Exhibit T___ (YKGM-1T)
Docket No. UE-031725
Witness: Yohannes K.G. Mariam

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.,** **Respondents.**	**DOCKET NO. UE-031725**

DIRECT TESTIMONY OF

Yohannes K.G. Mariam

STAFF OF
WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION

January 30, 2004

DIRECT TESTIMONY OF

Dr. YOHANNES K.G. MARIAM
DOCKET No. UE-031725

Q. Please state your name and business address.

A. My name is Yohannes K.G. Mariam. My business address is Chandler Plaza Building, 1300 South Evergreen Park Drive S.W., Olympia, Washington, 98504-7250.

Q. By whom are you employed and in what capacity?

A. I am employed by the Washington Utilities and Transportation Commission (Commission) as a Regulatory Analyst (Economist) in the Energy Section of the Regulatory Services Division.

Q. Please describe your educational background and professional employment experience?

A. I hold Masters of Science (M.Sc.) and Doctor of Philosophy (Ph.D) degrees from McGill University (Canada). My areas of specialization are quantitative economics (econometrics and operations research) and resource economics. I minored in applied cognitive psychology and anthropology. I was a fellow of the

Natural Science and Engineering Research Council (NSERC) of Canada from 1993-1995. I worked as a regulatory and socio-economic consultant for Environment Canada from 1995 to 1997. In 1998 and 1999, I worked as a staff economist for the Canadian Federal Department of the Environment (Environment Canada). In these positions I worked on a wide variety of projects and wrote several manuscripts dealing with economics, the environment, agriculture, development and regulatory issues. I have served as an invited reviewer for the Journal of the Air and Waste Management, and as an invited lecturer at McGill University. Since September 1999, I have been employed by the Commission as an economist in the Energy Section of the Regulatory Services Division. In that capacity, I have worked on purchased gas adjustments, incentive mechanisms, other tariff revisions, integrated resource planning, and general rate cases including Docket Nos. UE-991832 (PacifiCorp), UG-000073 (Northwest Natural), and UE-011595 (Avista). My analyses in these general rate cases concerned the prudence of new resources, rate spread, weather normalization, and cost of service. I also contributed to the small business impact analysis of implementing railroad, telecommunication and energy related rules. I collaborate with other Staff on issues relevant to economic disciplines and write technical papers dealing with regulated energy industries.

PURPOSE AND SUMMARY OF TESTIMONY

Q. What is the purpose of your testimony in this proceeding?

A. I present Staff's recommendation regarding Puget Sound Energy's ("PSE" or the "Company") proposed weather normalization adjustment, including the impact on revenue requirement.[1]

Q. Please summarize staff's weather normalization adjustment.

A. Staff proposes several modifications to the Company's weather normalization adjustment that will increase PSE's normalized test year electricity consumption by 34,000 MWh (34,000,000 kilowatt hours). This results in an increase in PSE's proforma revenue by about $2.6 million (Exhibit__ (YKGM-2), Tables 4 and 5, columns "F" rows # 31; and Table 6, rows 15 and 16). Mr. Russell's testimony presents the overall revenue and rate impact of this adjustment.

Q. Are you sponsoring any exhibits?

[1] Weather normalization is also called temperature normalization. In this testimony, both refer to the same issue: adjusting test year electricity usage based on the difference between normal and test year average temperature.

A. Yes, I present Exhibit__ (YKGM-2) in support of Staff's proposed weather normalization adjustment. The exhibit contains six tables. The descriptions are as follows:

Table 1: Statistical Estimation Results of Weather Sensitivity Coefficients Using Autoregressive Procedure;

Table 2: Statistical Estimation Results of Weather Sensitivity Coefficients Using Linear Regression Model;

Table 3. Differences Between Staff and PSE's Estimated Weather Sensitivity Coefficients;

Table 4: Staff's Summary of Normalized Electricity Consumption and its Impact on Revenue;

Table 5: PSE's Summary of Normalized Electricity Consumption and its Impact on Revenue; and

Table 6: Differences in Loss Adjusted Weather Sensitive Load.

