Exhibit ___T (YKGM-1T)
Docket Nos. UE-060266, et al.
Witness: Yohannes K.G. Mariam

BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.** **Respondent.**	**DOCKET NO. UE-060266** **DOCKET NO. UE-060267** ***(consolidated)***

TESTIMONY OF

Yohannes K.G. Mariam

STAFF OF
WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION

Electric and Gas Weather Normalization

July 25, 2006

I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Yohannes K.G. Mariam. My business address is 1300 S. Evergreen Park Drive S.W., P.O. Box 47250, Olympia, WA 98504.

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

A. I am employed by the Washington Utilities and Transportation Commission as a Regulatory Analyst (Economist).

Q. How long have you been employed by the Commission?

A. I have been employed by the Commission since September 1999.

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

A. I hold Masters of Science (M.S.) from McGill University in Montreal, Canada, and I was awarded a Doctor of Philosophy (Ph.D) degree from that school in 1993. My areas of specialization were quantitative economics (econometrics and operations research) and resource economics.

From 1993 to 1995, I was a fellow of the Natural Science and Engineering Research Council (NSERC) of Canada. From 1995 to 1997, I worked as a regulatory and socio-economic consultant for Environment Canada. In 1998 and 1999, I worked as a staff economist for the Canadian Federal Department of the Environment (Environment Canada). In those positions, I worked on a wide variety of projects and

wrote several manuscripts dealing with economics, the environment, agriculture, development, and regulatory issues. I was invited to serve as a reviewer for the Journal of the Air and Waste Management, and as an occasional lecturer at McGill University.

Since September 1999, I have been employed by the Washington Utilities and Transportation Commission as an economist in the Energy Section of the Regulatory Services Division. In that capacity, I have analyzed purchased gas adjustments, incentive mechanisms, and integrated resource planning. In general rate cases and other rate proceedings, I have analyzed new resource prudence, power costs, rate spread, hydro and weather normalization, and cost of service. Docket Nos. UE-031725 and UE-040640/UG-040641 (Puget Sound Energy, Inc.); Docket Nos. UE-991832 and UE-050684 (PacifiCorp); Docket Nos. UG-031885 and UG-000073 (Northwest Natural Gas, Inc.); and Docket No. UE-011595 (Avista Corp.).

I have contributed to the Commission's analysis of the impacts of proposed rules on small businesses in the railroad, telecommunication and energy industries. I also collaborate with other Staff members on issues relevant to economic disciplines and I write technical papers dealing with regulated energy industries.

II. PURPOSE AND SUMMARY OF TESTIMONY

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

A. First, I discuss generally the purpose and implementation of a weather normalization adjustment.

Second, I explain a change from the last general rate case, Docket Nos. UE-040640 and UG-040641, that Puget Sound Energy, Inc. (PSE or the Company) now proposes to its weather normalization adjustment. Staff accepts the Company's weather normalization adjustment for the limited purpose of this case because the change proposed by PSE has an insignificant impact on rates. However, the Company has failed to substantiate the proposed change with the necessary detailed load research analysis. I recommend a plan for data collection to be implemented by PSE to cure that deficiency.

Q. Have you prepared any exhibits in support of your testimony?

A. Yes, they are:

Exhibit No. ___ (YKGM-2), Differences in Mean Temperature of Counties Served by Puget Sound Energy

Exhibit No. ___ (YKGM-3), Differences in Socioeconomic Characteristics among Counties Served By Puget Sound Energy

III. DISCUSSION

A. General Purpose and Implementation of a Weather Normalization Adjustment

Q. Why is a temperature normalization adjustment necessary?

A. PSE's customers use electricity and natural gas for space heating. Consequently, temperature greatly affects usage of electricity and natural gas by the residential, commercial and industrial classes. This effect is reflected in the Company's total revenues.

A temperature normalization adjustment allows the Commission to estimate electric and gas loads, and resulting revenue, as if weather had been "normal" during the test year. This ensures that rates are not set too high, if the test year was warmer than normal, or too low, if the test year was colder than normal.

