EXHIBIT NO. ___(JAD-1T)
DOCKET NO. UE-072300/UG-072301
2007 PSE GENERAL RATE CASE
WITNESS: DR. JEFFREY A. DUBIN

BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY, INC.,** **Respondent.**	**Docket No. UE-072300** **Docket No. UG-072301**

PREFILED REBUTTAL TESTIMONY (NONCONFIDENTIAL) OF DR. JEFFREY A. DUBIN ON BEHALF OF PUGET SOUND ENERGY, INC.

JULY 3, 2008

PUGET SOUND ENERGY, INC.

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I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, business and address.

A. My name is Jeffrey Alan Dubin. My address is Pacific Economics Group, L.L.C. ("PEG"), 301 North Lake Street, Suite 330, Pasadena, California 91101.

Q. Who retained you for this testimony?

A. Puget Sound Energy, Inc. ("PSE") retained me to provide this testimony.

Q. What is your position with PEG?

A. I am a Co-Founding Member of PEG.

Q. What are your duties as a member of PEG?

A. I actively consult with clients on demand issues, environmental issues, market issues, and antitrust policies. I specialize in microeconomic and micro-econometric modeling with an emphasis on statistical and demand analysis. Some of my current research topics include discrete-choice econometrics, energy economics, tax compliance, sampling and survey methods, and intellectual property valuations.

Q. Do you hold any other positions?

A. I am an Adjunct Full Professor of Economics at the University of California, Los Angeles Anderson School of Management. I am also, at present, a Visiting Professor of Economics at the University of California, Santa Barbara.

Q. What is your educational background?

A. I received my A.B. in Economics in 1978 from the University of California, Berkeley, with highest honors and great distinction. In 1982, I received my Ph.D. in Economics from the Massachusetts Institute of Technology (MIT).

Q. Please summarize your professional experience.

A. From 1982 to 1986, I was an Assistant Professor of Economics at the California Institute of Technology (Caltech). I became a tenured Associate Professor at Caltech in 1988 and a tenured Full Professor in 2005. In 2008, I left Caltech to assume a new position as Adjunct Full Professor of Economics and Statistics at the University of California, Los Angeles Anderson School of Management. Among my responsibilities at the Anderson School of Management will be to guide and assist in directing the UCLA Anderson Forecast. The UCLA Anderson Forecast provides forecasts for the economies of California and the United States and detailed insight to decision makers in business, academia, and government.

Q. What is your teaching experience?

A. For over twenty-five years, I have taught at least two courses in econometrics per year at the undergraduate or graduate level. Econometrics is the application of statistics to economic problems. I regularly use econometric methods in my empirical work and frequently rely on regression and other statistical techniques. I am also the author of computer software that performs various econometric analyses, including outlier detection.

Q. Have you published any papers or articles?

A. Yes. I have published several articles on energy and environmental issues, public utility regulation, competition, and antitrust. I have also published four books. Please see the First Exhibit to the Prefiled Direct Testimony of Dr. Jeffrey A. Dubin, Exhibit No. ___(JAD-2), for a complete listing of my publications.

Q. Have you ever given expert testimony in a court or administrative proceeding?

A. Yes. Please see the First Exhibit to the Prefiled Direct Testimony of Dr. Jeffrey A. Dubin, Exhibit No. ___(JAD-2), for a list of the proceedings in which I have provided expert testimony.

Q. Have you previously provided expert testimony before the Washington Utilities and Transportation Commission?

A. Yes. I testified before the Washington Utilities and Transportation Commission (the "Commission") in PSE's 2004 general rate case, Docket Nos. UE-040641, *et al*., ("2004 GRC"), about the appropriate hydro record to examine for forecasting the likely future levels of hydro-generation and the appropriate gas prices to utilize when establishing power costs. I testified in PSE's 2006 general rate case, Dockets UG-060266 & UE-060267 (the "2006 GRC"), about the appropriate methods that should be employed in weather normalization.