Q. Please explain the need for a weather normalization adjustment.

A. Electricity consumption is influenced by changes in temperature, household size, income, price of competing fuels, and efficiency of energy using appliances, among other factors. In regions such as the Northwest, where electricity is used

to provide space heating and/or cooling, temperature greatly impacts total usage. Major normalization adjustments in the electric industry reflect the impact of temperature and stream flow. Without these normalization adjustments, a company's revenue requirement, as depicted in the proforma results of operations, may not produce a reasonable level of rates.

Q. Please explain generally how a weather normalization adjustment is implemented.

A. In order to implement the weather normalization procedure, the impact of heating degree days ("HDD") and cooling degree days ("CDD") on consumption of electricity (also called, "the weather sensitivity factor" or "coefficient") is estimated using an appropriate statistical method.[2] Normalized electricity usage for the test year is calculated using the statistically estimated weather sensitivity factor, the number of customers, HDD, CDD and actual electricity consumed (see pages 10-12 of this testimony).

[2] CDD refers to non-zero difference between average temperature and 65 degree Fahrenheit (CDD={average temperature- 65^0F} ≥0) (the internationally accepted mean daily temperature). Similarly, HDD refers to non-zero difference between average temperature and 65 degree Fahrenheit (HDD={65^0F- average temperature} ≥0).

Q. Does PSE propose to implement the weather normalization procedure used in the settlement of the Company' last general rate case?

A. No.

Q. Does Staff agree with PSE that the method used in the prior case should not be used in this case and going forward?

A. Yes.

Q. Please explain.

A. In the general rate case filed by PSE in Docket Nos. UE-011570 and UG-011571, PSE utilized different temperature normalization procedures for the gas and electric portions of its business. The method used for the electric operations was the same method used by Puget Sound Power & Light Company in several rate proceedings prior to the merger with Washington Natural Gas. That prior method was based on simple linear regressions between total daily load and temperature. This approach utilized 52 separate regressions for the weekdays and separate monthly regressions for Saturdays, Sundays and holidays. The weather sensitivity coefficients obtained from these regressions were applied to the deviation between actual and normal temperatures. The resulting

adjustment to loads in KWhs was converted to a sales level, after adjusting for losses, and then to revenue by pricing at residential rates.

In Docket No. UE-011570, the parties discussed the reliability of continuing to use this method. Comparisons of normalized electricity usage with results from prior rate proceedings revealed that the results of the regressions in Docket No. UE-011570 were not as statistically valid as those previously presented by the Company. For instance, the results showed more than 50% daily load fluctuation from one week to the next, despite the fact that the analysis used a large number of common data points. Contrary to current knowledge of the behavior of residential and commercial customers in the Northwest, in Docket No. UE-011570 the Company assigned to the residential class the increasing sensitivity of electricity usage to changes in summer temperature. In the settlement of Docket No. UE-011570, therefore, the parties agreed informally to modify the temperature normalization method in the next proceeding, although the parties did not agree on any specific method. PSE's proposal in the current case, Docket No. UE-031725, is its attempt to modify the approach used in prior general rate case.

Q. Please explain how PSE derived normal temperature in this case.

A. First, PSE acquired hourly temperature data from the Seattle-Tacoma International ("SEA-TAC") airport for the period 1973-2003.

Second, PSE computed the simple daily average temperature, for 365 days, from data collected 24 hours a day over a 30-year period.

Finally, PSE substituted the simple daily average temperature computed in step two for normal temperature derived from 30-year data by the National Oceanographic and Atmospheric Administration ("NOAA"). Normal temperature derived by NOAA is universally accepted by most utilities and energy traders in the USA.

Q. Please explain how PSE's method of deriving normal temperature differs from the method used by NOAA.

A. NOAA uses 30-year data to derive normal temperature. The most recent data is for the period 1971-2000. NOAA implements a relatively robust method to remove or minimize the effects of missing data, errors in recording data, changes in instrumentation, observation practices, observation time, weather abnormalities, and so on, in order to derive normal temperature. Thus, substitution of simple averages of daily measurement (the method used by PSE)

as a proxy for normal temperature may not result in the same normal temperature value derived by NOAA.

