

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-Jul-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

			Standard		Approx
	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

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

			Standard		Approx
	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	Approx 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	Approx 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