

Exhibit No. __ (BR-3)
Docket No. UG-17____
Witness: Brian Robertson

WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION,
Complainant,

v.

CASCADE NATURAL GAS
CORPORATION,

Respondent.

DOCKET UG-17____

CASCADE NATURAL GAS CORPORATION

EXHIBIT OF BRIAN ROBERTSON

ANALYSIS OF METHODOLOGY OF CALCULATING HDDs

31-Aug-17

Citygate

Based on 65 degree reference temperature

BREMERTON (SHELTON)

Maximum Likelihood Estimates

BREMERTON (SHELTON)	SSE	1.19812166	DFE	2341
BREMERTON (SHELTON)	MSE	0.0005118	Root MSE	0.02262
BREMERTON (SHELTON)	SBC	-11086.994	AIC	-11104.273
BREMERTON (SHELTON)	MAE	0.01686718	AICC	-11104.263
BREMERTON (SHELTON)	MAPE	12.3833026	HQC	-11097.98
BREMERTON (SHELTON)	Log Likelihood	5555.13661	Regress R-Square	0.3457
BREMERTON (SHELTON)	Durbin-Watson	2.1161	Total R-Square	0.9659
BREMERTON (SHELTON)			Observations	2344

BREMERTON (SHELTON)

Autoregressive parameters assumed given

BREMERTON (SHELTON)			Standard		Approx
BREMERTON (SHELTON)	Variable	DF	Estimate	Error	t Value Pr > t
BREMERTON (SHELTON)	Intercept	1	0.1108	0.0122	9.05 <.0001
BREMERTON (SHELTON)	HDD65	1	0.005375	0.000153	35.17 <.0001

BREMERTON (SHELTON)

Based on 60 degree reference temperature

BREMERTON (SHELTON)

Maximum Likelihood Estimates

BREMERTON (SHELTON)	SSE	1.10006888	DFE	2341
BREMERTON (SHELTON)	MSE	0.0004699	Root MSE	0.02168
BREMERTON (SHELTON)	SBC	-11287.16	AIC	-11304.439
BREMERTON (SHELTON)	MAE	0.01581359	AICC	-11304.429
BREMERTON (SHELTON)	MAPE	10.7542173	HQC	-11298.145
BREMERTON (SHELTON)	Log Likelihood	5655.21947	Regress R-Square	0.3996
BREMERTON (SHELTON)	Durbin-Watson	2.212	Total R-Square	0.9687
BREMERTON (SHELTON)			Observations	2344

BREMERTON (SHELTON)

Autoregressive parameters assumed given

BREMERTON (SHELTON)			Standard		Approx
BREMERTON (SHELTON)	Variable	DF	Estimate	Error	t Value Pr > t
BREMERTON (SHELTON)	Intercept	1	0.1267	0.0113	11.2 <.0001
BREMERTON (SHELTON)	HDD60	1	0.006371	0.000161	39.47 <.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	1.08946583	DFE	2339
MSE	0.0004658	Root MSE	0.02158
SBC	-11298.041	AIC	-11315.317
MAE	0.01436218	AICC	-11315.307
MAPE	12.408402	HQC	-11309.024
Log Likelihood	5660.65846	Regress R-Square	0.4557
Durbin-Watson	2.1757	Total R-Square	0.9781
		Observations	2342

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > t
Intercept	1	0.0984	0.0131	7.48	<.0001
HDD65	1	0.004933	0.000111	44.25	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	1.00547648	DFE	2339
MSE	0.0004299	Root MSE	0.02073
SBC	-11485.857	AIC	-11503.133
MAE	0.01346624	AICC	-11503.123
MAPE	10.7196336	HQC	-11496.84
Log Likelihood	5754.56664	Regress R-Square	0.4969
Durbin-Watson	2.256	Total R-Square	0.9798
		Observations	2342

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > t
Intercept	1	0.109	0.0135	8.05	<.0001
HDD60	1	0.005515	0.000115	48.06	<.0001

Citygate Based on 65 degree reference temperature

Sumas SPE Loop **Maximum Likelihood Estimates**

Sumas SPE Loop	SSE	2.11816811	DFE	2341
Sumas SPE Loop	MSE	0.0009048	Root MSE	0.03008
Sumas SPE Loop	SBC	-9752.1848	AIC	-9769.4637
Sumas SPE Loop	MAE	0.0195435	AICC	-9769.4534
Sumas SPE Loop	MAPE	16.4424914	HQC	-9763.1701
Sumas SPE Loop	Log Likelihood	4887.73183	Regress R-Square	0.3203
Sumas SPE Loop	Durbin-Watson	2.278	Total R-Square	0.9435
Sumas SPE Loop			Observations	2344

Sumas SPE Loop **Autoregressive parameters assumed given**

Sumas SPE Loop			Standard		Approx
Sumas SPE Loop	Variable	DF	Estimate	Error	t Value Pr > t
Sumas SPE Loop	Intercept	1	0.1041	0.007526	13.83 <.0001
Sumas SPE Loop	HDD65	1	0.006068	0.000183	33.22 <.0001

Sumas SPE Loop Based on 60 degree reference temperature

Sumas SPE Loop **Maximum Likelihood Estimates**

Sumas SPE Loop	SSE	1.98155306	DFE	2341
Sumas SPE Loop	MSE	0.0008465	Root MSE	0.02909
Sumas SPE Loop	SBC	-9908.4982	AIC	-9925.777
Sumas SPE Loop	MAE	0.01857648	AICC	-9925.7668
Sumas SPE Loop	MAPE	15.4882449	HQC	-9919.4834
Sumas SPE Loop	Log Likelihood	4965.88851	Regress R-Square	0.3666
Sumas SPE Loop	Durbin-Watson	2.329	Total R-Square	0.9471
Sumas SPE Loop			Observations	2344