Q. Please describe how PSE calculated HDD and CDD?

A. PSE, similar to other electric utilities, operates under the assumption of normal heating and cooling degree days. PSE implemented the following procedure to calculate HDD and CDD. Actual average daily temperature was calculated for the test year. Normal temperature was computed from hourly temperature data for the period 1973-2003. On a daily basis, 65 degrees Fahrenheit less test year actual mean temperature equals actual HDD, and 65 degrees Fahrenheit less 30 year mean (normal) temperature equals normal HDD.[3] Similarly, actual mean daily temperature or 30 years mean (normal) temperature less 65 degrees Fahrenheit results in actual or normal CDD, respectively.

[3] 65°F is an internationally accepted average outside temperature that would result in an indoor bodily comfortable temperature. When the outside temperature is below 65, the indoor temperature needs to be increased by space heating.

Q. Please explain the data and statistical estimation method used by PSE in its weather normalization analysis.

A. The Company used data from 1994 to 2001 to estimate electricity consumption or usage. PSE used linear statistical models and applied ordinary least square techniques to estimate the weather sensitivity coefficients. The estimation methodology used by the Company is not statistically robust because it does not correct for serially correlated error terms prevalent in time series data (see pages 14-16 of this testimony).

Q. Please describe the weather normalization adjustment proposed by PSE.

A. PSE proposed a two-step procedure to implement the weather normalization adjustment.

First, the Company divided total electricity usage per day by the total number of electricity customers. The result is labeled "usage per customer" or "UPC". UPC was then regressed on monthly heating and cooling degrees days, day of the week, and holiday variables. This statistical analysis results in weather sensitivity coefficients or "WSC". The WSC indicates changes in electricity usage for a unit change in temperature. Then, actual electricity usage or load was adjusted to take into account the impact of changes in temperature.

Second, to adjust electricity usage in the test year for deviations from normal HDD and CDD, test year actual degree days were subtracted from normal degree days. Multiplying the difference in degree days by the weather sensitivity coefficient obtained from statistical analysis resulted in unbilled sales or load per customer.

The sum of actual UPC and unbilled sales of electricity resulted in the normalized daily sales or load per customer. Multiplying daily normalized load per customer by the number of customers in all rate schedules resulted in system-wide total normalized daily load or consumption. The monthly and annual normalized electricity load or usages are calculated from the normalized daily electricity load or consumption data.

Q. Please comment on the credibility of PSE's UPC data.

A. The weather normalization method adopted by PSE assumes homogeneity among the various classes of customers with respect to consumption patterns and sensitivity to weather. Residential customers account for the largest share of PSE's customers (~90%) and electricity usage (~50%). Residential customers are also the most heat load sensitive class of customers. PSE's calculation of electricity usage per customer may not provide an accurate representation of weather sensitive average electricity consumption per customer because it does not recognize inter-class differences in

electricity usage due to changes in weather. Therefore, a statistical analysis that utilizes this kind of aggregate variable may not produce results that reflect the "true" weather sensitive electricity usage by rate schedule.

Q. Please explain how PSE calculated weather sensitive electricity usage by rate schedule.

A. The monthly normalized load was multiplied by adjustments for transmission and distribution losses (6.49%) to obtain loss-adjusted normalized electricity usage. The percentage of customers in each rate schedule multiplied by the monthly loss adjusted load produced the monthly normalized load for each rate schedule.

Q. Please discuss other issues related to PSE's weather normalization procedure.

A. PSE used a rounding technique to insure that the sum of normalized loads allocated to all rate schedules equals the system-wide normalized load. This rounding technique does not cause significant changes in normalized load. Thus, Staff accepts PSE's method.

