

# **BHE 230 kV and CLFP 115 kV Transmission Loss Factor Study**

**Prepared for:  
Black Hills Energy and Cheyenne Light Fuel Power**

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(Revision 2)**

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**Submitted By:**

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**Revision History**

Date	Rev	Description
10/21/2025	0	Initial Draft
10/22/2025	1	Revised Draft
11/21/2025	2	Revised Based on Updated SCADA Data & Boundary Map

# 1. Table of Contents

1. Table of Contents.....	3
2. Executive Summary.....	4
3. Introduction.....	5
4. BHP 230 kV Losses.....	6
4.1 Data .....	7
4.2 Methodology .....	7
4.3 Results.....	8
5. CLFP 115 kV Losses .....	9
5.1 Data .....	10
5.2 Methodology .....	10
5.3 Results .....	11
Appendix A – BHE 230 kV Details.....	12
Appendix B – CLFP 115 kV Details .....	18

## 2. Executive Summary

RMS Energy conducted a transmission loss factor estimation study for Black Hills Energy (BHE) 230 kV and Cheyenne Light Fuel Power (CLFP) 115kV transmission systems in the South Dakota (SD) and Wyoming (WY) study area, using historical SCADA coincident peak data and steady-state power flow modeling. The objective was to estimate transmission losses and corresponding loss factors for the defined study conditions.

### Approach Overview:

- Calibrated the study area powerflow using the WECC PSS/E 2026 Heavy Summer base case based on the reported SCADA coincident system peak load condition.
- Transmission losses were estimated by evaluating the difference in active power (MW) at line terminals; with loss factors expressed as a percentage of the total estimated losses divided by total load served within the study area.
- Excluded shunt devices' losses and corona losses.

### Key Findings:

- **BHP 230 kV System (SD & WY):** Estimated loss factor of **2.16%** under coincident system peak conditions.
- **CLFP 115 kV System:**
  - Scenario 1 (existing system): Estimated loss factor of **0.452%**.
  - Scenario 2 (with 230 kV expansion): Estimated loss factor of **1.162%**.

### 3. Introduction

This report presents the results and methodology used in the transmission losses factor estimate study conducted for Black Hills Power 230 kV in SD and WY footprint, and Cheyenne Light Fuel Power 115 kV transmission systems. The study was based on SCADA coincident system peak data provided by Black Hills Power. The objective of this study was to estimate transmission losses and loss factor.

RMS Energy conducted a transmission loss study for the Black Hills Energy transmission system (115 kV and above) utilizing both SCADA/EMS historical loss data and steady-state power flow study results. The SCADA data used was a historical peak instantaneous snapshot for Black Hills Power (BHP) and Cheyenne Light Fuel and Power Co (CLFP). These two datasets were used in a complementary manner accuracy and consistency in the analysis.

The study involved the use of Siemens PSS/E to model system conditions to analyze and validate branch flows and associated losses for the BHP 230 kV network and CLFP 115 kV network.

## 4. BHP 230 kV Losses

The BHP 230 system boundary includes the interconnected 230 kV facilities of Power River Energy (PREC), Basin Electric Power Co-op (BEPC), and Black Hills Energy (BHE) within the South Dakota (SD) and Wyoming (WY) footprint, as shown in . The system boundary is indicated by double red lines on the transmission elements. The BHP subsystem PSS/E model was calibrated to available SCADA loads, generation and interchange branch flow data as recorded on August 7, 2025 at 5PM local time. The detailed loss calculation is described in the Methodology subsection.

