EXHIBIT NO. ___(JAD-15T)
DOCKET NO. UG-040640, *et al.* (consolidated)
2004 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. UG-040640** **Docket No. UE-040641** **(*consolidated*)**
In the Matter of the Petition of **PUGET SOUND ENERGY, INC.** **For an Order Regarding the Accounting Treatment for Certain Costs of the Company's Power Cost Only Rate Filing.**	**Docket No. UE-031471 (*consolidated*)**
In the Matter of the Petition of **PUGET SOUND ENERGY, INC.** **For an Accounting Order Authorizing Deferral and Recovery of the Investment and Costs Related to the White River Hydroelectric Project.**	**Docket No. UE-032043 (*consolidated*)**

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

NOVEMBER 3, 2004

PUGET SOUND ENERGY, INC.

PREFILED REBUTTAL TESTIMONY OF DR. JEFFREY A. DUBIN

CONTENTS

PUGET SOUND ENERGY, INC.

PREFILED REBUTTAL TESTIMONY OF DR. JEFFREY A. DUBIN

I. INTRODUCTION

Q. Are you the same Jeffrey A. Dubin who submitted direct testimony in this proceeding on behalf of Puget Sound Energy, Inc. ("PSE" or the "Company")?

A. Yes.

Q. Please summarize the purpose of your rebuttal testimony.

A. I will respond to and rebut the testimony filed by Dr. Mariam on behalf of Commission Staff. More specifically, I will respond to several issues related to Dr. Mariam's hydro analysis. I will respond to and critique the forward gas price analysis presented by Dr. Mariam, provide an alternative analysis, and comment on the modified procedure proposed by PSE. I will also respond to the argument put forth by Mr. Schoenbeck that the natural gas market's illiquidity precludes using the NYMEX forward market prices as the basis for forecasting gas prices for establishing power costs.

Q. Please summarize the conclusions you reach in your rebuttal testimony.

A. With respect to the best estimate of future hydro flow or future hydro generation, I

continue to recommend using all available data. At present this represents 60 years of water flow and hydro generation information. Dr. Mariam agrees that there is no statistical basis to exclude the first twenty years (1928 - 1947) or the most recent ten years (1978 - 1987) of hydro information. His analysis confirmed my findings that hydro flow is normally distributed, trendless, and not forecastable. Dr. Mariam's recommendation to exclude the most recent ten year period is based on non-statistical grounds.

With respect to forecasting the spot price of natural gas in the rate year, I find that Dr. Mariam has reached a set of conclusions that are not supported by his econometric analysis. Dr. Mariam used data from Gas Daily for the period May 2001 through July 2004 to determine which forward price averaging periods are best correlated to forward spot prices. Dr. Mariam concluded that periods up to three months in length are good correlates of forward prices. He then formed a set of three-month rolling average forward price strips for the period between December 2003 and April 2004. He found that data available subsequent to April 2004 is somehow biased. He then relied on the average of his three-month forward price strips to forecast the likely level of spot prices in the rate year.

I find that Dr. Mariam made several logical and methodological errors in his gas price analysis. These errors include: (1) analyzing the correlation between averaging periods of various length to forecast only one month into the future even though this analysis is not relevant to (a) PSE's present need to forecast five to seventeen months into the future or (b) its need to forecast up to two years in the future when preparing its direct case filing for subsequent rate cases,

(2) forming strip averages that are in most cases shorter than he intended due to errors in his computer programming, (3) misunderstanding his regression results, and (4) erroneously excluding some months in 2004 from his average of 3-month average prices because they are somehow biased.

Based on my independent econometric analysis using Gas Daily prices from a much longer time period, I conclude that there is little to distinguish averaging periods of one to six months when forecasting far into the future. However, based on the volume of contracts represented by the three-month period as compared to shorter periods, and the tendency for longer periods to underestimate the forward spot price, I conclude that PSE's modification of Dr. Mariam's methodology using a three-month period ending September 2004 is sound. Finally, I conclude that forward NYMEX natural gas prices are strong correlates of forward spot prices even when the forecast period is two years into the future.

II. HYDRO

Q. What conclusion did you reach in your direct testimony with respect to the best estimate of future water flow or future hydro generation?

A. Based on my analysis of natural water flow for water years between 1928 and 1998 and of hydro generation between the years 1928 through 1987, I concluded that water flows and generation were trendless, normally distributed, and not forecastable. The best estimate of future water flow is, consequently, a simple long-run average using all available data.