Q. What has PSE asked you to examine in this proceeding?

A. PSE has asked that I review the proposal of Commission Staff to filter the hydro generation series by eliminating certain hydro years that Commission Staff considers to be outliers. Commission Staff uses the resulting sub-sample of hydro-generation data and its corresponding power costs to estimate the rate year (November 2008 through October 2009) average AURORA model power costs. Commission Staff's methodology eliminates both high and low hydro generation years but removes more years that are associated with large estimated AURORA power costs. Thus, Commission Staff's methodology results in a downward adjustment to the PSE's baseline power cost.

Q. Please summarize your conclusions.

A. Commission Staff proposes a methodology to truncate or trim the hydro data used to set power costs for PSE. Commission Staff's methodology is a statistical technique subject to numerous critiques. There exists no statistical or intuitive reason to filter the hydro-generation in the manner suggested by Commission Staff--it is neither appropriate nor statistically sound to eliminate twenty of the fifty data points ((40 percent) to force data to be "normal". In short, Commission Staff's methodology is inappropriate, and the Commission should reject this adjustment.

Finally, I support Commission Staff's proposal to study and better align the Power Cost Adjustment ("PCA") sharing bands to consider the asymmetrical nature of power costs.

Q. How is your testimony organized?

A. Section II discusses my previous testimony before this Commission on hydro issues and the various methodologies that can be used to filter data. Section III critiques Commission Staff's methodology. Section IV discusses my conclusions and recommendations. Section V summarizes this testimony.

II. TECHNIQUES FOR FILTERING DATA

Q. What conclusions did you reach in PSE's 2004 GRC proceeding with respect to the appropriate hydro record to examine for forecasting the likely future levels of hydro-generation?

A. In PSE's 2004 GRC, I concluded that PSE’s hydro generation and hydro flow are actually quite simple--the data are trendless and normally distributed. Consequently, I concluded that the best estimate of future water flow generation is a simple, long-run average that uses all available data. For these reasons, I advocated using the long-run average value based on the full information available.[1] It was--and is still--my opinion that forecasts of future water flow and generation should be made on a fifty-year or longer hydrological record. There was--and currently is--no reason to exclude any data, including those from low-water years. Further, there was no evidence of outliers in the data I reviewed for the 2004 GRC.

Q. Commission Staff has proposed to use a “water filter”. What is a water filter?

A. Commission Staff proposes to limit the water years used to establish hydro generation and the resulting AURORA modeled power costs. To accomplish this, Commission Staff has proposed a methodology termed “water filtering”. *See* Exhibit No. ___T (APB-1T), at page 13, line 17, through page 18, line 17.

Water filtering is a technique that censors certain water years before calculation of the historical average water generation and corresponding rate year power costs.

Q. Please describe Commission Staff's proposed water filtering.

A. Commission Staff proposes to utilize an annual hydro filter that combines monthly hydro generation for all months in a year to form annual hydro generation. For the fifty-year period from 1929 through 1978, Commission Staff proposes to estimate the standard deviation of the fifty annual water generations and then exclude any water year (and the power costs for such year) that exceeds more than one standard deviation from the average of the original fifty years. Commission Staff regards these excluded observations as "extreme" or "outliers". Commission Staff uses the resulting sub-sample of observations to determine and reduce the AURORA modeled power costs for the corresponding years. *See* Exhibit No. ___T (APB-1T), at page 16, line 1, through page 17, line 2; *see also* Exhibit No. ___(APB-4C).

Q. Is Commission Staff's methodology consistent with how hydro filtering has been used in other proceedings?

A. No. To my knowledge, the general rate case of Avista Corporation ("Avista") in Docket No. UE-070804 is the only proceeding that adopted a hydro filter. In that

[1] *See WUTC v. Puget Sound Energy, Inc.*, Order No. 6, Docket Nos. UE-040640, *et al.*, ¶¶ 124, 128 & 131.

proceeding, Commission Staff and Industrial Customers of Northwest Utilities ("ICNU") proposed a *monthly* hydro filter. Moreover, the hydro filter proposed by Commission Staff and ICNU in the Avista proceeding considered *all* of Avista's hydro generation. If Commission Staff had used all of PSE's hydro generation in its hydro filter calculation, the hydro filter adjustment would have resulted in a $7.413 million reduction to PSE's rate year power costs, rather than the $9.380 million calculated in Commission Staff's Exhibit No. ___(APB-4C). A corrected calculation is presented in Mr. Mills' Exhibit No. ___(DEM-14C).