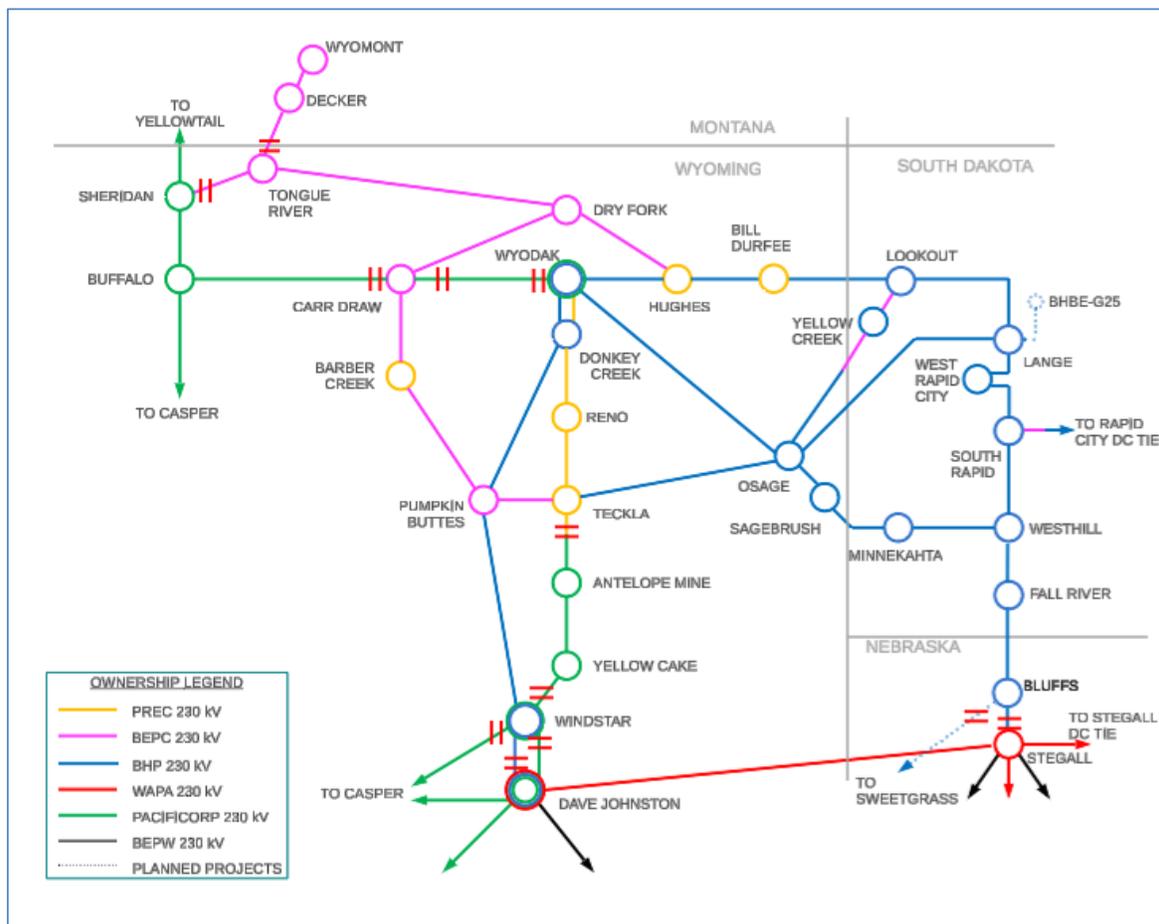


Figure 4-1 : BHP 230 kV System Boundary

#### 4.1 DATA

The BHP system boundary map, WECC 2026 Heavy Summer base case, SCADA load, generation and branch flow data were provided by BHP and are currently listed in Table 1 .

Table 2 BHP Provided Dataset

Data File Name	Description
BHP 2024-2025 BRANCH SCADA VALUES_highlighted.xlsx	BHP 230 kV SCADA Branch flows recorded at 5:00 PM on August 7, 2025
2024-2025 BHP LOAD GEN VOLT SCADA VALUES.xlsx	BHP owned load and generation SCADA data recorded at 5:00 PM on August 7, 2025
BHE Line Loss Boundaries- BHP and CLFP.docx	BHP System Boundary Schematic Map
26HS3ap_v34.sav	WECC 2026 Heavy Summer base case

#### 4.2 METHODOLOGY

BHP 230 kV loss factors were estimated in PSS/E using the WECC 2026 Heavy Summer base case (26HS3ap\_v34\_2025.sav) together with 2025 SCADA load and generation data. The BHP 230 kV subsystem was calibrated to operating conditions recorded at 5:00 PM on August 7, 2025. Loss factors were estimated for the BHP 230 kV, PREC 230 kV, and BEPC 230 kV systems within the South Dakota and Wyoming footprint.

The following steps were followed in the estimation of transmission loss factor:

- The Black Hills Power systems PSS/E model was calibrated using SCADA load and generation data.
- An equivalent subsystem was created including up to one adjacent bus outside the boundary; the subsystem was isolated and the interchange variables were represented through boundary equivalents.
- Power flowing into and out of the boundary was represented as equivalent injections and withdrawals at the boundary buses.
- A swing unit was selected and the interchange line flows were calibrated to SCADA interchange branch flow values; the case was then solved with internal flows conditioned by the calibrated inputs.
- Line losses were estimated from MW differences at each line terminal, with absolute values aggregated.

- Transmission loss factor was estimated as:  $\text{Loss factor} = (\text{Total Estimated Transmission System Loss} / \text{Total Load Served})$  within the studied 230 kV systems

**Assumptions & Exclusions:**

- No shunt or series compensation device losses were included.
- The loss analysis did not model and include corona losses for transmission lines.
- Results were interpreted using provided data only; RMS Energy did not independently verify historical data accuracy or future conditions.
- SCADA data were assumed adequate, complete, and time-synchronized.
- The equivalent subsystem was calibrated to the coincident peak at 5:00 PM on August 7, 2025, with the external system represented via equivalents at 230 kV boundary tie-line buses.
- WECC PSS/E 2026 Heavy Summer Operating Base Case (26HS3ap-v34.sav) was used.

**4.3 RESULTS**

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Losses were estimated at the coincident peak represented by the 5:00 PM SCADA snapshot on August 7, 2025 for the interconnected BHE, BEPC, and PREC 230 kV systems within the South Dakota and Wyoming study area, as summarized in Table 3.

Table 4 – Wyoming and South Dakota – 230 kV Losses and Loss Factors

<b>Element</b>	<b>Total Loss (MW)</b>	<b>Loss Factor (%)</b>
BHP 230 kV, BEPC 230 kV & PREC 230 kV only	16.450	<b>2.160</b>

## 5. CLFP 115 kV Losses

The Cheyenne Light, Fuel & Power (CLFP) 115 kV transmission network boundary, as shown in , includes the transmission facilities owned and operated by CLFP. The system elements under evaluation are shown in green and orange, and the boundary buses/elements are indicated by double red lines. The intent of this section is to document the data inputs and methodology used to estimate transmission losses for the CLFP 115 kV system.