Q. Has generation data become available for the period after 1987?

A. No. I understand that the generation data will not be available until early next year.

Q. Do you still advocate updating forecasts as data becomes available after 1987?

A. Yes.

Q. In his direct testimony at page 23, Dr. Mariam stated that 50 water years should be used in modeling hydroelectric generation. Do you agree?

A. No. Based on the statistical analysis, there is no reason not to use the full 60 years of water data available for forecasting.

Q. Is Dr. Mariam's position based on statistical grounds?

A. No. Dr. Mariam has performed a statistical analysis of a 50-year subset of the water data I analyzed. His subset includes the water years from 1928 through 1977. He concludes, at page 23 of his direct testimony, that there is no difference in the results of the statistical analyses of streamflow data performed by Staff and PSE, respectively. Instead, Dr. Mariam agrees that there are no statistical reasons to exclude either the first ten years or the most recent ten years of available hydro data. However, he argues that the power cost modeling software requires using constraints (such as flood control curves) that have not yet been updated to reflect estimated water run-off volumes for the sixty-year period. Consequently, he

concludes that the fifty-year period from 1928 to 1977 should be used.

Q. Did you replicate Dr. Mariam's analysis of the 50-year period of water flow data?

A. No, it was not necessary to do so. Dr. Mariam's conclusions for the 50-year period were the same as mine for the 60-year period. We both performed similar statistical analyses. I do not challenge his findings. Additionally, at page 25 of his direct testimony, Dr. Mariam cited recent literature that reinforces my belief that a recurrence of low flow water years is not an aberration, but a likely outcome in the near future.[1]

Q. Please summarize your position on Dr. Mariam's analysis of the correct water years to use for forecasting?

A. Dr. Mariam's position with respect to the statistical analysis of water flows and the use of the data for forecasting is for all intents and purposes the same as mine.

III. NATURAL GAS PRICES

Q. Have you been asked by PSE to respond to Commission Staff's testimony with respect to using forward prices to predict forward spot prices of natural gas?

A. Yes.

[1] See Dr. Mariam's Exhibit __(YKGM-5).

Q. What specifically have you been asked to do at this point in time?

A. I have been asked to review Dr. Mariam's work and his statistical analysis of natural gas futures data, to respond to his conclusions, and assess his methodologies.

Q. Could you summarize Dr. Mariam's approach?

A. Yes. Dr. Mariam begins, at page 27 of his testimony, by discussing the relationship between current forward prices and corresponding spot prices in the future. He argues that while some studies have addressed efficiency and causality issues, there is little known about the length of averaging periods used in forming forecasts. Dr. Mariam then uses data from Gas Daily for forward natural gas prices and spot prices from the period from May 2001 through July 2004 to determine which forward price averaging periods exert statistically significant effects on forward spot prices.

He concludes, at page 29 of his testimony, that up to three month averaging periods of forward prices are good correlates of future spot prices. Based on this analysis, Dr. Mariam then calculates a set of three-month average forward prices for the time period between December 2003 and April 2004. He relies on an average of these calculations to forecast the level of spot prices in the rate year.

Q. Do you agree with Dr. Mariam's methods or conclusions?

A. No.

Q. To begin, could you explain the difference between a forward price, a spot price, and an average forward price?

A. Yes. A forward price contract is an agreement to deliver a specified quantity of a commodity at a specified future date, at a price (the forward price) to be paid at the time of delivery. A futures contract is also an agreement to a deliver a specified quantity of a commodity at a specified future date, at a price (the futures price) to be paid on delivery. However, futures contracts are typically traded without physical delivery actually taking place. Futures contracts are usually traded on organized exchanges such as the New York Mercantile Exchange (NYMEX) and contain specifications with respect to the contract terms (*e.g.,* a standardized amount of the commodity to be delivered, a minimum price increment for the contract, and other restrictions).[2] A spot price is the price for immediate delivery of a product, typically in a regional physical market. Finally, an average forward price is an average of forward prices for a certain number of days (averaging period) with respect to the same future date of delivery.

Q. Could you provide an example?

A. Yes. The future date might be March 2005 (the first period of the PSE rate year). Spot prices for natural gas will not exist until immediately prior to March 2005.