Sumas SPE Loop **Autoregressive parameters assumed given**

Sumas SPE Loop			Standard		Approx
Sumas SPE Loop	Variable	DF	Estimate	Error	t Value Pr > t
Sumas SPE Loop	Intercept	1	0.1199	0.006858	17.48 <.0001
Sumas SPE Loop	HDD60	1	0.007097	0.000193	36.82 <.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	1.23759722	DFE	2342
MSE	0.0005284	Root MSE	0.02299
SBC	-11016.911	AIC	-11034.191
MAE	0.0145458	AICC	-11034.18
MAPE	10.4411582	HQC	-11027.897
Log Likelihood	5520.09536	Regress R-Square	0.4543
Durbin-Watson	2.2205	Total R-Square	0.9708
		Observations	2345

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.096	0.0102	9.43	<.0001
HDD65	1	0.005058	0.000114	44.17	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	1.14781443	DFE	2342
MSE	0.0004901	Root MSE	0.02214
SBC	-11193.415	AIC	-11210.695
MAE	0.01363929	AICC	-11210.685
MAPE	9.07169753	HQC	-11204.402
Log Likelihood	5608.34772	Regress R-Square	0.4924
Durbin-Watson	2.3247	Total R-Square	0.9729
		Observations	2345

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.1073	0.0108	9.91	<.0001
HDD60	1	0.005609	0.000118	47.66	<.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	30.086691	DFE	2341
MSE	0.01285	Root MSE	0.11337
SBC	-3531.9365	AIC	-3549.2154
MAE	0.08525813	AICC	-3549.2051
MAPE	10.6449499	HQC	-3542.9218
Log Likelihood	1777.60769	Regress R-Square	0.3495
Durbin-Watson	2.1526	Total R-Square	0.9551
		Observations	2344

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.595	0.0407	14.63	<.0001
HDD65	1	0.0273	0.000769	35.48	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	27.8014845	DFE	2341
MSE	0.01188	Root MSE	0.10898
SBC	-3717.1607	AIC	-3734.4395
MAE	0.08062394	AICC	-3734.4293
MAPE	9.70103368	HQC	-3728.146
Log Likelihood	1870.21977	Regress R-Square	0.4008
Durbin-Watson	2.2375	Total R-Square	0.9585
		Observations	2344

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.6765	0.0362	18.7	<.0001
HDD60	1	0.0322	0.000814	39.58	<.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	25.921812	DFE	2339
MSE	0.01108	Root MSE	0.10527
SBC	-3875.5058	AIC	-3892.782
MAE	0.07104163	AICC	-3892.7718
MAPE	10.6345951	HQC	-3886.4891
Log Likelihood	1949.39102	Regress R-Square	0.4607
Durbin-Watson	2.1978	Total R-Square	0.9757
		Observations	2342

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.5197	0.0529	9.82	<.0001
HDD65	1	0.0243	0.000544	44.7	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	24.1567055	DFE	2339
MSE	0.01033	Root MSE	0.10163
SBC	-4040.6117	AIC	-4057.888
MAE	0.06737305	AICC	-4057.8777
MAPE	9.66048527	HQC	-4051.5951
Log Likelihood	2031.944	Regress R-Square	0.4965
Durbin-Watson	2.2658	Total R-Square	0.9773
		Observations	2342

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.5735	0.054	10.63	<.0001
HDD60	1	0.0271	0.000563	48.04	<.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	36.9143507	DFE	2341
MSE	0.01577	Root MSE	0.12557
SBC	-3053.4945	AIC	-3070.7734
MAE	0.07804935	AICC	-3070.7631
MAPE	15.7185526	HQC	-3064.4798
Log Likelihood	1538.38669	Regress R-Square	0.3372
Durbin-Watson	2.2736	Total R-Square	0.9186
		Observations	2344

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.393	0.0188	20.86	<.0001
HDD65	1	0.0254	0.000736	34.53	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	34.8289444	DFE	2341
MSE	0.01488	Root MSE	0.12197
SBC	-3189.9518	AIC	-3207.2307
MAE	0.07534402	AICC	-3207.2204
MAPE	15.605125	HQC	-3200.9371
Log Likelihood	1606.61534	Regress R-Square	0.4075
Durbin-Watson	2.2906	Total R-Square	0.9232
		Observations	2344

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.4498	0.015	30	<.0001
HDD60	1	0.0308	0.000766	40.15	<.0001

Based on 65 degree reference temperature

Maximum Likelihood Estimates

SSE	45.0506022	DFE	2342
MSE	0.01924	Root MSE	0.13869
SBC	-2587.8316	AIC	-2605.1117
MAE	0.08826835	AICC	-2605.1014
MAPE	8.81294301	HQC	-2598.8177
Log Likelihood	1305.55584	Regress R-Square	0.4639
Durbin-Watson	2.2041	Total R-Square	0.9652
		Observations	2345

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.6493	0.0459	14.13	<.0001
HDD65	1	0.0311	0.000691	45.03	<.0001

Based on 60 degree reference temperature

Maximum Likelihood Estimates

SSE	42.2415069	DFE	2342
MSE	0.01804	Root MSE	0.1343
SBC	-2738.734	AIC	-2756.0141
MAE	0.08419123	AICC	-2756.0038
MAPE	8.11820502	HQC	-2749.7202
Log Likelihood	1381.00705	Regress R-Square	0.4953
Durbin-Watson	2.2963	Total R-Square	0.9674
		Observations	2345

Autoregressive parameters assumed given

Variable	DF	Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.7206	0.0477	15.11	<.0001
HDD60	1	0.0343	0.000715	47.95	<.0001