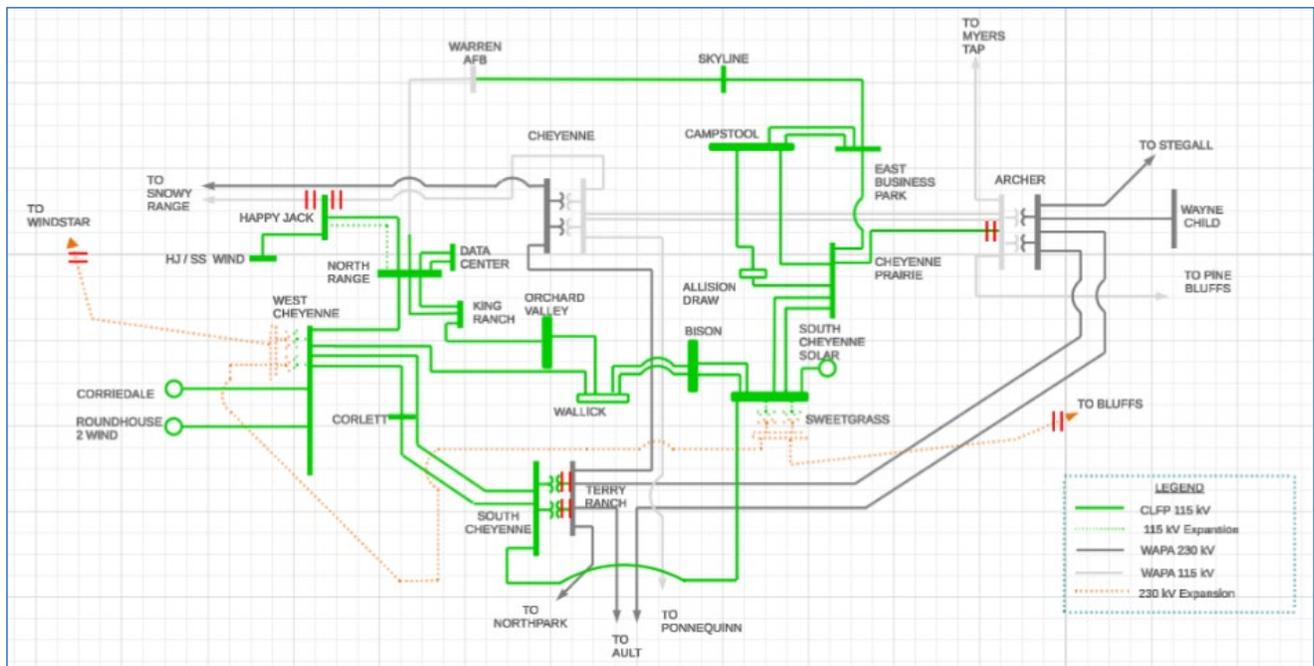


Figure 5-1 - CLFP 115 kV Transmission Network

## 5.1 DATA

Table 3 below shows the data sets provided by CLFP in support of this study performed.

Table 5 - CLFP Data Sets Provided

File Name	Description
CLFP 2024-2025 BRANCH SCADA VALUES BES-ONLY CF 11-10-2025.xlsx	CLFP network SCADA information recorded on August 20 <sup>th</sup> 2025 at 5 PM local time.
2024-2025 CLFP LOAD GEN VOLT SCADA VALUES_CF.xlsx	CLFP owned generation and load SCADA information recorded on August 20 <sup>th</sup> 2025 at 5 PM local time.
26HS3ap_v34.raw	WECC 2026 Heavy Summer Base Case

## 5.2 METHODOLOGY

CLFP 115 kV losses and loss factors were estimated in PSS/E using the WECC 2026 Heavy Summer base case (26HS3ap\_v34\_2025.sav) calibrated against the 2025 SCADA load and generation data that was provided under following different scenarios:

- **Scenario 1:** Existing CLFP 115 kV transmission system in its current configuration.
- **Scenario 2:** Future configuration with the CLFP system modeled to include the Windstar–West Cheyenne–Sweet Grass–Bluffs 230 kV expansion in service.

The following steps were followed in the calculation of transmission losses and loss factors for each scenario:

- CLFP network from the WECC bases representative of assumptions from scenario definitions were calibrated against the SCADA information provided.
  - Table 9 and Table 10 in Appendix B shows the case calibration for Scenario 1
  - Table 11 and Table 12 in Appendix A shows the case calibration for Scenario 2.
- An equivalent subsystem was created that included up to one bus outside of the boundary to represent interchange lines. The subsystem was isolated from the main grid, and external influences were represented through boundary equivalents in PSS/E.
- Power flowing into and out of the boundary was represented as equivalent injections or withdrawal at the boundary buses.
- Transmission line losses were estimated from MW differences at both ends of the 115 kV transmission lines, with absolute values aggregated.
- Transmission loss factor was estimated using the relationship, Loss factor = (Total Estimated Loss / Total Load Served by CLFP system).

**Assumptions & Exclusions:**

- No shunt or series compensation device losses were included.
- The loss analysis did not model and include corona losses for transmission lines.
- Results were interpreted using provided data only; RMS Energy did not independently verify historical data accuracy or future conditions.
- SCADA data were assumed adequate, complete, and time-synchronized.
- The power flow cases and associated model files were assumed to be current, properly converged, and validated by Black Hills Energy for use in steady-state simulations.
- Scenario 1 was calibrated to the August 20, 2025 SCADA coincident-peak conditions. The external system was represented in PSS/E by equivalent sources at the CLFP 115 kV boundary interchange buses, adjusted to match the recorded boundary flows.
- Scenario 2 was derived from Scenario 1 by modeling the Windstar–West Cheyenne–Sweet Grass–Bluffs 230 kV expansion in service. Losses on the added 230 kV facilities were included in the totals. A representative 100 MW flowing into the CLFP system at Windstar and 35 MW flowing into the CLFP system at Bluffs was assumed and associated transmission line loss was then estimated.
- The second Happy Jack–North Range circuit was modeled out of service in both scenarios, and its losses were excluded.
- The coincident-peak 115 kV SCADA data used for calibration was recorded on August 20, 2025 at 5:00 PM MST.
- WECC PSS/E 2026 Heavy Summer Operating Base Case “26HS3ap-1” was used.

**5.3 RESULTS**

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CLFP 115 kV loss factors were estimated in PSS/E using the 2025 SCADA coincident system peak data for the two scenarios described as per the methodology described in the previous section.

Total estimated system losses and corresponding loss factors for each scenario are summarized in Table 4.

Table 6 – CLFP 115 kV Loss Factors

Scenario	Total Losses (MW)	Loss Factor (%)
Scenario 1-CLFP 115kV Only	1.587	<b>0.452</b>
Scenario 2-CLFP 115kV & 230kV	4.085	<b>1.162</b>

## Appendix A – BHE 230 kV Details

Table 7 - Scenario BHP - Generation Calibration

Gen Bus Number	ID	Bus Name	SCADA MW	PSS/E Case MW	Delta MW
66730	1	WYODAK	128.538	128.538	0.0000
73289	1	RCCT1	-0.012	-0.012	0.0000
73291	2	RCCT2	0.000	0.000	0.0000
73292	3	RCCT3	0.012	0.012	0.0000
73293	4	RCCT4	-0.012	-0.012	0.0000
73341	2	NSS2	85.569	85.569	0.0000
73520	1	BFDIESEL	-0.046	-0.046	0.0000
74014	1	NSS CT1	32.385	32.385	0.0000
74015	1	NSS CT2	34.580	34.580	0.0000
74016	1	WYGEN	95.000	95.000	0.0000
74017	1	WYGEN2	94.762	92.530	2.2320*
74018	1	WYGEN3	79.705	79.705	0.0000
74029	1	LNG CT1	-0.110	-0.110	0.0000
74635	PV	FALLRVR PV	71.933	71.933	0.0000
76404	1	DRYFORK	321.670	321.670	0.0000