[2] The most important difference between a futures contract and a forward contract is that the former is a standardized contract that trades on an exchange and the latter is a commitment between two parties to deliver and take delivery of a product in a regional, physical market. In a futures contract, an exchange (e.g., NYMEX) acts as the counterparty to all transactions, until the expiration of the future contract. At the expiration of the contract, the parties who still own the futures contracts are matched with parties who sold the futures contracts. At this time, physical

However, forward contracts do exist going back to November 30, 2001 for natural gas to be delivered in March 2005. The settlement price for a NYMEX futures contract for natural gas delivery in March 2005 was $3.51 per MMBtu on November 30, 2001. By January 2, 2003, futures for natural gas delivery in March 2005 had risen to $4.18. As I explained above, one creates an average of forward prices by averaging the prices for a range of dates. For instance, a one-week average would include the forward prices on each day of December 23, 2002 through December 31, 2002, where prices ranged from $4.03 to $4.13 on a daily basis, for a one week average of $4.07.

Q. Does finance and economic theory postulate a relationship between forward and future spot prices?

A. Yes. As explained by Dr. Mariam at page 27 of his direct testimony, in a perfectly efficient market, a futures market equilibrium condition exists when the futures (or forward) price set today for delivery at some later date is the rationally expected or expected value of the spot price on that later date, given all available information at the time the expected value is formed. In mathematical terms:

$$ {}_tF_{t+j} = E(S_{t+j}|I_t) $$

where:

${}_tF_{t+j}$ is the forward price established at time t for delivery of the commodity at a later time $t+j$,

---

delivery occurs between the parties who own the futures contracts and the parties who are short futures.

S_{t+j} denotes the unknown random future spot price,

I_t denotes all information available at time t, and

$E()$ denotes mathematical expectation.

This relationship between forward prices and expected future spot prices will generally hold for storable commodities in an efficient market provided that the j is not too distant into the future.[3]

Q. In a perfectly efficient market, does theory predict how futures price will evolve from period to period?

A. Yes. A consequence of efficient markets is that sequences of forward prices form a weak martingale[4] with respect to the information set (Samuelson (1965)[5]). This technical condition says that the difference between forward prices ${}_{t-1}F_{t+j}$ and ${}_tF_{t+j}$ (the forward prices at time $t-1$ and at time t for delivery at future time $t+j$) are purely random and non-forecastable. The law of iterated projections and the

[3] Pindyck (2001), for example, has argued that for a storable commodity, there is a relationship between the capitalized flow of marginal convenience from storage, the cost of storage, the risk-free interest rate and the spot rate at time t, and the futures rate at time t for delivery of a commodity at time $t+j$. Pindyck then shows that futures prices and the expected future spot prices may differ to account for the uncertainty and risk due to the fact that S_{t+j} is unknown and random. His argument leads to the conclusion that futures prices (${}_tF_{t+j}$) (known at time period t) and expected spot price ($E(S_{t+j})$) will differ by an amount equal to the difference between the risk free interest rate and the discount rate appropriate to risk-adjust, or discount, the risk in the future spot price multiplied by the current spot price. If either the future time period $t+j$ is not too far off or there is little difference in the risk-premium, this correction to the futures market equilibrium theory described above is not important. See Pindyck, Robert, "The Dynamics of Commodity Spot and Futures Markets," *The Energy Journal*, Vol. 22, No. 3, 2001, pp. 1-29.

[4] The martingale condition in this context is: $E({}_tF_{t+j}|I_{t-1}) = {}_{t-1}F_{t+j}$ (*i.e.* the expected value of tomorrow forward price given information available today is simply today's forward price).

[5] Samuelson, P.A. "Proof that Properly Anticipated Prices Fluctuate Randomly," Industrial Management Review, Vol. 6, No. 2, 1965, pp. 41-50.

recursive projection theorem (Sargent (1979)[6]) further show that the difference in futures prices depends only on new information that enters the information set between time period *t-1* and *t*. This result is variously known as Kalman filtering or the error-learning model.

Q. What results from this theory?

A. There are two important consequence of the efficient market hypothesis in this context. First, the optimal projection or expectation of future spot prices will only depend on the information available at time *t* and will not be further enhanced by past information such as forward prices that were known yesterday, last month, or during the last year. Hence, the optimal forecast will use the most recent information. Older forward prices are "stale" and cannot be used to improve the forecast. Second, intuitively, the further ahead one forecasts, the worse one does on average.[7] Yesterdays' future price for delivery in March 2005 is noisier and less precise than today's future price for natural gas delivery in March 2005, when the markets are efficient. Consequently, forming an average of forward prices using averaging periods closer to the actual delivery period has more desirable theoretical properties.