Q. Please describe the monthly hydro filtering used in the Avista rate case.

A. The monthly hydro filtering methodology used in the Avista rate case considered each month separately (*e.g.,* all January periods) for fifty years--from 1928 through 1977. One then calculates the standard deviation of monthly hydro-generation for all such January periods and retains any monthly period with generation within one standard deviation of the mean January generation. Any generation for a monthly period that is larger than one standard deviation is discarded. The resulting subset of January periods is used to calculate a new average for January. Under this methodology, only the associated power costs from the AURORA model that correspond to the subset of January periods is retained to form average power costs for January. The sum of each of the twelve months' average power costs corresponding to the standard deviation of the monthly hydro generation is then considered to be the AURORA power costs for the rate year.

Q. Has Commission Staff proposed a *monthly* hydro filtering in this case?

A. No.

Q. Have there been proposed alternatives to the hydro filtering methods described above?

A. Yes. In the general rate case for PacifiCorp in Docket No. UE-161546, PacifiCorp proposed to remove extreme or outlying hydro generation events based on rank-ordering techniques. In such a method, hydro-generation would be sorted from lowest to highest, and a certain percentage of the low and high hydro generation would be eliminated before forming the average (by month).

III. DISCUSSION AND CRITIQUE OF FILTERING METHODS

Q. Do the proposed hydro filtering methods have an analog in statistical theory?

A. The proposed hydro filter methods are statistical estimation techniques that trim the sample data observations in order to remove outliers. Techniques for dealing with outliers are well known in statistics and have been extensively studied.

Q. Please define outliers, extremes, and contaminants?

A. An *outlier* is defined as an observation (or subset of observations) that appears to be inconsistent with the remainder of the data. *Extreme* observations are those at the lower or upper tail of the data ranked from lowest to highest. *Contaminant* observations are those that come from another distribution, but that are occasionally mixed into the main population of interest. Extreme observations or contaminant observations may or may not be outliers.

Q. What should be done with outliers if they are detected?

A. Outliers should always be examined to understand whether they are part of natural variation or due to execution errors (*e.g.*, the recording of a person's height in inches when all other observations were in meters). Modern statistical methodology rarely rejects information unless, upon inspection, an observation is subject to an uncorrectable execution in its recording. When we reject data, we no longer have a random sample but a censored sample.

Q. Can outliers provide valuable insights?

A. Yes. Outlying observations may provide the *most* useful scientific information and indeed have been the basis of many scientific discoveries. Outliers, even if present, should be accommodated and not simply rejected. The disaster of the space shuttle Challenger is good case in point. Engineers had limited experience with cold temperatures in Florida and the effect of cold on the rubber O-rings that sealed the solid rocket boosters. With cold temperatures, the Shuttle O-rings became rigid, and hot gases were able to escape and ignite the solid fuel booster. Tragically, and as a consequence, the space shuttle Challenger exploded shortly after lift-off. Engineers based their forecasts about the behavior of the O-rings on the experience they had, which unfortunately, did not include very cold temperatures. In any analysis of the effect of cold weather on O-rings, it would have been derelict to eliminate data points about cold temperatures in Florida simply because these data points were considered "outliers." Extreme events provide valuable information that would have been lost had the engineers made the population of data analyzed somehow "more normal" by eliminating these data.

Q. Are certain statistical estimators sensitive to or influenced by outliers?

A. Yes. Statistical methods may be sensitive to outliers so that the presence of an outlier may have a significant effect on a statistical estimate. In this case, the outlier is termed influential. Statistical techniques have been developed to be robust or resistant to the presence of outliers, and attempt to accommodate their presence. For example, the median is a technique that is resistant to outliers because the estimate of central tendency is not influenced by outliers with the median (the presence of a large outlier would not change the result that 50 percent of the data is above the median). In contrast, an outlier would significantly affect the mean estimate. Statistical methods (*e.g.*, discordance tests) have also been proposed to detect outliers.

