Gross Domestic Product from the United States Bureau of Economic Analysis.

E. the effect of existing energy conservation programs on long term electrical demand; and

Some effect of existing energy conservation programs is implicit in the forecasts because they are part of the historical data used in the forecast. The true effect of the various programs implemented over the years is extremely difficult to determine, making it near impossible to remove them from the forecast.

F. any other factor considered by the applicant in preparing the forecast.

Not Applicable – see descriptions above

Subp. 6. Coordination of forecasts with other systems.

The utility shall provide:

A. a description of the extent to which the applicant coordinates its load forecasts with those of other systems, such as neighboring systems, associate systems in a power pool, or coordinating organizations; and

Otter Tail Power Company does not coordinate its long-term load forecasts with those of other systems.

B. a description of the manner in which such forecasts are coordinated, and any problems experienced in efforts to coordinate load forecasts.

Otter Tail Power Company does not coordinate its long-term load forecasts with those of other systems.