Q. Both PSE and Staff proposed using averages of forward marks. Do you disagree with this approach?

---

[6] Sargent, Thomas, *Macroeconomic Theory*, Academic Press, New York: New York, 1979.

[7] *See e.g,.* Granger and Newbold, pp. 119-122 in Granger, Clive and Newbold, Paul, *Forecasting Economic Time-Series*, Academic Press, New York: New York, 1977.

A. Not necessarily. As Dr. Mariam suggests, at page 27 of his direct testimony, the forward market in natural gas may not be perfectly efficient. This conclusion with respect to efficiency may also depend on how far out the forward price is being used to make a forecast and the particular market in question. Some local markets are more highly correlated with liquid trading hubs than others. Pipeline constraints that may vary over time may also influence the degree of market efficiency.

Q. Has efficiency been studied in natural gas future markets?

A. Yes. Walls (1995)[8] studied the efficiency of the market in natural gas futures using NYMEX data. He concluded that the market was efficient in all but three of the thirteen spot markets he studied.

Q. What is the rationale for relying on averages of forward prices for forecasting?

A. If the market is not perfectly efficient (which may occur when there is imperfect knowledge of supply and demand factors or if a commodity is thinly traded), futures prices will act more independently and an average can be used to reduce the variance in the forecast. This is the same way a mutual fund reduces the variance in return as compared to an individual stock. If the market is fully efficient, using an average of strips must increase the forecast variance. However, if the market is not fully efficient and forward prices contain idiosyncratic

randomness, an average of forward prices is a reasonable approach.[9]

Q. Did Dr. Mariam use statistical analysis to determine which averaging periods best correlate to future spot prices?

A. Yes. Dr. Mariam used a regression analysis to compare the spot price to various averages of futures prices that were known prior to the setting of the spot price. The basic idea is shown in the following regression:

$$S_{t+j} = b_0 + b_1 * {}_tF_{t+j} + error$$

According to the theory I discussed above, the coefficient b_0 should be zero (unless there is a known non-zero basis differential) and b_1 should be 1. In this case, the regression shows that $E(S_{t+j}) = {}_tF_{t+j}$, is identical to the finding I discussed above for an efficient market.

Q. How did Dr. Mariam modify the standard test?

A. Dr. Mariam's independent variable in a set of bivariate regressions was the average of forward prices for a two week, three week, four week, two month, three month, etc., period prior to time period t. In other words, he replaced the forward price ${}_tF_{t+j}$ by an average of some length. For instance, if t were measured

---

[8] Walls, David, "An Econometric Analysis of the Market for Natural Gas Futures," *The Energy Journal*, Vol. 16, No. 1, 1995, pp. 71-83.

[9] *See, e.g.*, Lien and Shaffer, "Multiperiod Strip Hedging of Forward Commitments," *Review of Quantitative Finance and Accounting*, Vol. 18, 2002, pp. 345-358. Lien and Shaffer argue that a multi-period strip (i.e. multi-period averaging period) hedge can be superior to a single-maturity contract hedge because of diversification and the econometric gains from forecasts using a larger information set. However, Lien and Shaffer also note that if forward

in months, then Dr. Mariam formed a two-month average as $({}_{t-1}F_{t+j} + {}_{t}F_{t+j})/2$. He similarly formed the three month average as $({}_{t-2}F_{t+j} + {}_{t-1}F_{t+j} + {}_{t}F_{t+j})/3$.

Q. Did Dr. Mariam make other modifications to the standard test?

A. Yes. Dr. Mariam used the forward price data adjacent to the spot price in forming his averages to conduct his regression analysis. Thus, in looking for the best correlate of March 2004, Dr. Mariam considered the average forward price in February 2004 for his one-month average and the average of forward prices in January and February 2004 to form his two-month average. Similarly, Dr. Mariam analyzed the relationship between forward prices and the May 2001 spot price. When examining the possible correlation of a three-month average forward price to the spot price in May 2001, he used forward prices in February, March, and April 2001 to form the average. Effectively, this means that Commission Staff did all of its analysis assuming that all forecasting was being done for a period in the immediate future and the only question was how far back to go in forming an average to forecast this near term period. In the context of the case, it is akin to being bumped right against the rate year when the forecast is made.