Q. Are there any statistical methods that reject outliers?

A. Yes. Most rejection schemes for treating outliers involve some form of trimming. The hydro filter methodology proposed by Commission Staff (annual or monthly, using a one standard deviation cutoff) and hydro filter methodology proposed by

PacifiCorp (removing the low and high observations from a ranked order set) are both trimmed-mean estimators.

Q. What is a trimmed-mean estimator?

A. In statistics, a trimmed-mean is the mean of a population after a certain (typically very small) fraction of the largest and smallest observations are removed.[2] This technique can produce a more efficient estimate of a population's mean when there are outliers or contaminant observations that are judged to be outliers. Trimmed mean estimators are unbiased for symmetric distributions (*i.e.*, they produce estimates of the center of symmetry that are, on average, correct).

Q. How does Commission Staff's hydro filtering methodology relate to the trimmed-mean?

A. For normal distributions, hydro filtering techniques that employ one standard deviation trim 15.87 percent of both the upper and lower tails of the distribution. Thus, for a normal distribution, the hydro filtering technique relying on one standard deviation retains only the center 68.3 percent of the distribution and discards 15.87 percent in each tail, or about 32 percent of the observations. This would be termed a 15.87 percent trimmed mean. A 5 percent trimmed mean would retain the center 90 percent of a distribution and a 2.5 percent trimmed mean would retain the center 95 percent of a distribution.

[2] *See e.g.*, "Comparing Location Estimators: Trimmed Means, Medians and Trimean" by James Rosenberger and Miriam Gasko in Understanding Robust and Exploratory Data Analysis,

Q. Normal populations are symmetrically distributed. How does Commission Staff's hydro filtering methodology apply in asymmetric distributions?

A. This is not completely known, but distributions with skewness in one direction or another will have asymmetric trimming when the analyst employs a plus or minus standard deviation threshold.

Q. When does one usually employ trimmed means?

A. A trimmed mean is usually employed when a population is presumed to be contaminated by very large or very small outliers. The trimmed mean estimator is meant to be robust to these outlying observations (*i.e.*, it is not sensitive to their values). Abundant literature in statistics is devoted to understanding robust statistical inference. This literature demonstrates that if a population is normally distributed, the mean is fully efficient and produces an estimate with the smallest degree of uncertainty. For such a normal population, however, the trimmed mean becomes less efficient the more it is trimmed.

Q. Please discuss the efficiency of trimmed means and untrimmed means.

A. In moderate size samples, the 20 percent trimmed mean is only 88 percent as efficient as the untrimmed mean. In other words, one would become more uncertain about the range of values that possibly would contain the true value with a given level of certainty (*i.e.*, the 95 percent confidence interval would be

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David Hoaglin, F. Mosteller, and J. Tukey, eds. John Wiley & Sons, New York: New York, 1983, pp. 297-338.

larger). On the other hand, in the presence of contaminants, the simple average is only 82.5 percent as efficient as the 5 percent trimmed mean, which itself is nearly fully efficient. Hence, in some cases, the trimmed mean may be more efficient and robust to outlying observations than the sample average. With respect to the trimmed-mean, however, it is also well known that the resulting estimate of the population may be quite sensitive (both in terms of bias and efficiency) to the amount of trimming. This is particularly true when the populations at issue are skewed.[3]

Q. Does Commission Staff advocate trimming certain hydro years?

A. Yes. Commission Staff has advocated trimming certain hydro years. Consequently, it is important to recognize whether some hydro years are extreme or outliers and, if they are, it is crucial to handle them appropriately.

Q. Can you summarize?

A. For normal distributions, the moral of the story is quite simple--use all the data. For non-normal populations with some degree of wild contamination, a 5 percent trimmed mean is often fully efficient. In my experience, no one has ever advocated throwing out or trimming nearly 40 percent of the available information.