\* Swing unit in the BHP equivalent system

Table 8 - Scenario BHP - Load Calibration

ID	Bus Number	Substation	SCADA MW Load	PSS/E Case MW Load	Delta MW
BA	65293	CARR DRA	8.623	8.623	0
BA	73168	RENO	42.042	42.042	0
BH	73237	38TH ST	5.683	5.683	0
BA	73239	ANGUSTORA	4.720	4.720	0
BH	73240	ARGYLE	0.625	0.625	0
BA	73242	BIG BEND	2.847	2.847	0
BH	73243	CAMBELL	4.244	4.244	0
BH	73244	CEMETERY	11.364	11.364	0
BH	73246	CUSTER	11.216	11.216	0
BA	73248	DUMONT	1.101	1.101	0
BH	73249	EDGEMONT	2.366	2.366	0
BH	73250	HILLCITY	7.690	7.690	0
BA	73250	HILLCITY - BA	0.875	0.875	0
BH	73251	HILLSVW	5.299	5.299	0

<b>ID</b>	<b>Bus Number</b>	<b>Substation</b>	<b>SCADA MW Load</b>	<b>PSS/E Case MW Load</b>	<b>Delta MW</b>
BH	73252	WESTHILL	11.430	11.430	0
BA	73253	JWL CAVE	1.573	1.573	0
BH	73254	KIRK	2.737	2.737	0
BH	73257	MERILLAT	12.242	12.242	0
BA	73258	MCFT PR	21.744	21.744	0
BH	73259	NSS1	1.289	1.289	0
BA	73260	OSAGE	3.121	3.121	0
BH	73261	PACTOLA	0.710	0.710	0
BH	73262	PLSNTVLY	7.808	7.808	0
BH	73263	PLUMA	11.349	11.349	0
BA	73265	PRINGLE	1.739	1.739	0
BH	73266	LANGE	0.000	0.000	0
BH	73268	5TH ST	12.630	12.630	0
BA	73269	SALT CRK	3.689	3.689	0
BA	73270	SPFSHBEC	5.532	5.532	0
BH	73271	SPFSHCIT	3.058	3.058	0
BH	73275	SUNDHILL	13.014	13.014	0
BH	73277	TROJAN	3.967	3.967	0
BH	73278	WESTBLVD	0.563	0.563	0
BH	73280	WTEWOOD	6.755	6.755	0
BH	73281	WNDYFLAT	1.800	1.800	0
BA	73282	WYODAK 69	26.086	26.086	0
BH	73286	ANAMOSA	7.321	7.321	0
BH	73287	4TH ST	2.277	2.277	0
BH	73290	EASTNRTH	10.603	10.603	0
BA	73295	HUGHES	8.234	8.234	0
SS	73341	NSS2	9.945	9.945	0
BA	73342	NSS2 - BA	9.826	9.826	0
BH	73440	CENTRYRD	11.097	11.097	0
BH	73511	MALL	7.661	7.661	0
BH	73514	E.MEAD	9.137	9.137	0
BH	73518	RADIO DR	9.054	9.054	0
BH	73519	44TH ST	7.352	7.352	0
BH	73521	BFRNCH26	5.002	5.002	0
BH	73522	CMNTPLNT	12.541	12.541	0
BH	73523	CROSS ST	8.513	8.513	0
BH	73525	BELLECRK	0.422	N/A	
BH	73528	MTNVIEW	15.539	15.539	0
BH	73530	NEWCASTLE	6.334	6.334	0

<b>ID</b>	<b>Bus Number</b>	<b>Substation</b>	<b>SCADA MW Load</b>	<b>PSS/E Case MW Load</b>	<b>Delta MW</b>
BH	74000	STURGIS	13.857	13.857	0
BH	74001	WY REFIN	7.467	7.467	0
BH	74006	SPRUCEGL	5.744	5.744	0
BH	74008	BENTON	1.568	1.568	0
BH	74011	CLOVIS	0.100	0.100	0
BH	74012	GILLETTE	26.600	26.600	0
BH	74013	PEDMNT	10.602	10.602	0
SS	74016	WYGEN	9.800	9.800	0
SS	74017	WYGEN2	9.699	9.699	0
SS	74018	WYGEN3	10.676	10.676	0
BH	74019	GILLETTS	41.834	41.834	0
BH	74021	BLUCKSBERG	4.954	4.954	0
BH	74028	RCSOUTH2	10.086	10.086	0
BH	74050	DENBURY	17.026	17.026	0
BH	74055	CLEVL D ST	5.371	5.371	0
BH	74075	RED ROCK	1.800	1.800	0
BA	76315	TEKLA T1	29.952	29.952	0
BA	76316	TEKLA T2	8.183	8.183	0
BA	76398	STURGBEC	6.798	6.798	0
BA	76400	PUMPKIN BTS	22.807	22.807	0
BA	76401	BARBERCK	16.089	16.089	0
SS	76404	DRYFORK	37.200	37.200	0
BA	76412	B.DURFEE	14.233	14.233	0
BH	76500	BELLEBEC	0.000	0.000	0
BH	76502	SPFSPRK	4.427	4.427	0
Total SCADA Load				718.840	

Table 9 - Scenario BHP – Non SCADA Load

Loads Available in PSS/E Model Only					
ID	Bus Number	Substation		PSS/E Case MW Load	PSS/E Case MVAR Load
BA	73249	EDGEMONT	69.000	0.3	0.1
BH	73264	POPE&TAL	69.000	4.278	1.89
BH	73267	RICHMHIL	69.000	1.141	0.504
BH	73279	WTRPLANT	69.000	0.342	0.166
BH	73280	WHEWOOD	69.000	6.807	-2.51
BH	73524	AMCOLOID	69.000	1.696	-0.043
BH	73526	COLONY	69.000	6.554	-0.165
BH	73527	BUTTEPMP	69.000	1.225	-0.031
BH	73528	MTNVIEW	69.000	10.033	-0.851
BH	74002	88 OIL	69.000	2.874	-0.279
BH	74007	OSAG CTY	69.000	1.971	-0.174
BH	74008	BENTON	69.000	1.366	0
BH	74009	UPTON C	69.000	1.015	-0.09
SS	74014	NSS CT1	13.800	0.7	0.3
SS	74015	NSS CT2	13.800	0.7	0.3
SS	74029	LNG CT1	13.800	1.4	0.7
BH	74051	BELLECRK	24.900	0.435	-0.201
Non SCADA Loads (MW)				42.837	