Q. Is there a problem with this?

A. It doesn't work. In actual practice the rate year will be many months into the future. As of October 2004, PSE's rate year begins 5 months into the future (March 2005) and ends 17 months into the future (February 2006). The best

---

prices are subject to a single source of uncertainty (such as changes in underlying spot prices),

forecast using historical data for a forecast of an event 5 months or 17 months into the future cannot be made by looking at historical events where future prices (or their averages) are compared to spot prices that occur in the following month.

Q. Are there further problems with Commission Staff's inquiry besides this logical inconsistency?

A. Yes. I discovered practical problems in implementing this regression model. For instance, I found that Dr. Mariam had used time periods that did not correspond precisely to his definitions (two week, three week, one month etc.).[10]

However, I do not find these methodological implementation issues to be nearly as problematic as the logical inconsistency and assumption of a one-month forecast window that I discussed above.

Q. Did Dr. Mariam test the average prices he formed collectively in a regression to discover their individual contributions to the forecast in a multivariate setting?

A. Yes. Dr. Mariam performed a regression analysis where he included multiple forward price averages. His model analyzed the relationship between Henry Hub spot prices, and one, two, and three-week average forward prices, and one, two, three, four, five, and six-month average forward prices. Dr. Mariam claims, at

---

there may be no benefit from using the strip hedge.

[10] For instance, the definition of the 1-week strip (i.e. averaging period) actually relates to a 5-day period. Similarly, the 2-week strip has 10 days, the 3-week strip has 15 days, the 1-month strip has 20 days, the 2-month strip has 40 days, the 3-month strip has 60 days, the 4-

page 30 of his testimony, that this multivariate analysis supports his view that using up to three-month average forward prices is a sound method to estimate future spot prices.

Q. Are there problems with this analysis conducted by Commission Staff?

A. Yes. In addition to the errors of execution I discussed previously, this regression method cannot be interpreted in the manner done by Dr. Mariam.

Q. How has Dr. Mariam misinterpreted the results of this regression analysis?

A. The basic problem is that the explanatory variables in his regression are arithmetically connected. The two-month average is, for instance, the average of the prices in a two-month period. It, therefore, uses the information in the one-month average that is already an explanatory variable in the model. This leads to a problem in the interpretation of the regression results, because the explanatory factors are correlated in a specific fashion. I explain this in detail in Appendix A.

Q. Did Dr. Mariam reach reliable conclusions using his regression analysis in light of this problem?

A. No. I conclude that Dr. Mariam has misinterpreted his regression results to imply a pattern that is not present. Properly interpreted, his regression implies no greater significance to averaging forward prices over a longer term as opposed to averaging forward prices over a shorter term.

---

month strip has 80 days, and the 6-month strip has 120 days. Finally, the 5-month strip is programmed (at least through October 2001) to average over 1,000 days.

Q. Did you perform your own statistical regression analysis of the relationship between forward prices and spot prices?

A. Yes. I began with a much longer period of data than did Commission Staff. I used NYMEX forward prices for futures contracts in the period from April 1990 through October 2004 as related to transaction dates in the period June 1990 through December 2009. I matched NYMEX closing spot prices to this data for the period from January 1991 through October 2004. In contrast, Commission Staff collected forward prices for contracts set for the period September 1999 through September 2003 as related to transaction dates from November 1999 through March 2006. Commission Staff analyzed spot prices from the period May 2001 through July 2004. My analysis, therefore, covers roughly nine years more information than Commission Staff considered. This greatly increased my regression's precision, while allowing more relevant tests.

Q. Why were your tests more relevant than Commission Staff's?

A. I calculated the averages of forward prices known at various points in time distant from the future period in which they would apply. In other words, I calculated average forward prices known one month prior to the transaction date, five months prior to the transaction data, eleven months prior to the transaction data, and seventeen months prior to the transaction date.[11] I made these calculations to mimic the extant situation for PSE. PSE requires a forecast of spot prices in the

rate year that begins five months from the present (at this writing) and ends some seventeen months from now. On average, this is roughly eleven months away from the rate year. The question I ask in the regression analysis is whether averaging periods of varying length provide better or worse correlates of future spot prices when forecasting at various distances from the rate year. Dr. Mariam only asked, in a much smaller dataset, whether averaging periods of varying lengths could be distinguished when one was forecasting one month into the future. While that question might have some relevance in the abstract, I find it irrelevant to this proceeding.

Q. How do your results compare to Commission Staff's?

A. First, my results were based on many more observations than Dr. Mariam's, as I discussed above. The results of my regression analysis are given in Exhibit Nos. ___(JAD-16) and ___(JAD-17). These exhibits present regression models with and without the presence of an intercept in the regression. The columns label the length of the period used to form the average forward prices, the period into the future for which the forecast is being made, the resulting coefficients, t-statistics, number of observations, and R-squared values for each regression.