[3] For additional discussions about the properties of the trimmed-mean estimator, when a population is skewed, see Carroll, R.J. (1979), "On Estimating Variances of Robust Estimates When Errors are Asymmetric," Journal of the American Statistical Association, Volume 74, pp. 674-679, and D'Agostino, R. and Lee, A., "Robustness of Location Estimators Under Changes of

Moreover, whether any trimming should be done at all depends on whether the hydro generation data is contaminated and whether certain hydro years are outliers and should be excluded in determining the average. Commission Staff's desire to "more appropriately share[] risk when developing normalized base power costs"[4] is best addressed by their proposal "to prepare a study and alternative proposal of a redesigned Power Cost Adjustment ("PCA") mechanism that better aligns risks and benefits in light of the asymmetrical distribution of power supply costs over water years".[5] This can be accomplished by conceptualizing the correct shape of the bands within the PCA mechanism.

Commission Staff's suggestion that a workshop be formed to discuss the design of recovery bands is a good one. Such workshop, however, should also consider the other, non-hydro effects of asymmetrical features of power cost recovery, such as the distributions of temperature and unplanned maintenance. Trimming cannot accomplish these goals.

Population Kurtosis," Journal of the American Statistical *Association*, Volume 72 (1977), pp. 393-396.

[4] Exhibit No. ___T (APB-1T), at page 5, lines 2-3.

[5] Exhibit No. ___T (APB-1T), at page 2, line 21, through page 3, line 2.

IV. CONCLUSIONS

Q. What conclusions did you reach in your testimony in PSE's 2004 GRC with respect to hydro generation and the presence of outliers?

A. In my testimony from PSE's 2004 GRC, I examined the historical water record for the sixty-year period, from 1928 through 1987. After an extensive statistical examination, I concluded that the process for water generation in the Pacific Northwest was rather simple--natural water flow (and water generation) was trendless, normally distributed, and random (not able to forecast). I also concluded that the best estimate of future water flow is a simple long-run average using all available data. Both Commission Staff witness Dr. Yohannes Mariam and the Commission agreed with my conclusion.

In the 2004 GRC I also tested the water data for outliers and did not detect any statistically significant outliers. Importantly, the early periods of low water flow were not outlying or extreme but perfectly consistent with a normal distribution. I have repeated this statistical analysis, and I still do not detect any outliers in the fifty-year hydro generation data.

Q. Is Commission Staff's proposal to censor part of the hydro record sensible in this case?

A. No. Commission Staff's proposal to trim 40 percent of the available data is unnecessary and likely to lead to bias and inefficiency. Without determining that some observations are outliers, it would be unwise to remove any data from the fifty-year samples being studied. Even after correcting Commission Staff's calculation, the resulting hydro filter censors 38 percent of the available data, which "throws the baby out with the bath water."

In short, Staff's proposal reduces power costs by asymmetrically trimming away more low water (high cost) years than high water (low cost) years, which circumvents the Commission finding that the fifty-year water record is appropriate for rate setting.

Q. Has Commission Staff demonstrated that the hydro years it proposes to exclude are outliers?

A. No. Commission Staff provides no evidence that data points greater than one standard deviation away from the mean are outliers. In fact, the hydro filtering methodology proposed by Commission Staff (*i.e.*, detect and eliminate outliers based on a one standard deviation cutoff) is, to my knowledge, unique in the literature of statistics.[6]

Q. Is a one standard deviation standard common in statistics for detecting or rejecting outliers?

A. No. Proposals to detect outliers are usually based on two or more standard deviations from the mean. For instance, Belsley, Kuh, and Welsch[7] discuss the

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[6] *See, e.g.*, Barnett, V. and T. Lewis, Outliers in Statistical Data, John Wiley & Sons, Great Britain: Chichester (1978).

[7] Belsley, D., E. Kuh, and R. Welsch, Regression Diagnostics: Identifying Influential Data and Sources of Collinearity, Wiley-Interscience, 2004.

"studentized residual" method to detect outliers based on the comparison of an observation's residual (prediction error) as compared to its estimated standard error. This technique assists in identifying outliers in the regression model. According to Belsley, Kuh, and Welsch, a studentized residual identifies a *potential* outlier if the deviation around the mean is larger than two standard deviations.