Total 230 kV BHP Load = SCADA Calibrated loads + Non SCADA Loads = 718.840 MW + 42.837 MW = 761.677 MW

Table 10 – BHP 230 kV Transmission Losses

Branch Data					Branch Flow			Owner
From Bus Number	From Bus Name	To Bus Number	To Bus Name	Id	From	To	Delta	
65293	CARR DRA 230.00	76401	BARBERCK 230.00	1	23.691	-23.681	0.010	WY
65293	CARR DRA 230.00	76402	DRYFORK 230.00	1	-92.779	93.050	0.271	WY
65420	DAVEJOHN 230.00	67814	WINDSTAR 230.00	2	-257.051	257.193	0.142	WY
66725	WYODAK 230.00	73148	OSAGE 230.00	1	204.665	-201.015	3.650	WY
66725	WYODAK 230.00	73294	HUGHES 230.00	1	59.612	-59.554	0.058	WY

Branch Data					Branch Flow			Owner
From Bus Number	From Bus Name	To Bus Number	To Bus Name	Id	From	To	Delta	
66725	WYODAK 230.00	74030	DONKYCRK 230.00	1	-74.073	74.080	0.007	WY
66725	WYODAK 230.00	74030	DONKYCRK 230.00	2	-51.730	51.730	0.000	WY
67814	WINDSTAR 230.00	76400	PUMPKIN_BTS 230.00	1	-26.037	26.122	0.085	WY
73087	WESTHILL 230.00	74027	RCSOUTH1 230.00	1	19.766	-19.731	0.035	SD
73087	WESTHILL 230.00	74035	MINNKHAT 230.00	1	-82.294	82.398	0.104	SD
73087	WESTHILL 230.00	74630	FALLRVR_TAP 230.00	1	46.336	-46.250	0.086	SD
73148	OSAGE 230.00	73164	LANGE 230.00	1	115.368	-114.234	1.134	SD+WY
73148	OSAGE 230.00	73276	TEKLA 230.00	1	-106.041	107.373	1.332	WY
73148	OSAGE 230.00	73283	YELLOWCRK 230.00	1	60.693	-60.446	0.247	SD+WY
73148	OSAGE 230.00	74058	SGBRUSH 230.00	1	121.940	-121.709	0.231	WY
73164	LANGE 230.00	73186	LOOKOUT1 230.00	1	-78.481	79.021	0.540	SD
73164	LANGE 230.00	74068	WESTRC 230.00	1	110.882	-110.822	0.060	SD
73168	RENO 230.00	73276	TEKLA 230.00	1	34.398	-34.348	0.050	WY
73168	RENO 230.00	74030	DONKYCRK 230.00	1	-76.440	76.767	0.327	WY
73186	LOOKOUT1 230.00	73283	YELLOWCRK 230.00	1	-4.518	4.518	0.000	SD
73186	LOOKOUT1 230.00	76412	SUNDANCE 230.00	1	-171.968	173.633	1.665	SD+WY
73276	TEKLA 230.00	76400	PUMPKIN_BTS 230.00	1	-35.499	35.578	0.079	WY
73294	HUGHES 230.00	76402	DRYFORK 230.00	1	-136.447	136.888	0.441	WY
73294	HUGHES 230.00	76412	SUNDANCE 230.00	1	190.071	-187.866	2.205	WY
74027	RCSOUTH1 230.00	74068	WESTRC 230.00	1	-54.656	54.686	0.030	SD
74027	RCSOUTH1 230.00	76351	RCDC W 230.00	1	19.687	-19.673	0.014	SD
74030	DONKYCRK 230.00	76400	PUMPKIN_BTS 230.00	1	33.843	-33.756	0.087	WY
74035	MINNKHAT 230.00	74058	SGBRUSH 230.00	1	-100.485	101.236	0.751	SD+WY
74206	BLUFFS 230.00	74630	FALLRVR_TAP 230.00	1	-114.941	117.305	2.364	SD
74630	FALLRVR_TAP 230.00	74631	FALLRVR_HS 230.00	1	-71.054	71.055	0.001	SD

Branch Data					Branch Flow			Owner
From Bus Number	From Bus Name	To Bus Number	To Bus Name	Id	From	To	Delta	
76312	TONGRIVR 230.00	76402	DRYFORK 230.00	1	-53.926	54.289	0.363	WY
76312	TONGRIVR 230.00	66335	SHERIDAN 230.00	1	43.326	-43.287	0.039	WY
76400	PUMPKIN_BTS 230.00	76401	BARBERCK 230.00	1	-29.150	29.192	0.042	WY
BHP 230 kV Transmission Losses (MW)							<b>16.450</b>	

## Appendix B – CLFP 115 kV Details

Table 11 - Scenario 1 - Generation Calibration

Bus number	Machine ID	Bus Name	SCADA MW	Case MW	Delta MW
74042	1	HAPPY JACK - HJ	2.9240	2.9240	0.0000
74043	1	HAPPY JACK - SS	7.7530	7.7530	0.0000
74061	G1	CPGS1 G1	37.5000	37.5000	0.0000
74061	G2	CPGS1 G2	36.9000	36.9000	0.0000
74061	S1	CPGS1 S1	22.0710	22.0710	0.0000
74062	G1	CPGS 2 G1	0.0000	0.0000	0.0000
74203	W1	CORRIEDALE	21.2310	21.2310	0.0000
74712	W1	ROUNDHOUSE 2 WIND	26.0000	26.0000	0.0000
74773	W2	ROUNDHOUSE 2 WIND	4.2360	4.2300	0.0060
74716	PV	SOUTH CHEYENNE SOLAR	134.264	134.2640	0.0000