Typically, I was able to examine 160 months for possible correlations. In contrast, Dr. Mariam's analysis used less than 40 observations. Second, I also limited my sample to Dr. Mariam's period and followed his use of auto-regressive

[11] I also made such calculations for periods as long as twenty-five months into the future in order to mimic the situation that PSE faces at the beginning of a rate case where longer term

correction to replicate his results. These analyses produce similar, but not identical, results. For instance, I find the coefficient on the one-month average to be 0.905 when forecasting one-period into the future, whereas Dr. Mariam found it to be 0.907. These and other differences may be due to the incorrect manner in which Dr. Mariam formed his average prices (recall that Dr. Mariam's one month average only uses twenty days of data) or the subtle differences in the implementation of the auto-regressive procedure in the statistical software packages.

Q. What did you find in your regression analysis when forecasting for longer lead periods using the full dataset of 160 months of NYMEX prices?

A. Using the full dataset, I found a rather different pattern than Dr. Mariam found, even when forecasting one period into the future. My results indicate that averaging periods of one to six months have similar regression coefficients. For instance, the coefficients on the one through six-month averages were 0.95, 0.96, 0.97, 0.98, 0.99, and 1.0, respectively, with t-statistics of 33.8, 28.9, 26.5, 24.8, and 23.1, respectively. The R-squared values drop from 88% to 74%, due to incorporating "noisier" information in the short-term forecast.

Q. What is the importance of R-squared in this context?

A. R-squared is a statistic that represents the proportion of the variation in the dependent variable in a regression explained by the independent (or explanatory)

---

forecasts are required.

variables. A large R-squared value in this context means that a large proportion of the variation in future spot prices is explained by the current forward prices.

Q. What were the results of your longer-term forecasts?

A. As I expected, the longer-term forecast had lower R-squared values. The five-month forward forecasts have R-squared values around 50 percent, while the eleven month forecasts have forecasts around 35 percent. Interestingly, the R-squared values are also around 35 percent when forecasting seventeen months into the future. Generally, as the forecast period increased (from 1 to 25 months into the future) the forward averages under-predicted the forward spot price to larger degree (consistent with the risk-premium theory described by Pindyck (2001)). Also, I find that there are similar regression results (holding constant the forecast period) for average forward prices of differing lengths (between 1 and 6 months) but that amount of under-prediction increases somewhat with longer averaging periods. Thus, there is little basis to choose an averaging period based on the regression results alone and no basis to conclude (as did Dr. Mariam, page 30) that averaging periods up to three months are "relatively efficient" or "robust".

Q. Did you look for seasonality in the regression results?

A. I did examine seasonality to determine whether the forecasts differed by time of year. I was not able to determine any seasonal pattern to the forecast errors. This seemingly contradicts Dr. Mariam's argument, at page 31 of his testimony, that the summer is somehow different than the rest of the year with respect to the

ability of forward prices to accurately forecast forward spot prices.

Q. At page 31 of his testimony, Dr. Mariam advocated a compromise approach that used three-month rolling average forward prices from December 2003 through April 2004 to forecast the rate year spot price. What did Dr. Mariam do to calculate the likely level of rate year gas prices?

A. Dr. Mariam first calculated three-month averages of forward prices for the Sumas market for the period December 2003 through April 2004. The forward prices were NYMEX Henry Hub forward prices less a constant $0.504 per MMBtu to account for the difference between Sumas and Henry Hub pricing. For instance, Dr. Mariam used forward prices for the period December 22, 2003 through March 22, 2003 to determine the 3-month average at March 23, 2003, while he used forward prices for the months of February, March, and April to calculate the three-month average for April 30, 2003. Dr. Mariam then calculated a simple average of the resulting three-month rolling averages for this period that, given the length of period (*i.e.* a lack of additional historical data), resulted in the same answer as if Dr. Mariam had applied a simple average of all the forward prices for the five month period. Hence, while Dr. Mariam paid lip service to his regression results, his recommended procedure ignored the regressions' results in several dimensions (including the nominal use of a three month average when his results suggested that two was better and, in fact, using a five month period, which was not at all supported by his regression results).

Q. Did Dr. Mariam exclude the months of May to July 2004 in forming his

forecasts?