Similarly, in standard significance testing, t-statistics must be larger than two before they are considered to be statistically significant. In teaching and in practice, I would not regard a data point as a potential outlier unless its studentized residual was three or more, which corresponds to a deviation three times greater than the standard error. However, these techniques vary from the methodology proposed by Commission Staff in this proceeding.

Q. Please explain your contention with respect to Commission Staff's methodology.

A. Commission Staff arbitrarily uses the one standard deviation level for eliminating a data point as an outlier. When analysts identify a data point as a potential outlier, they must then decide whether that data point should be accommodated with a new understanding of the process that was used to generate the data or whether the data point should be eliminated. Commission Staff's approach, however, simply eliminates 38 percent of the available water generation data. In doing so, Commission Staff changes the underlying distribution that is found in nature and replaces it with something that it thinks is more normal.

Q. If the Commission were to adopt some level of trimming, what would you suggest?

A. The Commission should not trim *any* data from the hydro generation record. As stated above, there exists no statistical or intuitive reason to filter the hydro-generation in the manner suggested by Commission Staff.

If the Commission were to adopt some level of trimming, however, I would recommend employing, at most, a 5 percent trimmed-mean. As discussed above, the 5 percent trimmed-mean is nearly fully efficient in the face of outlier contamination. Trimming the lowest 5 percent and highest 5 percent of the water generation years, although unnecessary, would result in the least statistical harm.

Q. How should PSE forecast likely future hydro generation?

A. Water generation data is an input to the AURORA model. When fifty years of water data are employed, AURORA is run fifty separate instances to estimate the range and expected levels of power costs. Therefore, it is not necessary to make any single forecast of likely water flow that will occur under baseline conditions. Such a "best" single forecast of future water generation is called a point forecast.

The best value of a point forecast depends on the criterion against which alternatives can be judged. To weigh the costs of being wrong, analysts rely on a cost function that describes the penalty or cost of the forecast errors that are virtually certain to occur in connection with the random process being forecast. No matter what point forecast we make, it is likely that actual water generation will differ from the baseline forecast. In classic statistics, the expected costs are minimized (a procedure also known as minimum risk). When the cost function depends on the squared error made by the forecast, it is well known that the optimal forecast is the mathematical expectation of the variable being forecast, given information available at the time the forecast is made.[8]

As discussed in my testimony in PSE's 2004 GRC, the optimal forecast for water generation is simply the historical average because hydro generation is trendless and normally distributed. *See* Exhibit No. 111 (JAD-1T), at page 24, lines 5-10, in PSE's 2004 GRC.

Q. How do statisticians compare the accuracy of forecasts and estimates?

A. Any estimation method raises the question of how close the true value will be to the estimate. To answer this question, statisticians rely on confidence intervals. A forecast or an estimate will rarely be exact. However, statisticians like some way of bounding the range of possibility so that we can say that there is a high probability that the true value will fall within the confidence band around the estimate. For a specified probability, the estimator with the tightest confidence is

[8] *See* Granger, C.W.J. and P. Newbold, Forecasting Economic Time Series, Chapter 4, Academic Press, New York: New York (1977).

best because it provides confidence that the estimate and the true value will not be too far apart.

Q. Are some estimators better than others?

A. Some estimation methods are better than others because they have superior accuracy (*i.e.*, tighter confidence intervals). For instance, an average based on more observations from a population will be more accurate than an average based on fewer observations. In fact, the Gauss-Markov theorem states that among all unbiased linear estimators (*i.e.*, correct on average), the sample average using all of the data is best (*i.e.*, the confidence band around this estimate is most precise) because the variance of this estimate is smallest. A corollary to this result (and under its same conditions) is that the estimator is less accurate if he or she uses an alternative to the sample average.

Commission Staff makes this mistake by suggesting that a single water year could be chosen that is "typical" or "average" to represent future water generation. *See e.g.*, Exhibit No. ___T (APB-1T), at page 17, lines 12-14. However, any single year, whether average or typical (even if those concepts could be defined, and they cannot), will have a forecast variance that is much larger than a forecast variable based on the full sample. For example, the notion that "one should not put all one's eggs in one basket" is an example of diversification to reduce variance (risk). Using any estimator other than the sample average must necessarily result in a larger variance and wider confidence interval.