Q. What parameters are required to compute temperature normalized electricity and natural gas consumption for the test year?

A. Four parameters are needed to compute electricity and natural gas temperature normalized consumption for the test year. They are: (1) normal temperature; (2) variations or differences between normal and test year temperature; (3) temperature sensitivity coefficients; and (4) test year number of customers.

Q. How is normal temperature determined?

A. Normal temperature is determined from data published by the National Oceanographic and Atmospheric Administration (NOAA). NOAA computes normal heating degree days (HDD) and cooling degree days (CDD) at various locations, including locations in PSE's service area in Washington. HDD and CDD are quantitative indices that reflect demand for energy to heat or cool houses. They are calculated using a "balance" or "base point" outside temperature that is assumed to trigger heating or cooling energy.[1] When the outside temperature is below the base point, the indoor temperature needs to be increased by space heating. Conversely, when the outside temperature is greater than the base point, the indoor temperature

[1] HDD is given as HDD=65^0F-Average temperature, for average temperature $\leq 65^0$F. CDD is given as CDD=Average temperature-65^0F, for average temperature>65^0F.

needs to be reduced by air conditioning. 65^0F is the most commonly used balance point temperature in determining both HDD and CDD.[2]

Q. How are variations from normal calculated?

A. Variations from normal are computed using HDD and CDD. In normalizing test year electricity and natural gas consumption, the temperature for each day of the test year is compared to the normal temperature for that day. The difference, or variation between normal and actual test year temperature, is called "unbilled heating" or "cooling degree days".

Q. How are temperature sensitivity coefficients and test year customers used in the calculation of a weather normalization adjustment?

A. Temperature sensitivity coefficients are computed from a regression analysis between temperature (HDD and CDD) and energy consumption. These coefficients are multiplied by the variation of test year temperature from normal temperature and the number of customers. The result is temperature normalized electricity and natural gas consumption for the test year.

[2] Although 65^0F is commonly used base temperature, Staff agrees with the Company that one base temperature does not capture the non-linear relationship between energy consumption and temperature (Exhibit No.__(JAD-1T), pages 25-26). The issue addressed in this testimony is what kind of data should be collected, and over what period of time, geographic area, and customer class(es), in order to determine a base temperature(s) that would capture that nonlinearity.

B. PSE's Proposed Changes to the Weather Normalization Adjustment

Q. Please summarize the change from the prior general rate case that PSE now proposes to its weather normalization procedure.

A. PSE proposes in its weather normalization procedure to change the base or balance point temperature of 65^0F. PSE computed degree days using four ranges of temperature (45^0F and 65^0F for HDD, and 60^0F and 65^0F for CDD) as base temperatures, rather than the 65°F base temperature used in previous rate cases.[3]

Q. Does Staff accept the Company's weather normalization adjustment despite the change in base temperature proposed by PSE?

A. Yes, but only for purposes of this case.

Q. Why does Staff accept the Company's weather normalization adjustment in this case?

A. The difference in energy load that would result if Staff used the same 65°F base temperature as in the last PSE rate case and the method proposed by PSE in this rate case is only 3%. This is a small percentage that does not materially impact rates.

Moreover, as compared with method used in its last rate case, PSE's proposed weather normalization procedure is a step in the right direction because it

[3] Specifically, PSE used the following four temperature ranges to calculate heating and cooling degree days:

1) Heating degree days-45 (HDD45) = 45-average daily temperature, if temperature is ≤ 45;
2) Heating degree days-65 (HDD65) = 65-average daily temperature, if temperature is > 45 & ≤ 65;
3) Cooling degree days-60 (CDD60) = Average daily temperature-60, if temperature is >60 & ≤ 65; &
4) Cooling degree day-65 (CDD65) = Average daily temperature-65, if temperature is >65.

attempts to capture the nonlinear relationship between energy consumption and temperature. Thus, Staff does not contest the result of the Company's adjustment in this case.