Table 12 - Scenario 1 - Load Calibration

Number	ID	NAME	SCADA		PSS/E Case		Delta	
			MW	MVAR	MW	MVAR	MW	MVAR
73043	BH	HILLTOP	49.966	4.828	Load connected to non-CLFP buses, represented using the boundary generators.			
73077	BH	HAPPY JACK	7.085	-3.766	7.085	-3.766	0.0000	0.0000
73183	BH	Skyline	43.227	6.628	43.227	6.628	0.0000	0.0000
73348	BH	Corlett	18.456	6.05	18.456	6.050	0.0000	0.0000
73375	WA	Warren	5.9	1.7	Load connected to non-CLFP buses, represented using the boundary generators.			
73480	BH	Crow Creek	38.179	8.8	Load connected to non-CLFP buses, represented using the boundary generators.			
74039	BH	NORTH RANGE	41.063	1.761	41.063	1.761	0.0000	0.0000
74041	BH	EAST BUSINESS PARK	29.41	2.212	29.410	2.212	0.0000	0.0000
74054	BH	MICROSOFT	38.502	-1.951	38.502	-1.951	0.0000	0.0000
74056	BH	KING RANCH	42.829	-2.599	42.829	-2.599	0.0000	0.0000
74059	BH	ORCHARD VALLEY	0	0	0.000	0.000	0.0000	0.0000
74080	BH	CAMPSTOOL	26.409	0.394	26.409	0.394	0.0000	0.0000
74221	BH	BISON	16.35	-3.414	16.350	-3.414	0.0000	0.0000
74170	BH	WALLICK	0	0	0.000	0.000	0.0000	0.0000
74222	BH	ALLISON DRAW	0	0	0.000	0.000	0.0000	0.0000
74061	SS	CPGSTN 1			5.800	2.500		
74062	SS	CPGSTN 2			0.500	0.200		

Table 13 - Scenario 2 - Generation Calibration

Bus number	Machine ID	Bus Name	SCADA MW	Case MW	Delta MW
74042	1	HAPPY JACK - HJ	2.9240	2.9240	0.0000
74043	1	HAPPY JACK - SS	7.7530	7.7530	0.0000
74061	G1	CPGS1 G1	37.5000	37.5000	0.0000
74061	G2	CPGS1 G2	36.9000	36.9000	0.0000
74061	S1	CPGS1 S1	22.0710	22.0710	0.0000
74062	G1	CPGS 2 G1	0.0000	0.0000	0.0000
74203	W1	CORRIEDALE	21.2310	21.2310	0.0000
74712	W1	ROUNDHOUSE 2 WIND	26.0000	26.0000	0.0000
74773	W2	ROUNDHOUSE 2 WIND	4.2360	4.2300	-0.0060
74716	PV	SOUTH CHEYENNE SOLAR	134.264	134.2640	0.0000

Table 14 - Scenario 2 - Load Calibration

Number	ID	NAME	SCADA		PSS/E Case		Delta	
			MW	MVAR	MW	MVAR	MW	MVAR
73043	BH	HILLTOP	49.966	4.828	Load connected to non-CLFP buses, represented using the boundary generators.			
73077	BH	HAPPY JACK	7.085	-3.766	7.085	-3.766	0.0000	0.0000
73183	BH	Skyline	43.227	6.628	43.227	6.628	0.0000	0.0000
73348	BH	Corlett	18.456	6.05	18.456	6.050	0.0000	0.0000
73375	WA	Warren	5.9	1.7	Load connected to non-CLFP buses, represented using the boundary generators.			
73480	BH	Crow Creek	38.179	8.8	Load connected to non-CLFP buses, represented using the boundary generators.			
74039	BH	NORTH RANGE	41.063	1.761	41.063	1.761	0.0000	0.0000
74041	BH	EAST BUSINESS PARK	29.41	2.212	29.410	2.212	0.0000	0.0000
74054	BH	MICROSOFT	38.502	-1.951	38.502	-1.951	0.0000	0.0000
74056	BH	KING RANCH	42.829	-2.599	42.829	-2.599	0.0000	0.0000
74059	BH	ORCHARD VALLEY	0	0	0.000	0.000	0.0000	0.0000
74080	BH	CAMPSTOOL	26.409	0.394	26.409	0.394	0.0000	0.0000
74221	BH	BISON	16.35	-3.414	16.350	-3.414	0.0000	0.0000
74170	BH	WALLICK	0	0	0.000	0.000	0.0000	0.0000
74222	BH	ALLISON DRAW	0	0	0.000	0.000	0.0000	0.0000
74061	SS	CPGSTN 1			5.800	2.500		
74062	SS	CPGSTN 2			0.500	0.200		

Table 15 - Scenario 1 – CLFP Branch Losses

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
ARCHER	CPGSTN	115	115	-13	-1.897	0.004	0.042
HAPPYJCK	NORTHRNG	115	115	5.926	-0.766	0	0.001
HAPPYJCK	HJWIND	115	115	-10.655	-3.315	0.005	0.025
SKYLINE	WARRENLM	115	115	-0.794	-7.564	0.005	0.022
SKYLINE	EB PARK	115	115	-42.433	0.936	0.135	0.851
CORLETT	CHEY S	115	115	-17.88	5.727	0.029	0.177
CORLETT	WEST CHEY	115	115	-0.576	-11.777	0.004	0.023
WARRENLM	SKYLINE	115	115	0.799	6.948	0.005	0.022
TERRY RANCH	CHEY S	230	115	-0.254	-2.943	0	0.007
TERRY RANCH	CHEY S	230	115	-0.25	-2.902	0	0.007
CHEY S	CORLETT	115	115	17.909	-6.263	0.029	0.177
CHEY S	TERRY RANCH	115	230	0.254	2.95	0	0.007
CHEY S	TERRY RANCH	115	230	0.25	2.909	0	0.007
CHEY S	WEST CHEY	115	115	25.114	-17.213	0.073	0.3
CHEY S	SWEETGRAS S	115	115	-43.528	17.617	0.021	0.206
WEST CHEY	CORLETT	115	115	0.579	11.555	0.004	0.023
WEST CHEY	CHEY S	115	115	-25.04	16.549	0.073	0.3
WEST CHEY	NORTHRNG	115	115	82.839	24.183	0.137	1.348
WEST CHEY	WALLICK	115	115	-9.064	7.69	0.009	0.084
WEST CHEY	CORWNDHI	115	115	-20.989	-10.23	0.003	0.017
WEST CHEY	RNDHS HI	115	115	-28.325	-49.748	0.047	0.449
NORTHRNG	HAPPYJCK	115	115	-5.926	0.743	0	0.001
NORTHRNG	WEST CHEY	115	115	-82.703	-23.08	0.137	1.348
NORTHRNG	MCRSFT	115	115	19.252	-0.986	0.001	0.004
NORTHRNG	MCRSFT	115	115	19.252	-0.986	0.001	0.004
NORTHRNG	KINGRNCH	115	115	1.245	-0.982	0	0
NORTHRNG	KINGRNCH	115	115	1.245	-0.982	0	0
EB PARK	SKYLINE	115	115	42.568	-0.706	0.135	0.851
EB PARK	CPGSTN	115	115	-44.554	0.344	0.051	0.301
EB PARK	CAMPSTOOL	115	115	-13.712	-0.925	0.003	0.015
EB PARK	CAMPSTOOL	115	115	-13.712	-0.925	0.003	0.015
HJWIND	HAPPYJCK	115	115	10.661	3.075	0.005	0.025
MCRSFT	NORTHRNG	115	115	-19.251	0.976	0.001	0.004
MCRSFT	NORTHRNG	115	115	-19.251	0.976	0.001	0.004