Commission Staff's proposal to eliminate a full 40 percent of the available water generation history is without merit because replacing the historical average with an average based on a significant subset of the data will lead to much less accurate estimates.

Q. Does excluding some years of information potentially bias the estimated mean hydro generation?

A. Yes. As discussed in my testimony in PSE's 2004 GRC, the persistence of low-water or high-water flow periods in hydrological observations is an empirical regularity. Sampling only some of the available information has every potential to bias estimates of mean flow or to erroneously "find" trends in the data that are, in fact, *not* present.

Q. Can you explain that further?

A. Yes. If, hypothetically, one were to conclude that the first ten-year period (*e.g.,* the low-water period of 1929-1938) comes from a different geological process than the last forty-year period (*e.g.,* the normal-water period of 1939-1978), we would be left with the inference that in a fifty-year period, 20 percent of that time period was subject to a different geological process. In statistics, this is termed a mixture model. In this case, we might say that there is a 20 percent chance that we are in a "low-water" period and an 80 percent chance of being in a "normal-water" period. In future years, we might expect to see the "low-water" period 20 percent of the time and the "normal-water" period 80 percent of the time.

Q. What is the net result of mixing these two states of nature?

A. The net result for forecasting purposes is that one should combine, 20 percent of the time, the average level of water from the "low-water" period (first ten years) with the average level of water in "normal-water" period (subsequent forty years). The resulting forecast would simply equal the full time period forecast. This is the approach I recommend. The fact that water generation in certain historical period is very low or very high proves that this has occurred in the past and can likely occur again. Such information should *not* be rejected.

Q. Does Commission Staff attempt to discount statistical arguments cast doubt on Mr. Buckley's proposed technique?

A. Yes. Commission Staff eschews "statistic-based arguments" about whether outliers should or should not be included in the calculation. *See* Exhibit No. ___T (APB-1T) at page 10, lines 1-20. In such testimony, Mr. Buckley notes that Commission Staff's Colstrip Forced Outage Rate adjustment "does not get bogged down in theoretical application issues." Exhibit No. ___T (APB-1T) at page 10, line 15. In discussing Commission Staff's hydro filtering adjustment, however, Mr. Buckley uses terms like "more normal", "outlier", and "extreme",[9] which are terms of science and have particular meaning. More importantly, Commission Staff's proposal to censor data above one standard deviation *is* a statistical technique, whether "simple" or not. Therefore, the Commission should

[9] *See, e.g.,* Exhibit No. ___T (APB-1T), at page 13, line 17, through page 18, line 21.

be cognizant of the statistical arguments against Commission Staff's proposed hydro filtering methodology.

Q. What is the basis for Commission Staff's proposed hydro filtering methodology?

A. Commission Staff asserts without support that in situations where a PCA mechanism is in place, there is no need to consider extreme circumstances because PSE's PCA mechanism "already allows for the recovery and sharing of costs or benefits associated with outlier years if and when they occur." Exhibit No. ___T (APB-1T) at page 10, lines 8-10. This unsupported assertion erroneously suggests that the PCA mechanism allows PSE the opportunity for "double recovery" to recover power costs first through base rates and then again if extreme hydro conditions occur. *See* Exhibit No. ___T (APB-1T) at page 15, lines 1-11.

Q. Do you agree with Commission Staff's unsupported assertion?

A. No. The PCA mechanism works in conjunction with the hydro conditions that are expected to occur. For example, this Commission, in PSE's 2004 GRC, came to the:

> …practical conclusion that power costs determined in general rate proceedings and in PCORC proceedings should be set as closely as possible to costs that are reasonably expected to be actually incurred during short and intermediate periods following the conclusion of such proceedings.

WUTC v. Puget Sound Energy, Inc., Docket Nos. UE-040640, *et al*., Order 06 at ¶ 108 (Feb. 18, 2005).

Similarly, in PSE's 2006 GRC, this Commission reiterated its determinations to set baseline rates at what is expected in the rate year:

> The Commission has reset the Power Cost Baseline Rate on several occasions and each time it has done so on the basis of a fully developed record. The Commission's goal has been to set the baseline as close as practicable to what is likely to be experienced during the rate year. We expect that practice to continue and we also expect the parties to continue to refine the method and improve the data upon which we act.