Q. Does Staff agree with the weather normalization method used by PSE?

A. No.

Q. Please describe the changes that Staff proposes to PSE's normalization method.

A. Recognizing that the present rate case has to be completed within a short time period and that it requires a lengthy time to collect daily electricity consumption and billing data by rate schedule, Staff opted to use data provided by the Company. With respect to statistical methods, Staff utilized an autoregressive model in place of PSE's linear regression model. And, Staff employed the Cochrane-Orcutt estimation technique, rather than the ordinary least squares technique used by PSE. Finally, Staff removed the holiday variable from the model because it resulted in an illogical or unexplainable impact on changes in consumption of electricity (see page 18 of this testimony).

Q. What is the Cochrane-Orcutt Estimation Technique?

A. Cochrane-Orcutt estimation technique is a statistical method for estimating a time series linear regression in the presence of autocorrelated errors. This

method corrects for statistical problems caused because of correlated error terms or serial correlations (see next page on serial correlation).

Q. Please explain the benefits of the changes Staff proposes to PSE's weather normalization method.

A. Staff's changes in model and estimation technique provide better estimates of the probability with which to accept or reject the impact of changes in temperature on electricity consumption. Correcting for autocorrelation improves the reliability of estimated weather sensitivity coefficients without violating the properties of the statistical model. The ordinary least square method used by the Company does not correct for the presence of serially correlated errors.

Q. Please explain the importance of serial correlation in the weather normalization adjustment.

A. Serial correlation, or autocorrelation, refers to the relatively higher degree of association between components of two observations (often adjacent or consecutive time periods) that cannot be explained by variables included in the analysis (also called error or residual terms). The statistical measure that determines the existence of serial correlation is called the "Durbin-Watson" or D-W statistic. In general, if the value of the D-W statistic is close to 2.00, then there

is no problem with serial correlation.[4] The impact of serial correlation is that it leads to a conclusion that the statistical estimates are more precise than they really are. It will result in consistently under- or over-estimation of future values of the same variables. For example, it may show significantly higher or lower usage of electricity for the next 1, 2, 3, or 5 years that is substantially different from the results of a model that makes correction for these kinds of correlations. Therefore, in order to improve the reliability of estimates of weather sensitive electricity usage, it is necessary to correct correlations between residuals of adjacent observations. Staff's recommendation does so.

Q. Does Staff propose to use the same data and method for all weather normalization procedures?

A. No. Staff's proposed changes to PSE's method are applicable only to this rate proceeding. Later in this testimony, Staff will suggest changes that PSE should implement to its weather normalization procedure in future rate case filings.

[4] For a sample size ≥100, a Durbin Watson (D-W) statistics that lies between 1.57 and 2.20 implies that there is no problem of serial correlation.

Q. Please discuss how Staff's weather normalization result differs from that filed by PSE.

A. Exhibit__ (YKGM-2), Tables 1 and 2, Columns "B", show the estimated weather sensitivity coefficients. Further, Exhibit__ (YKGM-2), Table 3, Column "D" shows differences in weather sensitivity coefficients estimated by Staff and PSE. Comparing Staff's and PSE's weather sensitivity coefficient estimates shows that PSE's analysis over-estimated the sensitivity of electric usage to changes in temperature in all months. This overestimation is more significant (about 20%) in the summer than in the winter months.

PSE's result shows that electricity usage will always increase regardless of changes in temperature (Exhibit__ (YKGM-2), Tables 1, 2 and 3). In reality, however, the most weather sensitive ratepayers (residential customers) do not use space heating and rarely use air conditioning when temperature gets warmer. Consequently, there must be a reduction in electricity usage when temperature is warmer (i.e., above 65 degree Fahrenheit). Staff's findings support this assertion regarding the relationship between electricity usage and warmer weather in July and August (Exhibit__ (YKGM-2), Table 1, Column "B"). That is, electricity usage for heating needs decline in July and August. On the other hand, PSE's analysis overestimated electricity usage for air conditioning

needs by an average of 25% compared with results obtained from Staff's analysis (Exhibit__ (YKGM-2), Table 3, column "D", row #21).