A. Yes.

Q. What was the basis for this decision by Dr. Mariam?

A. Dr. Mariam stated, at page 31 of his testimony, that since these prices were higher than those that occurred previously, they were somehow biased.

Q. How did Dr. Mariam reach this conclusion?

A. He looked at a graph on which these more recent prices were larger and compared the mean levels in the period from December 2003 through April 2004 to the mean level in May 2004 to July 2004.

Q. Is this a valid basis to conclude that these later months are biased?

A. No. Just because one period of data has a larger average than another does not make it biased. Indeed, theory and practice tells us, in this instance, that the recent data should be more informative, not less informative. Indeed, Dr. Mariam concedes this relationship earlier at page 27 of his testimony.

Q. Did Dr. Mariam properly conduct the equality of means tests?

A. He did not. I have examined his workpapers, which indicate that Dr. Mariam performed a "paired" comparison of means using Excel. As explained in the Excel documentation, this test is appropriate when the data occur in natural pairs (one person at two points of time, twins, a case matched to a control, etc.). In fact, there is no pairing of the observations in the early months compared to the

latter months. Thus, this statistical calculation was entirely irrelevant.

Q. Is there anything else with which you take exception in Dr. Mariam's comparison of the early months with the later months?

A. Yes. Dr. Mariam calculated tests of normality for the forward prices in order to determine whether they were normally distributed. He did not report the results in any testimony.

Q. What specifically did Dr. Mariam calculate?

A. Dr. Mariam calculated standard summary statistics for the 52 days between May 3, 2004 and July 16, 2004 of forward prices for the rate year period (March 2005 through February 2006). He also calculated these statistics for the period of December 22, 2003 through April 30, 2004 (88 daily observations) and for the combined period of 140 days. Among the statistics presented are Jacque-Berra tests for normality. Dr. Mariam's test reveals that futures prices are normally distributed for each rate year month using the full sample. Additionally, the statistics indicate that future prices are normally distributed in 11 of 12 rate year months using the contract dates from May 2004 through July 2004; yet the statistics reject normality in 9 of 12 rate year months based on the December 2003 through April 2004 contract days. By Dr. Mariam's logic, the period he excluded is more normal than the period he retained. Yet Dr. Mariam posits that reaching a conclusion of normality means that there are no grounds to exclude critical

periods or subdivide the data.[12] Consequently, using Dr. Mariam's own logic, there is no reason to exclude or sub-divide this data.

Q. Is there any logical reason for Dr. Mariam to exclude one data period over another?

A. No. Moreover, I think it is incorrect to make conclusions with respect to bias based solely on the normality of a data series.

Q. PSE is proposing to adopt an aspect of Dr. Mariam's work and use a three-month average of forward prices to project gas prices in the rate year. Is this approach sensible to you?

A. Yes. Based on my study of pricing for periods five, eleven, and seventeen months in the future I think that a three-month average is sound. Using three months helps provide an average price that is based on larger volumes traded as compared to shorter periods. On the other hand, I found that while the regression results were similar across specifications with differing averaging lengths, there was a tendency for longer periods to under-predict the forward spot rate. Using a longer period than three months would, therefore, compel a further increase in the forecasted rate.

IV. MARKET ILLIQUIDITY

[12] Dr. Mariam at page 22 of his Direct Testimony states: "The finding of normality also implies that there are no statistical reasons to exclude any subset of observations from the analysis."

Q. Mr. Schoenbeck testified (on behalf of Industrial Customers of Northwest Utilities) at page 14 of his testimony that using forward prices may be unwarranted when the futures markets are illiquid. Do you agree?

A. No. While I agree this should be a consideration, I also think that it is a matter subject to econometric investigation.

Q. Did you investigate this issue quantitatively?

A. Yes. I calculate that, as of September 2004, the situation of thinly traded forward markets described by Mr. Schoenbeck has improved considerably. For instance, using NYMEX contract data from December 2003 through September 2004, I find that 12.7% of the volume of contracts occurring in September 2004 pertain to the rate year, 10.2% of August 2004 contracts pertain to the rate year, and 8.5% of July 2004 contracts pertain to the rate year. These are more than double the percentages calculated by Mr. Schoenbeck when he analyzed the volumes for contracts set in late December 2003 and early January 2004. Forward price volumes generally get larger as we get closer to the rate year. Additionally, thus far, over 46% of the volumes traded in forward markets for the rate year period have traded in the last 3 months. This percentage will further change as we get closer to the rate year, but the 600,000 contracts represented in the last three months is far from paltry.