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
KINGRNCH	NORTHRNG	115	115	-1.245	0.907	0	0
KINGRNCH	NORTHRNG	115	115	-1.245	0.907	0	0
KINGRNCH	ORCHARDVAL	115	115	-40.338	0.785	0.073	0.719
ORCHARDVAL	KINGRNCH	115	115	40.411	-0.655	0.073	0.719
ORCHARDVAL	WALLICK	115	115	-40.411	0.655	0.01	0.102
CPGSTN	ARCHER	115	115	13.004	1.612	0.004	0.042
CPGSTN	EB PARK	115	115	44.605	-0.25	0.051	0.301
CPGSTN	CAMPSTOOL	115	115	43.311	1.973	0.025	0.248
CPGSTN	SWEETGRASS	115	115	-10.797	0.142	0.005	0.053
CPGSTN	SWEETGRASS	115	115	-10.797	0.142	0.005	0.053
CPGSTN	ALLISONDRW	115	115	10.563	-0.644	0.004	0.024
CAMPSTOOL	EB PARK	115	115	13.715	0.817	0.003	0.015
CAMPSTOOL	EB PARK	115	115	13.715	0.817	0.003	0.015
CAMPSTOOL	CPGSTN	115	115	-43.286	-1.901	0.025	0.248
CAMPSTOOL	ALLISONDRW	115	115	-10.552	-0.128	0.006	0.036
WALLICK	WEST CHEY	115	115	9.073	-8.381	0.009	0.084
WALLICK	ORCHARDVAL	115	115	40.422	-0.637	0.01	0.102
WALLICK	BISON_BH	115	115	-24.747	4.509	0.013	0.126
WALLICK	BISON_BH	115	115	-24.747	4.509	0.013	0.126
CORWNDHI	WEST CHEY	115	115	20.992	10.17	0.003	0.017
SWEETGRASS	CHEY S	115	115	43.549	-17.535	0.021	0.206
SWEETGRASS	CPGSTN	115	115	10.802	-0.698	0.005	0.053
SWEETGRASS	CPGSTN	115	115	10.802	-0.698	0.005	0.053
SWEETGRASS	BISON_BH	115	115	32.946	-6.389	0.011	0.105
SWEETGRASS	BISON_BH	115	115	32.946	-6.389	0.011	0.105
SWEETGRASS	SOCHEY_HI	115	115	-131.045	31.71	0.88	4.131
BISON_BH	WALLICK	115	115	24.76	-4.65	0.013	0.126
BISON_BH	WALLICK	115	115	24.76	-4.65	0.013	0.126
BISON_BH	SWEETGRASS	115	115	-32.935	6.357	0.011	0.105
BISON_BH	SWEETGRASS	115	115	-32.935	6.357	0.011	0.105
ALLISONDRW	CPGSTN	115	115	-10.559	0.341	0.004	0.024
ALLISONDRW	CAMPSTOOL	115	115	10.559	-0.341	0.006	0.036
RNDHS_HI	WEST CHEY	115	115	28.372	50.099	0.047	0.449

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
SOCHEY_HI	SWEETGRASS	115	115	131.925	-27.941	0.88	4.131
<b>Total Losses (MW)</b>						<b>1.587</b>	

Table 16 - Scenario 2 – CLFP Branch Losses

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
WINDSTAR	WEST CHEY	230	230	100	-24.755	2.155	21.449
ARCHER	CPGSTN	115	115	-13	-2.272	0.004	0.043
HAPPYJCK	NORTHRNG	115	115	5.926	-0.766	0	0.001
HAPPYJCK	HJWIND	115	115	-10.655	-3.315	0.005	0.025
SKYLINE	WARRENLM	115	115	-0.794	-7.468	0.005	0.022
SKYLINE	EB PARK	115	115	-42.433	0.84	0.135	0.851
CORLETT	CHEY S	115	115	3.169	4.505	0.003	0.017
CORLETT	WEST CHEY	115	115	-21.625	-10.555	0.016	0.099
WARRENLM	SKYLINE	115	115	0.799	6.852	0.005	0.022
TERRY RANCH	CHEY S	230	115	-67.004	1.142	0.056	3.503
TERRY RANCH	CHEY S	230	115	-66.073	1.111	0.054	3.454
CHEY S	CORLETT	115	115	-3.166	-5.2	0.003	0.017
CHEY S	TERRY RANCH	115	230	67.06	2.361	0.056	3.503
CHEY S	TERRY RANCH	115	230	66.127	2.343	0.054	3.454
CHEY S	WEST CHEY	115	115	-16.721	-11.754	0.033	0.134
CHEY S	SWEETGRASS	115	115	-113.299	12.25	0.123	1.216
WEST CHEY	CORLETT	115	115	21.641	10.409	0.016	0.099
WEST CHEY	CHEY S	115	115	16.754	10.925	0.033	0.134
WEST CHEY	NORTHRNG	115	115	90.183	26.602	0.162	1.599
WEST CHEY	WALICK	115	115	0.065	7.249	0.003	0.033
WEST CHEY	CORWNDHI	115	115	-20.991	-10.096	0.003	0.017
WEST CHEY	WEST CHEY	115	230	-39.627	1.707	0.019	1.212
WEST CHEY	WEST CHEY	115	230	-39.627	1.707	0.019	1.212
WEST CHEY	RNDHS_HI	115	115	-28.397	-48.503	0.045	0.433
NORTHRNG	HAPPYJCK	115	115	-5.926	0.743	0	0.001
NORTHRNG	WEST CHEY	115	115	-90.021	-25.248	0.162	1.599
NORTHRNG	MCRSFT	115	115	19.252	-0.986	0.001	0.004
NORTHRNG	MCRSFT	115	115	19.252	-0.986	0.001	0.004