The impact of PSE's statistical result also suggests that ratepayers use less energy on holidays. Logic tells us that residential and commercial customers may actually use more energy on holidays. And, the raw data provided by PSE showed higher UPC on holidays compared with usage on other days.[5] Since PSE's estimates did not conform to these assertions, Staff removed this variable from the analysis.

The Durbin Watson statistic from the Company's estimates (D-W= 0.778) shows evidence of positive serial correlation because its value is less than 2 and greater than zero. Thus, PSE's model suffers from the impacts of autocorrelation.[6] On the other hand, Staff's proposed model and estimation technique resulted in a D-W statistic of 2.17 that suggests an absence of serial correlation (see footnote 4).

[5] Although PSE's original data used in the analysis showed higher UPC on holidays, the estimated statistical output showed lower UPC on holidays. That is why Staff decided to drop the holiday variable from the statistical model.

[6] The Durbin-Watson statistic is used to conclude whether or not a model exhibits serial correlations. The criteria to confirm or reject the presence of serial correlations are found in most time series econometric textbooks.

Q. You have described Staff's recommended changes to PSE's weather normalization model and estimation technique for this case. Are there changes to PSE's weather normalization method that Staff suggests the Company implement for future cases?

A. Yes. Staff suggests that the Company implement the following changes to its weather normalization procedure for use in future general rate case filings:[7]

i. PSE should develop daily electricity usage data by rate schedule for at least 10 years including the test year.[8]

ii. PSE's service territory covers several counties. Service territories that are near the Canadian border (e.g., Whatcom County) exhibit temperature that is about 2 degrees Fahrenheit colder than the temperature recorded at Sea-Tac. These temperature differences should take into account the impact of insulation per the requirements of the Washington State housing code. Thus, Staff proposes that the Company analyze the relationship between weather and electricity usage in a manner that takes into account differences in temperature of its service territories.

[7] Of these recommended changes, only changes in model and estimation method are implemented by Staff in this proceeding.

[8] Meteorologists argue that most climatic changes are observed every ten years. That is why NOAA revises estimates of normal temperature every ten years. Ten-year data allows normalization procedure to capture the impacts of decadal climatic changes.

iii. PSE should develop appropriate sample size for use in its weather normalization study. The sample should be selected such that it: (a) replicates the major attributes of the customers from which it is drawn; and (b) is large enough to perform not only sound statistical analysis, but also enables inferences about all ratepayers in a rate schedule. The Company should develop sampling plan(s) that ensure that the selected sample meets the above features.

iv. PSE should implement robust statistical models and estimation techniques that correct for the presence of serial correction and other statistical attributes pertaining to time-series data. And, a separate statistical analysis should be implemented for each rate schedule.

v. PSE should use consistent models, estimation method and data to normalize test and rate year electricity load.

vi. PSE should remove "redundant" variables. For instance, it is not necessary to include hourly and daily, or daily and monthly variables in the same model, unless empirical findings suggest significant variation in hourly or daily consumption of electricity. Inclusion of redundant variables may create a

statistical problem known as multicollinearity.[9] On the other hand, Staff proposes that the Company include variables that could capture the impacts of prices of competing fuels such as natural gas, seasonality and yearly variability, trends in new housing developments, and penetration of energy efficient appliances.

vii. The NOAA produces weather normals (heating and cooling degree-days) for thirty years, every ten years. The methodology used by NOAA accounts for the impact of factors that may influence normal temperature observed over several years. These include adjustments for missing data, for time of observation bias, instruments used, abnormal temperature, and so on. The objective of these adjustments is to ensure that the impacts of external factors on temperature are taken into account, and that the data become homogenous and representative. Therefore, Staff recommends that PSE use data developed by NOAA.

The implementation of Staff's suggested changes would improve the accuracy of estimates of weather sensitive heating and cooling loads by rate schedule. And, it

[9] In fact, it would not have been possible to implement statistical analysis if an intercept term was included in the present model because it contains dummy variables for days of the week. It would create a statistical problem known as multicollinearity.

will permit PSE to seek revenue requirements and pricing of electricity usage that appropriately reflects the impact of changes in temperature.

Q. Does this conclude your direct testimony?

A. Yes.