Q. Did you also investigate the market liquidity issue using regression analysis?

A. Yes. I examined the regression relationship between forward price averages of

varying lengths determined up to 25 months before the forecast period and the spot price realized in the forecast period. These regressions continued to show R-squared value over 30% with significance of the forward price at the 95% confidence level. Even though the total volume of contracts represented in these regressions declined as the forecast period lengthened, the forward prices continued to reveal useful correlation to forward spot prices. Thus I do not share Mr. Schoenbeck's concerns about market illiquidity in the NYMEX futures market.

V. CONCLUSION

Q. Please summarize your testimony.

A. I continue to recommend using all available data to obtain the best estimate of future hydro flow or future hydro generation. At present this represents 60 years of water flow and hydro generation information. Dr. Mariam agrees with me that there is no statistical basis to exclude either the first twenty or the most recent ten years of hydro information. His analysis confirmed my findings that hydro flow is normally distributed, trendless, and not forecastable. Dr. Mariam's recommendation to exclude the most recent ten-year period is based on non-statistical grounds.

With respect to forecasting the spot price of natural gas in the rate year, I find that Dr. Mariam has reached a set of conclusions that are not supported by his econometric analysis. I find that Dr. Mariam made several logical and

methodological errors in his analysis.

Based on my independent econometric analysis using Gas Daily prices from a much longer time period, I conclude that there is little to distinguish averaging periods of one to six months when forecasting far into the future. However, based on the volume of contracts represented by the three-month average as compared to shorter periods, and the tendency for longer periods to underestimate the forward spot price, I conclude that PSE's proposal to use a three-month average is sound. Finally, I conclude that forward NYMEX natural gas prices are strong correlates of forward spot prices even when the forecast period is two years into the future.

Q. Does this conclude your rebuttal testimony?

A. Yes.

[BA043030.009 / 07771-0089]

APPENDIX A

Suppose that we consider three forward prices that occur seriatim, all which pertain to a period of time j periods into the future from time period t: ${}_{t-2}F_{t+j}$, ${}_{t-1}F_{t+j}$, *and* ${}_{t}F_{t+j}$. Suppose also that a regression of spot prices at time period $t+j$, S_{t+j} is related to these forward prices by $E(S_{t+j}) = c * {}_{t-2}F_{t+j} + b * {}_{t-1}F_{t+j} + a * {}_{t}F_{t+j}$ where a, b, and c are the regression coefficients that optimally weight the historic information. Dr. Mariam forms the one-month, two-month, and three-month averages as ${}_{t}F_{t+j}$, $({}_{t}F_{t+j} + {}_{t-1}F_{t+j})/2$, and $({}_{t}F_{t+j} + {}_{t-1}F_{t+j} + {}_{t-2}F_{t+j})/3$. A regression of spot prices on these three factors yields $E(S_{t+j}) = d*{}_{t}F_{t+j} + e*({}_{t}F_{t+j} + {}_{t-1}F_{t+j})/2 + f*({}_{t}F_{t+j} + {}_{t-1}F_{t+j} + {}_{t-2}F_{t+j})/3$. Rearranging terms show that $E(S_{t+j}) = (d+e/2+f/3)*{}_{t}F_{t+j} + (e/2+f/3)*{}_{t-1}F_{t+j} + (f/3)*{}_{t-2}F_{t+j}$. This shows that there is a relationship between the coefficients in the spot/forward regression and the spot/average regression such that $c = f/3$, $b = e/2 + f/3$, and $a = d + e/2 + f/3$. This implies that the regression coefficients in Dr. Mariam's specification are respectively $d = (a-b)$, $e = 2*(b-c)$, and $f = 3*c$.

The coefficients on low-order periods averages are in fact differences of the optimal weights a, b, and c. I would expect that in a market that is efficient, or nearly efficient, that $E(S_{t+j}) = c * {}_{t-2}F_{t+j} + b * {}_{t-1}F_{t+j} + a * {}_{t}F_{t+j}$ with the additional property that $a + b + c = 1$ using properties of iterative expectation. Additionally, I would expect that these weights would be nearly equal since this is essentially a regression with near multicollinearity as the forward prices are only different due to random, non-forecastable innovations. Therefore, I would expect that $d = 0$, $e=0$ and that f would be non-zero in this specification. Only the last term (the average of longest length) has a coefficient that is directly related to the non-differenced optimal weights.

BA043070.009