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
NORTHRNG	KINGRNCH	115	115	4.904	-1.672	0	0.002
NORTHRNG	KINGRNCH	115	115	4.904	-1.672	0	0.002
EB PARK	SKYLINE	115	115	42.568	-0.61	0.135	0.851
EB PARK	CPGSTN	115	115	-44.555	0.298	0.051	0.301
EB PARK	CAMPSTOOL	115	115	-13.712	-0.95	0.003	0.015
EB PARK	CAMPSTOOL	115	115	-13.712	-0.95	0.003	0.015
HJWIND	HAPPYJCK	115	115	10.661	3.075	0.005	0.025
MCRSFT	NORTHRNG	115	115	-19.251	0.976	0.001	0.004
MCRSFT	NORTHRNG	115	115	-19.251	0.976	0.001	0.004
KINGRNCH	NORTHRNG	115	115	-4.904	1.599	0	0.002
KINGRNCH	NORTHRNG	115	115	-4.904	1.599	0	0.002
KINGRNCH	ORCHARDVAL	115	115	-33.021	-0.599	0.049	0.481
ORCHARDVAL	KINGRNCH	115	115	33.069	0.491	0.049	0.481
ORCHARDVAL	WALLICK	115	115	-33.069	-0.491	0.007	0.069
CPGSTN	ARCHER	115	115	13.004	1.987	0.004	0.043
CPGSTN	EB PARK	115	115	44.606	-0.203	0.051	0.301
CPGSTN	CAMPSTOOL	115	115	43.31	2.012	0.025	0.248
CPGSTN	SWEETGRASS	115	115	-10.796	-0.133	0.005	0.053
CPGSTN	SWEETGRASS	115	115	-10.796	-0.133	0.005	0.053
CPGSTN	ALLISONDRW	115	115	10.563	-0.635	0.004	0.024
CAMPSTOOL	EB PARK	115	115	13.714	0.842	0.003	0.015
CAMPSTOOL	EB PARK	115	115	13.714	0.842	0.003	0.015
CAMPSTOOL	CPGSTN	115	115	-43.285	-1.94	0.025	0.248
CAMPSTOOL	ALLISONDRW	115	115	-10.553	-0.137	0.006	0.036
WALLICK	WEST CHEY	115	115	-0.061	-7.991	0.003	0.033
WALLICK	ORCHARDVAL	115	115	33.076	0.475	0.007	0.069
WALLICK	BISON BH	115	115	-16.508	3.758	0.006	0.057
WALLICK	BISON BH	115	115	-16.508	3.758	0.006	0.057
CORWNDHI	WEST CHEY	115	115	20.994	10.036	0.003	0.017
SWEETGRASS	WEST CHEY	230	230	-18.544	-4.934	0.007	0.073
SWEETGRASS	BLUFFS	230	230	-34.844	-4.54	0.156	1.546
SWEETGRASS	SWEETGRASS	230	115	26.694	4.737	0.009	0.568
SWEETGRASS	SWEETGRASS	230	115	26.694	4.737	0.009	0.568
WEST CHEY	WINDSTAR	230	230	-97.845	0.489	2.155	21.449
WEST CHEY	WEST CHEY	230	115	39.647	-0.496	0.019	1.212
WEST CHEY	WEST CHEY	230	115	39.647	-0.496	0.019	1.212
WEST CHEY	SWEETGRASS	230	230	18.552	0.502	0.007	0.073
BLUFFS	SWEETGRASS	230	230	35	-19.836	0.156	1.546

From Bus Name (PSS/E)	To Bus Name (PSS/E)	From Bus kV	To Bus kV	MW Flow (PSS/E)	Mvar Flow (PSS/E)	MW Losses (PSS/E)	Mvar Losses (PSS/E)
SWEETGRASS	CHEY S	115	115	113.422	-11.159	0.123	1.216
SWEETGRASS	CPGSTN	115	115	10.802	-0.424	0.005	0.053
SWEETGRASS	CPGSTN	115	115	10.802	-0.424	0.005	0.053
SWEETGRASS	SWEETGRASS	115	230	-26.685	-4.169	0.009	0.568
SWEETGRASS	SWEETGRASS	115	230	-26.685	-4.169	0.009	0.568
SWEETGRASS	BISON_BH	115	115	24.695	-5.752	0.006	0.06
SWEETGRASS	BISON_BH	115	115	24.695	-5.752	0.006	0.06
SWEETGRASS	SOCHEY_HI	115	115	-131.045	31.85	0.88	4.131
BISON_BH	WALLICK	115	115	16.513	-3.968	0.006	0.057
BISON_BH	WALLICK	115	115	16.513	-3.968	0.006	0.057
BISON_BH	SWEETGRASS	115	115	-24.688	5.675	0.006	0.06
BISON_BH	SWEETGRASS	115	115	-24.688	5.675	0.006	0.06
ALLISONDRW	CPGSTN	115	115	-10.559	0.332	0.004	0.024
ALLISONDRW	CAMPSTOOL	115	115	10.559	-0.332	0.006	0.036
RNDHS_HI	WEST CHEY	115	115	28.443	48.838	0.045	0.433
SOCHEY_HI	SWEETGRASS	115	115	131.925	-28.082	0.88	4.131
<b>Total Losses (MW)</b>						<b>4.085</b>	