WUTC v. Puget Sound Energy, Inc.,, Docket Nos. UG-060266 & UE-060267, Order 08 at ¶ 22 (Jan. 5, 2007).

These orders echo sound statistical practice to provide forecasts based on what can be expected in the rate year. As discussed above, optimal forecasts are precisely the mathematical expectation of what will occur. In this instance, hydro forecasting must be based on the complete hydro generation record in order that the forecast be as accurate as possible.

Q. In the 2006 GRC order quoted above, the Commission sets the expectation that the parties would continue to refine and improve how the baseline rate is

set. Do you believe Commission Staff's proposed hydro filtering methodology meets this expectation?

A. No. Setting baseline power costs based on expected levels using the fifty-year hydro record will produce the most accurate forecast and will subject PSE and its customers to the least variance. When Commission Staff censors some hydro-generation years as outliers, it acknowledges that these extreme conditions will be handled by the PCA mechanism. Commission Staff fails to acknowledge, however, that PSE and its customers will experience low water years with significant probability. In such low water years, hydro-generation costs will be high, and the actual deviation from baseline power costs will be larger than it would have been had the baseline been properly centered from the outset. This means that PSE's customers will end up paying *more* in these low water period events under his proposal than they would have otherwise paid if the baseline had been properly set. Similarly, PSE's customers will under-recover benefits in high water periods because benefit deviations will be smaller under the hydro filtering methodology than if the baseline has been properly set.

Additionally, uncertainty about rates will increase because there will necessarily be a larger variance around the baseline produced by Commission Staff's proposed hydro filtering methodology than around the expected level that would be calculated from the full historical record. In a very real sense, Commission Staff's proposed hydro filtering methodology would have customers trade lower rates now for a more uncertain future with *higher* expected costs during low water years and *lower* expected benefits during high water years.

In addition to not meeting the Commission's expectation, customers are not necessarily better off under Commission Staff's proposed hydro filtering methodology.

Q. Does Commission Staff's proposed hydro filtering methodology attempt to fix something that is not broken?

A. Yes. Commission Staff's proposal to filter hydro generation is an attempt to correct an estimate that is not currently influenced by outliers or extremes. Although Commission Staff's attention is properly focused on the PCA mechanism and its relationship to the distribution of likely power costs, its proposed hydro filtering methodology is not the "solution". As the Commission recognized in its order in PacifiCorp's 2006 general rate case, power cost distributions are likely to be non-normal even if the water generation was itself normal. *See WUTC v. PacifiCorp d/b/a Pacific Power & Light Co.*, Docket Nos. UE-061546 & UE-060817, Order 08 at ¶ 101 (June 21, 2007).

V. SUMMARY

Q. Please summarize your conclusions.

A. A properly designed PCA mechanism should incorporate not only the deadband and sharing bands but should also recognize the distribution of power costs around the baseline. Moreover, I agree with the following finding in the Commission's final order in PacifiCorp's 2006 general rate case:

> filtering water-years is appropriate in the context of a PCAM, but that such filtering must reflect whether the distribution of variability in power costs is symmetrical or skewed as well as how the deadband and sharing bands are designed to reflect asymmetry in the risks and benefits that may accrue to both customers and the Company.

WUTC v. PacifiCorp d/b/a Pacific Power & Light Co., Docket Nos. UE-061546 & UE-060817, Order 08 at ¶ 101 (June 21, 2007).

Commission Staff's proposed hydro filtering methodology is not the solution to the asymmetry of power cost distributions. It would not be appropriate to ignore the likely distribution of power costs that occurs in nature by filtering away the upper tail of high costs. Instead, the PCA mechanism should be redesigned to reflect the actual distribution and shape of likely power costs to achieve a balance of risk and benefits between PSE and its customers. In this regard, Commission Staff and PSE agree that redesigning the PCA mechanism is a logical next step.

Q. Does this conclude your prefiled rebuttal testimony?

A. Yes, it does.