Q. Has PSE fully substantiated the proposed change in base temperature in its weather normalization procedures?

A. No. A change in balance point temperature, such as that proposed by the Company, requires a load research study based on highly granular and detailed data that take into account the impact of changes in temperature and a number of other environmental factors that can influence ratepayer "thermal comfort"[4] and, hence, ratepayer energy consumption. These environmental factors include:

1) Structure of the house (windows, doors, square foot, etc.) and year built;

2) Number and composition of household members (by age group);

3) Humidity, sunshine hours, precipitation, wind speed, and radiant temperature; and

4) Types or kinds of electric appliances and magnitude of reject heat or heat releases.

The Company has not performed this necessary study. Thus, PSE has not demonstrated that the proposed change in base temperature captures the impact of changes in temperature on energy usage.

[4] The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) defines thermal comfort as "that condition of mind in which satisfaction is expressed with the thermal environment." This definition states that the idea of thermal comfort is a perception process that involves many input variables and is the result of physical, physiological, and psychological processes. To have "thermal comfort" means that a person wearing a normal amount of clothing feels neither too cold nor too warm.

Q. What steps for future rate cases should PSE take to overcome the deficiencies of its weather normalization adjustment that you have identified?

A. The Commission should order PSE to take the following steps for its electric weather normalization adjustment:

1) PSE should develop a research plan for selecting study customers. The plan should identify study customers by rate schedule and by county.[5]

2) PSE should then collect data on hourly temperature and energy consumption for the study group over a period of 3 years.

3) PSE should collect data on weather variables that affect temperature (e.g., humidity, sunshine hours, precipitation, and wind speed).

4) PSE should collect data on non-weather variables such as housing square footage and age, family size, income, and related variables from study customers.

5) PSE should acquire and utilize commercially available full feature, non-linear statistical modeling software to capture the relationship between load and temperature.

For its natural gas weather normalization adjustment, the Company should be ordered to follow the same recommendations outlined for electric weather normalization, except it should collect daily instead of hourly data on the consumption of natural gas. Furthermore, the daily data must be collected for at least 5 years, rather than 3 years as recommended for electric weather normalization.

PSE should also be ordered to submit the weather normalization study plan that contains the steps identified above for approval by the Commission within three

[5] PSE used data only collected at SeaTac under the assumption that SeaTac represents temperature throughout PSE's service territory. However, the average temperature difference between SeaTac and other counties served by PSE ranges from -2.49^{0}F to 2.88^{0}F. (Exhibit No.___ (YKGM-2). This temperature difference can have a substantial impact on energy consumption. Moreover, PSE's service territory covers counties that exhibit different socioeconomic characteristics (Exhibit No. __(YKGM-3). These differences in socioeconomic characteristics may also affect the sensitivity of usage patterns to changes in temperature and non-temperature variables.

months after the conclusion of this rate case. Once the plan is approved by the Commission, the Company should also be ordered to submit status reports of its data collection on a regular basis.

Q. Please explain why an appropriate weather normalization study should be based on hourly load research study.

A. The estimate of any empirical or statistical model is only as good as the data used in the analysis. The better the data captures real or actual phenomena, the better will be the estimates of energy consumption. Real time minute-by-minute analysis of energy consumption in response to changes in temperature is the most ideal data to compute a weather normalization adjustment. However, monitoring minute-by-minute energy usage and temperature would be costly and take huge computer resources. Thus, hourly data is the next best level of aggregation for load research. PSE has the infrastructure (automated meter reading) to collect hourly data at a cost of about $7/month per customer. (See Company Response to Staff Data Request No. 340) PSE can easily acquire nonlinear modeling software such as Multivariate Adaptive Regression Splines (MARS). A weather normalization procedure that uses granular data such as hourly data not only allows a valid method of determining more than one balance point temperature, but also produces results that are fair and reasonable to ratepayers and company.

Q. Does this conclude your testimony?

A. Yes.